Appendix L Noise and Vibration Assessment

AGL Newcastle Power Station

Noise and Vibration Assessment

30 October 2019

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The business of sustainability

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30 October 2019

AGL Newcastle Power Station

Noise and Vibration Assessment

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Acronyms and Abbreviations

Name	Description
AWS	Automatic Weather Station
BOM	Bureau of Meteorology
dB(A)	dB(A) denotes a single number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).
EPA	Environment Protection Authority
ICNG	Interim Construction Noise Guideline
L_{10}	The noise level exceeded for 10 per cent of the time and is approximately the average of the maximum noise levels.
L_{90}	The noise level exceeded for 90 per cent of the time and is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the “background” noise level and is commonly used as a basis for determining noise criteria for assessment purposes.
L_{eq}	The ‘equivalent continuous sound level’, L_{eq}, is used to describe the level of a time-varying sound or vibration measurement. L_{eq} is often used as the “average” level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB L_{Aeq}. Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.
L_{max}	The absolute maximum noise level in a noise sample.
NML	Noise Management Level
NPI	Noise Policy for Industry
NSW	New South Wales
OOHW	Out-of-Hours Work
PPV	Peak Particle Velocity
RBL	The RBL is the overall single figure background level representing each assessment period (day, evening and night) over the whole monitoring period (as opposed to over each 24 hour period used for the ABL). This is the level used for assessment purposes. It is the median value of: ■ All the day assessment background levels over the monitoring period for the day; ■ All the evening assessment background levels over the monitoring period for the evening; or ■ All the night assessment background levels over the monitoring period for the night.
RMS	Roads and Maritime Services
RNP	Road Noise Policy
SPL	Sound Pressure Level
SWL	Sound Power Level
TfNSW	Transport for NSW
VC	Generic Vibration Criterion
VDV	Vibration Dose Values
VML	Vibration Management Level

EXECUTIVE SUMMARY

Assessment Overview

Environmental Resources Management Australia Pacific Pty Ltd (ERM) has been engaged by Aurecon Australia Pty Ltd (Aurecon) on behalf of AGL Energy Ltd (AGL) to undertake a construction and operational noise and vibration assessment for the Environmental Impact Statement (EIS) of the proposed AGL Newcastle Power Station project (the Project) in Tomago, New South Wales(NSW).

This report has been prepared to document the methodology, findings and recommendations of the noise and vibration assessment conducted for the EIS of the Project. This assessment has been conducted with due regard to and in accordance with the NSW policy and guidelines relevant to noise. The key documents which have been applied to this assessment include:

- NSW Department of Environment and Climate Change – *NSW Interim Construction Noise Guideline* (ICNG), July 2009.
- NSW Environment Protection Authority – *NSW Noise Policy for Industry* (NPI), October 2017 and relevant application notes.
- NSW Department of Environment, Climate Change and Water – *NSW Road Noise Policy* (RNP), March 2011.
- NSW Department of Conservation – *Assessing Vibration: A Technical Guideline*.
- German Standard – *DIN 4150-3 Structural Vibration – effects of vibration on structures.*

This assessment considered the following acoustical factors:

- air-borne construction noise.
- road traffic noise during construction and operations.
- ground-borne construction vibration.
- air-borne operational noise.

Road traffic generated by the operation of the Project is only expected to be due to maintenance activities, and as such there would be minimal increase to the existing road traffic. Hence, road traffic noise impact due to operational noise is not assessed in this study.

Due to the intervening distances (greater than 500m to nearest residence) between the Project and the nearest residences, ground-borne noise impacts are deemed to be negligible and are therefore not assessed in this assessment. Blasting activities are not likely to be required for the Project and are therefore also not addressed in this assessment. This report is technical in nature, a glossary of relevant acoustical concepts and terminology is provided in Appendix A of this report.

Summary of Results

Thirteen sensitive receivers, i.e. eight residential and five non-residential receivers, were identified to be representative of the nearest and/or potentially most affected locations situated within the potential area of influence of the Project. These receivers do not represent all receivers located in the vicinity of the Project but have been selected for the purposes of this assessment. They are considered to be representative of receivers that are anticipated to experience the highest noise-related impacts associated with the Project.

Potential impacts associated with construction and operational road traffic noise were quantitatively assessed using the RMS Construction Road Traffic Noise Estimator and no adverse impacts are anticipated.

Quantitative construction noise and vibration impact assessment was conducted by predicting noise levels via modelling and by estimating vibration levels. The predictions were conducted for applicable assessment scenarios (refer to Section 6). Resultant noise levels were then compared to project-specific management levels at each receiver and no exceedances were identified. Intervening distances between the Project and nearest sensitive receptors were used to determine safe working distances at which project-specific management levels will not be exceeded.

Based on the predicted operational noise levels, the maximum sound power levels of the Project's noise sources have been determined in Table 9-2. The recommended maximum sound power levels presented in Table 9-2 should be adhered to by the Project through engineering noise control techniques, which will ensure compliance with the criteria at all receivers.

The predicted operational noise levels when compared with existing and proposed industrial noise indicate that receivers are primarily influenced by existing industrial noise and proposed activates. At Receivers R1, R4and R6 contribution from the Project is not expected to result in a change in industrial noise levels. At receiver R3 the Project may result in a 1dB increase to existing levels of industrial noise, however existing industrial noise sources are the primary influence to noise levels at this location.

Noise impacts from construction and operation of Project are not predicted to impact the Hunter Estuary Wetlands approximately 2.4km south and 4.4km east of the project. Construction noise levels are anticipated to be within similar ranges to existing industrial noise levels, and operational noise emissions are not expected to increase existing industrial noise levels with the Project.

Cumulative noise impact of the Project and the Roads and Maritime Services' (RMS) M1 to Raymond Terrace Motorway Project on surrounding receivers has not been assessed in this report due to insufficient information from the RMS project. However, due the small volume of vehicles movements generated by the operation of the Project as compared to the RMS motorway project, the Project would have negligible contribution to the cumulative road traffic noise impacts.

Based on the findings in this assessment, recommendations for construction and operational noise reducing mitigation, management measures, safeguards and/or provisions for monitoring have been made. The recommended safeguards are provided to assist with the management of any design changes or equipment specifications that occur subsequent to this study.

1. INTRODUCTION

AGL proposes to develop a power station in Tomago, NSW. The proposed power station and associated ancillary infrastructure will be built on a site which is located between Old Punt Road and the Pacific Highway. Environmental Resources Management Australia Pty Limited (ERM) has been commissioned by Aurecon on behalf of AGL to undertake a noise and vibration assessment for the construction and operation of the proposed power station.

1.1 Objectives

The objectives of this report are to provide an assessment of potential noise and vibration impacts associated with the construction and operations of the propsed power station (the Project), and to recommend feasible and reasonable noise reducing mitigation, management measures, safeguards and provisions for monitoring. These recommendations are designed to ensure that the construction and operations of the Project are carried out within the noise and vibration limits established in this report.

Noise and vibration assessments were undertaken based on the design information, site and layout plans and equipment lists and maunfacturers' specifications provided by AGL and Aurecon.

This noise and vibration study (study) has been conducted with consideration for the following key scenarios:

- Noise and vibration from the construction of the Project.
- Noise from the operation – Gas Turbine Option.
- Noise from the operation – Reciprocating Engine Option.

1.2 Scope of Works

The scope of the assessment incorporated the following tasks which are detailed in this report:

- Noise survey of the existing ambient noise environment and identification of critical receptor locations in the vicinity of the power station. Section 3.
- Establishment of project specific noise goals at the receptor locations for compliance with relevant noise guidelines. Section 5.
- Determining the extent of construction noise and vibration impacts (if any) associated with the construction of the proposed power station. Sections 6, 7 and 8.
- Determining the extent of operational noise impacts (if any) associated with the operation of the proposed power station. Section 9.
- Recommendation of mitigation measures to be implemented on site to ensure compliance with the noise goals. Section 10.

2. PROJECT DESCRIPTION

2.1 Overview

The Newcastle Power Station would be a dual fuel (gas and diesel) fast-start peaking power station with a nominal operating capacity of 250MW at Tomago in NSW. The Newcastle Power Station would supply electricity to the grid at short notice during periods of high electricity demand, and/or low supply, particularly during periods where intermittent renewable energy supply is low or during supply outages. This operation is aligned with AGL's move to a renewable energy mix. While the primary role of the Newcastle Power Station would be to provide firming or peaking capacity to the National Electricity Market, to maximise operational flexibility each unit of the power station would be designed for continuous operation. This impact assessment considers both the peaking load operation and the continuous operation.

The Project would also involve the construction and operation of a gas pipeline(s) and an electricity transmission line. The pipeline(s) would supply the proposed power station with gas from the eastern Australia gas transmission pipelines via the Jemena network and the Newcastle Gas Storage Facility (NGSF). A new electricity transmission line would transfer the electricity produced by the proposed power station to the national electricity network via connection to the existing 132kV Tomago switchyard.

The Project has a capital investment value of approximately $400 million and is anticipated to be operational in the year 2022.

The main elements of the Project are as follows:

- Power station comprising of either large reciprocating engine generators or aero-derivate gas turbine generators, necessary supporting ancillary equipment and supporting infrastructure. The power station would be capable of operating with diesel fuel, if necessary.
- 132kV electricity transmission line to the existing Tomago switching yard, operated by TransGrid.
- Gas transmission/storage pipeline(s) and receiving station, compressor units, and ancillary infrastructure.
- Storage tanks and laydown areas.
- Water management infrastructure including pond(s), a connection to Hunter Water potable service in line with Hunter Water requirements.
- Diesel storage and truck unloading facilities.
- Site access road.
- Office / administration, amenities, workshop / storage areas and car parking.

2.2 Power station

The power station would be a dual fuel power plant, capable of generating about 250MW of electricity. The proposed power station would either consist of large reciprocating engine generators or aero-derivate gas turbine generators. Generation units would be dual fuel capable, meaning they would be able to be supplied by natural gas and/or liquid fuel.

The decision to install gas turbines or reciprocating technology will be made based on a range of environmental, social, engineering and economic factors that would be considered as part of the power station design progresses.

2.2.1 Gas Turbine Technology

Electricity would be generated by gas turbine technology through the combustion of natural gas and/or liquid fuel in turbines. With its heritage in the airline industry, aero derivative gas turbine units consist of a compressor, combustion chamber, turbine and generator. Air is compressed to a high pressure before being admitted into the combustion chamber. Fuel (natural gas or diesel as required) is injected into the combustion chamber where combustion occurs at very high temperatures and the gases expand. The resulting mixture of hot gas is admitted into the turbine causing the turbine to turn, generating power. In an open cycle configuration, hot exhaust gas is vented directly to the atmosphere through an exhaust stack, without heat recovery.

2.2.2 Reciprocating Engine Technology

With its heritage in the shipping industry and a form of internal combustion engine, reciprocating engines used for power generation harness the controlled ignition of gas and/or diesel to drive a piston within a cylinder. A number of pistons move sequentially to rotate a crank shaft which turns the generator.

2.2.3 Ancillary Facilities

The power station, regardless of chosen technology, would require supporting ancillary facilities. These would include:

- Natural gas reception yard potentially including gas metering, pressure regulation, compression (dependent on technology chosen), heating stations, pigging facilities (dependent upon options chosen) and provision for flaring.
- Generator circuit breakers, generator step-up transformers and switchyard including overhead line support gantry.
- Water collection and treatment facilities.
- Water storage tanks and ponds.
- Truck loading/unloading facilities.
- Liquid fuel storage tanks.
- Emergency diesel generators with associated fuel storage.
- Closed circuit cooling systems.
- Control room.
- Offices and messing facilities.
- Electrical switch rooms.
- Occupational health and safety systems including an emergency warning and evacuation system.
- Workshop and warehouse.
- Firefighting system.
- Communication systems.
- Security fence, security lighting, stack aviation warning lights (if required) and surveillance system.
- Landscaped areas and staff parking areas.
- Concrete foundations, bitumen roadways, concrete pads in liquid fuel unloading station and gas turbine or engine unit maintenance areas.
- Concrete bund areas with drains for liquid fuel tanks, liquid chemicals store, oil filled transformers (if installed) and other facilities where contaminated liquids could leak.
- Level construction and laydown area.
- Engineered batters to support and protect the power plant platform.
- Sedimentation pond and associated diversion drain and earth bund.

2.3 Gas Pipeline

Natural gas fuel will originate from the existing Australian gas network and the many facilities that feed it. The nearest supply point in the gas network is the AGL owned Tomago to Hexham high pressure gas pipeline which terminates at the AGL owned and operated NGSF. The NGSF is located about two kilometres north east of the proposed power station site.

A new gas pipeline connection to the Tomago to Hexham high pressure gas pipeline (HPP) would supply the power station. This connection would be made just east of Old Punt Road, opposite the south-eastern corner of the proposed power station site.

To augment the proposed gas supply, AGL is considering a new gas pipeline to connect the power station to the gas supply available from the NGSF. The pipeline route would leave the NGSF in the existing HPP easement towards the Pacific Highway before heading southwest to the power station site. AGL would enter negotiations for a pipeline easement in accordance with the *Pipelines Act 1967*. The pipeline would be approximately 4.6km long.

Gas compression, conditioning, heating and other facilities necessary to transport and store gas are also likely to be required and would be constructed at the proposed power station site.

2.4 Electricity Transmission Line

A high voltage 132kV electricity transmission line would be required to connect the proposed power station to the TransGrid Tomago 132kV switchyard, approximately 500 m south east. The switching station would transfer the electricity produced at the power station to the regional electricity transmission system. The transmission line will be located alongside the existing transmission line running northwest from the switchyard before heading west to the power station.

2.5 Vehicular Access

The area around Tomago is serviced by a road network well suited to heavy haulage vehicles due to the existing surrounding industrial land uses. Old Punt Road is a sealed single lane, two-way council controlled road. Old Punt Road connects to the Pacific Highway approximately one kilometre to the north of the proposed power station site access point.

During construction heavy vehicle deliveries including oversized or heavy items would be delivered via the Pacific Highway and Old Punt Road.

During operation, vehicular access to the Project area would be provided via the newly constructed access road off Old Punt Road. This access would be used by operational staff and for heavy vehicle access. Parking for staff would be provided on site. If operated in peaking mode, heavy vehicles would only be required for fuel delivery if operating on diesel. If operated in an unconstrained continuous mode, road tankers would also be required for removal of wastewater and supply of fuel if running on diesel.

2.6 Construction Activities and Construction Staging

Key construction activities for the Project would include:

- Clearing of vegetation at the proposed power station site and as required along the electrical transmission and gas pipeline(s) easements.
- Demolition of an existing house if not repurposed during construction and operation.
- Installation of gas pipeline(s) and electrical transmission line infrastructure.
- Earthworks to prepare the power station site and construction areas.
- Installation of foundations and underground services.

- Installation of aboveground civil, mechanical and electrical plant and equipment.
- Commissioning and testing.

Construction work is proposed to occur during and outside of standard construction working hours. Works outside of standard construction working hours are justified so as to safely and efficiently ensure the Power Station will be operational before the proposed closure of Liddell Power Station occurs. Activities that would be undertaken outside of standard construction working hours would be undertaken in accordance with an Out of Hours Works procedure and may include:

- Site clearance, earthworks, civil works and equipment fit out
- HDD operations
- Tie-in works to gas, electricity and water networks
- Emergency situations where work is required to prevent personal or property harm
- Commissioning and operational testing.

Construction noise impacts during standard hours and out of hours periods are assessed in section

3. EXISTING NOISE ENVIRONMENT

The existing acoustic environment was characterised by a long term (unattended) noise monitoring. The nearest residential areas are suburban residential areas and larger rural residential blocks. The primary influences on ambient noise profiles included local community activity, fauna (birds and insects) and traffic on nearby arterial roads.

3.1 Representative Sensitive Receivers

Representative nearby sensitive receivers to the Project have been identified and listed in Table 3-1 and Figure 3-1. These receivers are considered to be representative of the surrounding sensitive receivers which consist of suburban and rural residential premises, commercial, industrial and a place of worship.

Table 3-1: Representative Sensitive Receivers

Receiver ID	Receiver Type	Address
R1	Residential	2171 Pacific Highway, Heatherbrae
R2	Residential	135 Oakfield Road, Woodberry
R3	Residential	838 Tomago Road, Tomago
R4	Residential	Tomago Village Van Park – 819 Tomago Road, Tomago
C5	Commercial	587 Tomago Road, Tomago
R6	Residential	47 School Drive, Tomago
R7	Residential	7 Graham Drive, Tomago
R8	Residential	18 Homebush Drive, Woodberry
C1	Commercial	Hunter Botanic Gardens Office – 2100 Pacific Highway, Heatherbrae
C2	Commercial	Tomago Bowling Club – 657 Tomago Road, Tomago
I1	Industrial	14 Kennington Drive, Tomago
I2	Industrial	11 Laverick Avenue, Tomago
W1	Place of Worship	Tomago House and Chapel – 421 Tomago Road, Tomago

3.2 Noise Catchment Areas

The intent of grouping receivers is to ensure a common assessment or mitigation approach for those receivers that have a similar exposure to noise to provide a more reasonable and practical approach. Where individual receivers are grouped together, they are referred to as a Noise Catchment Area (NCA). A noise catchment would typically include:

- All receivers that are exposed to similar noise levels and are usually at a similar proximity to the noise source.
- A logical delineation of the catchment area (e.g. by topography, cuttings, setbacks, road, rail or utility corridors, breaks in the landscape etc.)

Based on the above understanding, the study area has been divided into five NCAs.

A description of each NCA is provided in Table 3-2 and presented in Figure 3-1.

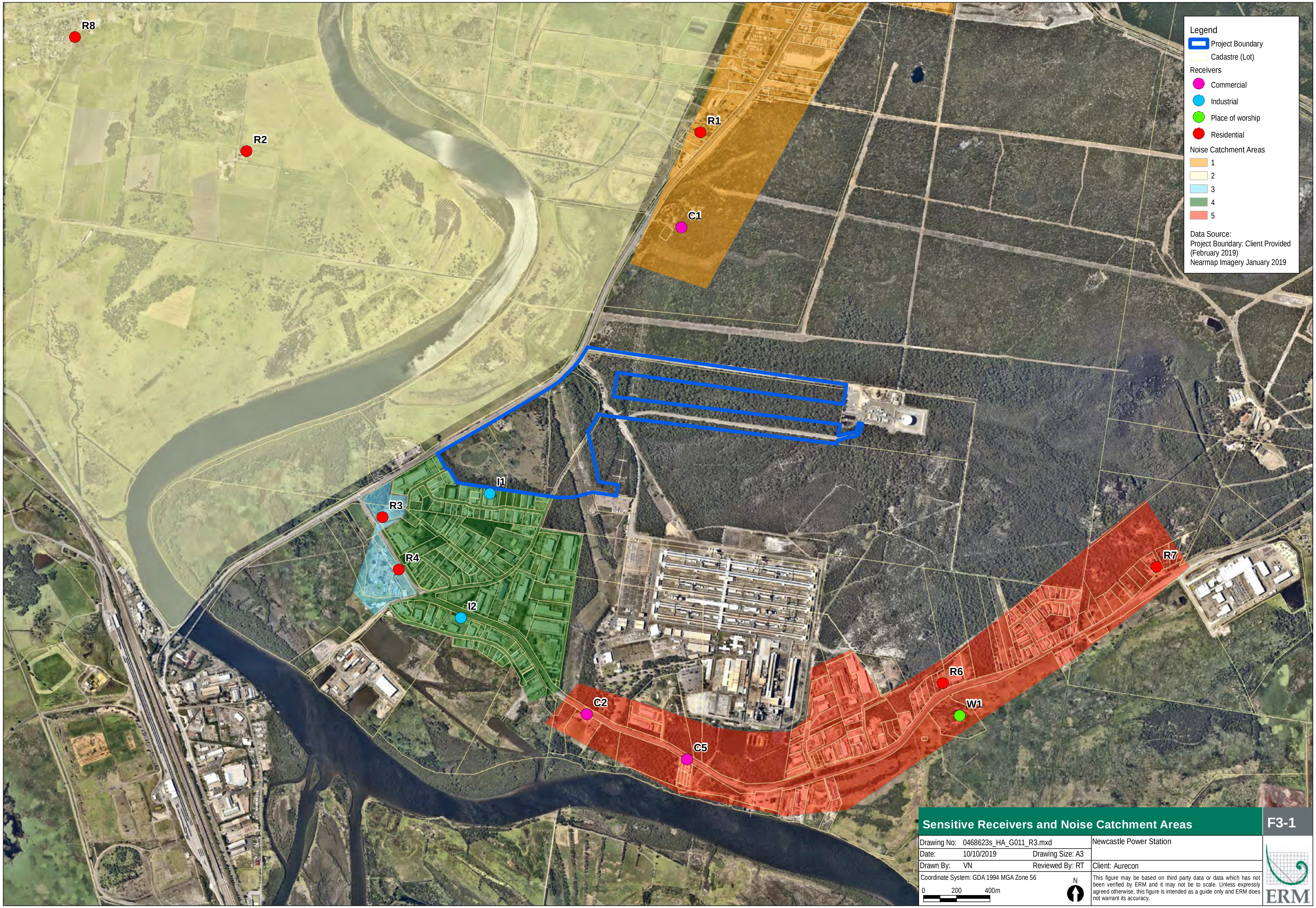
Table 3-2: Noise Catchment Areas

NCA	Minimum Distance from Project (metre)	Representative Logger	Description
NCA 1	1,200	L1	NCA 1 consists of three types of receiver in Heatherbrae – residential, commercial and industrial.
NCA 2	2,200	L2	NCA 2 consists of residential receivers in Woodberry.
NCA 3	450	L3	NCA 3 consists of residential and non-residential accommodation receivers in Tomago – 838 Tomago Road and the Tomago Village Van Park.
NCA 4	5	N/A[1]	NCA 4 consists of industrial receivers only
NCA 5	1,300	L3	NCA 5 consists of two types of receivers – residential and industrial.

Note 1: Noise logging is not required in this NCA as there are no residences. Noise logging is only required where there are no residences because the noise criteria for residential receivers are dependent on the baseline noise levels.

3.3 Hunter Estuary Wetlands Site

The Hunter Estuary Wetlands are located to the south and east of the project area, the Australian Wetlands Database (Department of Environment and Energy) identifies the nearest boundary of the wetlands on the southern side of the Hunter River northern channel, approximately 2.4 km south east of the Project and 4.4 km to the east.



Sensitive Receivers and Noise Catchment Areas

F3-1

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Drawn By:	VN	Reviewed By: RT	Client: Aurecon

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3.4 Existing Baseline Noise Survey

This section presents the measured noise levels from unattended noise logging and operator attended noise measurements completed adopting the methodology described below.

3.4.1 Monitoring Methodology

Ambient and background noise levels were quantified via monitoring, with due regard to the requirements described in NPI, 2017, applicable parts of Standards Australia AS1055–2018™ (AS1055) – *Description and Measurement of Environmental Noise* and other relevant Australian and international standards for environmental noise monitoring.

To quantify existing noise levels in the absence of the site under assessment, unattended noise logging and operator attended noise measurements were completed at select locations considered representative of existing conditions experienced by the community near the Project. The equipment used and the key features of the monitoring methodology are described below.

Unattended noise monitoring was undertaken at Tomago (L3) between 4 and 14 February 2019 and at Heatherbrae (L1) and Woodberry (L2) between 14 and 25 February 2019. The reason for conducting the unattended noise monitoring on two different periods was because the two noise loggers that was initially deployed at Heatherbrae and Woodberry had malfunctioned. Therefore, unattended noise monitoring at Heatherbrae and Woodberry had to be re-done from 14 February. These monitoring locations are shown in Figure 3-2 and detailed in Table 3-3.

Table 3-3: Noise Monitoring Locations, MGA Zone 56

Monitoring Location ID	Address	Suburb	Easting (m)	Northing (m)
L1	2171 Pacific Highway	Heatherbrae	378113	6368179
L2	135 Oakfield Road	Woodberry	377293	6370389
L3	838 Tomago Road	Tomago	380034	6370501

Noise loggers were installed to quantify the existing acoustic environment in residential areas potentially impacted by construction and operational activities. Loggers were set to record A-weighted noise levels at 15 minutes intervals and set to ‘fast’ response time.

Details of monitoring equipment used are as presented in Table 3-4.

Table 3-4: Noise Monitoring Equipment

Noise Monitoring Type	Location Used	Model	Serial Number
Unattended Noise Logger	L1	NGARA	878196
	L2	NGARA	878168
	L3	NGARA	878196

Weather conditions recorded at the nearest bureau of meteorology automatic weather station, Williamtown RAAF (station no. 61078) which is approximately 13 km from the Project site, were reviewed to identify periods of potentially adverse weather conditions. Observations were also made by ERM personnel of onsite weather conditions to assist in identifying likely periods of unsuitable weather data. Review of the weather station data found some adverse conditions likely to influence noise measurements. Periods excluded from the collected noise data are shown in Appendix B.

3.4.2 Unattended Noise Monitoring Results

Unattended noise monitoring results have been summarised in Table 3-5. Background noise levels were found to be typical of rural and suburban areas, ranging between 37 dBA and 52 dBA. Daily graphs for the noise monitoring results are included in Appendix B.

Residential receivers have been grouped together according to their proximity to the logging locations in order to set noise criteria that is relevant to each receiver. The residences in NCA 5 have been assumed to have similar noise environment to NCA 3 due to their close proximity to industries. Hence, the noise monitoring results at location L3 are considered to be representative of the baseline noise levels of NCA 5 residences.

Table 3-5: Long Term Noise Monitoring Results

Monitoring Location	Applicable Representative Residential Receivers (NCA)	Measured Noise Level, dBA								
		Day (7:00 am to 6:00 pm)			Evening (6:00 pm to 10:00 pm)			Night (10:00 pm to 7:00 am)		
		L_{10}	L_{90} (RBL)	L_{eq}	L_{10}	L_{90} (RBL)	L_{eq}	L_{10}	L_{90} (RBL)	L_{eq}
L1	R1 (NCA 1)	57	46	55	56	44	52	54	41	49
L2	R2 & R8 (NCA 2)	54	37	52	59	38	52	52	37	47
L3	R3 to R7 (NCAs 3 & 5)	65	52	60	62	48	57	62	41	56

Note: NCA 4 includes industrial receivers, and did not require baseline noise monitoring.

3.4.3 Operator Attended Noise Measurements

Operator attended noise measurements were conducted at the three noise logging locations on 4 February 2019 at L3 and 14 February 2019 at L1 and L2. Attended noise measurements were conducted to understand the broader acoustical environment better and to ensure that the unattended noise logging device was not under the influence of the extraneous noise sources.

Each measurement was of 15 minutes duration and time synchronised to the noise logging devices to allow for comparison of measured values at a range of acoustically different locations.

The sound level meter was set to show instantaneous noise levels throughout each measurement, with noise events noted by the operator. Overall 15 minute acoustical and statistical parameters were recorded by the device (in dBA) with L_{max}, L_{min}, L_{eq}, L_1, L_{10} and L_{90} values captured as a minimum.

The results of operator attended noise measurements are presented in Table 3-6 below.

Table 3-6 Operator Attended Noise Measurements

Location	Date	Start time	Measured Existing Noise Levels, dBA (Operator Attended Measurements)					
			Lmax	Lmin	Leq	L1	L10	L90
L01	14-Feb-19	12:42	68	49	53	59	55	50
L02	14-Feb-19	13:37	68	30	43	55	42	34
L03	4-Feb-19	12:50	76	53	62	70	64	56

Noise Logging Locations | **F3-2**

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Drawn By:	VN	Reviewed By: RT	Client: Aurecon
Coordinate System: GDA 1994 MGA Zone 56			This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

4. NOISE AND VIBRATION POLICIES, GUIDELINES AND STANDARDS

This assessment has been conducted with due regard to and in general accordance with the following policy, guidelines and standards:

- German Institute for Standardisation – DIN 4150 (2016) Part 3 (DIN4150-3) – *Structural Vibration - Effects of Vibration on Structures*.
- International Organisation for Standardisation (ISO) 9613-2:1996 (ISO 9613:2) - *Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation*.
- CONCAWE Report No. 4/81, Manning C.J., 1981, The propagation of noise from petroleum and petrochemical complexes to neighbouring communities.
- International Organisation for Standardisation (ISO) 17534:2015 – (ISO 17534:2015) – *Acoustics - Software for the Calculation of Sound Outdoors*, as achieved by the modelling software referenced in this report.
- NSW Department of Environment and Climate Change (DECC) – *NSW Interim Construction Noise Guideline* (ICNG, 2009), July 2009.
- NSW Department of Environment, Climate Change and Water (DECCW) – *NSW Road Noise Policy* (RNP), March 2011.
- NSW Department of Environment and Conservation – *NSW Environmental Noise Management – Assessing Vibration: a Technical Guideline* (the NSW Vibration Guideline), February 2006.
- NSW Environment Protection Authority – *Noise Policy for Industry* (NPI, 2017), October 2017.
- Standards Australia AS1055–2018™ (AS 1055) – *Description and Measurement of Environmental Noise*.
- Standards Australia AS IEC 61672.1–2004™ (AS 61672) – *Electro Acoustics - Sound Level Meters Specifications Monitoring or Standards Australia AS 1259.2-1990™ (AS 1259) – Acoustics – Sound Level Meters – Integrating Averaging* as relevant to the device.
- Standards Australia AS/IEC 60942:2004/IEC 60942:2003 (IEC 60942) – Australian Standard™ – *Electroacoustics – Sound Calibrators*.
- Standards Australia AS 2436–2010™ (AS 2436) – *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*.

Further information regarding the application of the key policy and guidelines is provided below.

4.1 NSW Interim Construction Noise Guideline

The NSW Department of Environment and Climate Change – NSW Interim Construction Noise Guideline (ICNG), presents an accepted method by which construction noise impacts may be assessed for a range of receptor types for works completed in NSW. It provides a set of recommended standard hours of construction, as reproduced below:

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

The ICNG encourages works to occur within the recommended standard hours of construction unless justification is provided. It focuses on minimising construction noise impacts, rather than only on achieving numeric noise levels, and recognises that some noise from construction sites is inevitable.

The ICNG encourages organisations involved with construction, maintenance or upgrading works (e.g. large scale contractors or Government agencies) to develop their best-practice techniques for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures.

In this case, the ICNG is the suitable guideline document to quantitatively assess potential noise emissions and impacts associated with project construction. The ICNG assessment methodology has been adopted to develop project-specific construction noise management levels (refer Section 5), assess potential impacts (refer Section 6) and recommend any necessary mitigation, management measures or provisions for monitoring (refer Section 10).

Table 4-1 details the construction noise management levels guidance for residential noise sensitive receptors developed in accordance with ICNG.

4.2 Noise Policy for Industry

Responsibility for the control of noise emissions in NSW is typically vested in Local Government and the NSW Environment Protection Authority (EPA). The Noise Policy for Industry (NPI) and relevant application notes provide a framework and methodology for deriving limit conditions for project consent and environment protection licence conditions.

The NPI is designed for large and complex industrial sources and outlines processes designed to strike a feasible and reasonable balance between the operations of industrial activities and the protection of the community from noise levels that are intrusive or unpleasant.

The NPI measurement and evaluation methodology to quantify existing ambient and background noise levels has been adopted for this assessment, with the baseline values utilised to derive construction noise criteria. The NPI assessment terminology is outlined in more detail in Appendix A of this report.

4.3 NSW Road Noise Policy

The NSW Road Noise Policy (RNP) outlines the range of measures needed to minimise road traffic noise and its impacts. It is intended for use by acoustics specialists as well as:

- Road project proponents.
- Determining authorities and regulators involved in the approval and construction of road projects and land use developments that generate additional traffic on existing roads.
- City and transport planners and policymakers dealing with issues such as route corridors, heavy vehicle transport and building codes.

The RNP aims to identify the strategies that address the issue of road traffic noise from existing roads, new road projects, road redevelopment projects and new traffic-generating developments. In this case, the RNP is considered the suitable document to qualitatively assess potential noise emissions and impacts associated with construction road traffic.

The RNP vary based on road type and are dependent on the development being assessed (refer to Section 5). The criteria values from the RNP were considered in the assessment of potential construction impacts, they are used to provide guidance on potential short-term and temporary impacts associated with heavy vehicle haulage and/or other like vehicles that may be required as part of the construction.

4.4 Potential Sleep Disturbance Issues

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

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

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

These screening method features have been adopted for likely maximum noise level events from construction vehicles associated with the Project.

4.5 Vibration Guidelines and Standards

The effects of vibration on buildings can be divided into three main categories: human comfort (annoyance), building damage (cosmetic/structural) and sensitive equipment (scientific/medical). An overview of the applicable standards and guidelines is provided below.

- **Human Comfort (annoyance)**: The NSW Vibration Guideline provides guidance for assessing human exposure (comfort or annoyance issues) to vibration. The publication is based on British Standard (BS 6472–1992) – *Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz*), dated 1992.
- **Cosmetic and Structural Damage**: There is currently no Australian policy or guideline for assessing the potential for building damage (cosmetic and structural**)** from vibration. The British Standard BS 7385 Part 2-1993 'Evaluation and measurement for vibration in buildings Part 2' has been considered for project works where applicable. BS 7385 provides safe limit guideline values, below which vibration is considered insufficient to cause structural or cosmetic damage to buildings. If a heritage building or structure is found to be structurally unsound a more conservative standard has been adopted i.e. German Standard DIN4150 Part 3-1999 (DIN4150-3) – *Structural Vibration - Effects of Vibration on Structures,* dated 1999. DIN4150-3 presents a set of safe limit values below which cosmetic or structural damage is unlikely to occur.

  The NSW Vibration Guideline, BS7385 and DIN 4150-3 criteria vary based on vibration type, receptor type and are dependent on the component frequency of the vibration event (refer Section 5). The criteria values from the NSW Vibration Guideline, BS7385 and DIN 4150-3 were considered in the assessment of potential impacts but are not reproduced here.
- **Sensitive Scientific and Medical Equipment**: Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

  Where manufacturer's data for the identified vibration sensitive scientific and/or medical instruments are not available, generic vibration criterion (VC) curves will be adopted as vibration goals.

  However, as there is no sensitive scientific and medical equipment housed in nearby buildings, the assessment of vibration impacts on sensitive scientific and medical equipment is not relevant and will not be conducted in this study.

Table 4-1: Construction Airborne Noise Management Levels for Residential Receptors (ICNG)

Time of day	Noise management level, $L_{eq\ (15min)}$ – dBA	How to apply
Recommended standard hours (SH): Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected Rating Background Level (RBL) + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{eq,\ 15\ minute}$ 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 dBA	The highly noise affected level represents the point above which there may be a 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: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOH) - All other times including Public Holidays	Noise affected Rating Background Level (RBL) + 5 dBA	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 dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

5. PROJECT SPECIFIC MANAGEMENT LEVELS AND CRITERIA

5.1 Construction Noise Management Levels

The project-specific construction “Noise Management Levels” (NML), for works within and outside the recommended standard hours for construction, are presented in Table 5-1 below.

These NML have been established with due regard to the requirements of the ICNG for all identified residential (dwelling) and other sensitive (non-residential) receptors. NML for all periods are provided for completeness despite construction works limited to the recommended standard hours for construction presented in the ICNG.

For residential (dwelling) receptors the NML are based on the RBL values presented in Section 3.4.2.

As per Section 4.4 of this report, two thresholds have been considered to establish sleep disturbance criteria based on which impacts to residential receptors can be evaluated.

Table 5-1: Construction Noise Management Levels (NML)

Receptor Type	Construction Noise Management Levels, $L_{eq(15\ min)}$, dBA				High Noise Affected, $L_{eq(15\ min)}$, dBA	Sleep Disturbance, dBA	
	Standard Hours	Out-of-Hours			Daytime (Standard Hours)	Night-time only	
	Day	Day	Evening	Night		$L_{eq(15\ min)}$	L_{max}
Residences in NCA 1	56	51	49	46	75	46	56
Residences in NCA 2	47	42	43	42	75	42	52
Residences in NCA 3 and NCA 5	62	57	53	46	75	46	56
Educational Facility	55[1]	55[1]	55[1]	55[1]	-[2]	-[2]	-[2]
Medical Facility	55[1]	55[1]	55[1]	55[1]	-[2]	-[2]	-[2]
Places of Worship	55[1]	55[1]	55[1]	55[1]	-[2]	-[2]	-[2]
Active Recreation	65	65	65	65	-[2]	-[2]	-[2]
Commercial	70	70	70	70	-[2]	-[2]	-[2]
Industrial	75	75	75	75	-[2]	-[2]	-[2]

Note 1: External goal of 55dBA applies. The ICNG recommends that construction noise levels do not exceed 45 dB (LAeq, 15minute) internally within school classrooms, hospital wards and places of worship when in use. For the purpose of this assessment the internal noise level has been translated to an external level of 55dB (LAeq, 15minute) based on the accepted level of attenuation (10dB) that is readily achieved through windows, partially opened for ventilation.

Note 2: Dash “-“ indicates that these criteria do not apply to that receptor.

5.2 Operational Noise Criteria

The project-specific intrusiveness and amenity noise levels are presented in Table 5-2 and Table 5-3 respectively below. These criteria represent the operational noise criteria used to assess potential impacts, with the most stringent of these values adopted as the “Project Noise Trigger Level” (PNTL).

The term PNTL is defined in Section 2.1 of the NPI and considers the lowest of the intrusive or amenity residential receptor criterion so that the most stringent threshold is set concerning existing industrial noise in the area. The PNTL have been established with due regard to the requirements of the NPI for all identified residential (dwelling) and other sensitive (industrial) receptors. PNTL for all times of day and associated assessment periods are provided as operational activities will occur during the daytime, evening and night-time.

5.2.1 Project Intrusiveness Noise Levels

A noise source will be deemed to be non-intrusive if the monitored $L_{eq, 15minute}$ noise level of the development does not exceed the RBL by more than 5 dBA. The RBL is the median of the measured L_{90} noise level during the day, evening and night periods during periods when the development is not in operation.

Based on the project RBL presented in Table 3-5, the project intrusive noise criteria have been determined and presented in Table 5-2 below.

Table 5-2: Project Intrusiveness Noise Criteria

Residential Location	Intrusive Noise Criteria $L_{eq, 15 minute}$ – dBA		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
R1	51	49	46
R2	42	43	42
R3	57	53	46
R6	57	53	46
R7	57	53	46
R8	42	43	42

Note: Receivers R4 is a caravan park and accommodation and not considered residential according to the NPI. Hence, the intrusiveness noise criteria are not applicable to R4.

5.2.2 Project Amenity Noise Levels

The project amenity noise levels applicable to an activity are defined by the recommended noise levels listed below (*Table 2.2* of the *EPA Noise Policy for Industry*) minus 5 dBA. In the selection of these noise levels, residential areas have been defined as follows:

- R1, R3, R6 and R7 – Urban. This noise amenity area is influenced by traffic noise from the Pacific Highway and arterial road through-traffic as well as industrial noise from commercial / industrial areas.
- R2 and R8 – Rural.
- R4 Urban. Caravan Park (R4) has through-traffic and is near commercial / industrial districts.

The above classification is based on the description of noise environments in the NPI. The project amenity noise criteria are presented in Table 5-3 below.

Table 5-3: Project Amenity Noise Criteria

Receiver Location	Receiver Type	Noise Amenity Area	NPI Recommended Amenity Levels $L_{eq, 15minute}$ – dBA		
			Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
R1, R3, R6 and R7	Residential	Urban	(60-5=) 55	(50-5=) 45	(45-5=) 40
R2 and R8	Residential	Rural	(50-5=) 45	(45-5=) 40	(40-5=) 35
R4	Caravan Park	Urban	(60+5=) 65	(50+5=) 55	(45+5=) 50
C1, C5	Commercial	-	65[1]	65[1]	65[1]

Receiver Location	Receiver Type	Noise Amenity Area	NPI Recommended Amenity Levels $L_{eq, 15minute}$ – dBA		
			Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
C2	Active Recreation	-	55[1]	55[1]	55[1]
I1, I2	Industrial	-	70[1]	70[1]	70[1]
W1	Place of worship (internal)		40[2]	40[2]	40[2]

Note 1: Limit applies when facility is in use.
Note 2: The NPI recommends that industrial noise levels do not exceed 40 dB (LAeq, 15minute) internally within places of worship when in use.

5.2.3 Project Noise Trigger Levels (PNTL)

The PNTL is the lower (or the more stringent) value of the project intrusiveness noise level and project amenity noise level determined in Sections 5.2.1 and 5.2.2. The PNTLs are presented in Table 5-4 below.

Table 5-4: Project Noise Trigger Levels

Receiver Location	PNTL $L_{eq, 15minute}$ – dBA		
	Day (7:00 am to 6:00 pm)	Evening (6:00 pm to 10:00 pm)	Night (10:00 pm to 7:00 am)
R1	51	45	40
R2	42	40	35
R3	55	45	40
R4	65	55	50
C5	65[1]	65[1]	65[1]
R6	55	45	40
R7	55	45	40
R8	42	40	35
C1	65[1]	65[1]	65[1]
C2	55[1]	55[1]	55[1]
I1, I2	70[1]	70[1]	70[1]
W1	40[2]	40[2]	40[2]

Note 1: Limit applies when facility is in use.

Note 2: The NPI recommends that industrial noise levels do not exceed 40 dB (LAeq, 15minute) internally within places of worship when in use.

5.3 Road Noise Criteria

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

Road traffic generated by the operation of the Project is expected to include light vehicle movements from staff traffic, and road tanker delivery of fuel, if running on diesel. In addition, where the plant is operated in a continuous unconstrained operation, wastewater would be required to be transported off site via road tanker.

The construction of the Project will generate additional traffic on surrounding public roads, such as construction worker car movements and delivery and construction vehicle movements.

The RNP details a number of noise assessment criteria for various road categories and land uses. Heavy Vehicle road access to the Project will be via Pacific Highway and Old Punt Road. These roads have been classed as an arterial and sub-arterial roads respectively due to their function of providing major regional and inter-regional traffic movements and acting as a connection between local and arterial roads.

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

If road traffic noise during the Project construction is within 2 dBA of current levels then the objectives of the RNP are met and no specific mitigation measures are required. Where the Project road traffic noise levels exceed 2 dBA of current levels than the consideration should be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the RNP criteria as presented in Table 5-5.

Table 5-5: RNP Residential Road Traffic Noise Criteria

Road Category	Type of Project/Land Use	Assessment Criteria – dBA	
		Day 7am to 10pm	Night 10pm to 7am
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)

Note: The assessment criteria for external noise levels apply at 1 metre from the façade of any affected residential receiver

5.4 Construction Vibration Management Levels

Impacts from vibration can be considered both in terms of effects on building occupants (human comfort) and the effects on the building structure (building damage). Of these considerations, the human comfort limits are the most stringent. Therefore, for occupied buildings, if compliance with human comfort limits is achieved, it would follow that compliance will be achieved with the building damage objectives.

5.4.1 Human Comfort

The NSW Vibration Guideline provides guidance for assessing human exposure to vibration. These documents are based on *British Standard (BS 6472–1992) – Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) dated 1992*. The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 5-6.

Table 5-6: Human Comfort – Vibration Dose Values

Location	Assessment Period	Preferred Values		Maximum Values	
		z axis	x and y axes	z axis	x and y axes
Continuous Vibration (m/s^2)					
Critical Areas	Daytime or Night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Daytime or Night-time	0.020	0.014	0.040	0.028
Workshops	Daytime or Night-time	0.040	0.029	0.080	0.058
Impulsive Vibration (m/s^2)					
Critical Areas	Daytime or Night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Daytime or Night-time	0.64	0.46	1.28	0.92
Workshops	Daytime or Night-time	0.64	0.46	1.28	0.92
Intermittent Vibration ($m/s^{1.75}$)					
Critical Areas	Daytime or Night-time	0.10		0.20	
Residences	Daytime	0.20		0.40	
	Night-time	0.13		0.26	
Offices, schools, educational institutions and places of worship	Daytime or Night-time	0.40		0.80	
Workshops	Daytime or Night-time	0.80		1.60	

Note: Daytime is 7am-10pm and Night-time is 10pm-7am.

Note: For continuous and impulsive vibration, the preferred and maximum values are weighted acceleration values (Wg for z-axis and Wd for x and y-axis)

Note: For intermittent vibration, the preferred and maximum values are Vibration Dose Values (VDVs), based on the weighted acceleration values

5.4.2 Building Damage

German Standard DIN 4150-3-1999 Structural Vibration – Part 3 Effects of vibration on structures provides methods for evaluating the effects of vibration on structures in the absence of an Australian Standard.

The recommended limits (guide values) from DIN 4150 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in Table 5-7.

Table 5-7: Guideline Vibration Values for Short Term Vibration on Structures (mm/s)

Type of Building	Guideline values for velocity (mm/s)			
	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	Vibration at horizontal plane of highest floor at all frequencies
Commercial and Industrial Building	20	20-40	40-50	40
Dwellings and buildings of similar occupancy or design	5	5-15	15-20	15
Structures that, because of their particular sensitivity to vibration cannot be classified under lines 1 and 2 and are of great intrinsic value	3	3-8	8-10	8

6. CONSTRUCTION NOISE ASSESSMENT

6.1 Modelling Methodology

Noise modelling has been undertaken using the ISO 9613 *Acoustics – Attenuation of sound during propagation outdoors* (ISO, 1996) algorithm, as implemented within SoundPLAN version 8.1. The noise modelling takes into consideration the sound power level (SWL) of the proposed site operations, activities and equipment, and applies adjustments for attenuation from geometric spreading, acoustic shielding from intervening ground topography, ground effect, meteorological effects and atmospheric absorption.

Neutral (class D stability and no wind effects) meteorological condition was modelled for the construction scenarios.

SWL for plant used in each construction phase have been adopted based on UK DEFRA construction noise database (frequency spectrums) adjusted in line with typical construction plant SWLs as described in the Transport for NSW's Construction Noise Strategy and the Roads and Maritime Services' Construction Noise and Vibration Guideline.

6.2 Assessment Scenarios

A number of construction scenarios were developed for this assessment and they are presented in Table 6-1. The final selection of engine technology will not affect the construction scenarios which are applicable to both technologies. These scenarios were modelled as per the methodology above assuming all equipment in each scenario will be operating simultaneous at any time. These scenarios have been developed based on typical construction activities for the construction of a power station. The construction scenarios might differ when the Project is at the detailed design stage of the Project. However, for the purpose of this assessment, the construction scenarios are considered to be suitable and appropriate for providing a general understanding of the construction impacts of the Project.

Table 6-1: Construction Assessment Scenarios

Scenario	Equipment	Sound Power Level[1] – dBA
S1 Site Preparation and Earthworks	Excavator	110
	Bulldozer	110
	Grader	116
	Roller	108
	Loader	108
	Dump truck	105
S2 Concrete Foundation Works	Concrete truck	108
	Concrete mixer	110
	Compactor	114
	Crane	106
S3 Building Construction	Crane	106
	Delivery trucks	106
	Pneumatic tools	112
	Electric tools	104
	Power generators	104

Scenario	Equipment	Sound Power Level[1] – dBA
	Hammers	110
S4 Pre-Pipeline Construction	Excavator	110
	Track trencher	114
	Crushing Machine	110
	Truck	106
	Crane	106
S5 Pipeline Construction	Welding/Bending Machine	96
	Pipe layer	102
	Bulldozer	110
	Padding machine	102
S6 Transmission Line Construction	Excavator	110
	Track trencher	114
	Crushing Machine	110
	Truck	106
	Crane	106

Note 1: Sound Power Levels of equipment were either sourced from Transport for NSW's "Construction Noise and Vibration Strategy", the UK's Department for Environment, Food and Rural Affairs "Update of Noise Database for Prediction of Noise On Construction and Open Sites", or ERM's construction plant & equipment noise database

6.3 Predicted Construction Noise Levels

Predicted $L_{eq,\ 15minutes}$ noise levels for all construction scenarios have been presented in Table 6-2. The predicted noise levels show that construction noise levels during all scenarios will comply with the construction NMLs for standard hours, out-of-hours and also highly noise affected. Based on this assessment, the noise levels from construction related activities are likely to comply with criteria for all periods of the day at all surrounding receivers.

The predicted $L_{eq,\ 15minutes}$ and L_{max} noise for comparison against the sleep disturbance criteria has been presented in Table 6-3. The predicted noise levels show that construction activities will likely comply with the sleep disturbance $L_{eq,\ 15minutes}$ and L_{max} criteria and as such will unlikely cause sleep arousal to surrounding residential receivers.

6.4 Hunter Estuary Wetlands

The predicted construction noise levels at the receiver points C5 and R7, the nearest receiver points to the wetlands, indicate $L_{eq,\ 15minutes}$ construction noise impacts up to 34dBA. L_{max} construction noise levels at these locations were predicted to 42 dBA.

Considering the additional distance to the wetlands, construction noise levels would be expected 2-3dB less than the above predicted levels.

The predicted construction noise impacts are expected to less than or equivalent existing ambient industrial noise level (refer section 9.5) at the wetland areas to the south and east.

Table 6-2: Predicted Construction Noise Levels (ICNG)

Receiver (NCA)	Predicted Construction Noise Levels of each Construction Scenario $L_{eq, 15minute}$ – dBA						Construction Noise Management Levels $L_{eq, 15minute}$ – dBA			Compliance (Yes / No)		
	S1	S2	S3	S4	S5	S6	Standard Day	Out-of-Hours (Day/Evening/Night)	Highly Noise Affected	Standard Day Hours	Out-of-Hours (Day/Evening/Night)	Highly Noise Affected
R1 (NCA 1)	26	28	34	37	26	36	56	51 / 49 / 46	75	Yes	Yes / Yes / Yes	Yes
R2 (NCA 2)	24	27	30	33	14	29	47	42 / 43 / 42	75	Yes	Yes / Yes / Yes	Yes
R3 (NCA 3)	38	38	38	34	20	37	62	57 / 53 / 46	75	Yes	Yes / Yes / Yes	Yes
R4 (NCA 3)	36	36	37	34	20	37	62	57 / 53 / 46	75	Yes	Yes / Yes / Yes	Yes
C5 (NCA 5)	25	29	30	34	21	33	65	65	75	Yes	Yes / Yes / Yes	Yes
R6 (NCA 5)	20	25	28	35	21	30	62	57 / 53 / 46	75	Yes	Yes / Yes / Yes	Yes
R7 (NCA 5)	16	23	25	33	17	27	62	57 / 53 / 46	75	Yes	Yes / Yes / Yes	Yes
R8 (NCA 2)	17	23	26	30	9	25	47	42 / 43 / 42	75	Yes	Yes / Yes / Yes	Yes
C1 (NCA 1)	31	31	38	42	32	38	65	65	75	Yes	Yes / Yes / Yes	Yes
C2 (NCA 5)	29	31	33	35	22	35	55	55	75	Yes	Yes / Yes / Yes	Yes
I1 (NCA 4)	50	51	49	37	26	45	75	75	75	Yes	Yes / Yes / Yes	Yes
I2 (NCA 4)	35	38	36	34	21	37	75	75	75	Yes	Yes / Yes / Yes	Yes
W1 (NCA 5)	19	25	27	34	20	29	45	45	75	Yes	Yes / Yes / Yes	Yes

Table 6-3: Predicted Construction Noise Levels (Sleep Disturbance)

Receiver (NCA)	Predicted $L_{eq, 15minute}$ Construction Noise Levels of each Construction Scenario – dBA						Sleep Disturbance $L_{eq, 15minute}$ Criteria (dBA)	Compliance (Yes / No)	Predicted Maximum Construction Noise Levels of each Construction Scenario[1] – Lmax (dBA)						Sleep Disturbance Lmax Criteria (dBA)	Compliance (Yes / No)
	S1	S2	S3	S4	S5	S6			S1	S2	S3	S4	S5	S6		
R1 (NCA 1)	26	28	34	37	26	36	46	Yes	34	36	42	45	34	44	56	Yes
R2 (NCA 2)	24	27	30	33	14	29	42	Yes	32	35	38	41	22	37	52	Yes
R3 (NCA 3)	38	38	38	34	20	37	46	Yes	46	46	46	42	28	45	56	Yes
R4 (NCA 3)	36	36	37	34	20	37	46	Yes	44	44	45	42	28	45	56	Yes
C5 (NCA 5)	25	29	30	34	21	33	n/a	n/a	33	37	38	42	29	41	n/a	n/a
R6 (NCA 5)	20	25	28	35	21	30	46	Yes	28	33	36	43	29	38	56	Yes
R7 (NCA 5)	16	23	25	33	17	27	46	Yes	24	31	33	41	25	35	56	Yes
R8 (NCA 2)	17	23	26	30	9	25	42	Yes	25	31	34	38	17	33	52	Yes

Note 1: The prediction of the Lmax level has been based on the assumption that the Lmax nose level is 8 dBA above the Leq,15min noise level.

7. TRAFFIC NOISE ASSESSMENT

This section assesses noise impacts from additional traffic generated noise during project construction and operations.

The RNP (as outlined in Section 4.3), traffic NMLs are set at 2 dBA above the existing road traffic noise levels during the daytime and night-time periods and are considered appropriate to identify the onset of potential noise impacts. Where the road traffic noise levels are predicted to increase by more than 2 dBA as a result of construction or operational traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

Traffic routes would involve both the Pacific Highway, Old Punt Road and Tomago Road. All heavy vehicle traffic will access the project from the Pacific Highway via Old Punt Road which avoids pass by of residential receptors.

Passenger vehicle traffic during construction is predicted to use both Old Punt Road and Tomago Road.

Construction traffic flows are as follows:

- Light vehicles - up to 300 construction staff daily, average of 100 over the project
- Heavy vehicles – up to 80 vehicles per day

Operational traffic flows are as follows:

- Light vehicles - up to 30 staff and visitors
- Heavy vehicles – if power station operating on diesel, then up to 60 fuel deliveries per day, continuous unconstrained operation up to 34 wastewater tankers per day.

7.1 Traffic Modelling Parameters

Traffic noise modelling was completed using traffic volume data for Pacific Highway (Roads and Maritime Services (RMS) station ID 05001 – 380 m West of Tomago Road) and estimated traffic flows on Tomago Road presented in the traffic assessment.

Posted speeds are 100 km/h on the Pacific Highway. It has been assumed this speed limit will remain unchanged during the Project.

Due to the high volume of traffic movement on the Pacific Highway, it is anticipated that construction road traffic noise associated with the Project is very likely to comply with the 2 dBA increase allowance. Residential receptors along the Pacific Highway haulage route are therefore unlikely to be adversely affected by construction road traffic noise levels

The following assumptions were used as inputs to the *RMS Construction Road Traffic Noise Estimator*:

- Day time traffic Pacific Highway:
  - Northbound: 22063
  - Southbound: 22275
- Night time traffic Pacific Highway:
  - Northbound: 3691
  - Southbound: 5071
  - Tomago Road West, (both directions)

- Day time: 13175
- Night time: 2604

- Day/night splits and heavy vehicle classifications for existing traffic flows on the Pacific Highway were calculated assuming a 30% rate of heavy vehicles during the night time and 18% during the day time. These numbers are based on an analysis of the RMS permanent classifier at M1 Pacific Motorway (Station ID: F3FWY005), as RMS traffic counters closer to the site did not include vehicle classifications.
- Traffic volumes and heavy vehicle percentages for Tomago Road (west of Old Punt Road) was based on data presented in the project traffic assessment (Seca Solution Newcastle Power Station traffic impact assessment 2019). Day (83%) vs night (17%) traffic percentages were assumed as similar to the Pacific Highway.
- Additional Project traffic was assumed to occur either all during the day time or all during the night time period to assess if project roads are potentially impacted by additional traffic.

The RMS *Construction Road Traffic Noise Estimator* was used to confirm compliance with the 2 dBA increase allowance. A screen shot of the construction traffic noise calculation is presented in Figure 7-1 below for the construction traffic volume scenario on the Pacific Highway assuming all construction traffic occurs in either night or day period.

Figure 7-1: Road Traffic, RMS Noise Estimator

Transport Roads & Maritime Services NSW GOVERNMENT

Construction Road Traffic Noise Estimator

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

Ground type	Developed settlements (urban and suburban areas)
Road surface	Low noise
Road type	Freeway/arterial/sub-arterial road

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

	Day	**Night**
Noise criteria (residences)	60	55
Existing speed	100	100
Speed during construction	100	100

	Day (7am to 10pm)		**Night (10pm to 7am)**		**Worst Case 1-hour Day**		**Worst Case 1-hour Night**	
Existing traffic	**Light vehicles**	**Heavy vehicles**	**Light vehicles**	**Heavy vehicles**	**Light vehicles**	**Heavy vehicles**	**Light vehicles**	**Heavy vehicles**
Direction (1)	20047	2227	4056	1014	[redacted]	[redacted]	[redacted]	[redacted]
Direction (2)	19856	2206	2953	738	[redacted]	[redacted]	[redacted]	[redacted]
Additional traffic					[redacted]	[redacted]	[redacted]	[redacted]
Direction (1)	300	80	300	80	[redacted]	[redacted]	[redacted]	[redacted]
Direction (2)	300	80	300	80	[redacted]	[redacted]	[redacted]	[redacted]

	Day	**Night**
Change in noise levels (dBA)	0.1	0.4
Mitigation level (dBA)	60	55
Is the change in noise level greater than 2.0 dBA?	No	No
Require consideration of additional mitigation measures?	No	No
Mitigation distance (m)		

alculating noise level at the receiver

Distance to receiver (m)		
Direction (1)	55	
Direction (2)	70	
	Day	**Night**
Predicted noise levels (dBA) @ 1m from the façade	67.6	64.4

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

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

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

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

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

Based on the proposed construction and operational traffic volumes, Road noise levels are not expected to trigger the 2 dB noise increase criteria. Worse case all construction traffic during night period predicted less than 0.5 dB increase).

8. CONSTRUCTION VIBRATION ASSESSMENT

Plant used during construction activities which are anticipated to generate vibration impacts at nearby receivers include a vibratory roller and hydraulic hammer. Locations within the project area and approximate distances to the closest residential and non-residential receivers are shown in Table 8-1.

Table 8-1: Location of Vibration Equipment and Distances to Receivers

Plant/Equipment	Location	Nearest Receiver to Plant/Equipment	Approximate Distance to Nearest Receiver (metres)
Vibratory Roller (15t)	Project site	I1 (Industrial Receiver)	260
		R3 (Residential Receiver)	1,130
Hydraulic Hammer	Project site	I1 (Industrial Receiver)	260
		R3 (Residential Receiver)	1,130

As vibration inducing equipment is generally located at significant offsets from the nearest receivers, it is not anticipated that vibration would be a significant issue. Although it is not expected, should vibration equipment be used closer to receivers for minor works such as; pavement roadworks or utilities works, Table 8-2 outlines necessary safe working distances for the use of this equipment.

No buildings are located within the safe working distances for structural damage for each of the construction scenarios presented in Table 6-1.

Table 8-2: Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (OH&E Vibration Guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

NOTE: This table has been extracted from the RMS Construction Noise and Vibration Guideline (2016).

Should vibratory rollers and hammers be used within 20 m of structures, then an assessment as to whether or not vibration testing is required would be undertaken. This would also be dependent on the rating of the equipment to be used.

Construction vibration mitigation measures would be considered as part of the construction noise and vibration management plan.

9. OPERATIONAL NOISE ASSESSMENT

9.1 Operational Engine Design Types

Two power plant technologies, i.e. gas turbine engine and reciprocating engine, were considered for this assessment.

For each generation technology, ERM has been provided with vendor specifications for a range of plant options that are currently under consideration for the Project. Within this assessment, emission data have been adopted for each technology as being representative of the proposed plant scale, and the respective generation technology. The plant / equipment and the associated sound power levels for each technology are presented in Table 9-2.

9.2 Methodology Conditions

Noise modelling has been undertaken using CONCAWE's *Special Task Forces in Noise Propagation* (CONCAWE, 1981) algorithm, as implemented within SoundPLAN 8.1. The noise modelling takes into consideration the sound power level of the proposed site operations, activities and equipment, and applies adjustments for attenuation from geometric spreading, acoustic shielding from intervening ground topography, ground effect, meteorological effects and atmospheric absorption.

Based on the analysis of the existing environment in the vicinity of the Project, the meteorological conditions presented in Table 9-1 have been adopted for this assessment.

Meteorological conditions were applied based on 24 hour operation of the Project for standard operations.

Table 9-1: Meteorological Scenarios

ID	Description	Temp (°C)	Relative Humidity (%)	Wind Speed (m/s)	Wind Direction (°)	Pasquill-Gifford Stability Class
1	Calm	20	70	-	-	D
2	Prevailing SE winds	20	70	3	135	D
3	Inversion	0	70	2	Source to receiver	F

9.3 Predicted Operational Noise Levels

Based on the operational assessment scenarios and associated data presented in Table 9-1 above, 24 hour $L_{eq,\ 15\ minute}$ have been predicted for representative worst-case conditions, i.e. concurrent equipment usage and activities across the site. These predicted values have then been compared to the PNTL established in Section 5 and presented in Table 5-4 of this report.

The resultant values (and an assessment of compliance for unmanaged and managed scenarios) for both engine design options are presented in Table 9-3 and Table 9-4 and the noise contours are presented in Figure 9-1 to Figure 9-8 below. Exceedances of the most stringent night-time criteria have been highlighted in bold.

The predicted $L_{eq,\ 15\ minute}$ noise levels of the worst-case operational scenario, as presented in Table 9-3 and Table 9-4, show that without any sound attenuation (i.e. noise control) the Project would exceed the PNTLs at most of the residential receivers. Predicted $L_{eq,\ 15\ minute}$ operational noise levels with sound attenuation show that the Project will likely comply with the PNTLs at all surrounding residential and non-residential receivers.

Due to the constant sound characteristic of the Project's operations, an L_{max} model was not considered the limiting criteria for assessing sleep disturbance. The $L_{eq,\ 15\ minute}$ noise level would be the most appropriate descriptor for assessing the Project's operational noise for sleep disturbance.

In order to achieve compliance for the operations of the Project, noise mitigation measures at the sources would need to be considered. Table 9-2 details attenuated sound power levels for the Project so as to achieve PNTLs compliance.

Table 9-2: Attenuated Sound Power Levels At Source[1]

Design Option	Plant / Equipment	Total Number of Equipment	SWL with No Noise Control, L_{eq} (dBA)	Required Attenuation Level[2, 3] (dBA)	Attenuated SWL at Source[2], L_{eq} (dBA)
Gas Turbine Engine	Exhaust	4	140	40	100
	Generator	4	104	10	94
	Fin Fan Cooler	4	102	5	97
Reciprocating Engine	Engine	13	134	40	94
	Exhaust Gas	13	108	15	93
	HT/LT Radiator Field	13	109	14	95
	Intake Air Noise	13	110	18	92
	Power House Vent (Outlet)	13	103	9	94
	Power House Vent (Inlet)	26	98	5	93

Note 1: "At Source" refers to at the plant / equipment and does not refer to at the receiver.

Note 2: The "Required Attenuation Level" and "Attenuated SWL at Source" have been calculated based on the un-mitigated predicted operational noise levels presented in Table 9-3 and Table 9-4.

Note 3: The "Required Attenuation Level" is preliminary for further investigation.

Possible sound attenuation measures at the noise sources could include, but not be limited to, silencers, lined ducts, acoustic enclosures, noise screens/barriers, selection of quieter plant/equipment or a combination of the above. All feasible and possible sound attenuation techniques would be investigated during the detailed design stage of the Project.

Should the noise from the equipment / plant be reduced in accordance with Table 9-2 attenuated sound power levels, compliance with the NPI criteria can be achieved for all periods at all surrounding receivers.

9.4 Hunter Estuary Wetlands

The predicted mitigated operational noise levels at the receiver points C5 and R7, the nearest receiver points to the wetlands, indicate $L_{eq,\ 15minutes}$ operational noise levels up to 29dBA and 27 dBA respectively.

Considering the additional distance to the wetlands, construction noise levels would be expected 2-3dB less than the above predicted levels.

The predicted operational noise impacts are expected to less than existing ambient industrial noise level (refer section 9.5) at the wetland areas to the south and east.

Table 9-3: Predicted Operational Noise Levels and Compliance – Gas Turbine Engine

Receptor ID	PNTLs Leq – dBA			Predicted Operational Noise Levels Leq, 15 minute – dBA			
	Day	Evening	Night	Neutral (No Noise Control)	SE Wind (No Noise Control)	Temperature Inversion (No Noise Control)	Temperature Inversion (With Noise Control)
R1	51	45	40	**55**	**58**	**59**	27
R2	42	40	35	**53**	**57**	**57**	25
R3	55	45	40	**68**	**70**	**71**	39
R4	65	55	50	**66**	**66**	**69**	37
C5	65	65	65	55	50	60	27
R6	55	45	40	**50**	**45**	**55**	23
R7	55	45	40	**45**	**41**	**50**	18
R8	42	40	35	**46**	**51**	**51**	19
C1	65	65	65	59	61	64	31
C2	55	55	55	**59**	55	**63**	31
I1	70	70	70	**84**	**83**	**85**	53
I2	70	70	70	65	63	69	37
W1	40[1]	40[1]	40[1]	39[2]	34[2]	**44**[2]	12[2]

Note 1: The NPI recommends that industrial noise levels do not exceed 40 dB (LAeq, 15minute) internally within places of worship when in use.

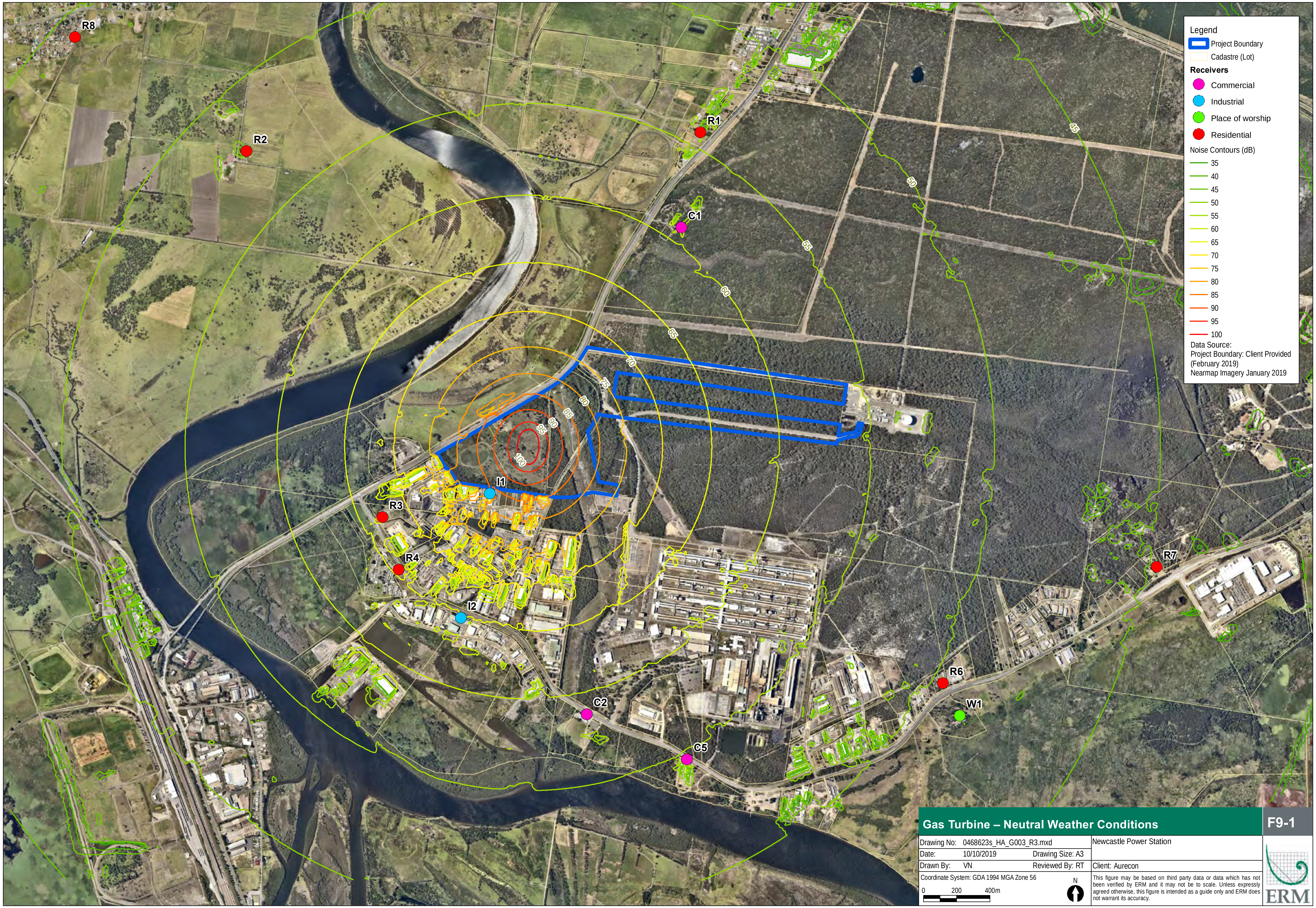
Note 2: The noise level presented is internal noise level as the noise criteria is an internal noise criteria. For the purpose of this assessment the predicted noise level has been translated to an internal level based on the accepted 10 dB attenuation that is readily achieved through windows, partially opened for ventilation.

Table 9-4: Predicted Operational Noise Levels and Compliance – Reciprocating Engine

Receptor ID	PNTLs Leq – dBA			Predicted Operational Noise Levels Leq, 15 minute – dBA			
	Day	Evening	Night	Neutral (No Noise Control)	SE Wind (No Noise Control)	Temperature Inversion (No Noise Control)	Temperature Inversion (With Noise Control)
R1	51	45	40	**52**	**56**	**57**	28
R2	42	40	35	**49**	**54**	**54**	26
R3	55	45	40	**63**	**67**	**68**	40
R4	65	55	50	**62**	**63**	**67**	38
C5	65	65	65	52	44	58	29
R6	55	45	40	**47**	**40**	**53**	24
R7	55	45	40	**41**	35	**47**	20
R8	42	40	35	**41**	**47**	**47**	20
C1	65	65	65	57	59	62	32
C2	55	55	55	**56**	49	**62**	32
I1	70	70	70	**75**	**76**	**80**	52
I2	70	70	70	62	57	67	37
W1	40[1]	40[1]	40[1]	36[2]	28[2]	**42**[2]	13[2]

Note 1: The NPI recommends that industrial noise levels do not exceed 40 dB (LAeq, 15minute) internally within places of worship when in use.

Note 2: The noise level presented is internal noise level as the noise criteria is an internal noise criteria. For the purpose of this assessment the predicted noise level has been translated to an internal level based on the accepted 10 dB attenuation that is readily achieved through windows, partially opened for ventilation.



R8
R2
R1
C1
R3
I1
R4
I2
C2
C5
R6
W1
R7
45
50
55
60
65
70
75
80
85
90
95
100
Legend
Project Boundary
Cadastre (Lot)
Receivers
Commercial
Industrial
Place of worship
Residential
Noise Contours (dB)
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Data Source:
Project Boundary: Client Provided (February 2019)
Nearmap Imagery January 2019
Gas Turbine – Neutral Weather Conditions
F9-1
Drawing No: 0468623s_HA_G003_R3.mxd
Date: 10/10/2019
Drawing Size: A3
Drawn By: VN
Reviewed By: RT
Coordinate System: GDA 1994 MGA Zone 56
0
200
400m
N
Newcastle Power Station
Client: Aurecon
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.
ERM

Gas Turbine – Noise Enhancing Conditions (Temperature Inversion)

F9-2

Drawing No: 0468623s_HA_G004_R3.mxd		Newcastle Power Station
Date: 10/10/2019	Drawing Size: A3	
Drawn By: VN	Reviewed By: RT	Client: Aurecon
Coordinate System: GDA 1994 MGA Zone 56	N	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

0 200 400m

ERM

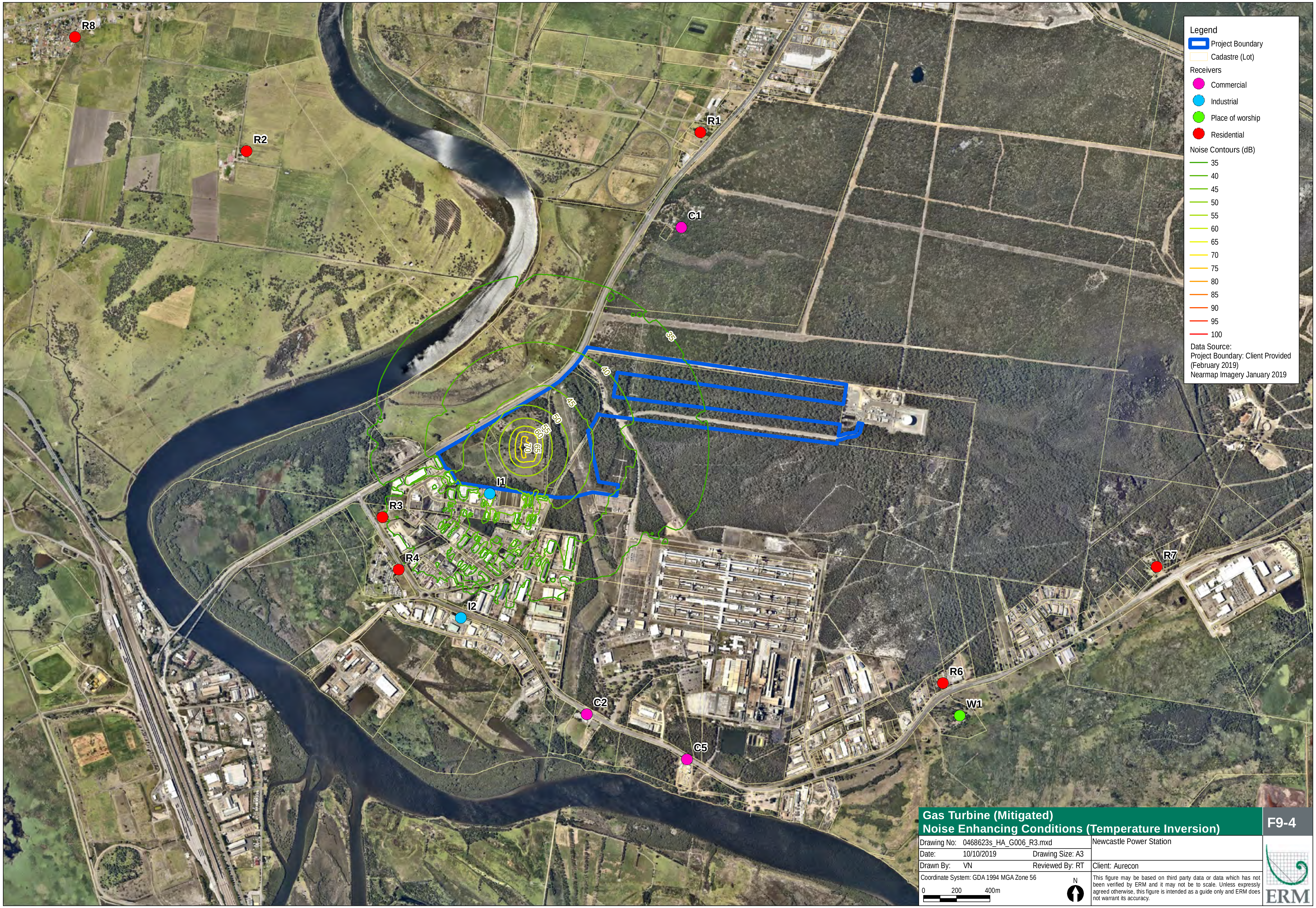
Gas Turbine – Noise Enhancing Conditions (Prevailing South-East Wind Condition)

F9-3

Drawing No:	0468623s_HA_G005_R3.mxd		Newcastle Power Station
Date:	10/10/2019	Drawing Size: A3	
Drawn By:	VN	Reviewed By: RT	Client: Aurecon

Coordinate System: GDA 1994 MGA Zone 56

ERM



Gas Turbine (Mitigated)
Noise Enhancing Conditions (Temperature Inversion)

F9-4

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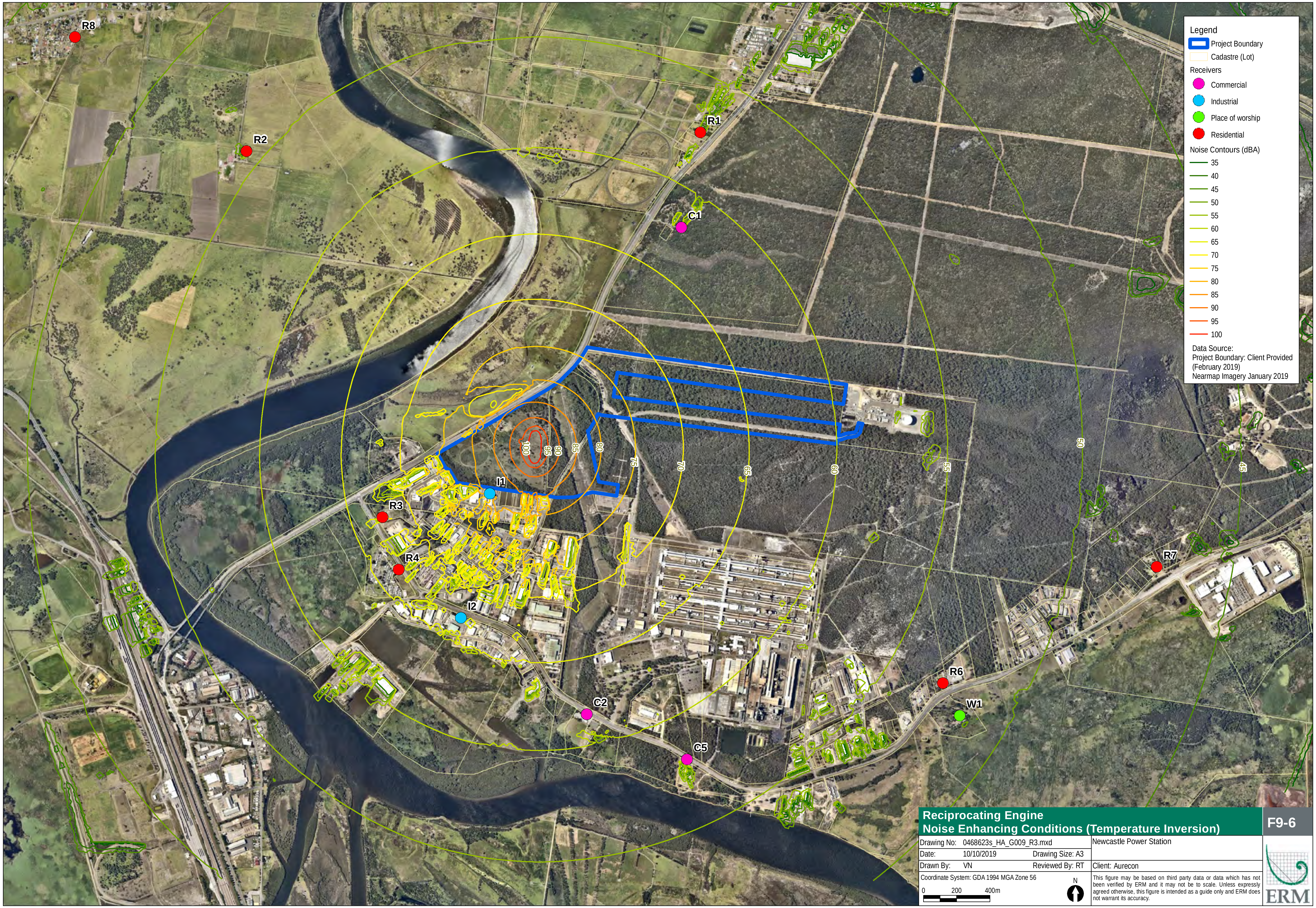
Date: 10/10/2019	Drawing Size: A3	
Drawn By: VN	Reviewed By: RT	Client: Aurecon
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Reciprocating Engine – Neutral Weather Conditions

F9-5

Drawing No: 0468623s_HA_G007_R3.mxd		Newcastle Power Station
Date: 10/10/2019	Drawing Size: A3	
Drawn By: VN	Reviewed By: RT	Client: Aurecon
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



Reciprocating Engine
Noise Enhancing Conditions (Temperature Inversion)

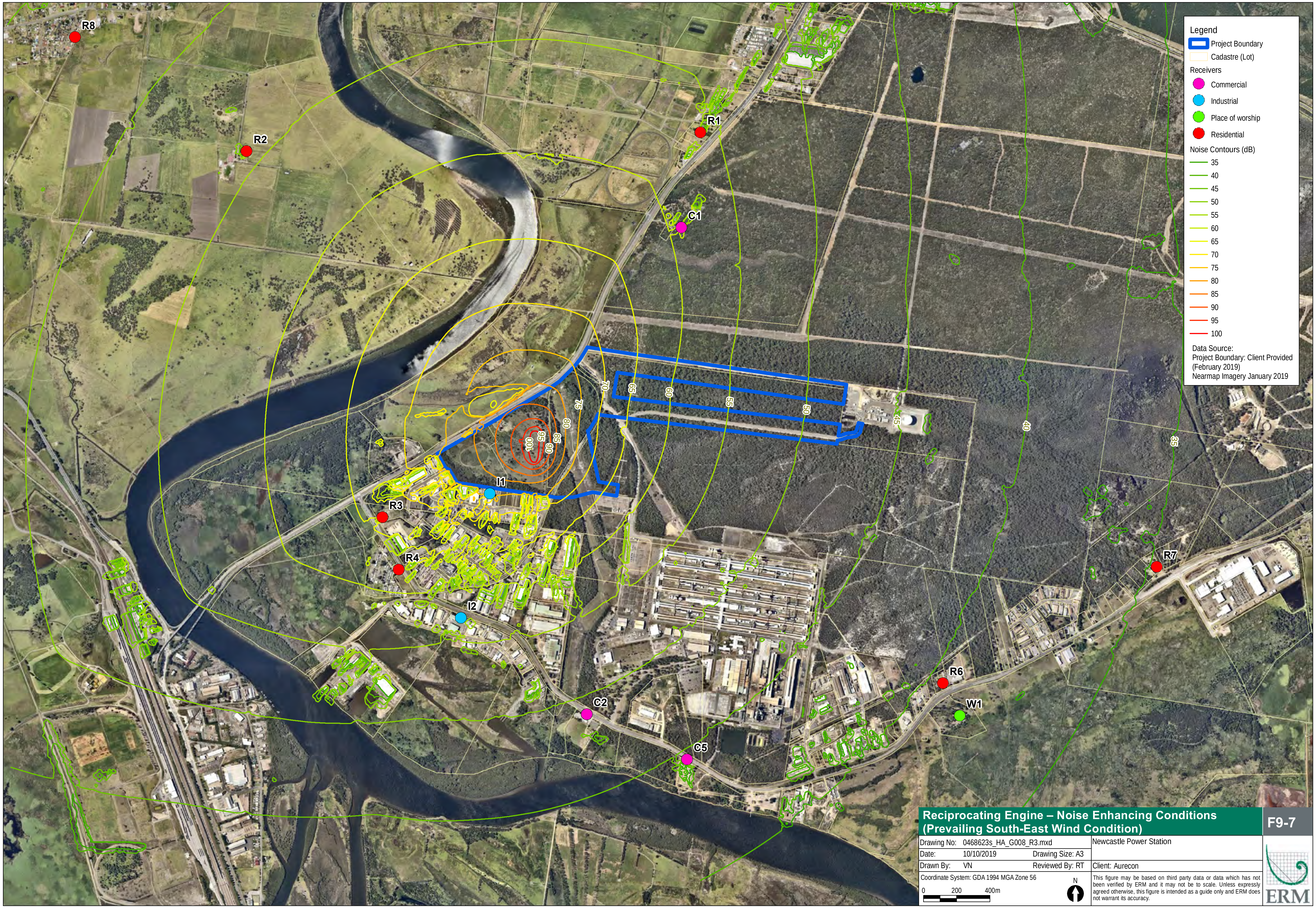
F9-6

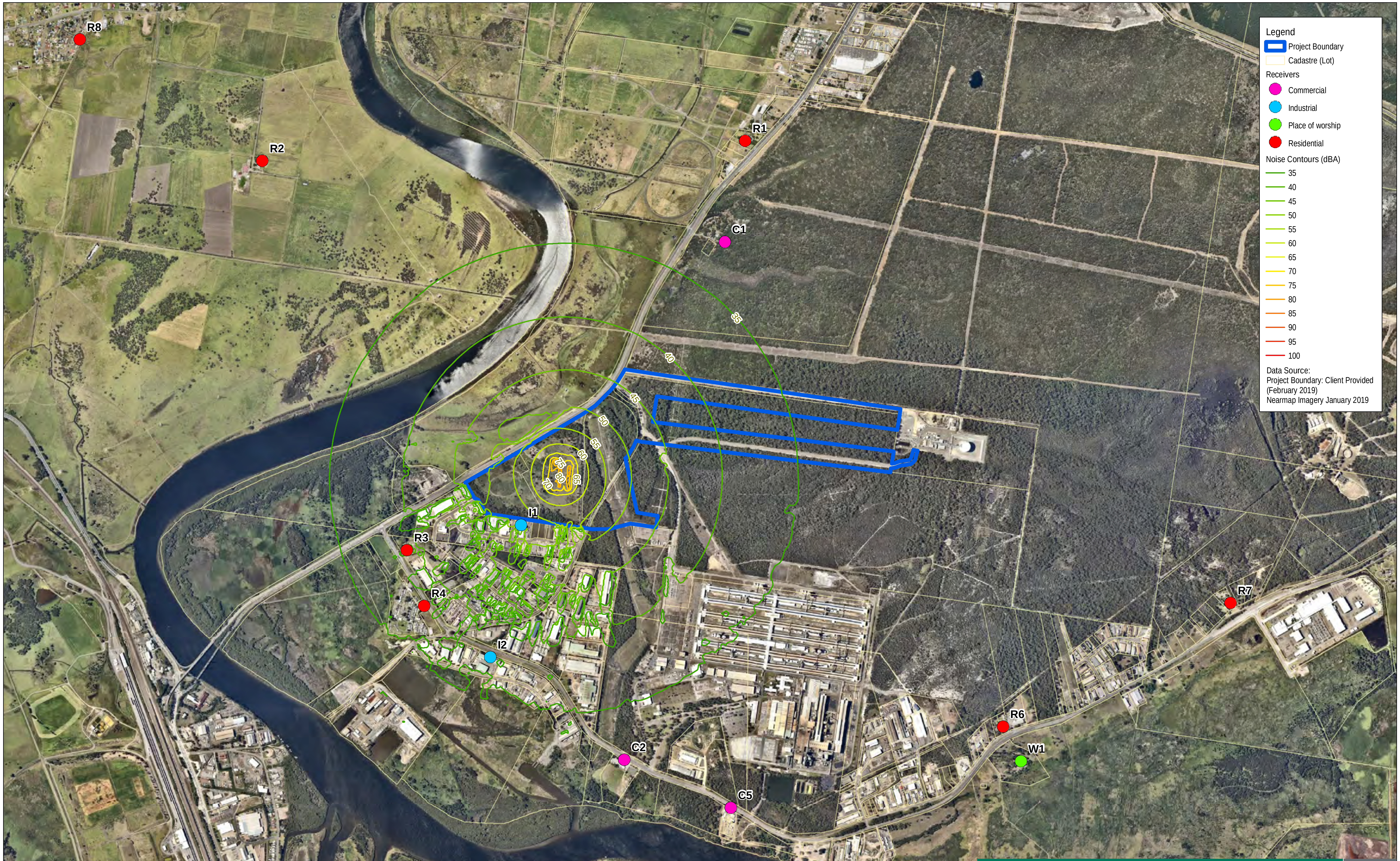
Drawing No: 0468623s_HA_G009_R3.mxd		Newcastle Power Station
Date: 10/10/2019	Drawing Size: A3	
Drawn By: VN	Reviewed By: RT	Client: Aurecon
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

0 200 400m

N

ERM


Legend
Project Boundary
Cadastre (Lot)
Receivers
Commercial
Industrial
Place of worship
Residential
Noise Contours (dB)
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Data Source:
Project Boundary: Client Provided (February 2019)
Nearmap Imagery January 2019
R8
R2
R1
C1
I1
R3
R4
I2
C2
C5
R6
W1
R7
Reciprocating Engine – Noise Enhancing Conditions (Prevailing South-East Wind Condition)
F9-7
Drawing No: 0468623s_HA_G008_R3.mxd
Date: 10/10/2019
Drawing Size: A3
Drawn By: VN
Reviewed By: RT
Coordinate System: GDA 1994 MGA Zone 56
0 200 400m
N
Newcastle Power Station
Client: Aurecon
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.



Reciprocating Engine (with Noise Control) Temperature Inversion Condition

F9-8

Drawing No: 0468623s_HA_G010_R3.mxd		Newcastle Power Station
Date: 10/10/2019	Drawing Size: A3	
Drawn By: VN	Reviewed By: RT	Client: Aurecon
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

9.5 Predicted Cumulative Noise Levels

The SEARs require an assessment of the likely interaction for the operations of the Project with existing and proposed operations in the project area including the TAC smelter facility, Newcastle Gas Storage Facility (NGSF) and RMS's M1 to Raymond Terrace Motorway Project.

Cumulative operational noise impact assessment of the Project and the existing industrial noise levels has been undertaken in this report to address this SEARs requirement.

The cumulative operational noise assessment of the Project and existing industrial noise sources has been based on the predicted noise levels presented in Section 9 and observed and reported noise levels within the project area. The predicted noise levels of the Project with noise control for the two engine technology types have been used in the comparison of noise levels.

A review of the NGSF Modification 3 *Environmental Assessment* Report (reference: J17068RP1), dated 20 October 2017, prepared by EMM Consulting, shows that the NGSF operations are inaudible at all surrounding noise sensitive receivers. This report presents observations on existing industrial noise levels in the project area for year 2017.

An environmental assessment was undertaken for the project *Capacity Increase at the Regain Spent Potlining Facility, Tomago*, dated 13 November 2018 prepared by AECOM. This report presented previous 2007 modelling for the TAC facility and included a noise contour for expanded TAC operations that was modelled in 2007 by Spectrum Acoustics. This modelling is likely out of date, but has been provided for comparison.

TAC prepared a *Statement of Environmental Effects* for the *Production Capacity Increase 585,0000 to 600,000 Tonnes Saleable Production* in August 2016. This document presented noise monitoring data for the project areas most recently from years 2014 and 2015.

Cumulative road traffic noise impact of the Project and the Roads and Maritime Services' (RMS) M1 to Raymond Terrace Motorway Project on surrounding receivers has not been assessed in this report due to insufficient information from the RMS project. Road traffic generated by the operation of the Project is expected to be due to maintenance activities, and would generate minimal additional road traffic on public roads. The M1 carries over 40,000 vehicles a day and the Project would not contribute to the cumulative road noise impact when the *M1 to Raymond Terrace Motorway Project* is in operation. Therefore, further investigation of the cumulative road traffic noise impact of the Project and the *M1 to Raymond Terrace Motorway Project* will not be required.

A comparison of predicted Project noise contributions with existing and proposed project noise levels is presented in Table 9-5.

9.5.1 Discussion

The predicted operational noise levels presented in Table 9-5 when compared with existing and proposed industrial noise indicate that receivers are primarily influenced by existing industrial noise and proposed activates. At Receivers R1, R4 and R6 contribution from the Project is not expected to result in a change in industrial noise levels. At receiver R3 the Project may result in a 1dB increase to existing levels of industrial noise, however existing industrial noise sources are the primary influence to noise levels at this location. A 1 dB contribution is not considered to be acoustically significant, as a change in 1 dB in sound is generally undetectable by the average human ear.

At receivers R2 and R8 further to the west of the project, existing industrial noise levels are low and not expected to be impacted by the Project.

Table 9-5: Predicted Cumulative Operational Noise Levels

Recept or ID	PNTLs Leq – dBA			Project Noise Contribution Leq - dBA		Existing Noise levels				NPI Amenity Noise Limit, Leq – dBA		
	Day	Eve	Night	Gas turbine (With Noise Control)	Reciprocating Engine (with noise control)	TAC modelling (2007)[1]	TAC monitoring (2014)[2]	TAC Monitoring (2015)[2]	NGSF monitoring (2017)[3]	Day	Eve	Night
R1	51	45	40	27	28	approx. 40	-	-	-	60	50	45
R2	42	40	35	25	26	-	-	-	-	50	45	40
R3	55	45	40	39	40	approx. 45	-	-	-	60	50	45
R4	65	55	50	37	38	47	46	48	45	65	55	50
C5	65	65	65	27	29	57	52	50		65	65	65
R6	55	45	40	23	24	approx. 45	33	37	40	60	50	45
R7	55	45	40	18	20	approx. 40	-	-	-	60	50	45
R8	42	40	35	19	20	-	-	-	-	50	45	40
C1	65	65	65	31	32	Approx 42	-	-	<37	65	65	65
C2	55	55	55	31	32	53	-	-	-	55	55	55

Note 1. noise levels referenced from esimated from Capacity Increase at the Regain Spent Potlining Facility, Tomago, dated 13 November 2018 prepared by AECOM. Approximated values estimated from noise contours

Note 2. TAC noise monitoring presented in the Statement of Environmental Effects, Tomago Aluminium Company 2016.

Note 3. NGSF industrial noise levels estimated from monitoring presented in the NGSF Modification 3 Environmental Assessment Report, EMM Consulting 2017.

10. RECOMMENDATIONS AND MITIGATION MEASURES

This section presents recommendations for construction and operational noise reducing mitigation, management measures, safeguards and/or provisions for monitoring. The recommended safeguards are provided to assist manage any design changes or equipment specifications that occur subsequent to this study. All recommendations are based on the predicted noise levels and evaluations of the magnitude and extent of potential impacts identified in Section 6 (for construction) and Section 9 (for operations) of this report.

They are designed to ensure that construction and operational noise emissions are maintained within acceptable levels at all receptors as far as may be feasible, reasonable and practical to implement. These recommendations also provide a general reassurance that suitable safeguards and provisions for monitoring are documented in this report to manage construction and operational noise if other issues arise.

10.1 Construction Noise

Based on the findings presented in Section 6, all predicted construction noise levels for all scenarios are well within the ICNG NMLs at all receptors, no additional noise control measures are necessary. That said, the following construction noise control measures are recommended to ensure that the predicted compliance are maintained:

- Noise generating work and activities should be (as proposed) limited (where possible) to the ICNG recommended standard hours (i.e. 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturdays and no work on Sundays or public holidays). Any unforeseen work that is required outside the recommended standard hours should be suitably mitigated and managed with a goal of achieving negligible noise levels at all residential receptors or undertaken with agreement from the appropriate consent authority.
- Where unforeseen works are likely to be occurring close to a receptor, and these works are anticipated to generate high levels of noise e.g. > 75 dBA, potential respite periods, e.g. three hours of work, followed by one hour of respite should be applied. Respite should be implemented if it is the preference of the affected receptor/s and if they are feasible and reasonable, and practical, to implement during the works. In some circumstances respite may extend the duration of works and inadvertently increase noise impacts; hence due care should be taken when considering this management measure.
- During the construction design, choose appropriate plant, equipment and/or machinery for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site.
- During the works, avoid unnecessary noise due to idling engines, and high engine speeds when equipment can be powered down and/or lower speeds are sufficient.
- During the works, instruct drivers to travel directly to the site and avoid any extended periods of engine idling at or near residential areas, especially at night.
- During the works, ensure all plant, equipment and/or machinery used on the site are in suitable condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site.
- During the works, seek to minimise triggering alarms that are typically required when these items are used in reverse. Where it is possible tonal motion alarms could be replaced with broadband “squash duck” motion alarms. If any unforeseen night works must occur, all activities with the potential to generate impulsive noise should be avoided. These types of events; especially at night have the limited potential to generate sleep disturbance or awakening impacts.

- If any validated noise complaints are received, operator attended noise validation and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the NMLs presented in this report. All site noise levels should be measured in the absence of any influential source not associated with the Project. If the measured site noise levels are below the predicted values and comply with the NMLs presented in this report, no further mitigation or management measures are required. If the measured site noise levels are above the predicted noise levels or NML presented in this report, further mitigation and/or management measures should be considered.

10.2 Additional Mitigation Measures working outside standard hours

Although out of hours construction works are not anticipated to result in noise exceedances, an out of hours work protocol may be considered an additional safeguard for working outside standard hours. The Construction Noise and Vibration Guideline (Roads and Maritime 2016) provides a framework for the implementation of mitigation measures dependent on the period impacted (such as evening, night time or weekends) and the magnitude of impact above background (RBL) during the specific period.

Adopting this framework, the level of noise impact expected (below noise criteria, but potentially noticeable) would trigger the requirement to notify residents where works are potentially noticeable. Additional mitigation measures such as verification noise monitoring, respite periods or specific notification are not anticipated, however could be implemented where additional works of a greater noise emission are being considered.The guideline states that these mitigation measures are more applicable to short term construction activities, as these measures may become less effective with increasing durations of works however given the intermittent requirement for out of hours works, it is expected that this approach to noise mitigation measures will be appropriate.

10.3 Construction Vibration

Where activities using significant sources of vibration (i.e. hydraulic hammers and vibratory rollers) occur within close proximity to structures and identified receivers, potential impacts are likely to be increased. In this case, the following mitigation measures are recommended for consideration:

- Substitution of methods of high vibration/impact emission to lower vibration/impact methods i.e. use smaller machine or lower mode.
- Preparation and implementation of a Construction Noise and Vibration Management Plan (CNVMP) to identify detailed assessment methods for high risk works, identify affected receivers, complaints handling and consultation protocols.
- Undertaking trial measurements to establish the site specific vibration propagation from higher risk activities to establish site specific offset distances required.
- Alternatives to high vibration source plant and equipment should be used where reasonable and feasible.

Where vibration monitoring is undertaken and any criteria exceedances identified, management measures should be implemented to ensure vibration compliance is achieved.

10.4 Road Traffic

Construction and operational traffic noise management should also be included in the CNVMP and operational environment management plan to be prepared prior to commencement of works on site. It is anticipated this may include: site awareness training / environmental inductions for construction staff and transport contracts that consists of a section on travelling to site/from the site to minimise traffic noise impacts on the surrounding community.

10.5 Operational Noise

Based on the findings presented in Section 9.3, the Project's worst-case operations without any sound attenuation would likely exceed the PNTLs at most surrounding receivers.

Where sound attenuation is considered, the findings show that the Project would likely comply with the PNTLs at all surrounding receivers.

It is recommended that the plant/equipment to be installed as part of the Project are to have sound power levels not exceeding those presented as "Attenuated Sound Power Level" in Table 9-2.

It is further recommended that a commitment is made to comply with the attenuated levels and to demonstrate how the attenuated levels would be achieved. If there are exceedances notwithstanding the attenuation, then we suggest that either further attenuation is considered to avoid the exceedances, or additional analysis as to the (in)significance of the exceedances is included.

10.5.1 Safeguards & Provisions

Given that operational compliance has been attained with the proposed design options, the following safeguards and provisions are provided.

- During plant / equipment procurement, primary noise generating equipment should achieve the attenuated sound power levels specified in Table 9-2.
- If any validated noise complaints are received, operator attended noise validation, and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the PNTLs presented in this report:
    - All site noise levels should be measured in the absence of any influential source not associated with the Project; and

In the event measured site noise levels exceed the predicted noise levels or PNTLs presented in this report then further mitigation and/or management measures should be considered. Noise mitigation measures might be, but not limited to, silencers, lined ducts, acoustic enclosures or noise screens/barriers or a combination of the above.

11. CONCLUSIONS

This noise impact assessment was completed on behalf of AGL for a dual fuel fired power station located in Tomago, New South Wales (NSW).

The assessment was conducted to achieve a scope of works that allowed for the successful identification of potential receptors situated in the vicinity and potential area of influence of site emission sources and identification of significant noise generating plant, equipment and/or activities associated with the project and their likely/known emissions.

Baseline unattended noise monitoring was undertaken in order to assess the existing ambient noise environment. This is presented in Section 3. The site specific noise criteria for the construction and operation of the site are presented in Section 5. This criteria was developed with due regard to and in accordance with recognised NSW standards and guidelines as applicable to the Projects construction and operational activities.

Applicable construction and operational assessment scenarios were developed based on Project information provided by AGL and noise levels were predicted and compared to NMLs and criteria to establish compliance, evaluate potential impacts and establish potential mitigation/management measures where necessary to reduce levels and minimise impacts.

The construction and operational noise assessments are presented in Section 6 and Section 9 respectively of this report.

The construction assessment has identified that construction noise levels for all scenarios are predicted to achieve compliance with the ICNG NMLs at all identified receptors. That said, noise control measures have been recommended to be implemented where reasonable and feasible to ensure that the construction noise emissions are maintained below the NMLs. The recommended noise control measures are outlined in Section 10 of this report.

Worst case operational noise levels were predicted for both a reciprocating engine and gas turbine design option based on information provided by AGL. Based on the findings of the operational noise assessment, The Project’s operational noise for both design options without any sound attenuation would potentially exceed the PNTLs at most surrounding receivers. Where sound attenuation is considered, the finding show that the Project’s operational noise is likely to comply with the PNTLs at all surrounding receivers. As such, attenuated sound power levels for key noise emitting equipment has been recommended in Table 9-2. General operational safeguards and provisions have also been provided in Section 10 to ensure compliance.

Noise impacts from construction and operation of Project are not predicted to impact the Hunter Estuary Wetlands approximately 2.4km south and 4.4km east of the project. Construction noise levels are anticipated to be within similar ranges to existing industrial noise levels, and operational noise emissions are not expected to increase existing industrial noise levels with the Project.

The predicted operational noise levels when compared with existing and proposed industrial noise indicate that receivers are primarily influenced by existing industrial noise and proposed activates. At Receivers R1, R4, R5 and R6 contribution from the Project is not expected to result in a change in industrial noise levels. At receiver R3 the Project may result in a 1dB increase to existing levels of industrial noise, however existing industrial noise sources are the primary influence to noise levels at this location.

12. REFERENCES

AECOM *Environmental Assessment Capacity Increase at the Regain Spent Potlining Facility, Tomago*, dated 13 November 2018

British Standard – BS5228-2:2009+A1:2014 (BS5228) – *Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration*.

British Standard (BS 6472–1992) – *Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*, dated 1992.

British Standard BS7385: Part 2-1993 (BS 7385) - *Evaluation and Measurement for Vibration in Buildings — Part 2 – Guide to Damage Levels from Ground-borne Vibration*, dated 1993.

CONCAWE Report No. 4/81, Manning C.J., 1981, *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*.

Department of Environment and Energy *Australian Wetland database* (searched October 2019)

EMM Consulting *NGSF Modification 3 Environmental Assessment Report* (reference: J17068RP1), dated 20 October 2017,

German Institute for Standardisation – DIN 4150 (1999-02) Part 3 (DIN4150:3) – *Structural Vibration - Effects of Vibration on Structures*, dated 1999.

International Organisation for Standardisation (ISO) 9613-2:1996 (ISO9613:2) - *Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation*.

NSW Department of Environment and Climate Change – *NSW Interim Construction Noise Guideline* (ICNG), July 2009.

NSW Department of Environment and Conservation – *NSW Environmental Noise Management – Assessing Vibration: a Technical Guideline (the NSW Vibration Guideline)*, February 2006.

NSW Department of Environment, Climate Change and Water – *NSW Road Noise Policy* (RNP), March 2011.

NSW Environment Protection Authority – *NSW Noise Policy for Industry* (NPI), October 2017 and relevant application notes.

Seca Solution *Newcastle Power Station Traffic Impact Assessment* October 2019

Standards Australia AS1055–2018™ (AS1055) – Description and Measurement of Environmental Noise.

Standards Australia AS 2436–2010™ (AS2436) – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.

Tomago Aluminium Company *Statement of Environmental Effects* for the *Production Capacity Increase 585,0000 to 600,000 Tonnes Saleable Production* in August 2016

APPENDIX A ACOUSTICAL CONCEPTS AND TERMINOLOGY

What Is Noise And Vibration?

Noise

Noise is often defined as a sound, especially one that is loud or unpleasant or that causes disturbance[1] or simply as unwanted sound, but technically, noise is the perception of a series of compressions and rarefactions above and below normal atmospheric pressure.

Vibration

Vibration refers to the oscillating movement of any object. In a sense noise is the movement of air particles and is essentially vibration, though in regards to an environmental assessment vibration is typically taken to refer to the oscillation of a solid object(s). The impact of noise on objects can lead to vibration of the object, or vibration can be experienced by direct transmission through the ground, this is known as ground-borne vibration.

Essentially, noise can be described as what a person hears, and vibration as what they feel.

What Factors Contribute To Environmental Noise?

The noise from an activity, like construction works, at any location can be affected by a number of factors, the most significant being:

- How loud the activity is?
- How far away the activity is from the receiver?
- What type of ground is between the activity and the receiver location e.g. concrete, grass, water or sand?
- How the ground topography varies between the activity and the receiver? For example, is it flat, hilly, mountainous? Blocking the line of sight to a noise source will generally reduce the level of noise; and
- Any other obstacles that block the line of sight between the source to receiver e.g. buildings or purpose built noise walls.

How To Measure And Describe Noise?

Noise is measured using a specially designed 'sound level' meter which must meet internationally recognised performance standards. Audible sound pressure levels vary across a range of 10^7 Pascals (Pa), from the threshold of hearing at 20μPa to the threshold of pain at 200Pa. Scientists have defined a statistically described logarithmic scale called Decibels (dB) to more manageably describe noise.

To demonstrate how this scale works, the following points give an indication of how the noise levels and differences are perceived by an average person:

- 0 dB - represents the threshold of human hearing (for a young person with ears in good condition).
- 50 dB – represents average conversation.
- 70 dB – represents average street noise, for example local traffic.
- 90 dB – represents the noise inside an industrial premises or factory.
- 140 dB - represents the threshold of pain – the point at which permanent hearing damage may occur.

[1] Copyright © 2011 Oxford University Press

Human Response to Changes in Noise Levels

The following concepts offer qualitative guidance in respect of the average response to changes in noise levels:

- Differences in noise levels of less than approximately 2 dBA are generally imperceptible in practice, an increase of 2 dBA is hardly perceivable.
- Differences in noise levels of around 5 dBA are considered to be significant.
- Differences in noise levels of around 10 dBA are generally perceived to be a doubling (or halving) of the perceived loudness of the noise. An increase of 10 dBA is perceived as twice as loud. Therefore an increase of 20 dBA is four times as loud and an increase of 30 dBA is eight times as loud.
- The addition of two identical noise levels will increase the dBA level by about 3 dBA. For example, if one car is idling at 40 dBA and then another identical car starts idling next to it, the total noise level will be about 43 dBA.
- The addition of a second noise level of similar character which is at least 8 dBA lower than the existing noise level will not add significantly to the overall dBA level.
- A doubling of the distance between a noise source and a receiver results approximately in a 3 dBA decrease for a line source (for example, vehicles travelling on a road) and a 6 dBA decrease for a point source (for example, the idling car discussed above).
- A doubling of traffic volume for a line source results approximately in a 3 dBA increase in noise, halving the traffic volume for a line source results approximately in a 3 dBA decrease in noise.

Terms to Describe the Perception of Noise

The following terms offer quantitative and qualitative guidance in respect of the audibility of a noise source:

- **Inaudible / Not Audible** - the noise source and/or event could not be heard by the operator, masked by extraneous noise sources not associated with the source. If a noise source is 'inaudible' its noise level may be quantified as being less than the measured L_{90} background noise level, potentially by 10 dB or greater.
- **Barely Audible** – the noise source and/or event are difficult to define by the operator, typically masked by extraneous noise sources not associated with the source. If a source is 'barely audible' its noise level may be quantified as being 5 - 7 dB below the measured L_{90} or L_{eq} noise level, depending on the nature of the source e.g. constant or intermittent.
- **Just Audible** – the noise source and/or event may be defined by the operator. However there are a number of extraneous noise sources contributing to the measurement. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.
- **Audible** - the noise source and/or event may be easily defined by the operator. There may be a number of extraneous noise sources contributing to the measurement. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.
- **Dominant** – the noise source and/or event are noted by the operator to be significantly 'louder' than all other noise sources. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.

The following terms offer qualitative guidance in respect of acoustic terms used to describe the frequency of occurrence of a noise source during an operator attended environmental noise measurements:

- **Constant** – this indicates that the operator has noted the noise source(s) and/or event to be constantly audible for the duration of the noise measurement e.g. an air-conditioner that runs constantly during the measurement.
- **Intermitten**t – this indicates that the operator has noted the noise source(s) and/or event to be audible, stopping and starting intervals for the duration of the noise measurement e.g. car pass-by's.
- **Infrequent** – this indicates that the operator has noted the noise source(s) and/or event to be constantly audible, however; not occurring regularly or at intervals for the duration of the noise measurement e.g. a small number of aircraft are noted during the measurement.

How to Calculate or Model Noise Levels?

There are two recognised methods which are commonly adopted to determine the noise at particular location from a proposed activity. The first is to undertake noise measurements whilst the activity is in progress and measure the noise, the second is to calculate the noise based on known noise emission data for the activity in question.

The second option is preferred as the first option is largely impractical in terms of cost and time constraints, notwithstanding the meteorological factors that may also influence its quantification. Furthermore, it is also generally considered unacceptable to create an environmental impact simply to measure it. In addition, the most effective mitigation measures are determined and implemented during the design phase and often cannot be readily applied during or after the implementation phase of a project.

Because a number of factors can affect how 'loud' a noise is at a certain location, the calculations can be very complex. The influence of other ambient sources and the contribution from a particular source in question can be difficult to ascertain. To avoid these issues, and to quantify the direct noise contribution from a source/site in question, the noise level is often calculated using noise modelling software packages. The noise emission data used in may be obtained from the manufacturer or from ERM's database of measured noise emissions.

Acoustic Terminology & Statistical Noise Descriptors

Environmental noise levels such as noise generated by industry, construction and road traffic are commonly expressed in dBA. The A-weighting scale follows the average human hearing response and enables comparison of the intensity of noise with different frequency characteristics. Time varying noise sources are often described in terms of statistical noise descriptors. The following descriptors are commonly used when assessing noise and are referred to throughout this acoustic assessment:

- **Decibel (dB is the adopted abbreviation for the decibel)** – the unit used to describe sound levels and noise exposure. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.
- **dBA** – the unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
- **dBC** – the unit used to measure 'C-weighted' sound pressure levels. C-weighting is an adjustment made to sound-level measurements which takes account of low-frequency components of noise within the audibility range of humans.
- **dBZ or dBL** – the unit used to measure 'Z-weighted' sound pressure levels with no weighting applied, linear.

- **Hertz (Hz)** - the measure of frequency of sound wave oscillations per second. 1 oscillation per second equals 1 hertz.
- **Octave –** a division of the frequency range into bands, the upper frequency limit.
- **1/3 Octave** – single octave bands divided into three parts.
- **L_{eq}** - this level represents the equivalent or average noise energy during a measurement period. The $L_{eq, 15\ minute}$ noise descriptor simply refers to the L_{eq} noise level calculated over a 15 minute period. Indeed, any of the below noise descriptors may be defined in this way, with an accompanying time period (e.g. $L_{10, 15\ minute}$) as required.
- **L_{max}** - the absolute maximum noise level in a noise sample.
- **L_N -** the percentile sound pressure level exceeded for N% of the measurement period calculated by statistical analysis.
- **L_{10} -** the noise level exceeded for 10 per cent of the time and is approximately the average of the maximum noise levels.
- **L_{90}** - the noise level exceeded for 90 per cent of the time and is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the "background" noise level and is commonly used as a basis for determining noise criteria for assessment purposes.
- **Sound Power Level (L_W)** - this is a measure of the total power radiated by a source. The Sound Power of a source is a fundamental property of the source and is independent of the surrounding environment.
- **Sound Pressure Level (L_P) -** the level of sound pressure; as measured at a distance by a standard sound level meter with a microphone. This differs from Lw in that this is the received sound as opposed to the sound 'intensity' at the source.
- **Background noise** – the underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{90} descriptor.
- **Ambient noise** – the all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far. This is described using the L_{eq} descriptor.
- **Assessment Background Level (ABL)** - is a single figure background level representing each assessment period (day, evening and night). Its determination is by the tenth percentile method, of the measured L_{90} statistical noise levels.
- **Rating Background Level (RBL) -** is the overall single figure background level representing each assessment period (day, evening and night) over the whole monitoring period (as opposed to over each 24 hour period used for the ABL). This is the level used for assessment purposes. It is the median value of:
  - All the day assessment background levels over the monitoring period for the day;
  - All the evening assessment background levels over the monitoring period for the evening; or
  - All the night assessment background levels over the monitoring period for the night.
- **Cognitive noise** – noise in which the source is recognised as being annoying.
- **Masking** – the phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street.

- **Extraneous noise** – noise resulting from activities that are not typical of the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
- **Most affected location(s)** – locations that experience (or will experience) the greatest noise impact from the noise source under consideration. In determining these locations, one needs to consider existing background levels, exact noise source location(s), distance from source (or proposed source) to receiver, and any shielding between source and receiver.
- **Noise criteria** – the general set of non-mandatory noise level targets for protecting against intrusive noise (for example, background noise plus 5 dB) and loss of amenity (for example, noise levels for various land uses).
- **Noise limits** – enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.
- **Project Specific Noise Levels** – target noise levels for a particular noise generating facility. They are based on the most stringent of the intrusive criteria or amenity criteria. Which of the two criteria is the most stringent is determined by measuring the level and nature of existing noise in the area surrounding the actual or propose noise generating facility.
- **Compliance** – the process of checking that source noise levels meet with the noise limits in a statutory context.
- **Non-compliance** – development is deemed to be in non-compliance with its noise consent/ licence conditions if the monitored noise levels exceed its statutory noise limit by more than 2 dBA, dBC or dBZ.
- **Feasible and Reasonable measures** – feasibility relates to engineering considerations and what is practical to build. reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors:
  - Noise mitigation benefits (amount of noise reduction provided, number of people protected);
  - Cost of mitigation (cost of mitigation versus benefit provided);
  - Community views (aesthetic impacts and community wishes);
  - Noise levels for affected land uses (existing and future levels, and changes in noise levels).
- **Meteorological Conditions** – wind and temperature inversion conditions.
- **Temperature Inversion** – an atmospheric condition in which temperature increases with height above the ground.
- **Adverse Weather** – weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

Operator Attended Noise Measurements

Table A.1 below presents typical abbreviations that are used to describe common noise sources that may be noted during environmental noise measurements.

Table A.1 General Field Note Abbreviations

Noise Source	Abbreviation
'Wind-blown vegetation'	WBV
'Car pass-by'	CP
'Operator Noise'	OP
'Animal Noise'	AN
'Distant Traffic'	DT
'Near Traffic'	NT
'Aircraft Noise'	AN
'Metal on Metal contact'	MMC

During operator attended noise measurements, the sound level meter will present the instantaneous noise level and record acoustical and statistical parameters. In certain acoustical environments, where a range of noise sources are audible and detectable, the sound level meter cannot measure a direct source noise level and it is often necessary to account for the contribution and duration of the sources.

Noted Percentile Contribution – *Table A.2* presents noise level deductions that are typically applied based on the percentage contribution of a noise source(s). **Noted Time Contribution** – *Table A.3* presents noise level deductions that may be applied based on the percentage of time that a noise source(s) is audible during a 15 minute measurement.

Where the noise emission from a source is clearly detectable and the contribution can be measured, these deductions are not necessary.

Table A.2 Noise Level Deductions – Noted Percentile Contribution

Percentage Contribution	Noise Level Adjustment, dBA
5%	-13.0
10%	-10.0
15%	-8.2
20%	-7.0
25%	-6.0
30%	-5.2
35%	-4.6
40%	-4.0
45%	-3.5
50%	-3.0
55%	-2.6
60%	-2.2
65%	-1.9
70%	-1.5
75%	-1.2
80%	-1.0
85%	-0.7
90%	-0.5
95%	-0.2
100%	0.0

1. **EXAMPLE:** the measured $L_{eq,\ 15\ minute}$ noise level is 49 dBA and the site contribution was observed to be 10% of this level (extraneous noise sources were noted to dominate the measurement), therefore the $L_{eq,\ 15\ minute}$ noise level deduction is 10 dBA, with a resultant noise level contribution of approximately 39 dBA.

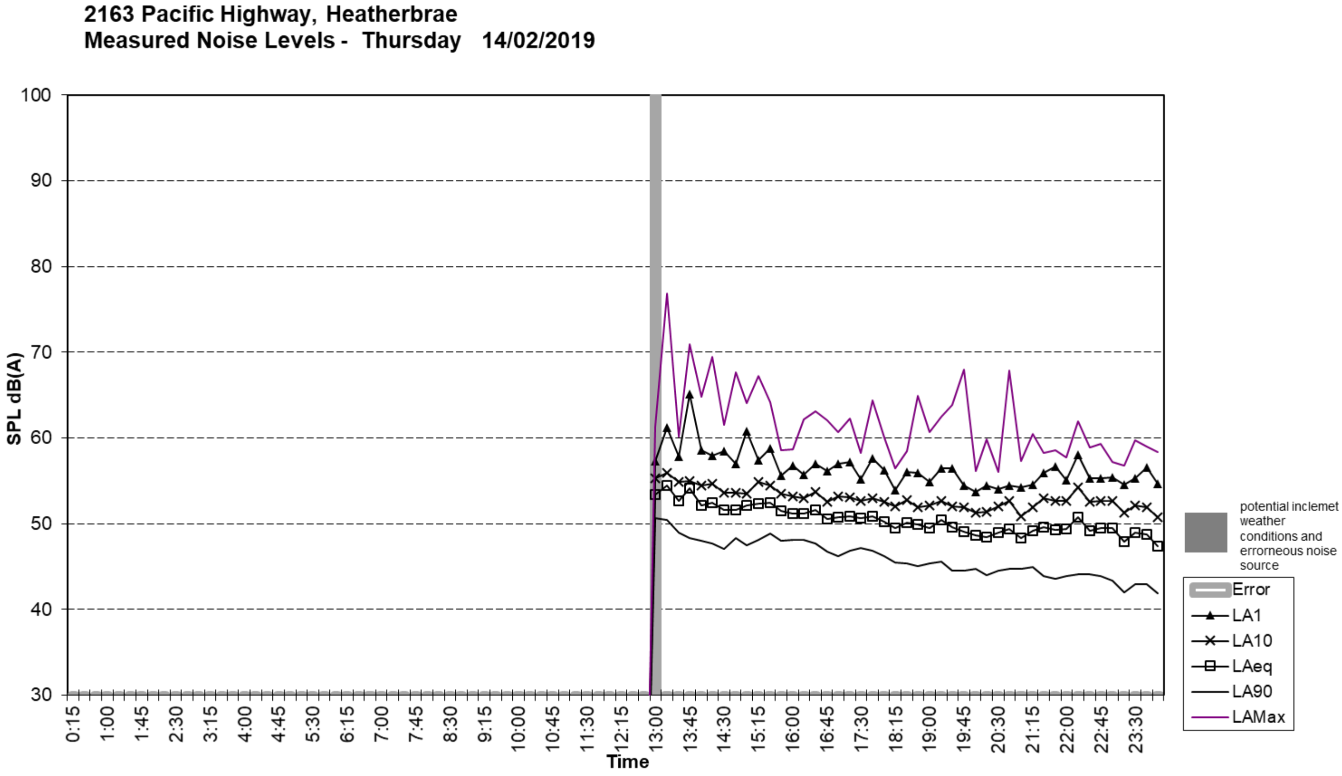
Table A.3 Noise Level Deductions – Noted Time Contribution

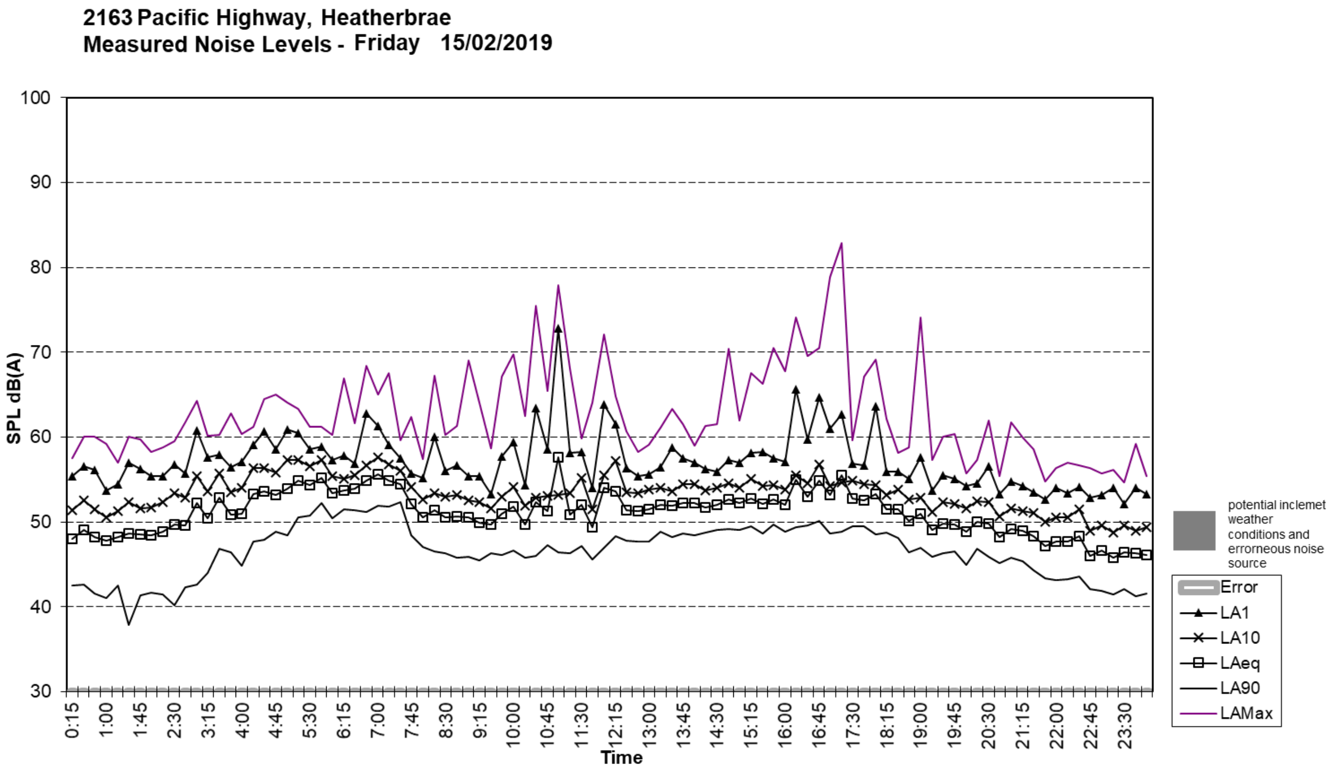
Event Duration (minutes)	Noise Level Adjustment, dBA
1	-11.8
2	-8.8
3	-7.0
4	-5.7
5	-4.8
6	-4.0
7	-3.3
8	-2.7
9	-2.2
10	-1.8
11	-1.3
12	-1.0
13	-0.6
14	-0.3
15	0.0

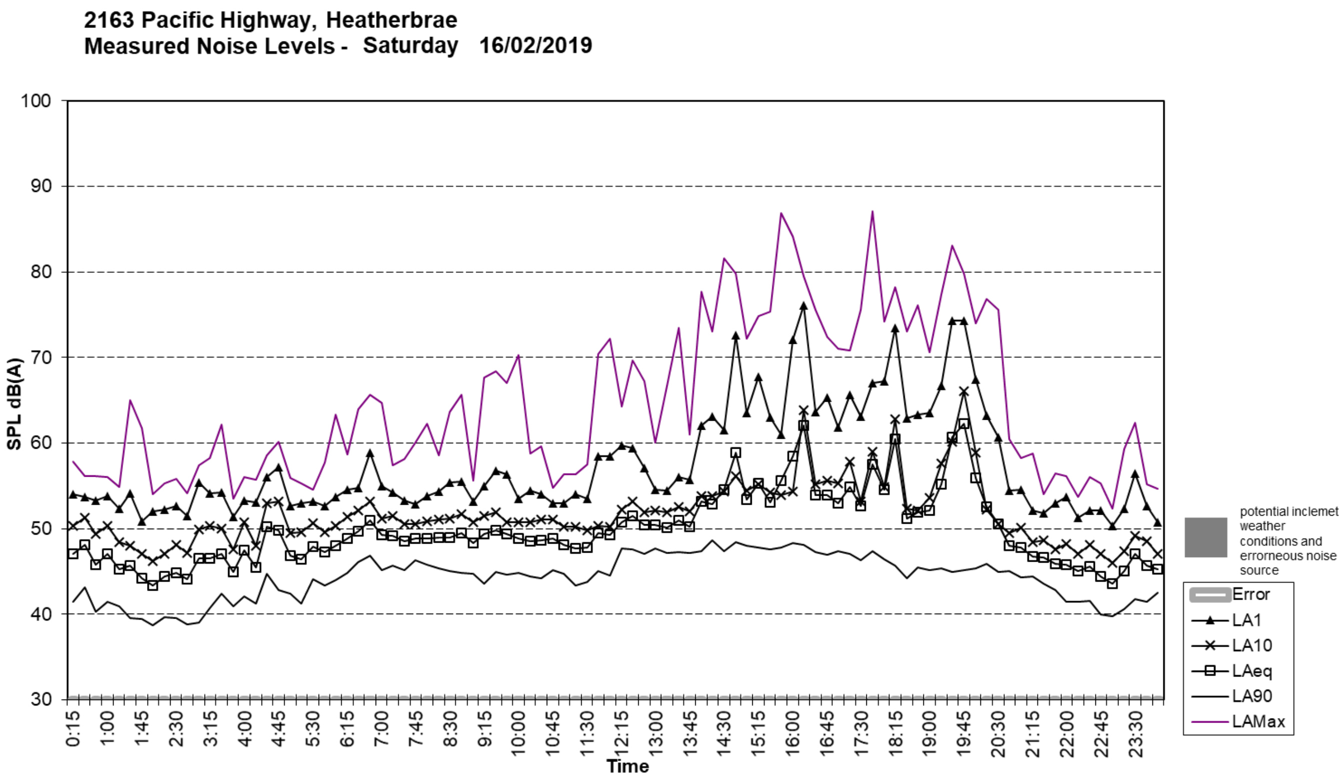
1. **EXAMPLE:** the measured $L_{eq,\ 15\ minute}$ noise level contribution of an excavator was noted to be 56 dBA, however it was only audible for six minutes during the 15 minute measurement period, therefore the $L_{eq,\ 15\ minute}$ noise level deduction is 4 dBA, with a resultant noise level contribution of approximately 52 dBA.

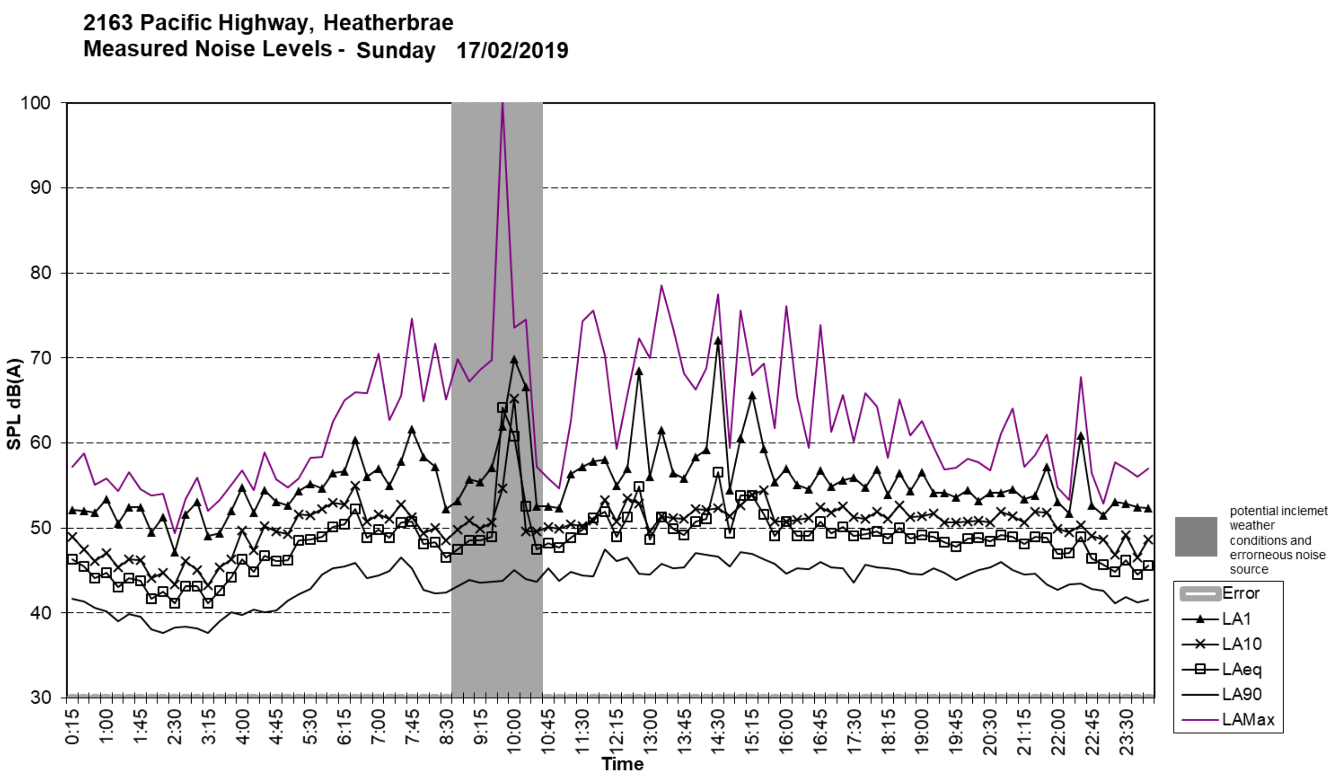
APPENDIX B UNATTENDED NOISE MONITORING

L1 – 2171 Pacific Highway, Heatherbrae

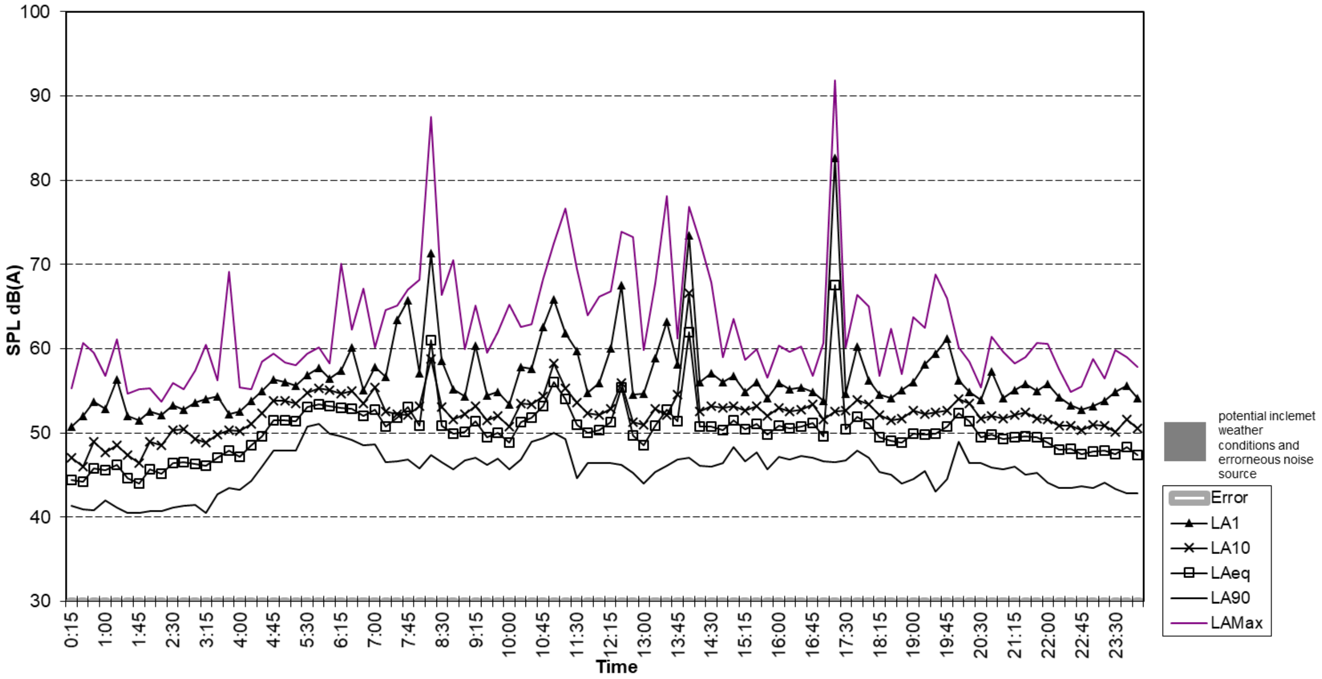




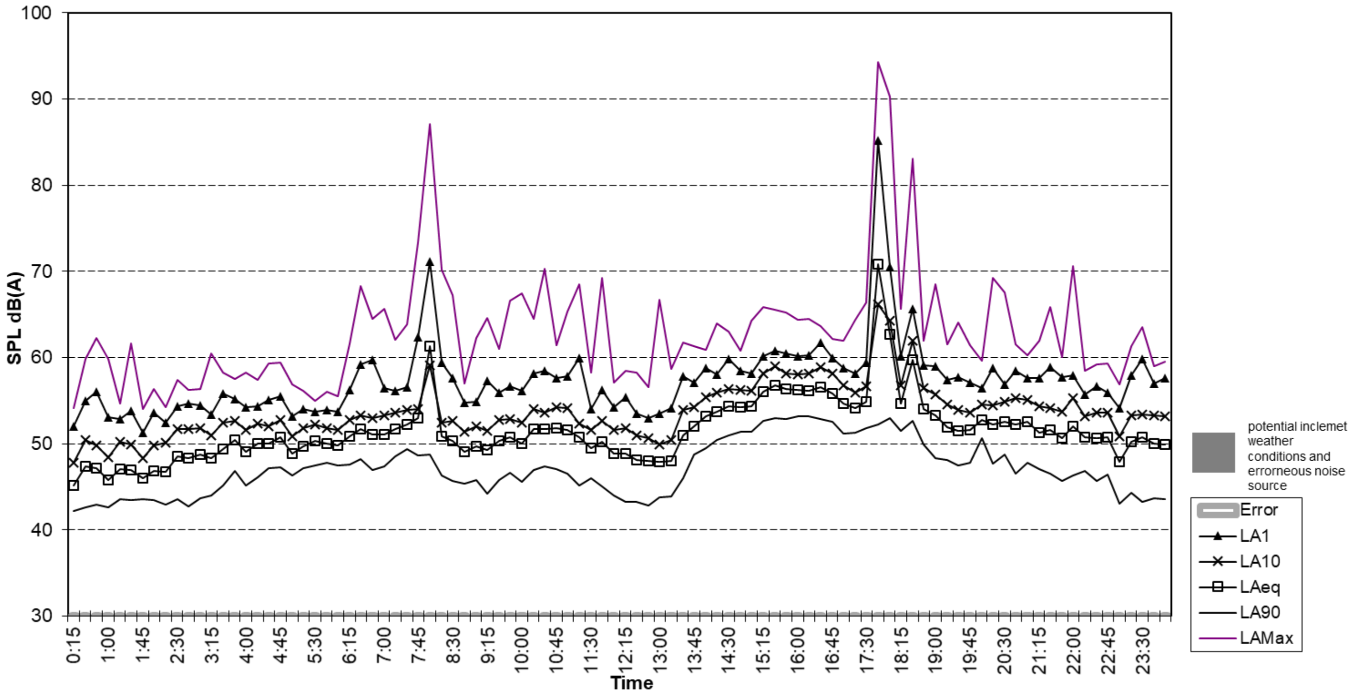

2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Saturday 16/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

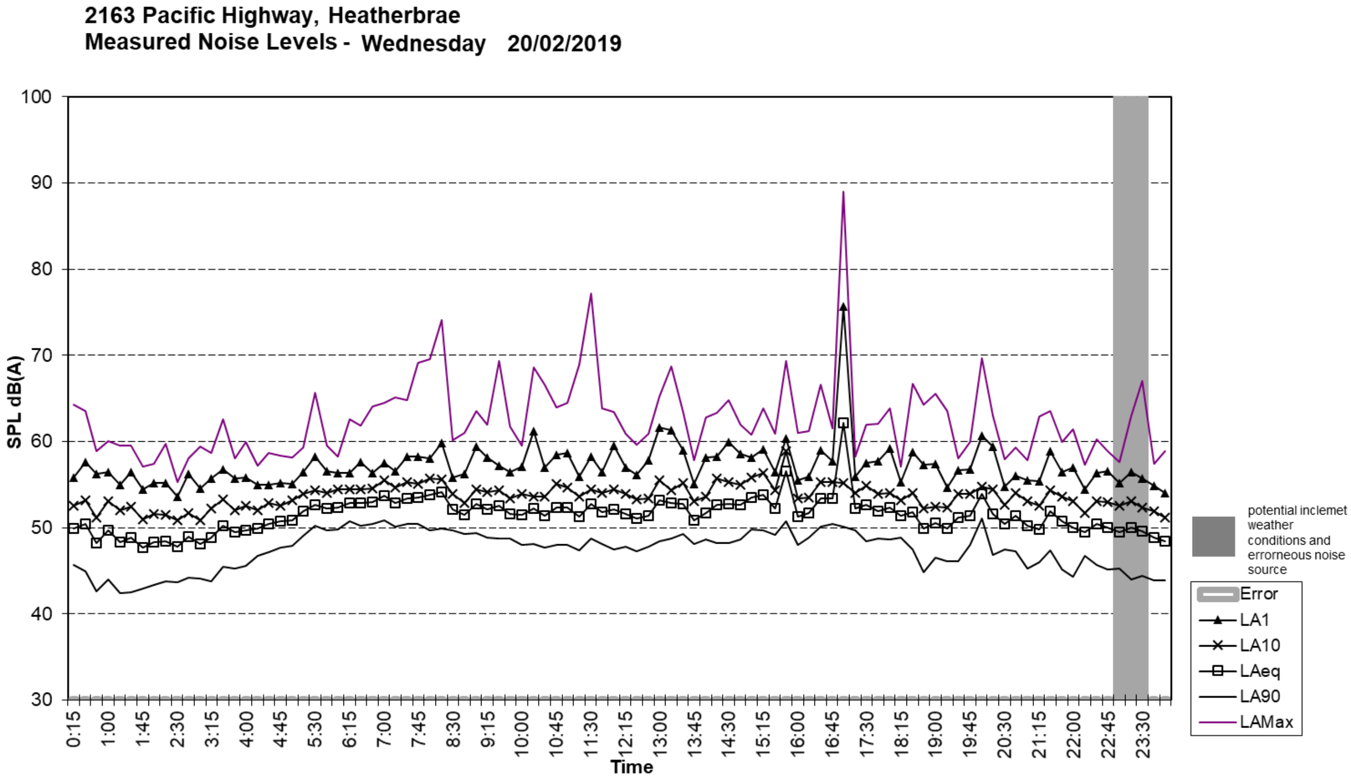

2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Sunday 17/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

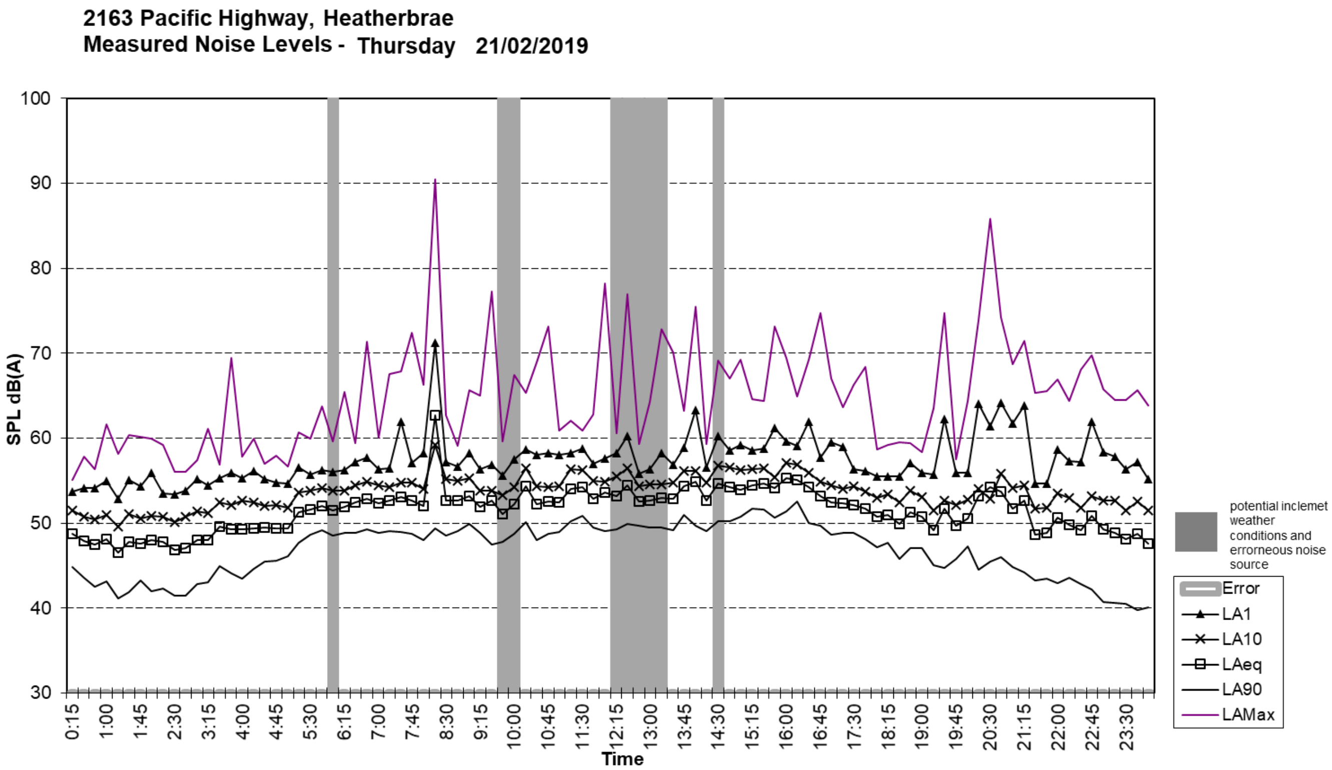
2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Monday 18/02/2019

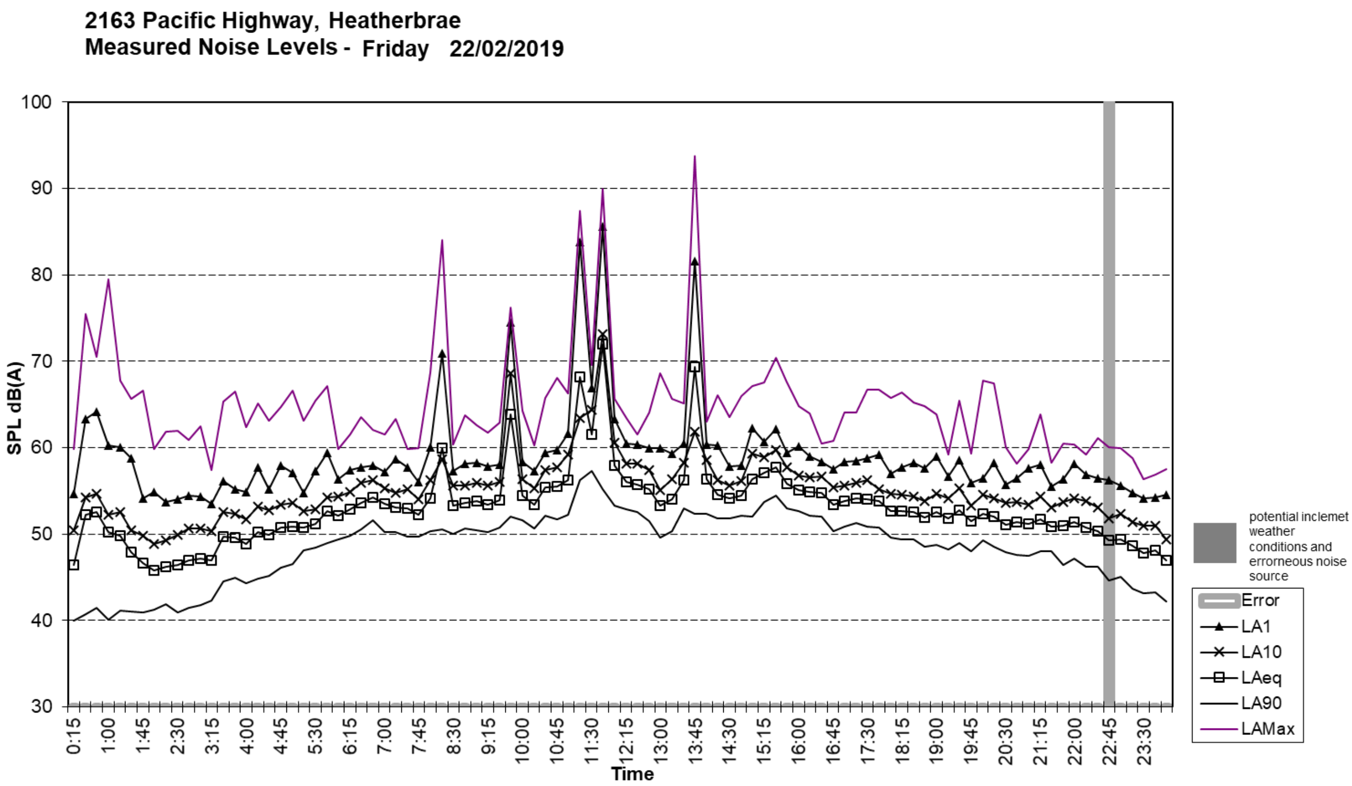


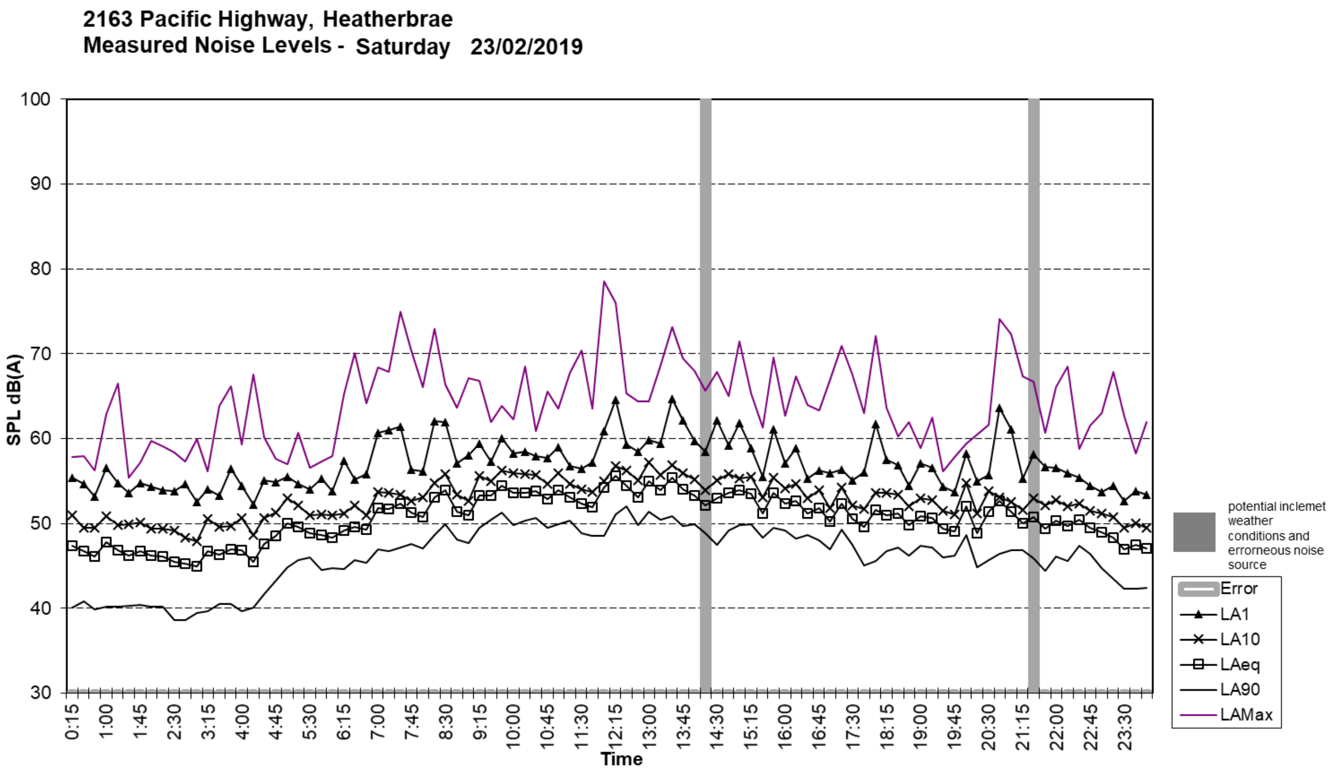
2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Tuesday 19/02/2019

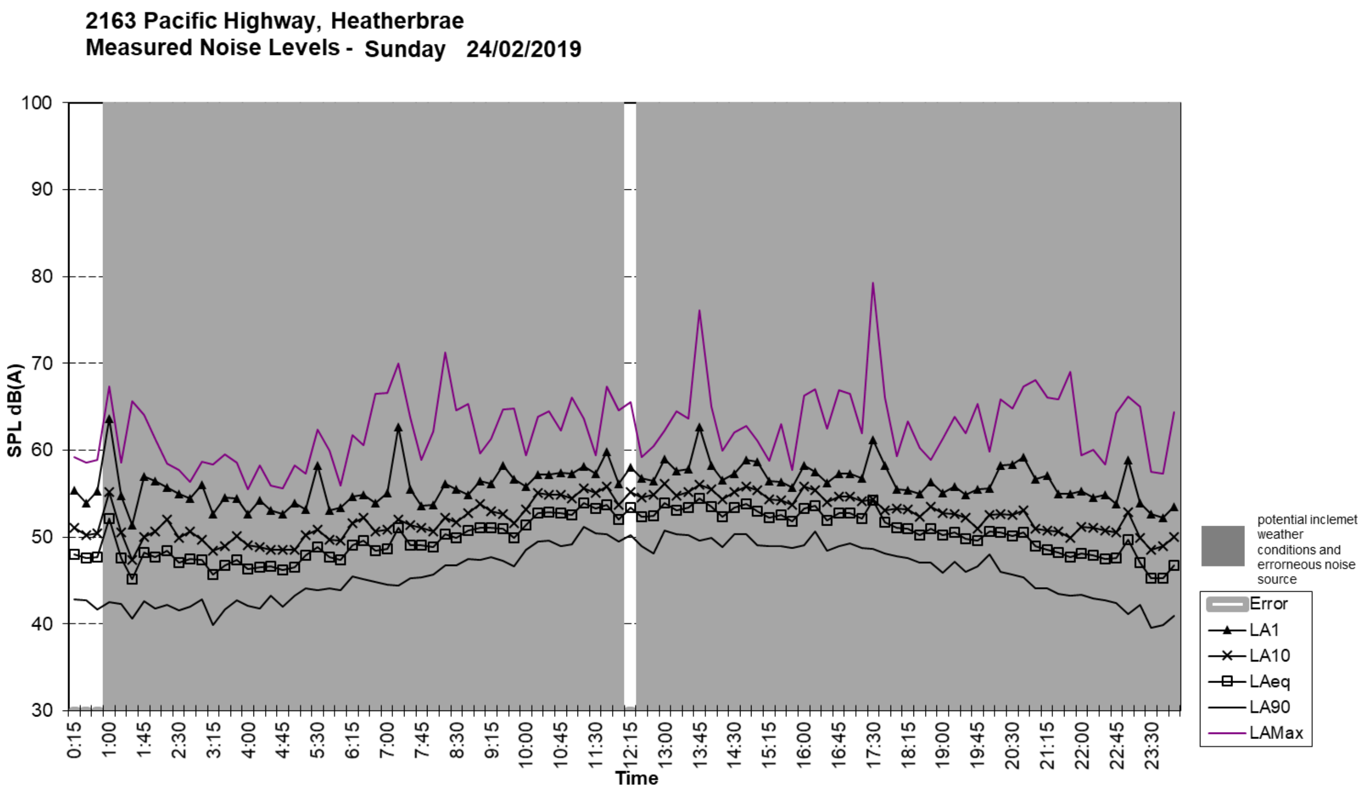


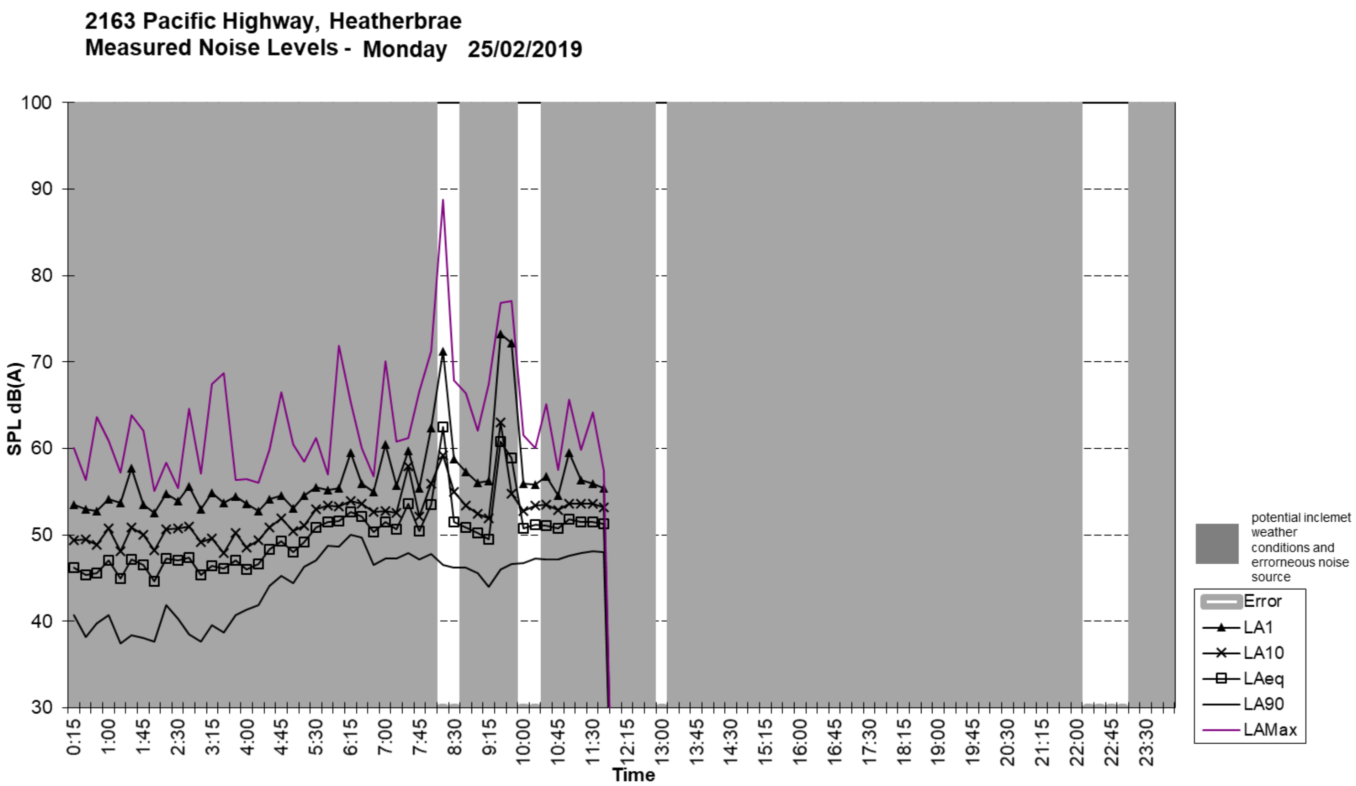

2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Wednesday 20/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax


2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Thursday 21/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

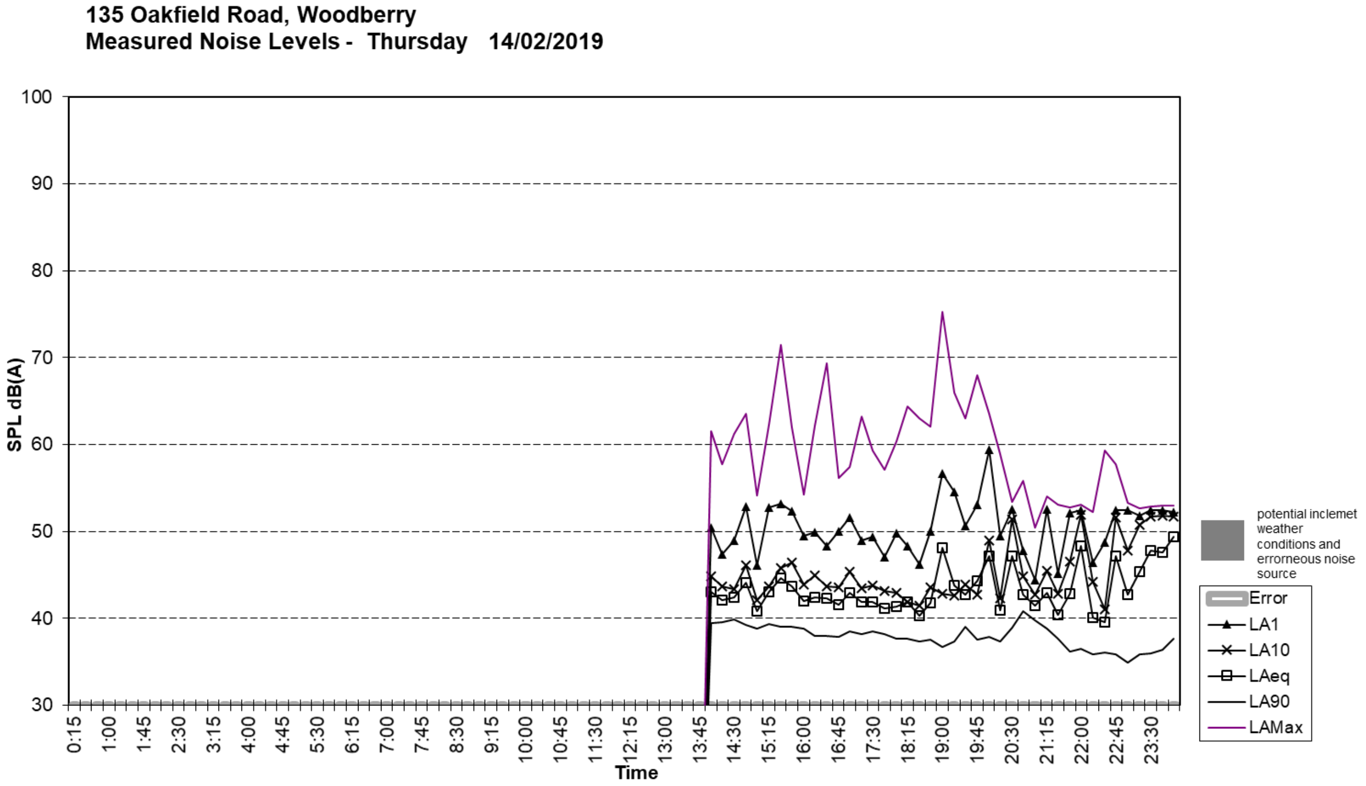

2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Friday 22/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

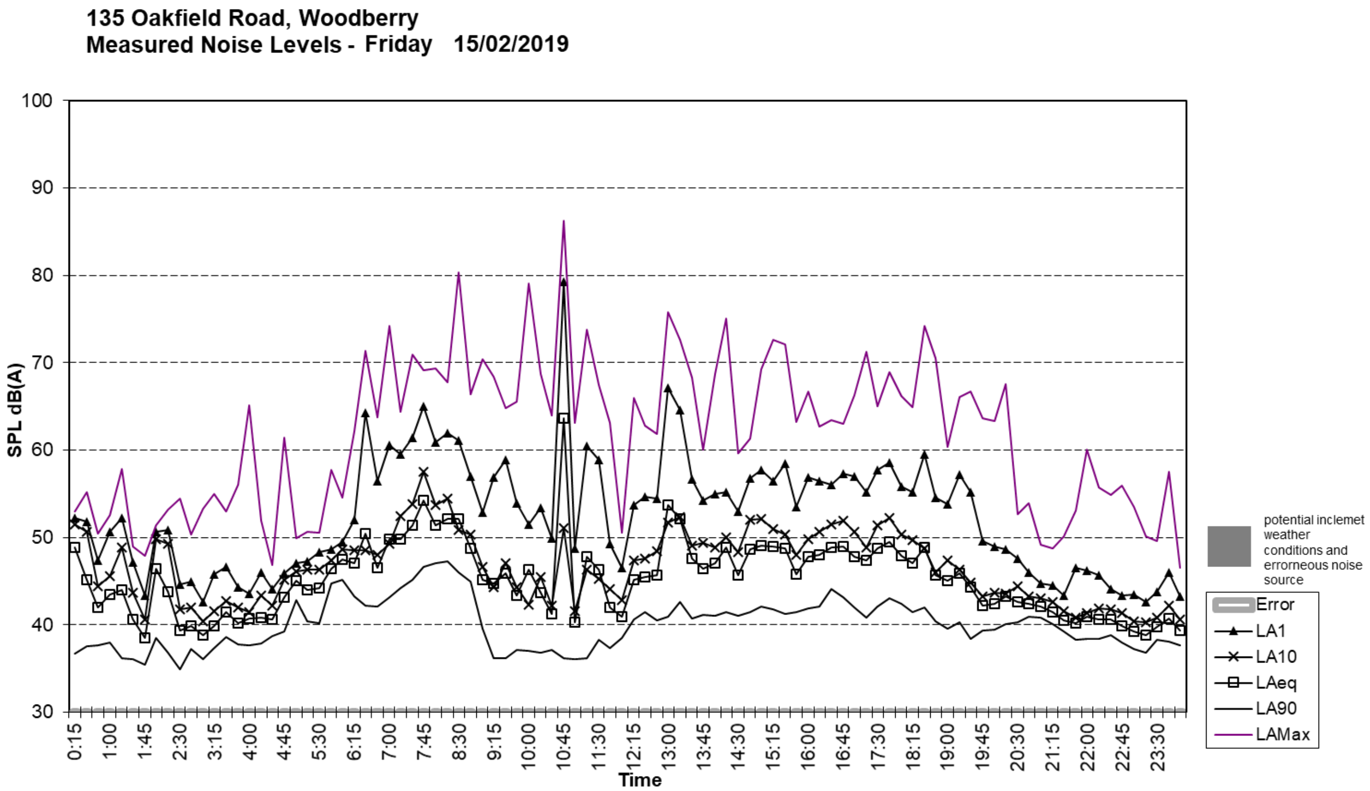

2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Saturday 23/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax


2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Sunday 24/02/2019
SPL dB(A)
100
90
80
70
60
50
40
30
Time
0:15
1:00
1:45
2:30
3:15
4:00
4:45
5:30
6:15
7:00
7:45
8:30
9:15
10:00
10:45
11:30
12:15
13:00
13:45
14:30
15:15
16:00
16:45
17:30
18:15
19:00
19:45
20:30
21:15
22:00
22:45
23:30
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

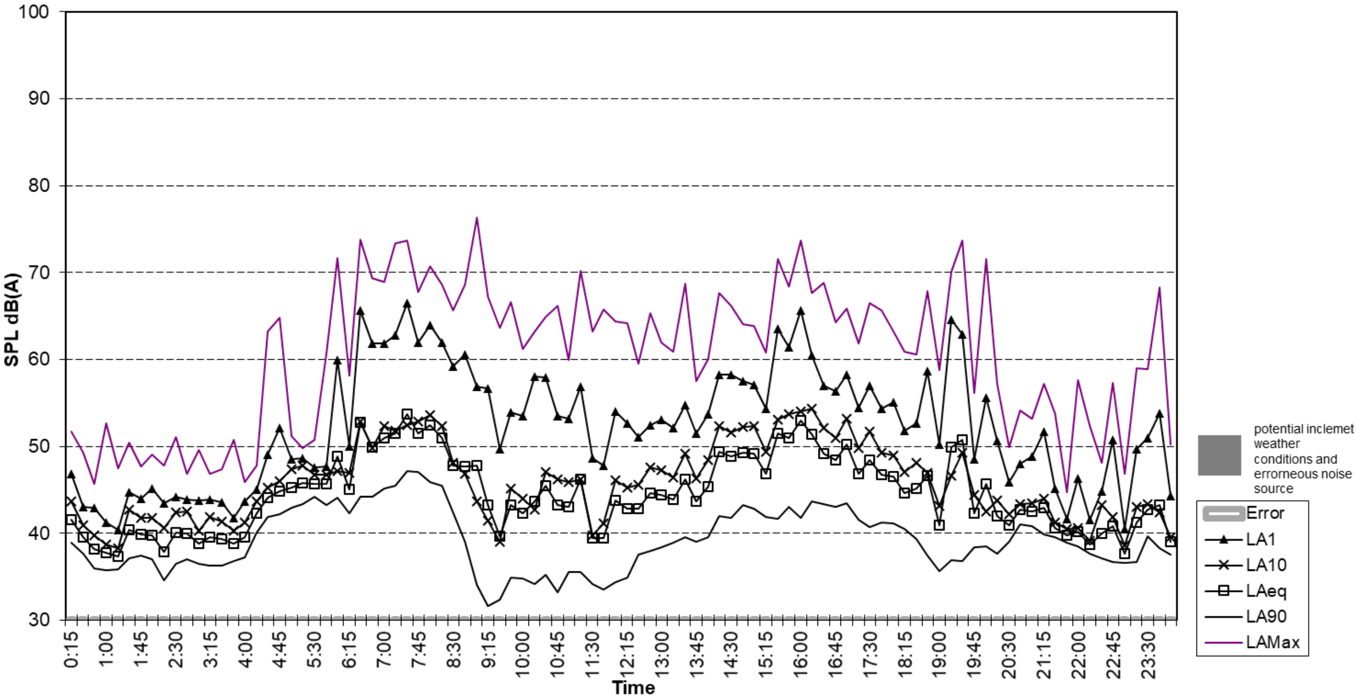

2163 Pacific Highway, Heatherbrae
Measured Noise Levels - Monday 25/02/2019
SPL dB(A)
100
90
80
70
60
50
40
30
Time
0:15
1:00
1:45
2:30
3:15
4:00
4:45
5:30
6:15
7:00
7:45
8:30
9:15
10:00
10:45
11:30
12:15
13:00
13:45
14:30
15:15
16:00
16:45
17:30
18:15
19:00
19:45
20:30
21:15
22:00
22:45
23:30
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

L2 - 135 Oakfield Road, Woodberry

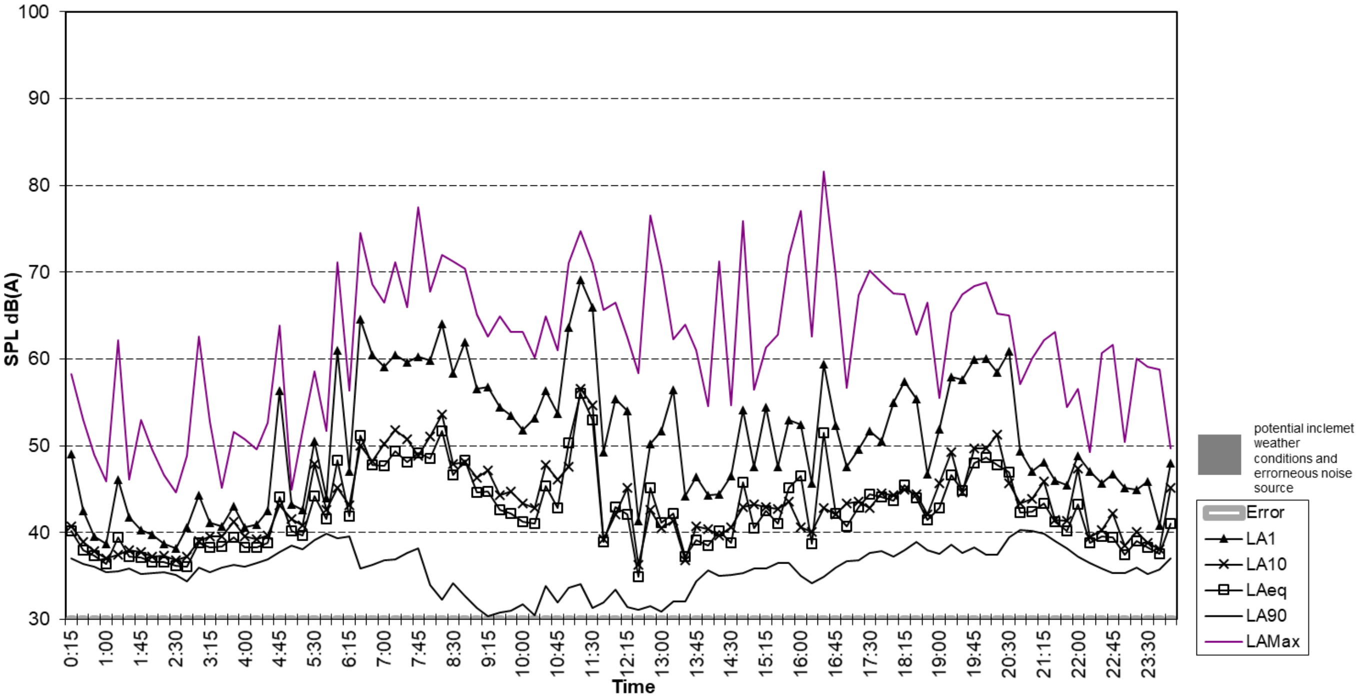




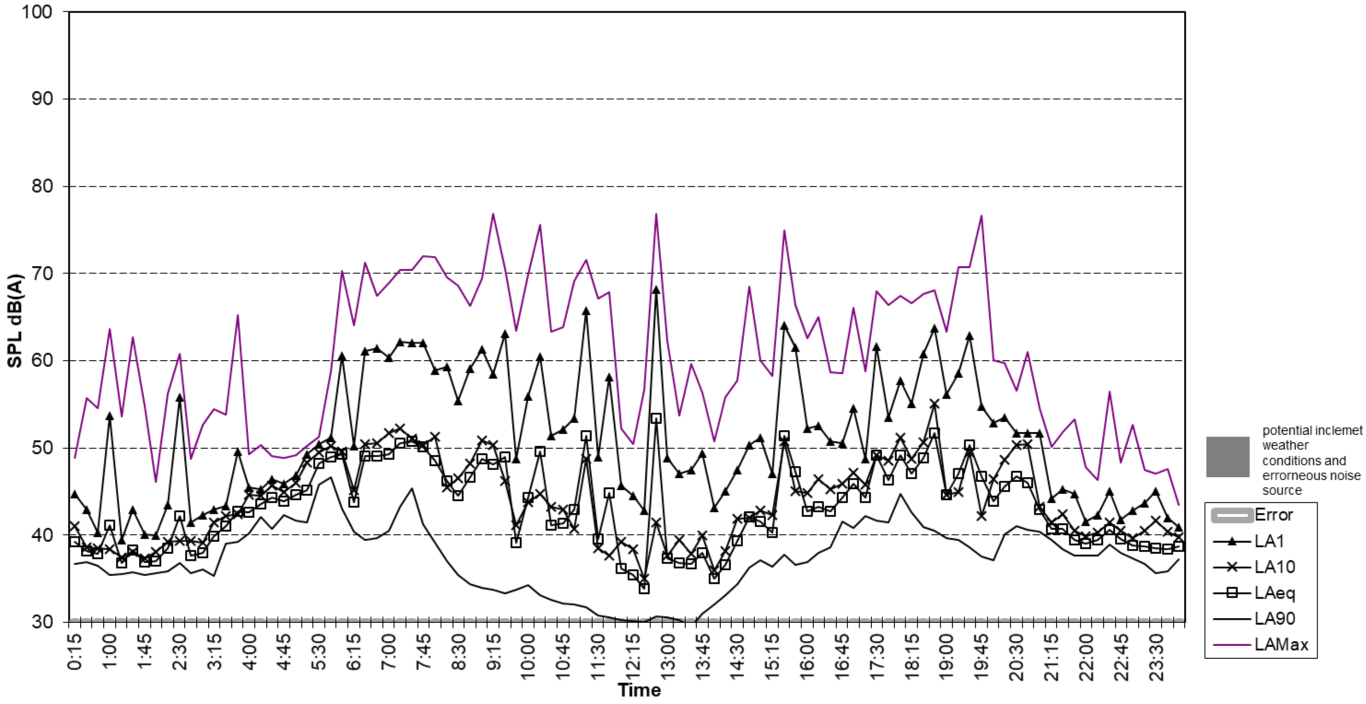
135 Oakfield Road, Woodberry
Measured Noise Levels - Saturday 16/02/2019



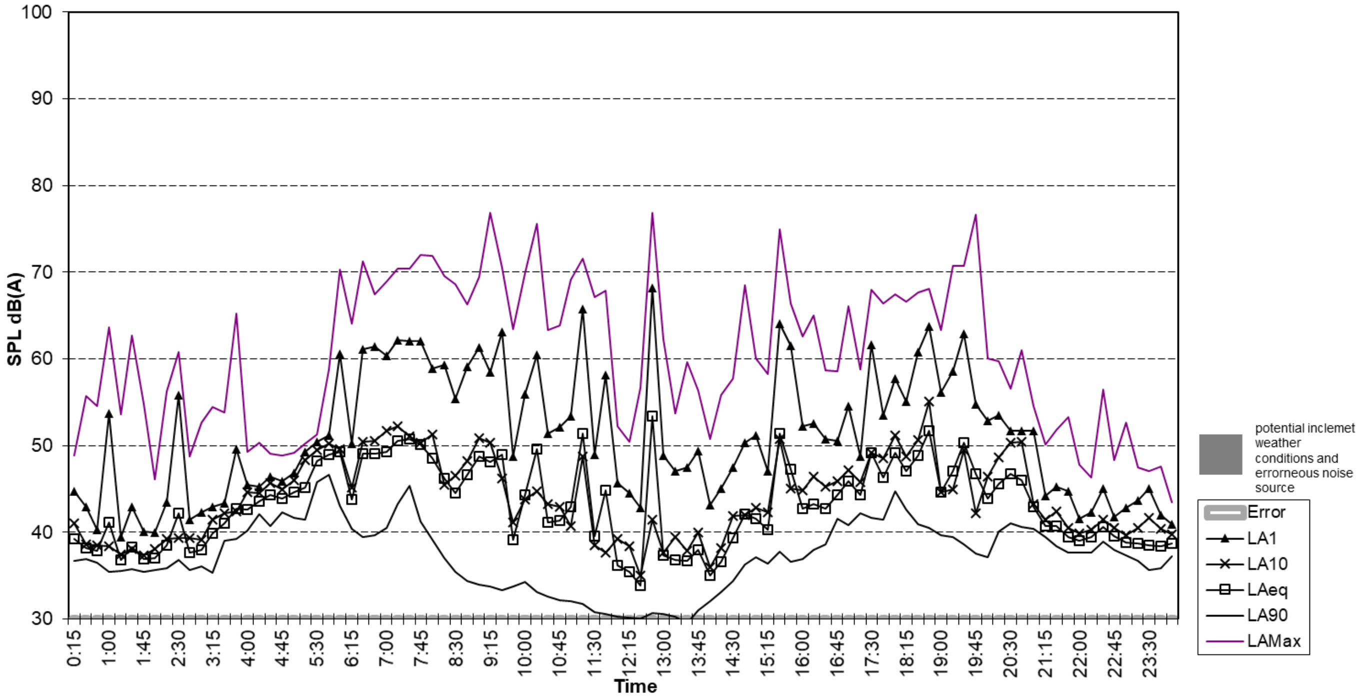
135 Oakfield Road, Woodberry
Measured Noise Levels - Sunday 17/02/2019

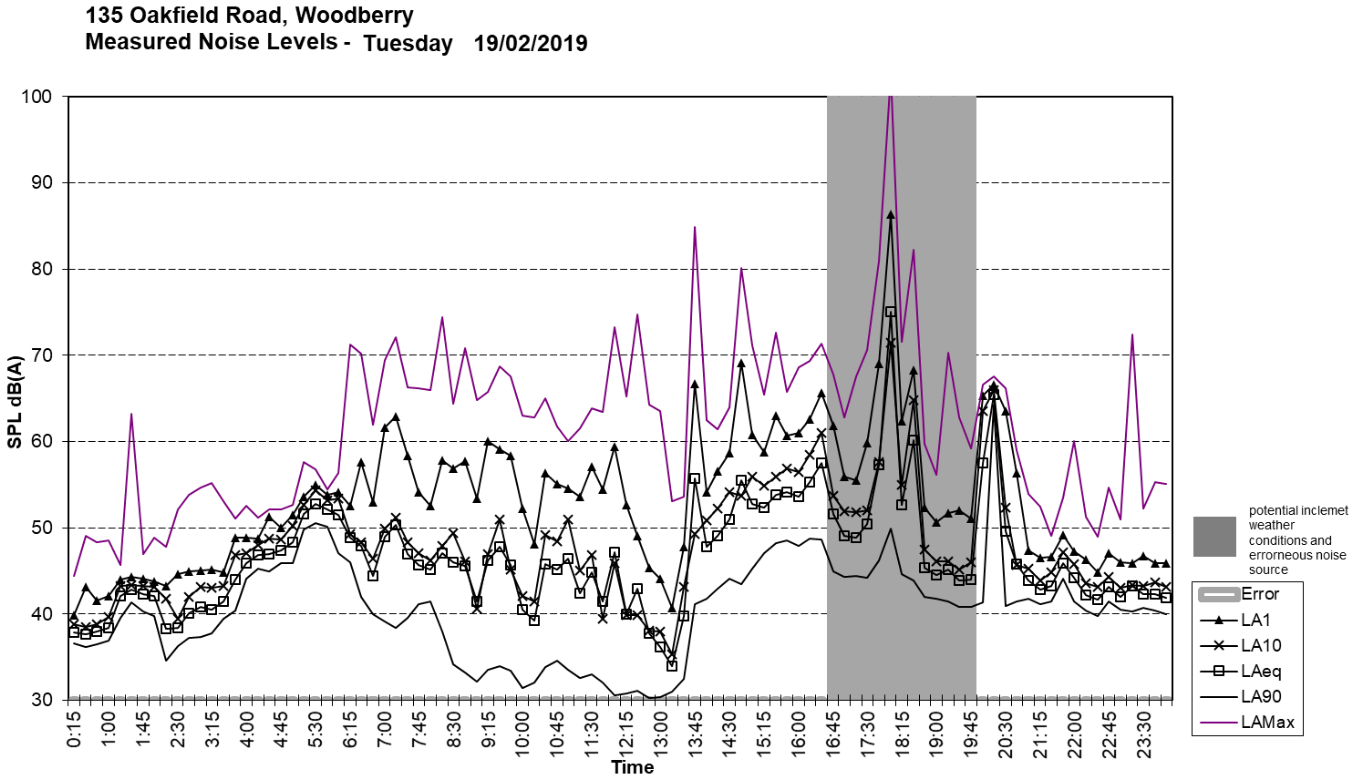


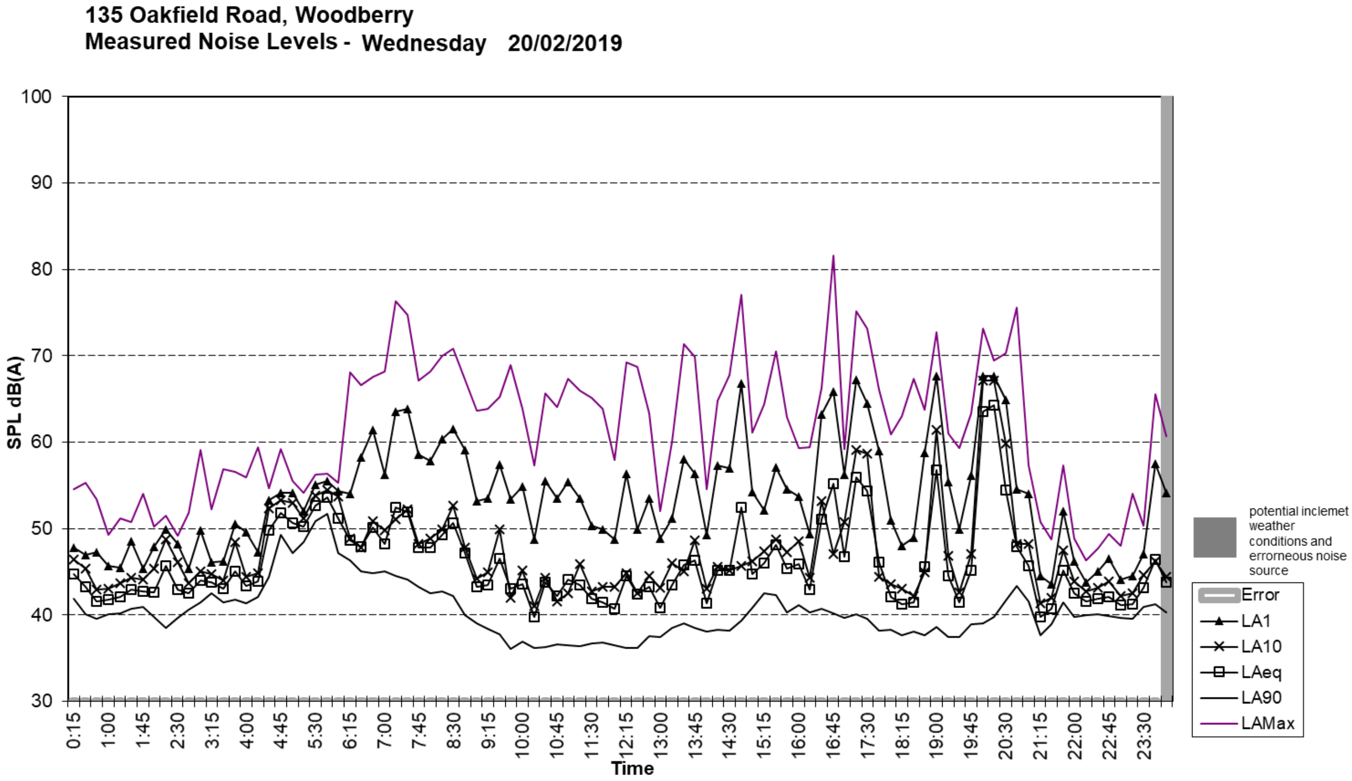
135 Oakfield Road, Woodberry
Measured Noise Levels - Monday 18/02/2019

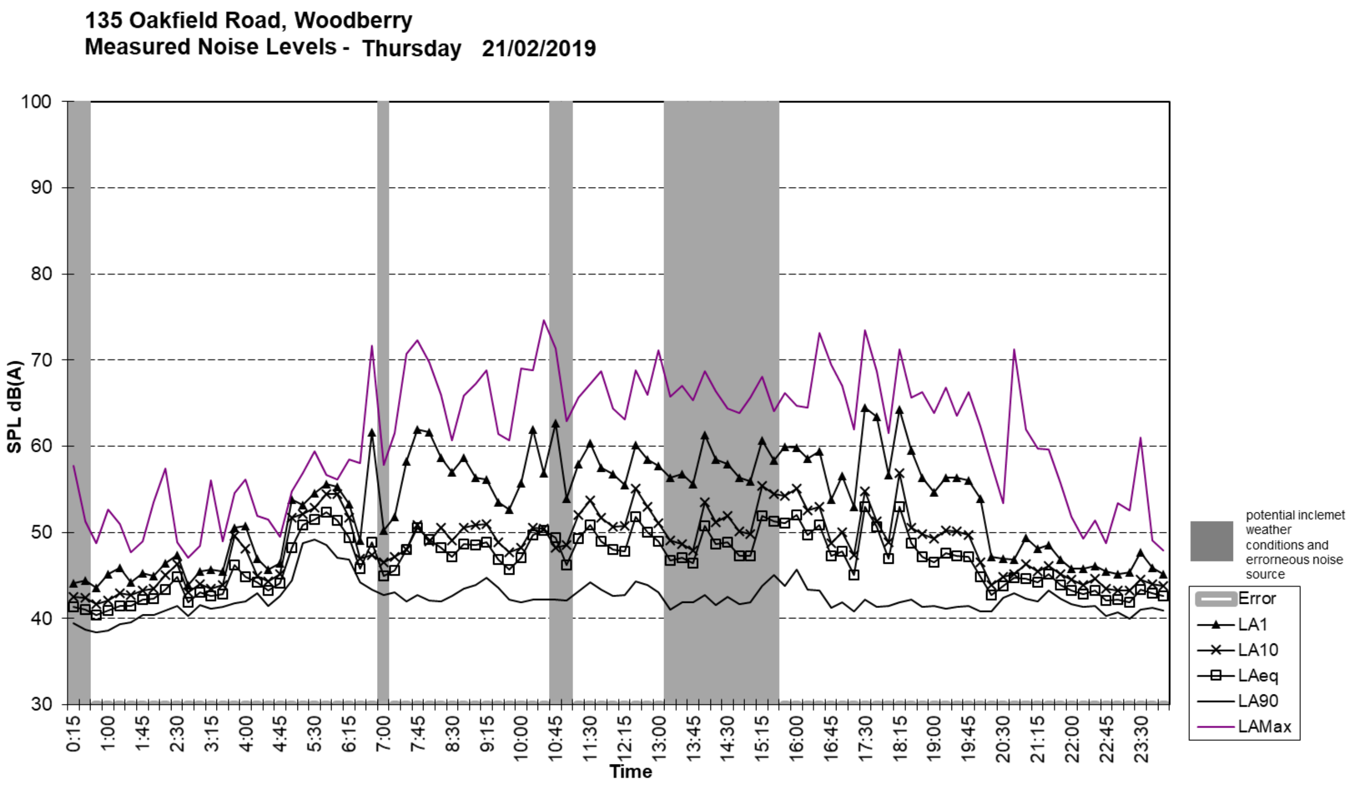


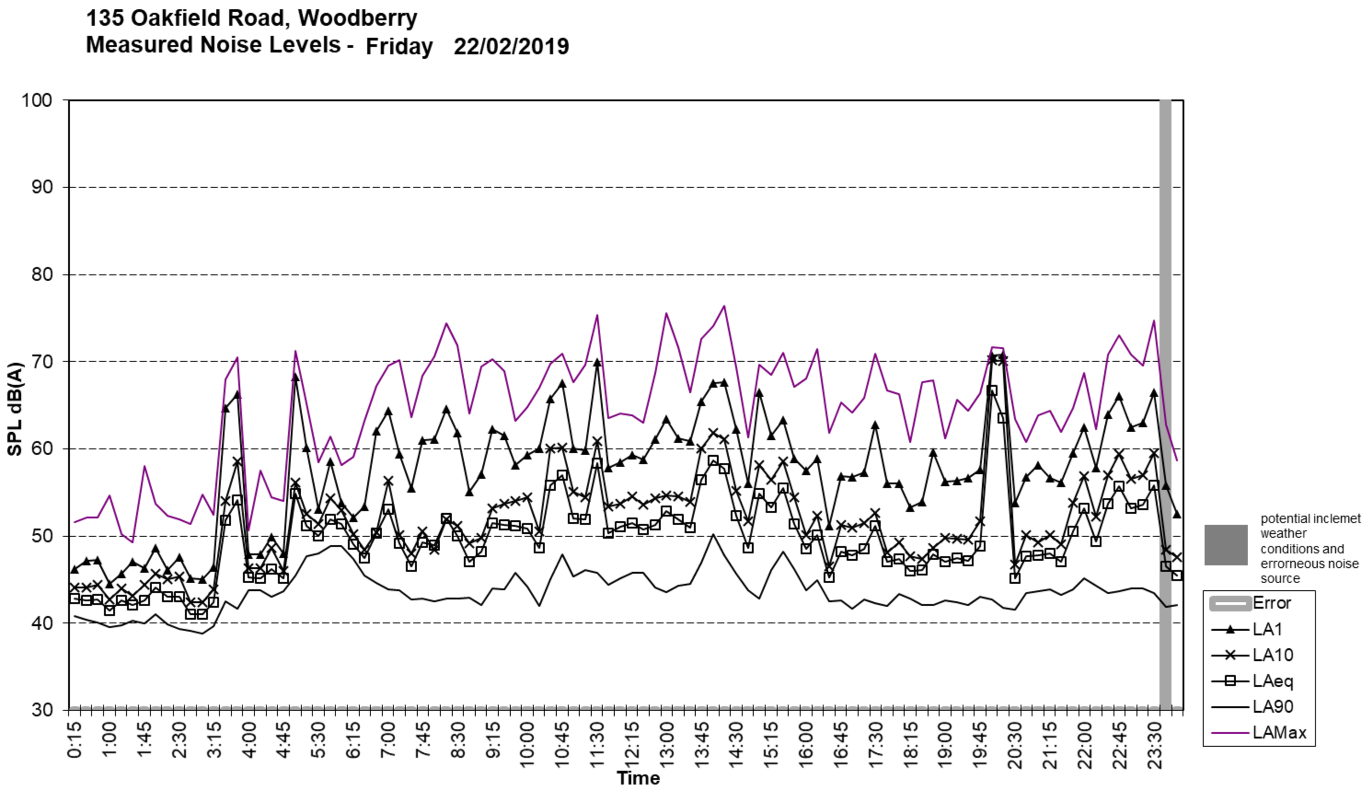
135 Oakfield Road, Woodberry
Measured Noise Levels - Monday 18/02/2019

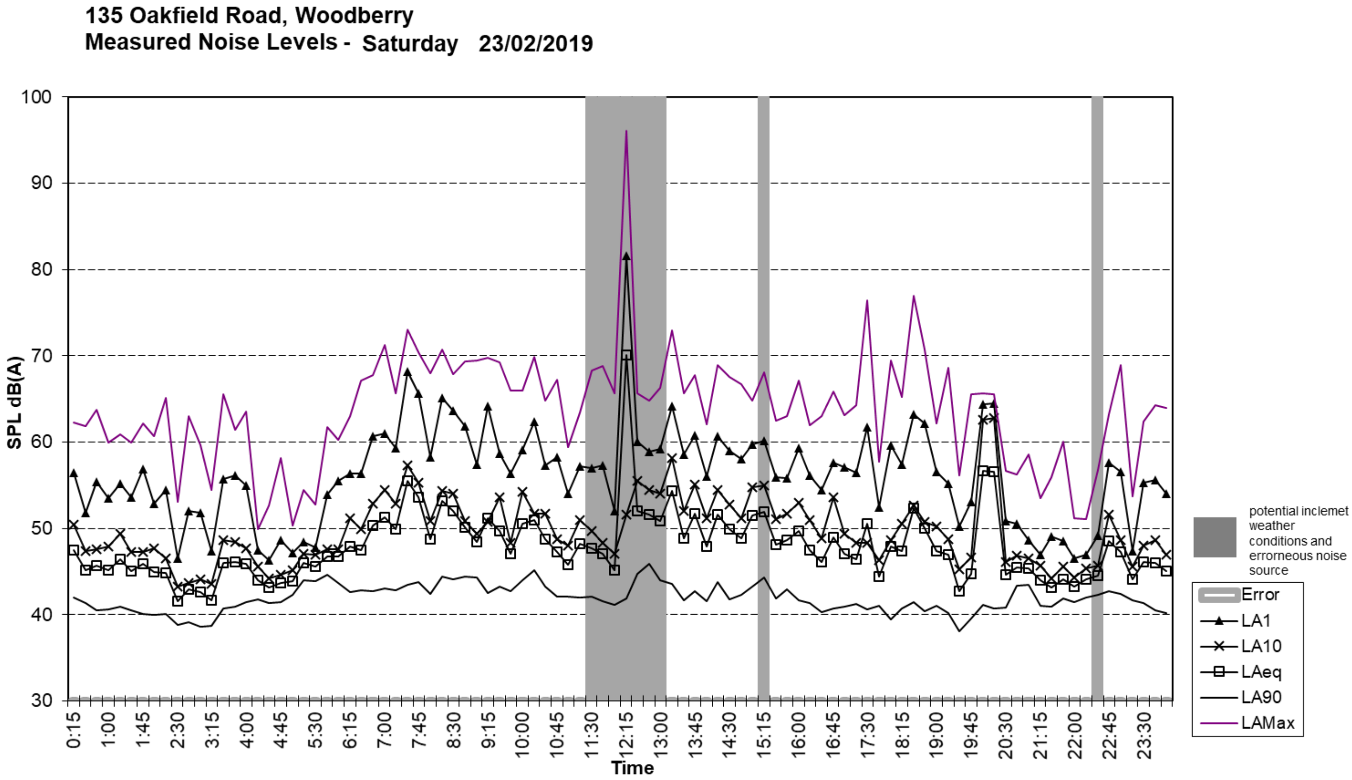


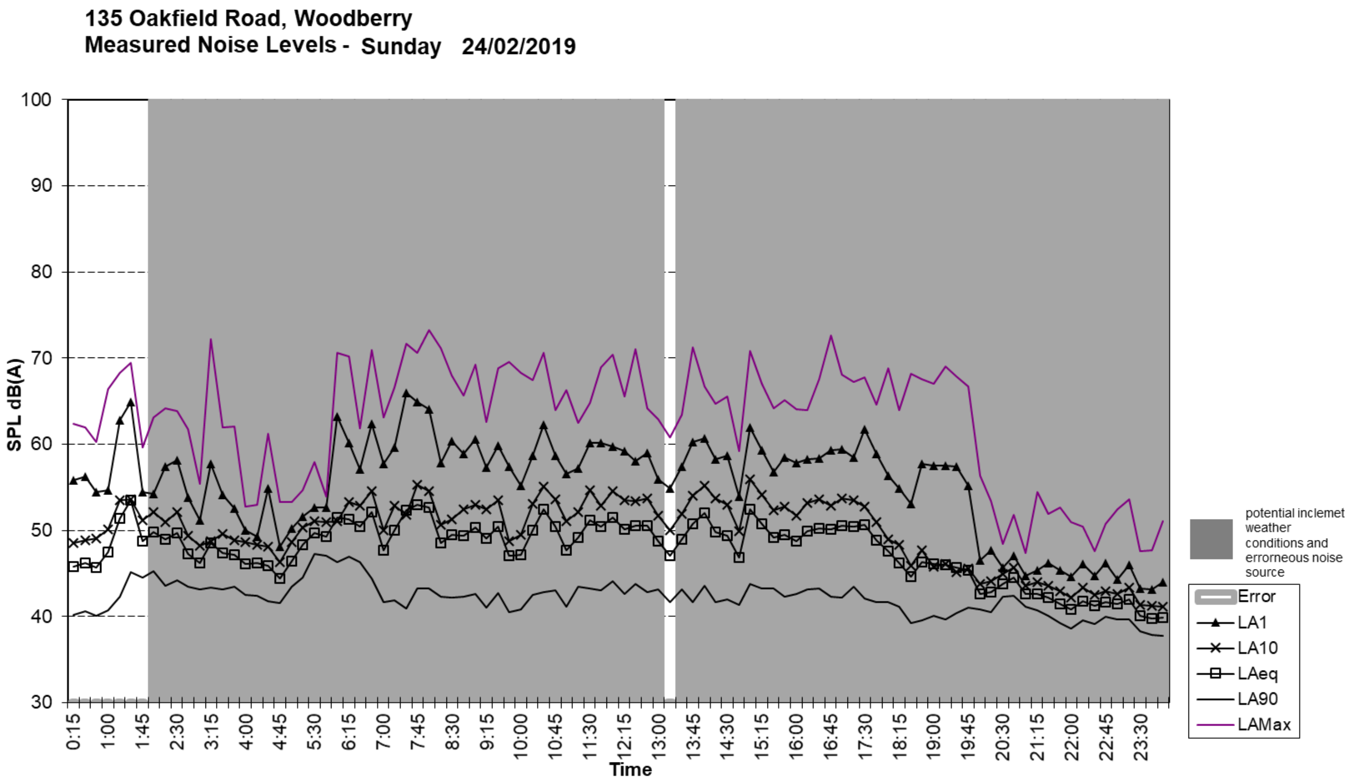

135 Oakfield Road, Woodberry
Measured Noise Levels - Tuesday 19/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

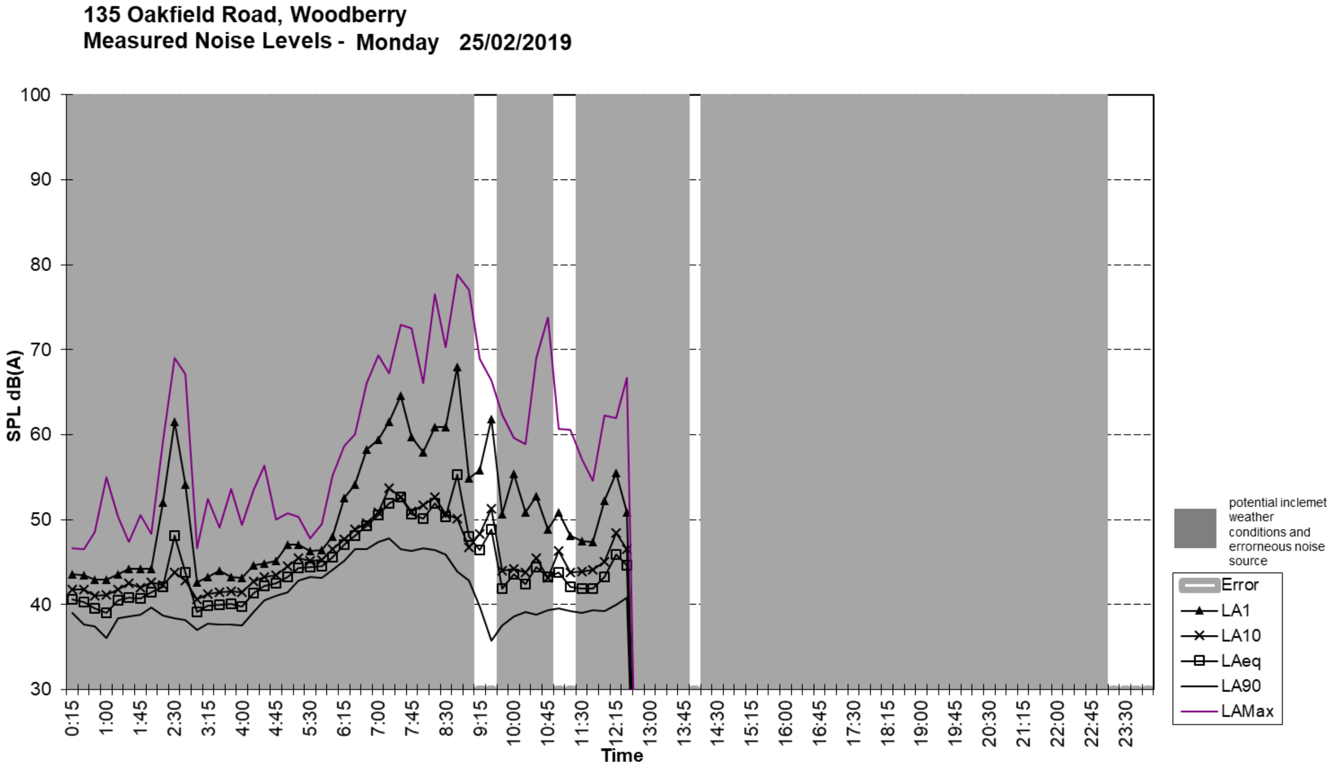

135 Oakfield Road, Woodberry
Measured Noise Levels - Wednesday 20/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax


135 Oakfield Road, Woodberry
Measured Noise Levels - Thursday 21/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax


135 Oakfield Road, Woodberry
Measured Noise Levels - Friday 22/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

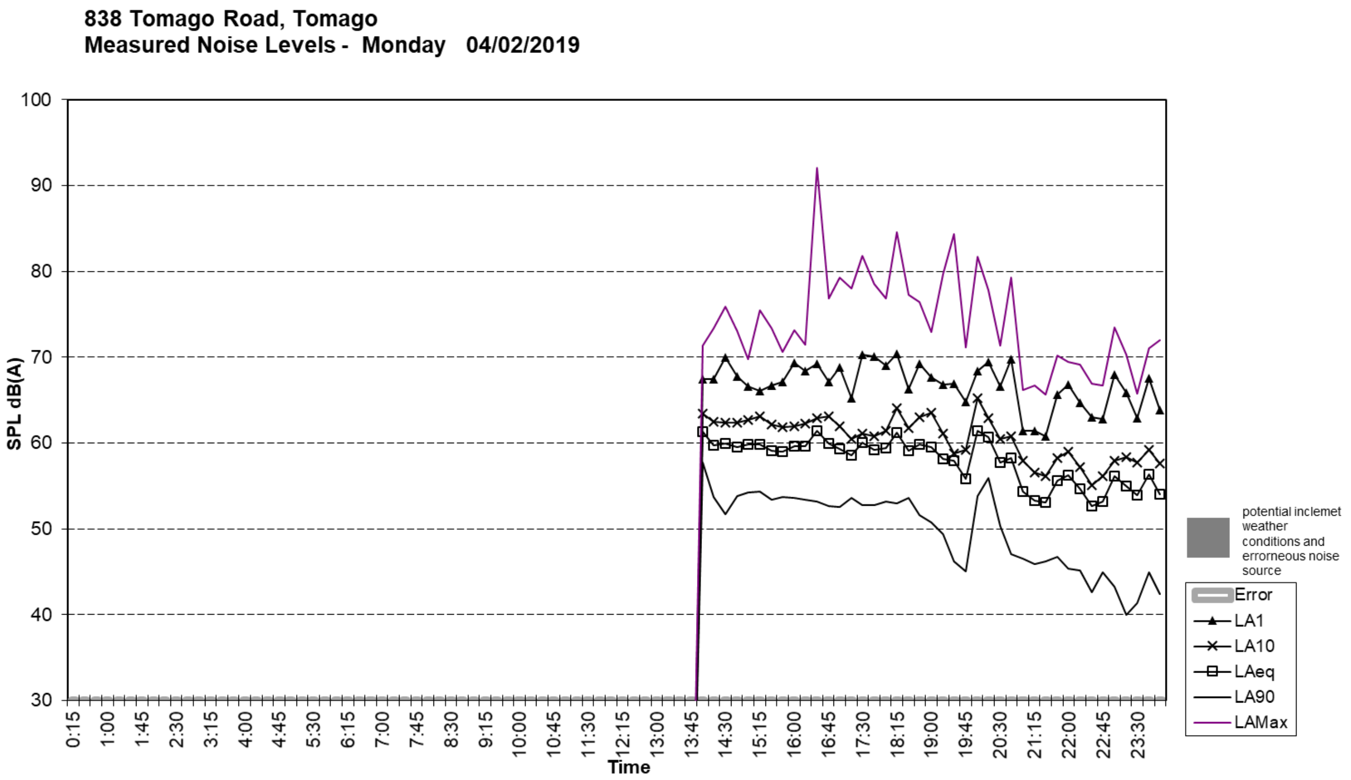

135 Oakfield Road, Woodberry
Measured Noise Levels - Saturday 23/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and errorneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

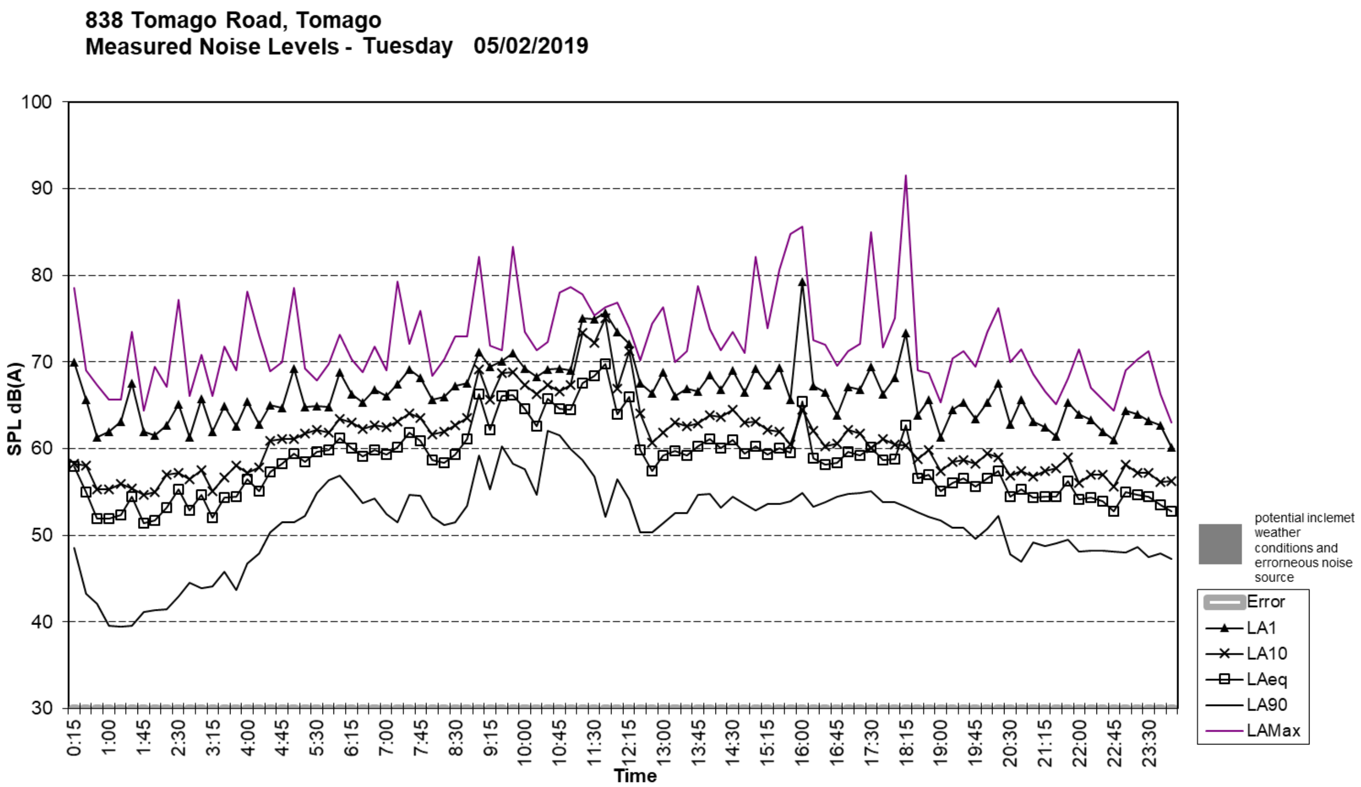

135 Oakfield Road, Woodberry
Measured Noise Levels - Sunday 24/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and errorneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

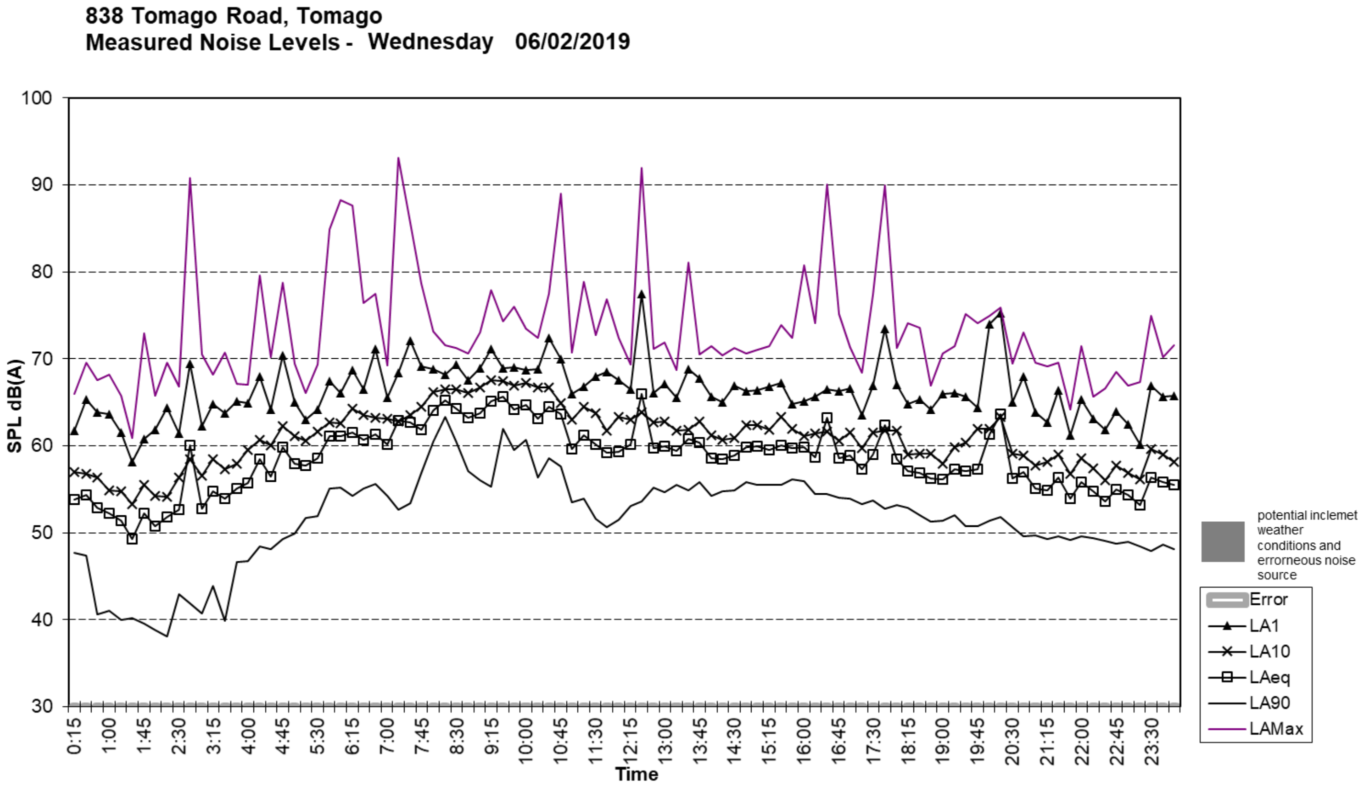


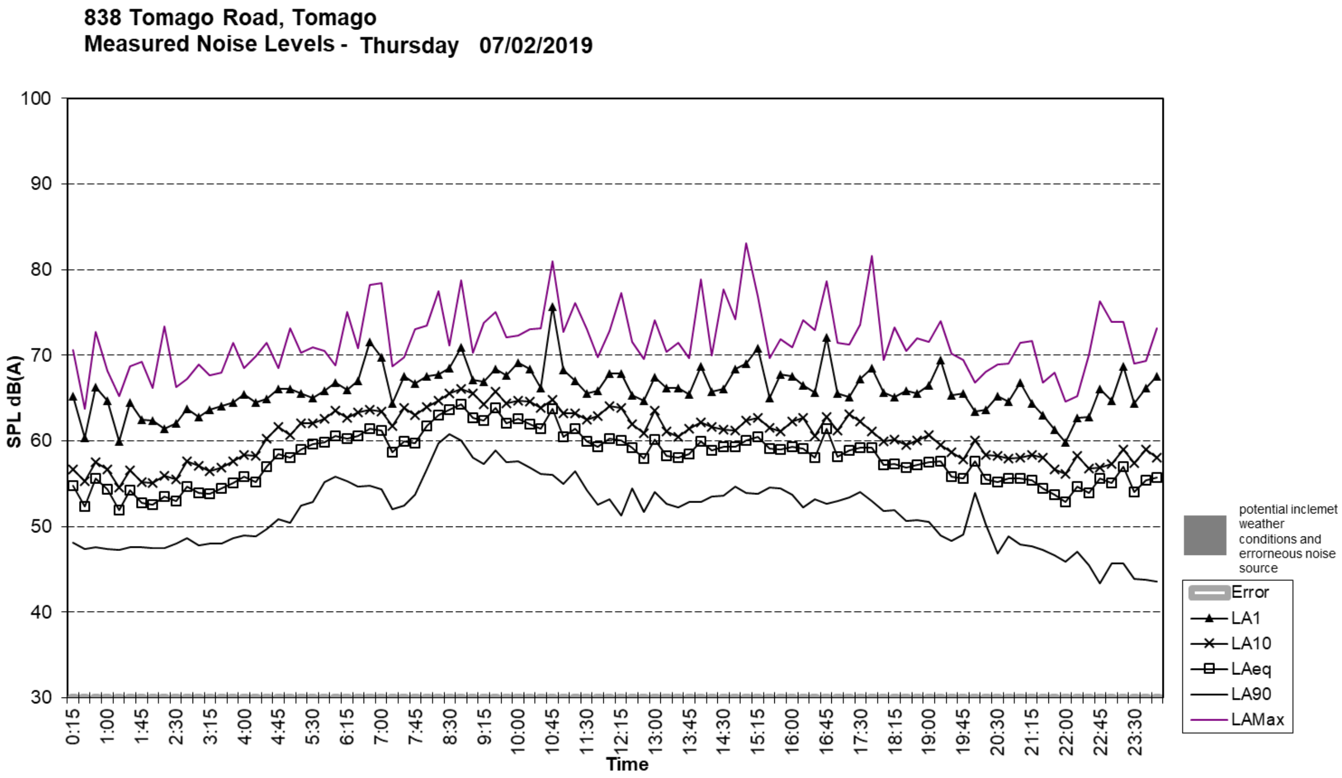
135 Oakfield Road, Woodberry
Measured Noise Levels - Monday 25/02/2019
SPL dB(A)
100
90
80
70
60
50
40
30
0:15
1:00
1:45
2:30
3:15
4:00
4:45
5:30
6:15
7:00
7:45
8:30
9:15
10:00
10:45
11:30
12:15
13:00
13:45
14:30
15:15
16:00
16:45
17:30
18:15
19:00
19:45
20:30
21:15
22:00
22:45
23:30
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

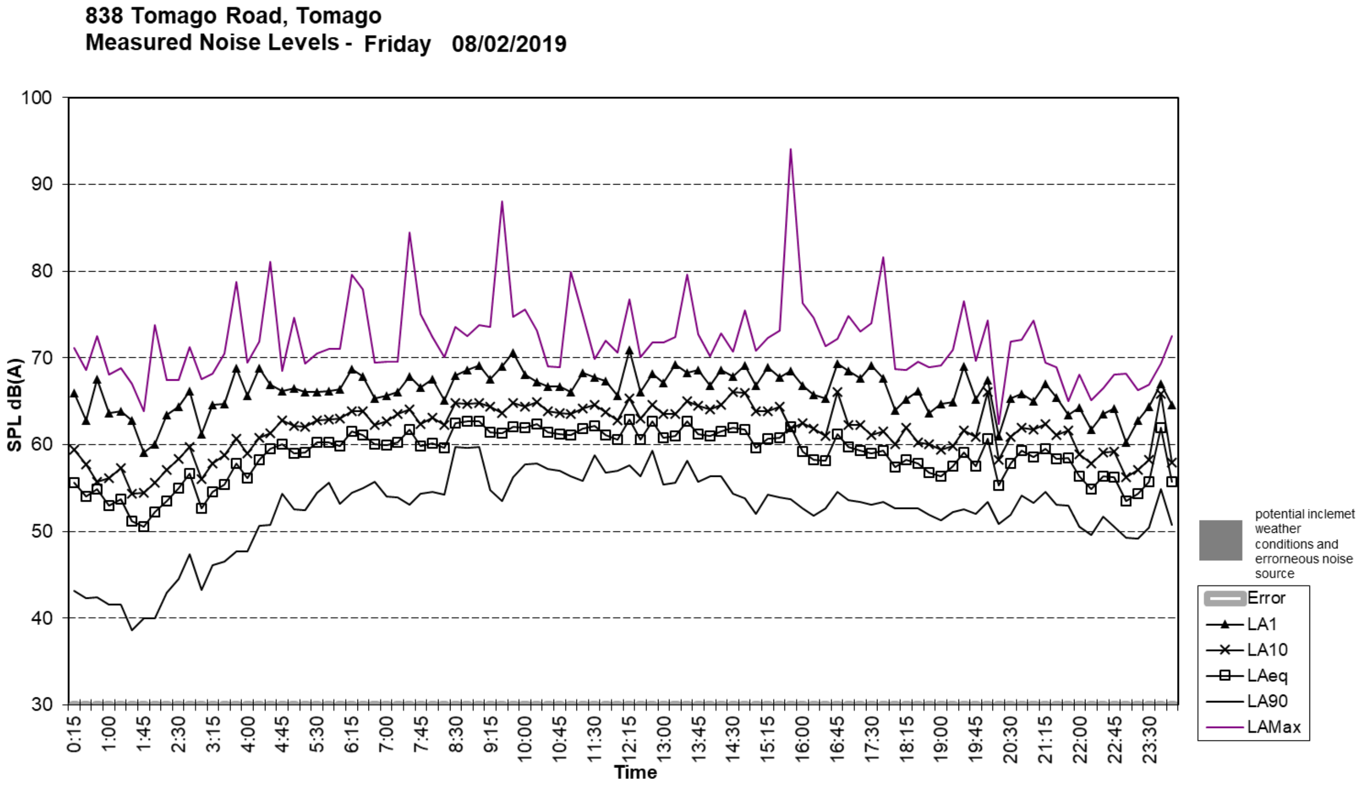
L3 – 838 Tomago Road, Tomago



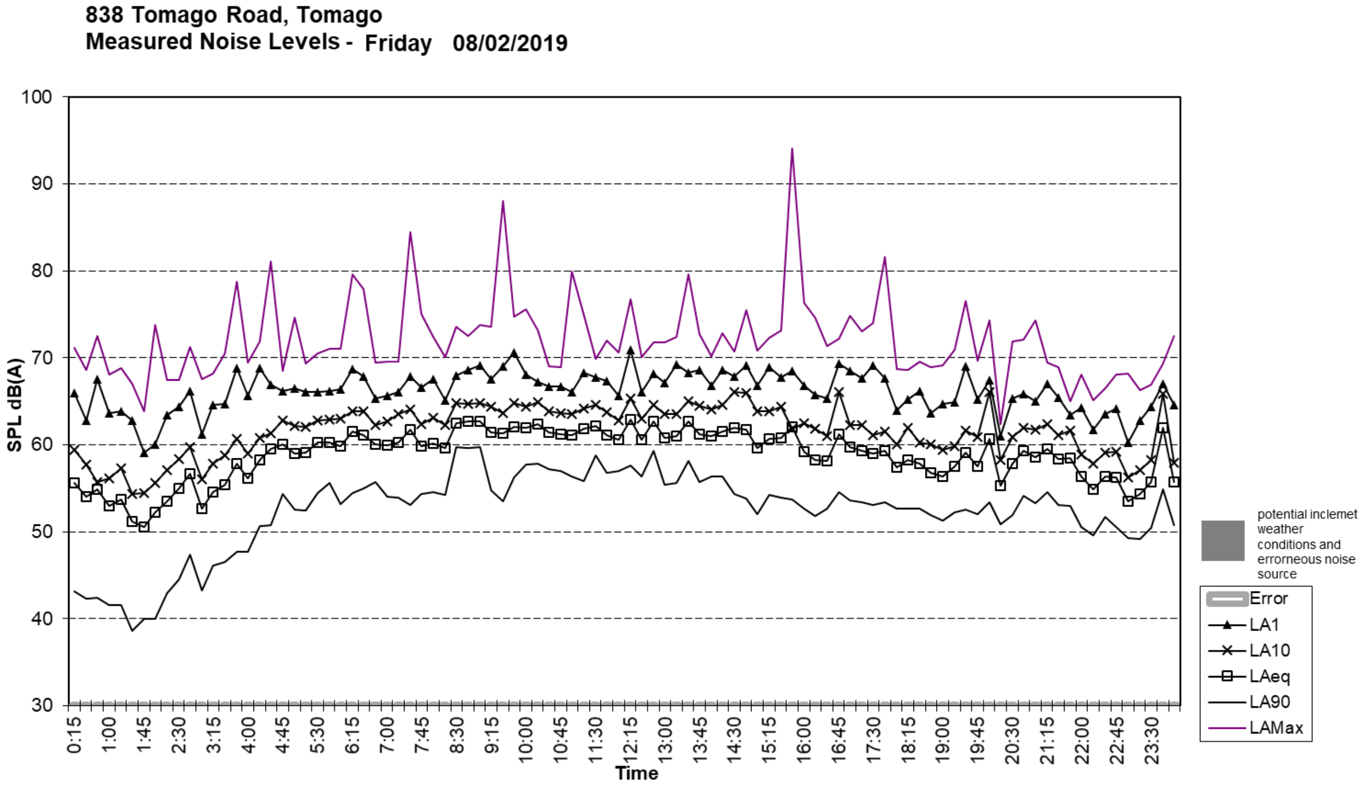



838 Tomago Road, Tomago
Measured Noise Levels - Wednesday 06/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and errorneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

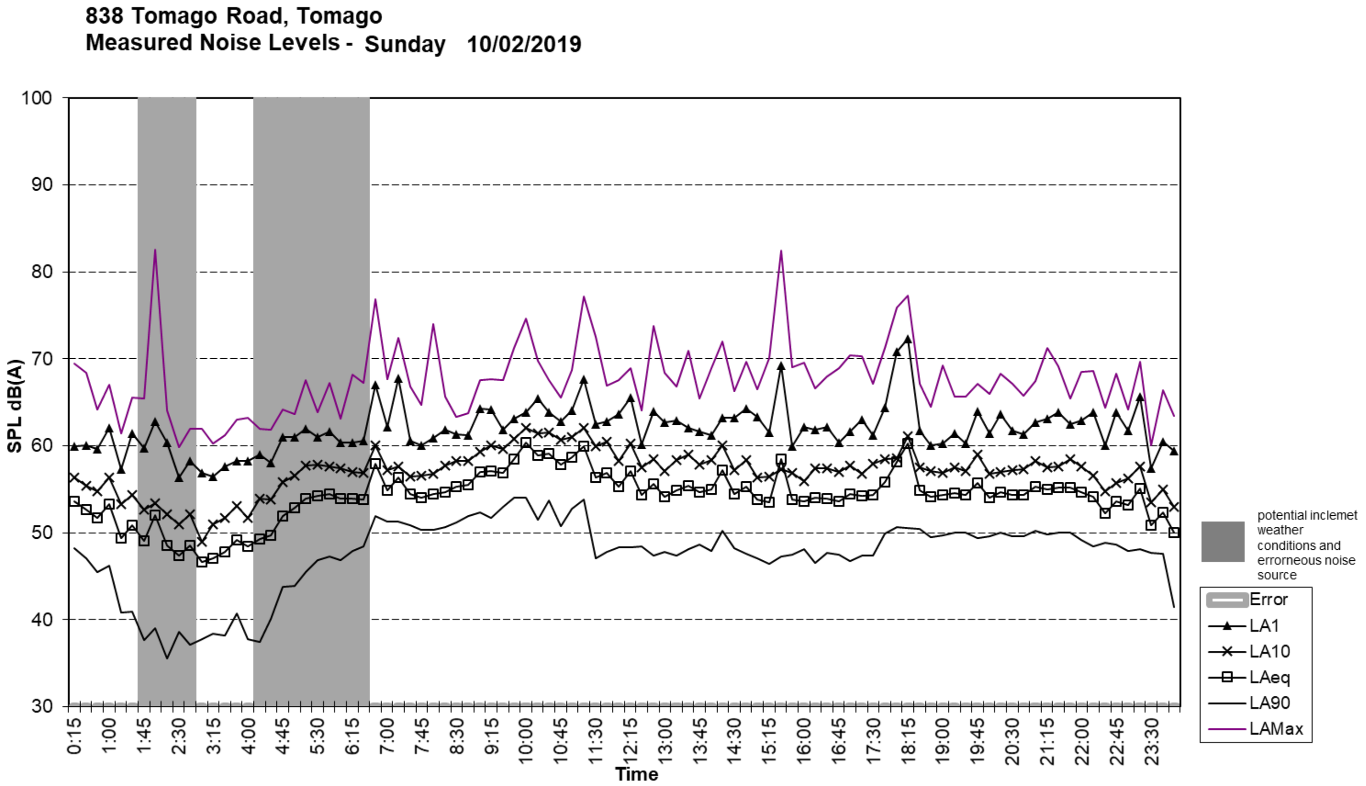

838 Tomago Road, Tomago
Measured Noise Levels - Thursday 07/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and errorneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

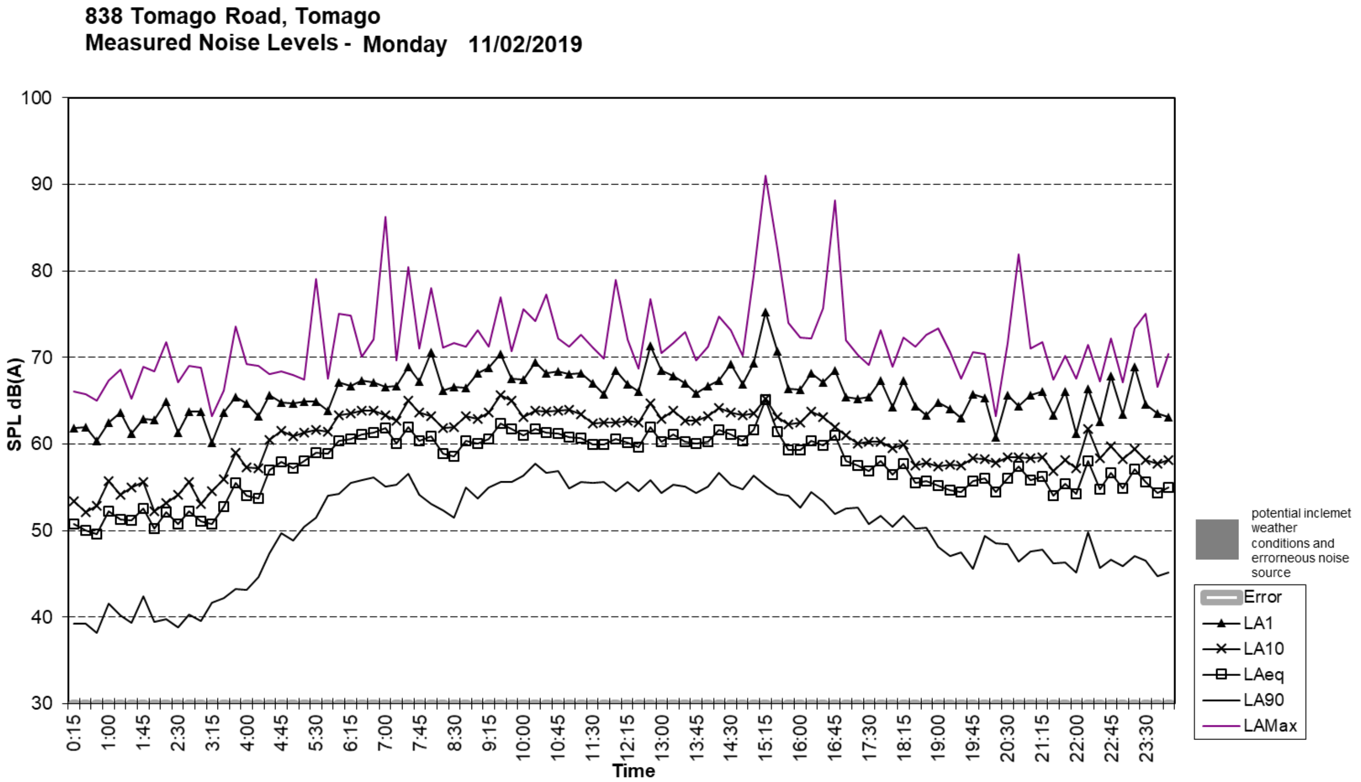


838 Tomago Road, Tomago
Measured Noise Levels - Friday 08/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

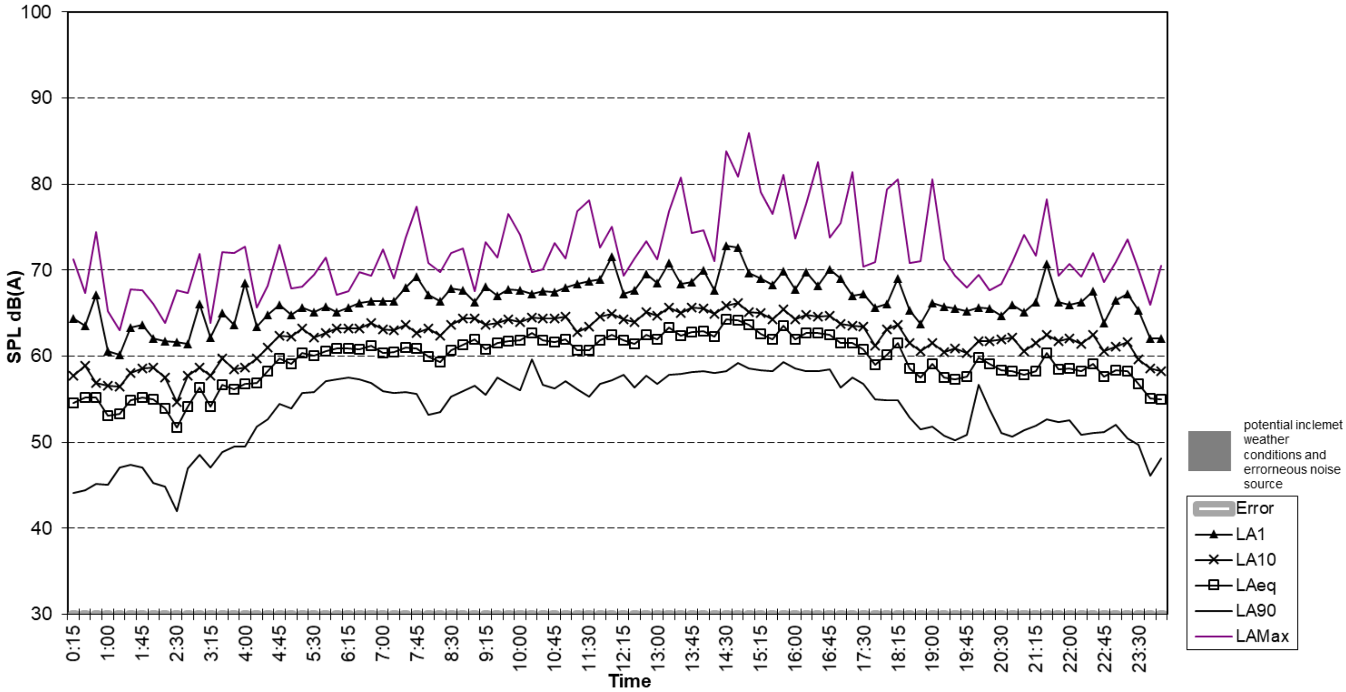


838 Tomago Road, Tomago
Measured Noise Levels - Friday 08/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

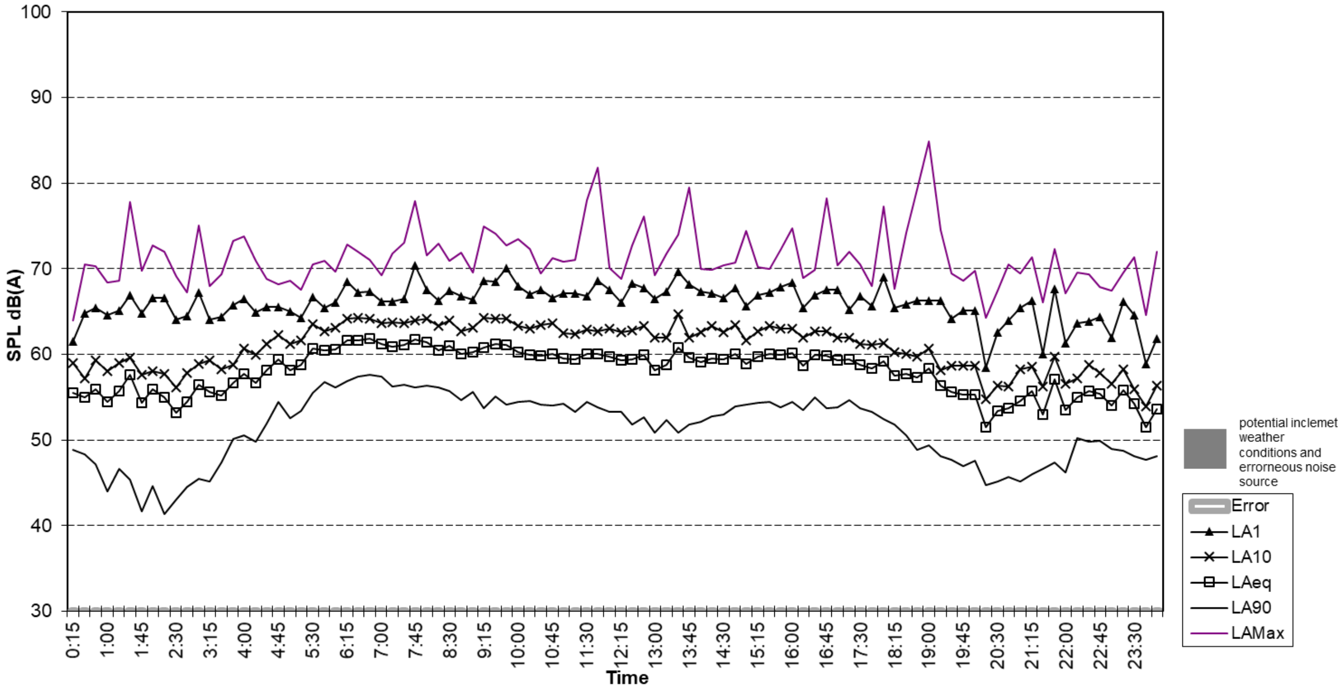

838 Tomago Road, Tomago
Measured Noise Levels - Sunday 10/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax


838 Tomago Road, Tomago
Measured Noise Levels - Monday 11/02/2019
SPL dB(A)
Time
potential inclemet weather conditions and erroneous noise source
Error
LA1
LA10
LAeq
LA90
LAMax

838 Tomago Road, Tomago
Measured Noise Levels - Tuesday 12/02/2019



838 Tomago Road, Tomago
Measured Noise Levels - Wednesday 13/02/2019



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