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Report

PLANNING PROPOSAL AREA WITHIN SOUTH JERRABOMBERRA –NOISE ASSESSMENT

QUEANBEYAN CITY COUNCIL

Job ID. 08832

19 August 2015

PROJECT NAME:	Planning Proposal Area within South Jerrabomberra – Noise Assessment
JOB ID:	08832
DOCUMENT CONTROL NUMBER	ACO-NW-001-08832
PREPARED FOR:	Queanbeyan City Council
APPROVED FOR RELEASE BY:	D. Roddis
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DOCUMENT CONTROL			
VERSION	**DATE**	**PREPARED BY**	**REVIEWED BY**
01 Draft	29.07.2014	C. Marsh	A. McKenzie
Final Draft	03.10.2014	C. Marsh	A. McKenzie, D. Roddis
Final	19.08.2015	C. Marsh	A. McKenzie, D. Roddis

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EXECUTIVE SUMMARY

Introduction and Site Description

A noise assessment was conducted for Queanbeyan City Council (QCC) to examine the potential constraints and risks associated with rezoning the parcel of land currently known as Forest, Morrison and Tralee Station (Walsh) located in the South Jerrabomberra area, NSW.

The assessment reviewed the existing and potential impacts from aircraft, industrial, road traffic and rail noise in addition to rail vibration.

A number of areas to the north of the site have either been approved or are in planning for rezoning and development for residential, mixed use and commercial land use.

The site is located within the QCC area and is currently undeveloped. It is in proximity to a number of noise sources which have the potential to cause adverse impacts at sensitive land uses.

The existing Hume Industrial Area is located north of the site in ACT. The industrial zone has been approved to expand west of its current location and along the northern boundary of the site.

The Monaro Highway is located in proximity to the site and runs from west to east to the north of the site, approximately 600m to 1km from the nearest point to the site. A disused section of the Goulburn to Bombala railway runs along the northern boundary of the site, between the Hume Industrial Area and the site. The railway marks the border between NSW and ACT.

The site is also located under the flight path for aircraft using Canberra Airport. The site is located in proximity to the Australian Noise Forecast (ANEF) 20 contour.

Proposed Development

The proposed development comprises residential land uses across the site. As part of the development of the site and the surrounding area, a number of roads are proposed. The most significant roads would connect the site with other proposed and approved developments and the existing road network.

At present, a number of different road connection options are being considered and are the subject of discussion and further review by the NSW and ACT governments.

Existing Environment

The existing noise environment was determined using long-term unattended and short-term attended measurement. The results of the monitoring determined that in general road traffic noise was the dominant noise source. All measured noise sources were generally below the acceptable limits and existing sources were not identified as significant risks for noise impact.

Assessment Methodology

Indicative assessments were conducted according the relevant guidelines applicable to the proposed land use.

The assessments generally took a worst-case approach to identify the potential constraints when potential noise sources are fully developed. This approach attempts to negate noise issues occurring as a result of adjacent incompatible land uses.

Aircraft Noise

Aircraft noise was assessed according to Australian Standard AS 2021 – Acoustics – Aircraft Noise Intrusion – Building Siting and Construction. The standard considers residential development acceptable outside of the ANEF 20. Guidance within AS 2021 states that aircraft impacts may occur near the ANEF 20. An indicative assessment to AS2021 was performed and identified that aircraft noise impacts may occur. In order to reduce the potential noise impacts and complaints arising from sensitive land use occupiers, the following recommendations are made:

- Residential development is considered acceptable for the site.
- All noise sensitive developments within the site to be assessed against AS 2021 to ensure that building constructions have the required acoustic performance.

Industrial Noise

Industrial noise was identified as a potential source of adverse impact. Measurement of the existing noise environment identified that at present, industrial noise is not an issue. However, the potential for further development of the industrial area was considered using a worst case scenario. The results of the assessment indicated that adverse impacts may occur within the site. As a result, the following recommendations are made:

- The potential for industrial noise should be considered and assessed at the DA stage for the development and appropriate controls should be incorporated in the proposed development designs. Any residential development within the night time L_{Aeq} 40 dB(A) contour buffer zone of the Hume Industrial Area should be assessed for industrial noise with reference to the NSW INP.
- The extent of the buffer zone could be altered provided that design and planning measures can demonstrate that adverse industrial noise impacts would not occur outside of the zone.
- Planning layouts and building design should consider the direction of potential industrial noise sources when developing designs for the proposed sensitive land uses.

Road Traffic Noise

The potential for road traffic noise to cause adverse impacts was assessed. The existing noise survey indicated that existing road traffic noise sources are currently the dominant noise sources in the area. The existing level of noise was found to be below the relevant criteria. The potential for traffic noise impact from new access roads built as part of this and other developments was assessed.

At present, the access road arrangements have not been finalised and five access arrangements were assessed. Adverse noise impacts could be expected at receivers in proximity to the main access road. As a result, the following recommendations are made:

- Road traffic noise intrusion assessment should be conducted at the DA stage for all residential dwellings and sensitive developments along the planned sub-arterial/arterial roads.

Rail Noise and Vibration

The existing railway line is currently not in use and currently causes no adverse impacts. For a reinstated railway line, the rail line operator would be required to meet external rail noise limits at sensitive receivers. However, the resultant internal levels may not meet the noise goals in the Department of Planning's interim guideline for development near rail corridors and busy roads without additional mitigation. By adopting these guidelines for noise and vibration sensitive developments, the potential for unacceptable impacts to occur is minimised. As a result, the following recommendations are made:

- A rail vibration assessment should be carried out for proposed vibration sensitive development within 60m of the rail line.

- A rail noise assessment should be carried out for proposed noise sensitive development within 40m of the rail line.
- Where noise sensitive developments are proposed between 40 and 80m from the rail line, Category 2 building constructions in Appendix C of the interim guideline should be considered, unless it can be demonstrated that potential rail noise is sufficiently shielded or mitigated.

Conclusion

Overall the assessment indicated that the most significant risk associated with adverse noise impact on any potential residential development is from industrial noise. However all noise aspects are expected to be able to be controlled by suitable planning considerations.

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GLOSSARY OF TERMS

Item	Explanation
ABL	The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night-time) for each day. It is determined by calculating the 10th percentile (lowest 10 percent) background level (LA90) for each period.
Adverse meteorological conditions	Meteorological conditions under which noise propagation is enhanced. This typically includes the presence of wind and temperature inversions.
Ambient Noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
A-weighting	Refers to an adjustment made to noise levels to take into account the frequency composition of an acoustic signal relative to the ear's response to the various frequencies that make up the noise. A-weighting is applied to approximate the perception of noise by an "average" human ear response.
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_{A90} descriptor.
C-weighting	Refers to an adjustment made to noise levels to take into account the frequency composition of an acoustic signal relative to the ear's response to various frequencies with added sensitivity in the low frequencies compared with the A-weighting.
dB(A)	Decibel level with an applied A-weighting.
dB(C)	Decibel level with an applied C-weighting
dB(Lin)	Decibel level with a Linear weighting i.e. no frequency weighting applied.
Decibel, dB	Decibel is a logarithmic unit used to describe the ratio of the magnitude of a signal relative to a reference and is used to describe sound pressure and sound power magnitudes. The decibel is used to describe sound magnitude as it simulates the ear's response to changes in the magnitude of sound pressure.
L_1	The L_1 level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_1 level for 99% of the time.
L_{10}	The L_{10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{10} level for 90% of the time. The L_{10} is a common noise descriptor for environmental noise and road traffic noise.
L_{50}	The L_{50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{50} level for 50% of the time.
L_{90}	The L_{90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{90} level for 10% of the time. This measure is commonly referred to as the background noise level.
L_{eq}	The equivalent continuous sound level (L_{eq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.
L_{max}	The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.
L_n	The level exceeded for N% of the monitoring time.
Neutral meteorological conditions	Meteorological conditions under which no enhancements to noise propagation are present, i.e. temperature inversions and windy conditions.
Peak Particle Velocity (PPV)	The peak particle velocity is a measure of the maximum instantaneous velocity of a particle during a given time period.
RBL	The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night-time.
Rw	Weighted sound reduction index. Rw is measured in a laboratory. Rw is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete.
Sound Power Level (SWL)	A logarithmic measure of source acoustic power expressed in dB. The sound power level is fixed and inherent to the source similar to how electric power is inherent to an electrical device. The resulting sound pressure level due to a given sound power level is dependent on various environmental factors such as distance, acoustic shielding, meteorological factors etc.
Stability Class	The system of classifying atmospheric stability using considerations of solar radiation, surface wind speed, cloud cover and temperature lapse rate. The scale ranges from A (strongly unstable) to F (moderately stable). Typically Stability Class D is considered to represent moderately unstable atmospheric conditions and the conventional temperature gradient, typical of daytime conditions. Stability Class F is considered to represent moderately stable atmospheric conditions when a temperature inversion is present.
Temperature Inversion	An atmospheric condition when the temperature gradient in the air is inverted so that sound waves are refracted in the air back towards the ground, enhancing the distance over which noise propagates.
Vibration Dose Value (VDV)	The vibration does value defines a relationship that provides a consistent assessment of vibration which correlates well with receivers responses taking into account the magnitude and duration of vibration exposure as defined in *BS6472 2008 Guide to evaluation of human exposure to vibration in buildings.*

1 INTRODUCTION

1.1 Background

Queanbeyan City Council (QCC) are proposing to rezone two parcels of land on the ACT/NSW Border near to Queanbeyan and Hume, known as South Jerrabomberra (the site). The land parcels are currently known as Tralee Station (Walsh) and Forest/Morrison. The land is a greenfield site and currently has limited residential development. The council are considering rezoning the land to allow residential development across the site.

The area immediately to the north of the site, the area known as South Tralee, was successfully rezoned in 2012 and included zones for residential, commercial and mixed use land uses. Additional rezoning and development is also proposed to the north of South Tralee in the areas known as Poplars, North Tralee and Environa which is intended to include employment/commercial lands.

The *South Jerrabomberra Structure Plan* (The Structure Plan) (**QCC, 2013**) identifies that development at the site is in line with QCC's residential and economic strategy.

1.2 Objectives of study

To provide an assessment and identify any constraints relating to noise and vibration impacts for the proposed rezoning of South Jerrabomberra.

1.3 Scope of work

The scope of work was as follows:

- Review legislative and other regulatory requirements as well as relevant planning controls which may be relevant to noise issues including aircraft, road, rail and industrial/commercial noise.
- Review of existing land uses adjoining the area as well as with potential land uses and other planning provisions of the ACT Territory Plan, any proposed variations to it as well as those local environmental plans affecting adjoining land.
- Consultation with the ACT Planning and Land Authority in regard to possible future variations to the Territory Plan and possible land uses in adjoining areas.
- Review of all previous studies and their findings and recommendations which relate to the immediate area. These include existing industries in the Hume area:
    - An asphalt batching plant;
    - Landscaping supply companies;
    - Joinery companies;
    - Pre-mix concrete batch plants;
    - The Mugga Lane Resource Management Centre; and
    - Truck maintenance facilities.
- Review previous studies relating to road traffic noise and traffic volumes on the Monaro Highway and Lanyon Drive.
- Review the ANEF contours and requirements for land planning including *AS 2021 Acoustics - Aircraft noise intrusion - Building siting and construction*.
- Review the potential for rail noise impacts on the subject sites.
- Attend site and install three environmental noise monitors on site for one week. Perform attended measurements to characterise the noise environment and identify noise sources.
- Whilst on site, inspect the surrounds of the site to identify potential noise sources within the general vicinity.
- Meteorological data during the monitoring was taken from the nearest Bureau of Meteorology Site at Tuggeranong.
- Prepare an assessment to incorporate the suitability and constraints relevant to the parcels of land within the context of the noise issues mentioned above. The assessment includes:

- An assessment of existing industrial noise impacts on the subject sites with reference to the NSW *Industrial Noise Policy* (INP) (**EPA, 2000**).
- An assessment of road traffic noise impacts from existing and proposed significant roads with reference to the NSW *Road Noise Policy* (RNP) (**EPA, 2011**) and Department of Planning's *Development near Busy Roads and Rail Corridors Interim Guideline* (ISEPP) (**DoP, 2009**).
- An aircraft noise intrusion assessment from Canberra Airport, including where required provide in principal building envelope requirements for potential residential dwellings to meet *AS2107 Acoustics - Recommended design sound levels and reverberation times for building interiors*.
- An in-principal rail noise assessment considering the potential impacts of rail noise on the subject site were the rail line to be reactivated with reference to the *Rail Infrastructure Noise Guideline* (RING) (**EPA, 2013**) and Department of Planning's *Development near Busy Roads and Rail Corridors Interim Guideline* (ISEPP) (**DoP, 2009**).

- Consultation with the NSW EPA (as required and instructed by Queanbeyan City Council).
- Provide recommendations based on the findings of the noise assessment.

1.4 Reviewed Documents

Table 1-1 provides a summary of the documents reviewed as part of this study.

Table 1-1: Summary of Reviewed Documents

Author	Year	Title	Reference
ACT Government	1997	Environment Protection Act	-
ACT Government	2005	Environment Protection Regulation	-
ACT Government	2010	Noise Environment Protection Policy	-
ACT Government	2014	ACT Territory Plan	-
Arup	2013	South Tralee Traffic Report	205810-75 007 TIA-01
Australian Government	2009	National Aviation White Paper	-
Canberra Airport	2009	Masterplan	-
Canberra Airport	2014	Preliminary Draft Master Plan	-
NSW Department of Planning	2008	Development near busy roads and rail corridors – Interim Guideline	-
NSW Department of Planning	2009	Section 117 Ministerial Direction Chapter 3.5 "Development Near Licensed Aerodromes"	-
NSW EPA	2000	Industrial Noise Policy	-
NSW EPA	2011	Road Noise Policy	-
NSW EPA	2013	Rail Infrastructure Noise Guideline	-
NSW Government	1979	Environmental Planning and Assessment Act 1979	-
NSW Government	2007	Infrastructure State Environmental Planning Policy	-
Queanbeyan City Council	2009	Aircraft Noise Assessment Guidelines	-
Queanbeyan City Council	2012	Queanbeyan Local Environmental Plan (LEP) (South Tralee) 2012 Queanbeyan City Council	-
Queanbeyan City Council	2013	South Jerrabomberra Structure Plan	C1356307
Renzo Tonin	2010	South Tralee Supplementary Report to LES –Acoustic Review	TE543-02F02 (Rev3)
Wilkinson Murray	2013	South Tralee Sub-Division Concept - DA Noise and Air Assessment	02147-DA Version D
Standards Australia	2000	Australian Standard AS 2021 – Acoustics – Aircraft Noise Intrusion – Building Siting and Construction	-
Standards Australia	2000	AS 2107 – Acoustics – Recommended design sound levels and reverberation times for building interiors	-
TDG	2014	Draft Queanbeyan City Council TRACKS Model, South Jerrabomberra & Queanbeyan Traffic Analysis 2014	-

1.5 Consultation

Consultation on the project was carried out on 23 May 2014. Pacific Environment consulted the following people from a range of regulatory authorities in the ACT and NSW:

- Daniel Walters, ACT EPA.
- Sharon Peters, NSW EPA.
- Justineta Balberona, ACT Environment and Sustainable Development Directorate.
- Alix Kaucz, ACT Environment and Sustainable Development Directorate.
- Mike Thomson, Queanbeyan City Council.

2 PROJECT DESCRIPTION

2.1 Study area

The proposed site is currently a greenfield area covering 111 hectares in South Jerrabomberra, NSW. The site is considered an extension of South Tralee that has recently been rezoned for residential purposes.

The site comprises two parcels of land under separate ownership, as shown in **Figure 2-1**. The eastern most land parcel is known as the Forest/Morrison property and the other is Tralee Station (Walsh).

The site is situated to the immediate southeast of the NSW/ACT border, separated by the disused Goulburn to Bombala railway line. To the northwest of the rail line is the existing Hume Industrial Area.

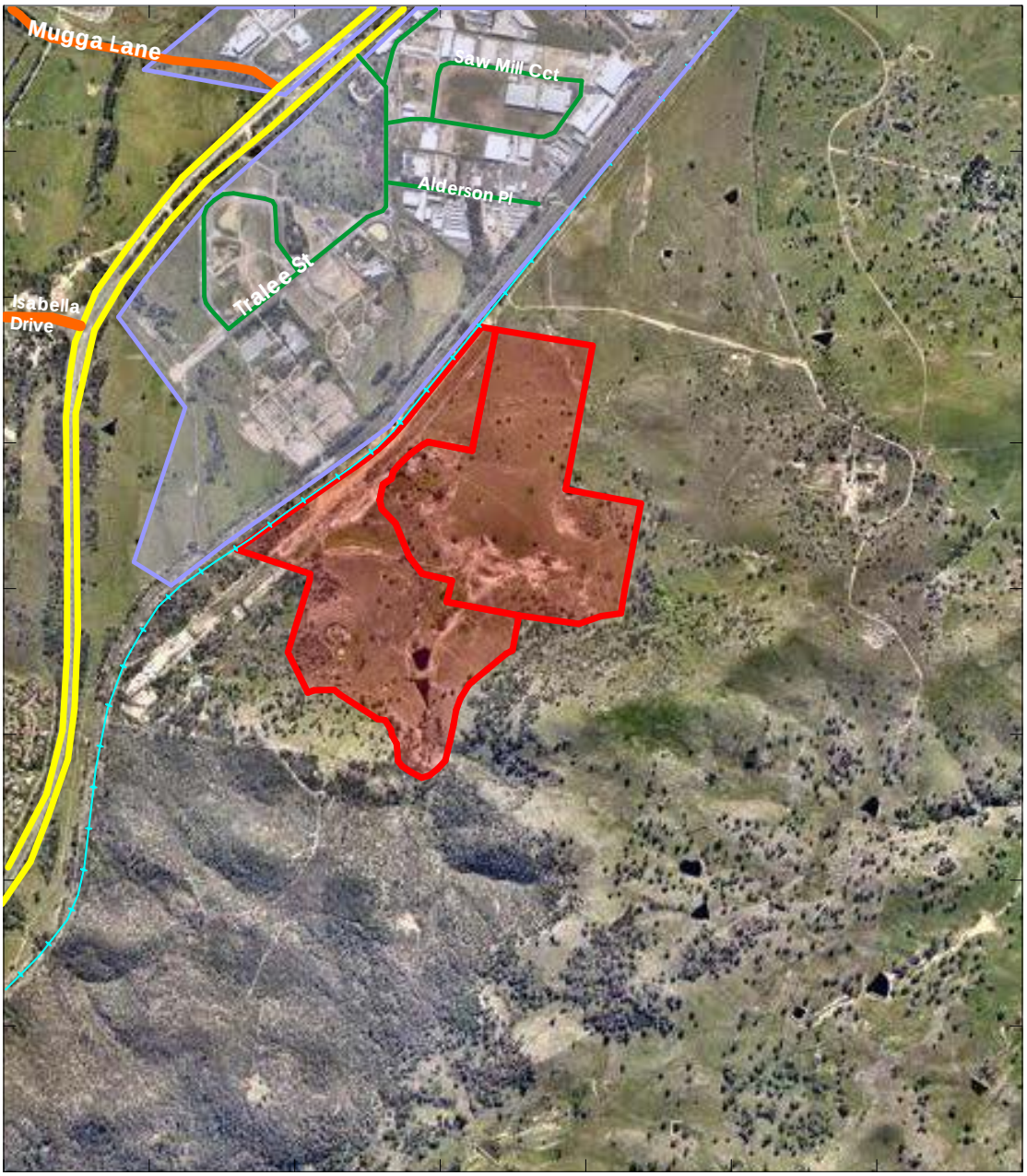


Figure 2-1: South Jerrabomberra planning proposal parcels

2.2 Surrounding land use

The South Jerrabomberra site is currently zoned Environmental Protection (E2) under the *Queanbeyan Local Environmental Plan (LEP) (South Tralee)* 2012 and the *Yarrowlumla LEP 2002*. The current land use is shown in **Figure 2-2**.

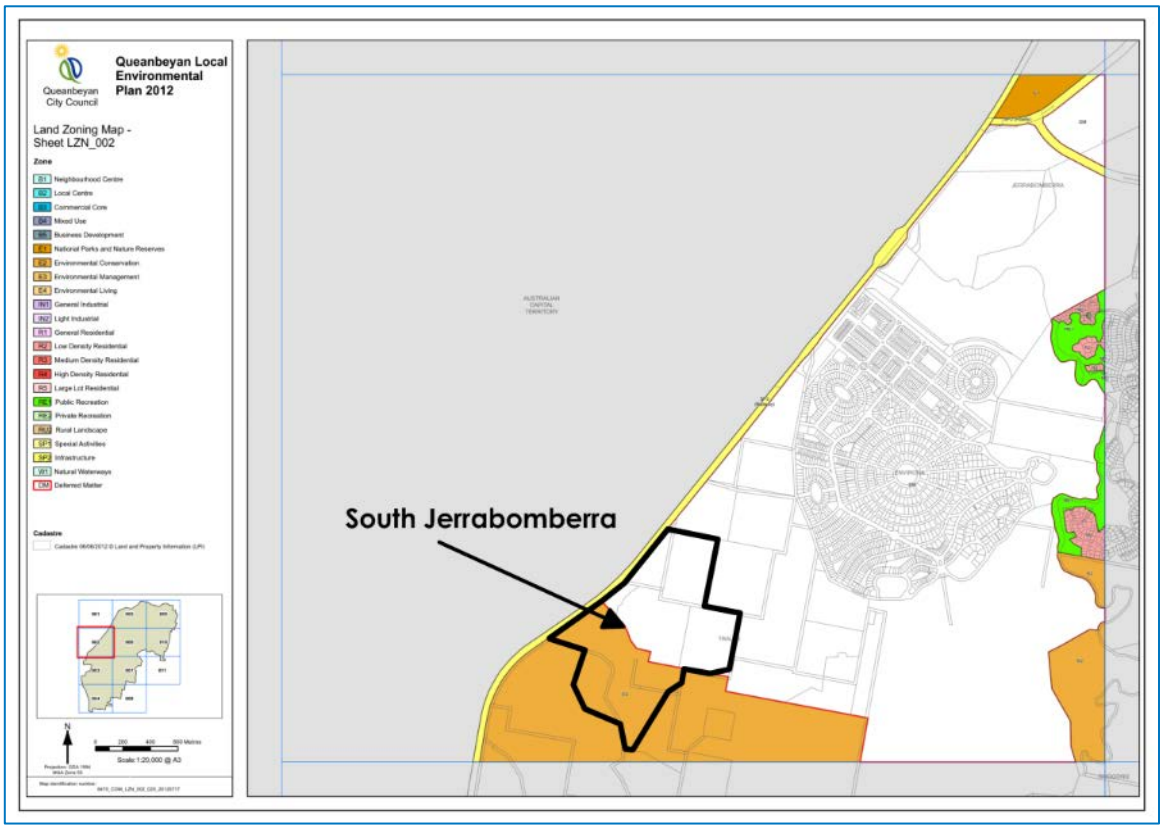


Figure 2-2: Land use at proposed site [Source: QCC]

The northern component of the proposed site forms part of the now abandoned 'Environa' subdivision. The area currently has no specified land use. Further to the east forms part of the Jerrabomberra residential area.

The Structure Plan (**QCC, 2013**) indicates the potential future land uses in the area. This includes residential land uses in South Tralee and the site with potential employment lands located at the north of the Environa property.

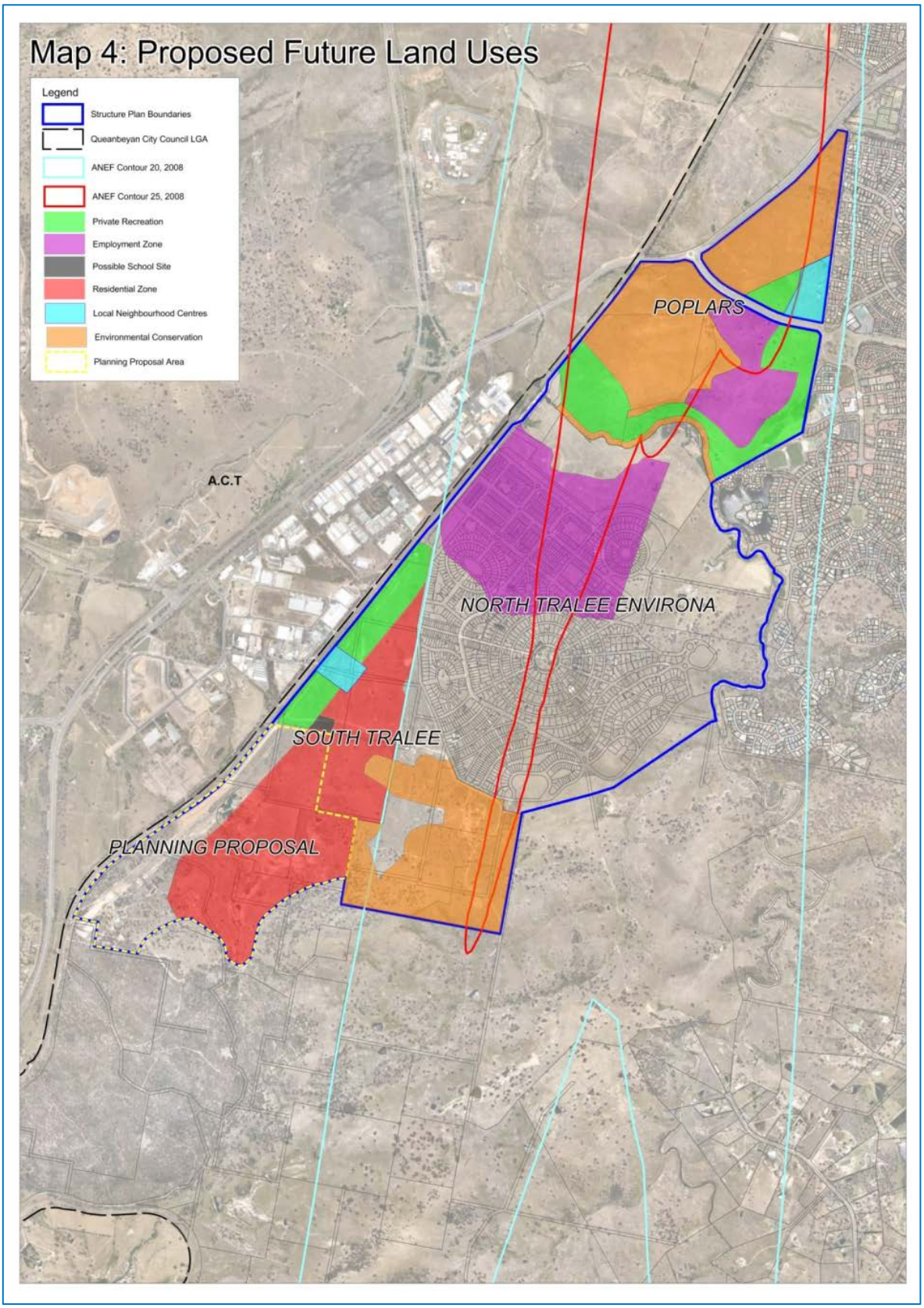


Figure 2-3: Proposed Future Land Uses – subject to further detailed assessment [source: South Jerrabomberra Structure Plan]

As described in **Section 2.1** the railway line adjacent to the proposed site defines the NSW/ACT border. Therefore, any land located to the northwest of the railway is subject to the *ACT Territory Plan* zoning requirements (**ACT Government, 2014**). This includes the Hume Industrial Area, located immediately adjacent to the proposed site.

Land use in Hume, for the most part, comprises 'IZ1 – General Industrial' that makes up the Hume Industrial Area. A small portion of this area is allocated as 'IZ2 – Mixed Use Industrial', restricting the level of industry able to operate within this zone.

Further afield comprises 'NUZ1 – Broadacre', 'CZ6 – Leisure and Accommodation', 'NUZ3 – Hills Ridges and Buffer' transitioning to a mixture of 'RZ1 – Suburban' and 'RZ2 – Suburban Core' zones to the southwest.

Figure 2-4 provides an overview of the land use zoning for the Hume Industrial Area.

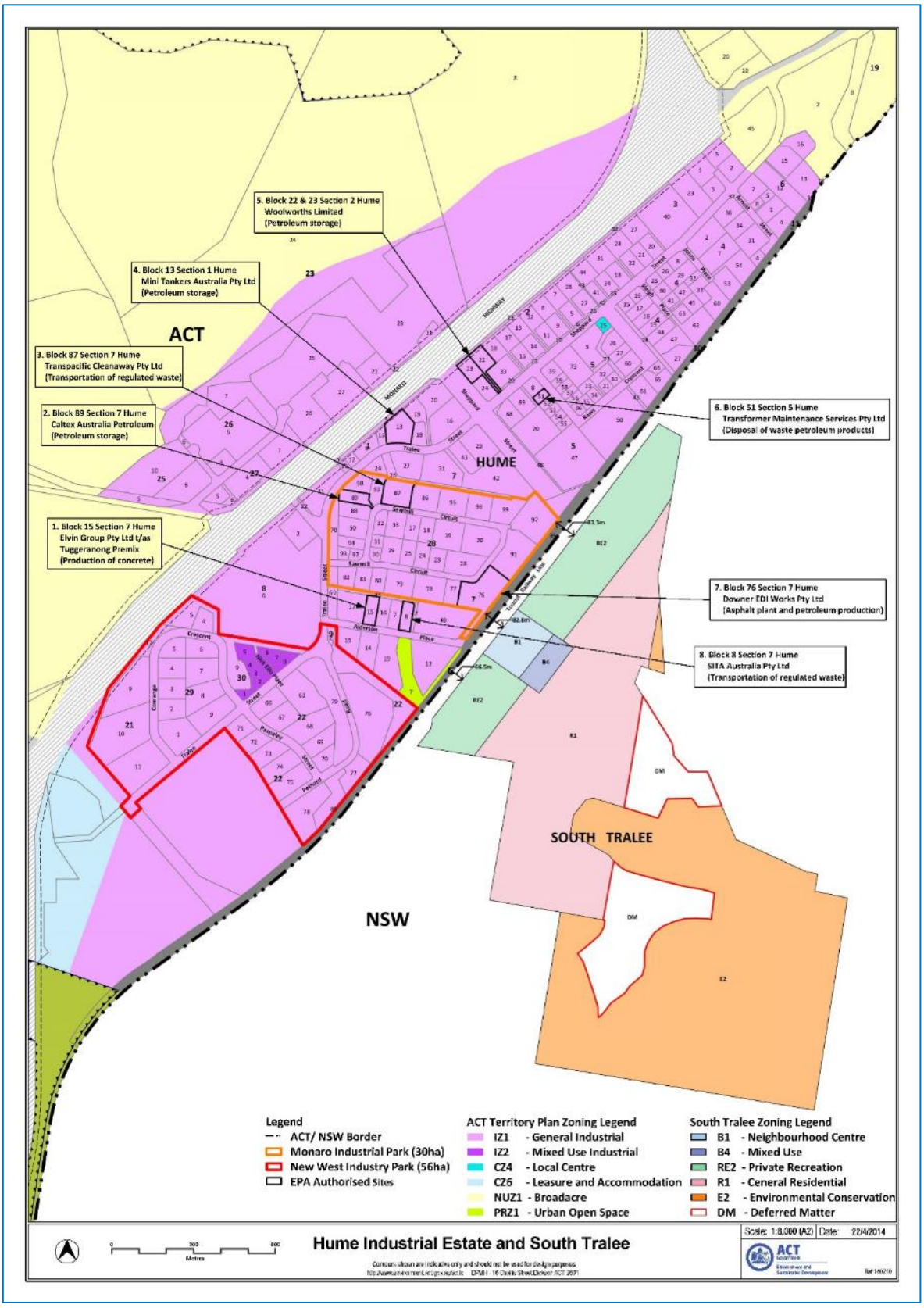


Figure 2-4: ACT land use in vicinity of the site [Source ACT Planning and Land Authority]

2.3 Development Concept

The Structure Plan presents the development concept including potential land uses and road links.

Map 6.2 of the Structure Plan, reproduced in **Figure 2-5**, shows the potential future transportation links between the site and the existing road infrastructure. At this stage it is envisaged that the main links to the development site would initially link the site and Tompsitt Drive via proposed development areas in Poplars, South Tralee and North Tralee/Environa.

An additional link would utilise the existing roundabout between Isabella Drive and the Monaro Highway to the north west of the site. The potential for a further link between Sheppard Street and South Tralee/South Jerrabomberra is currently subject to ongoing investigation and negotiation between NSW and ACT governments.

A road link called Dunns Creek Road (indicated in yellow in **Figure 2-5**) travelling from the access road, north west to south east is also proposed as part of the South Tralee development. The link is eventually planned to connect with Googong.

The South Jerrabomberra site is proposed to contain primarily residential properties, with local roads providing connections from residential areas to the main access road running parallel to the rail corridor and Dunns Creek Road.

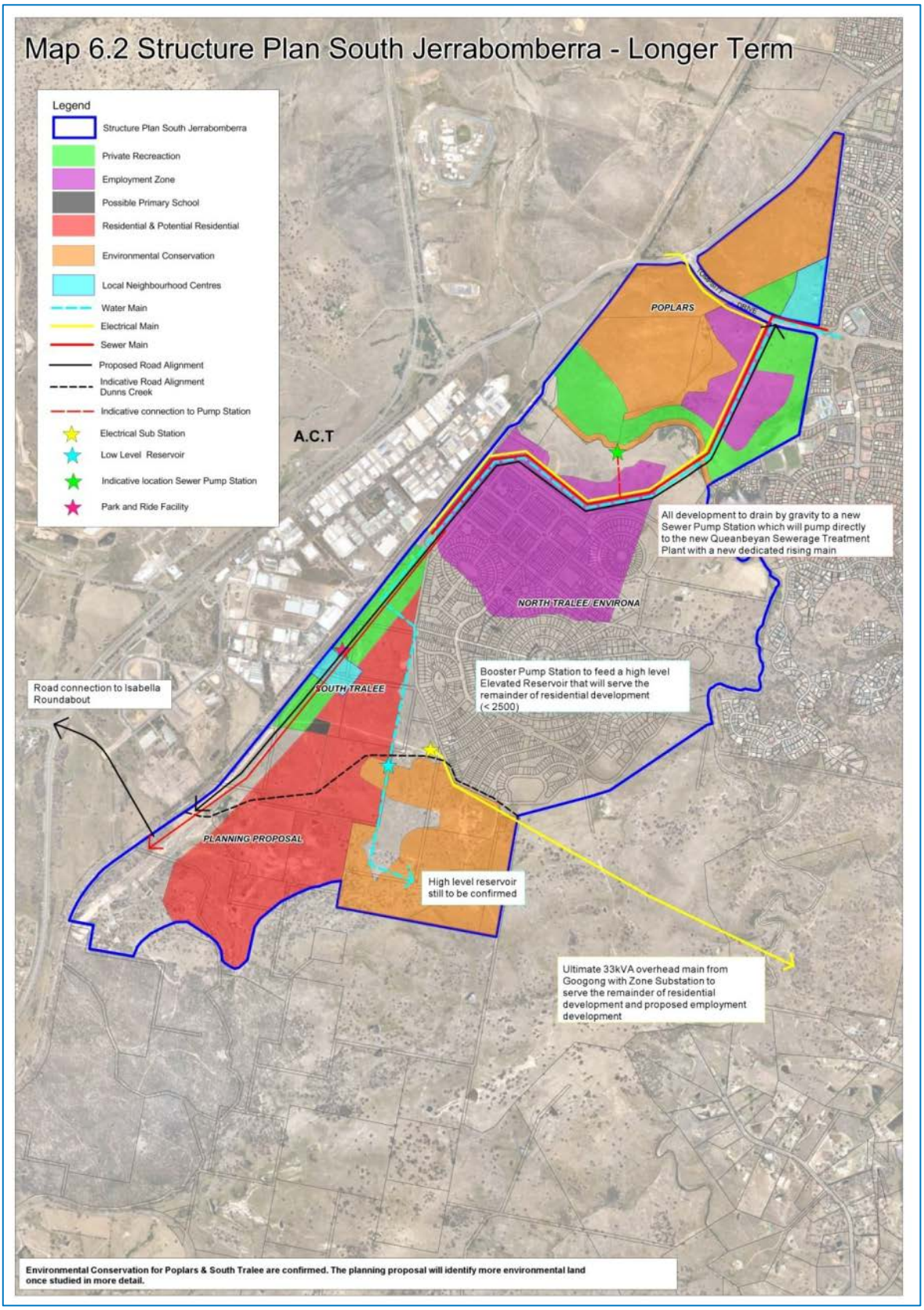


Figure 2-5: Longer Term Development Concept [Source: The Structure Plan (QCC, 2013)]

2.4 Potential Noise Issues

Noise emission sources that have the potential to impact on the local noise amenity of South Jerrabomberra have been identified as follows:

- Aircraft noise from aircraft movements associated with Canberra Airport
- Industrial noise associated with:
  - Hume Industrial Area including:
    - Asphalt plant.
    - Landscaping supply companies.
    - Joinery companies.
    - Pre-mix concrete batch plants.
    - Logistics and distribution companies.
    - Mobile plant and equipment hire companies.
    - Heavy vehicle movements.
    - Material and product loading/unloading.
    - Waste management facilities.
  - Mugga Lane Resource Management Centre (RMC).
  - Truck maintenance facilities.
  - Reversing alarms on mobile plant and heavy vehicles.
  - Holcim Cooma Road Quarry.
  - Potential mixed use land uses in South Tralee.
- Road Traffic noise from:
  - Monaro Highway.
  - Tralee Street and other roads within the Hume Industrial Area.
  - Isabella Drive.
  - Mugga Lane.
  - New roads constructed within the proposed development area.
- Potential rail noise and vibration from reinstating the currently disused Goulburn to Bombala railway line.

3 LEGISLATION, GUIDELINES AND STANDARDS

The applicable legislation, guidelines and standards relevant to noise issues in NSW are as follows:

- NSW *Industrial Noise Policy* (INP) (**EPA, 2000**).
- NSW *Department of Planning Section 117 Ministerial Direction Chapter 3.5 "Development Near Licensed Aerodromes"* (**DoP, 2009**).
- *AS 2021 – Acoustics – Aircraft Noise Intrusion – Building Siting and Construction.*
- Queanbeyan City Council *Aircraft Noise Assessment Guidelines.*
- *AS 2107 – Acoustics – Recommended design sound levels and reverberation times for building interiors.*
- *Road Noise Policy* (RNP) (**EPA, 2011**).
- *Rail Infrastructure Noise Guideline* (RING) (**EPA, 2013**).
- *Infrastructure State Environmental Planning Policy* (ISEPP) (**NSW Government, 2007**).
- *Development near busy roads and rail corridors – Interim Guideline* (**DoP, 2008**).
- *Assessing Vibration: A Technical Guideline* (**EPA, 2006**).

4 EXISTING ENVIRONMENT

4.1 Acoustic Environment

The existing acoustic environment was characterised by a combination of long term and short term noise measurements.

Long term noise measurements were carried out between the 11 and 19 June at two locations (BG1 and BG3) and the 11 and 24 June 2014 at one locations (BG 2). BG1 was located at the south of the site representing the site nearest the highway. BG2 was located at a point representative of the closest part of the site to existing developed industrial areas within Hume. BG2 experienced a hardware fault from contact with local fauna and the monitoring period was repeated from 19 to 24 June 2014. BG3 was located at a typical set back for proposed residential properties from the Highway and Hume area.

Noise monitoring was conducted using two NTi Audio XL2 Type 1 and one Rion NL-31 noise logger. All equipment carries current calibration certificates and the calibration was checked in the field before and after the measurements and no significant drift (>0.5 dB) was noted.

For the duration of the monitoring period, meteorological conditions were recorded at the Bureau of Meteorology (BoM) Stations located at Canberra Airport and Tuggeranong, located approximately 13 km and 6km away respectively.

Where monitoring data were identified to be adversely affected by extraneous noise or during periods of adverse weather (significant rainfall or wind speeds greater than 5 m/s), these periods were removed from the monitoring.

The noise levels obtained are expressed in terms of, $L_{A1,15min}$, $L_{A10,15min}$, $L_{A90,15min}$ and $L_{Aeq,15min}$.

- $L_{A1,15min}$ is the A-weighted noise level that is exceeded for 1% of the monitoring time period (15 minutes).
- $L_{A10,15min}$ is the A-weighted noise level that is exceeded for 10% of the monitoring time period (15 minutes).
- $L_{A90,15min}$ is the A-weighted noise level that is exceeded for 90% of the monitoring time period (15 minutes).
- The $L_{Aeq,15min}$ is the 15 minute equivalent continuous noise level containing the same acoustic energy as the actual fluctuating noise level.

The $L_{A90,15min}$ is commonly referred to as the background noise level and the lowest 10th percentile $L_{A90,15min}$ level over a period (day, evening, night) is referred to as the period assessment background level (ABL). The Rating Background Level (RBL) for each day, evening and night period of the monitoring occurrence is the median ABL.

Table 4-1 provides a summary of the noise monitoring data from the three locations. Graphs of the monitoring results are presented in **Appendix A**.

Table 4-1: Long Term Noise Monitoring Results

Location	Measured Noise Level, dB(A)											
	Day				Evening				Night			
	L_1	L_{10}	RBL	L_{eq}	L_1	L_{10}	RBL	L_{eq}	L_1	L_{10}	RBL	L_{eq}
BG1	57	51	40	47	56	48	36	44	50	47	27	41
BG2	58	51	40	49	51	47	37	43	52	49	31	42
BG3	58	49	37	45	58	45	34	42	48	45	28	39

Short term (attended) noise measurements were also carried out at BG1, 2 & 3 on 11 and 12 June 2014 Measurements were taken at the long term monitoring locations over 15 minutes using a NTi Audio XL2 Type 1 Sound Level Meter. Field calibration was checked before and after each measurement occasion and no significant drift (±0.5 dB) was noted. The weather conditions during the day and evening were observed to be generally overcast with calm to very light winds. During the night, cloud cover (5/8 oktas) and misty conditions were observed with calm wind conditions.

Appendix B provides results and observations from the attended noise measurements.

The general ambient noise environment is dominated by road traffic noise from the Monaro Highway and the other roads in the vicinity of the site. It was noted as the most significant noise source at all locations during the day, evening and night. The road traffic noise was generally steady state and constant with occasional peaks observed from accelerating vehicles and truck compression braking.

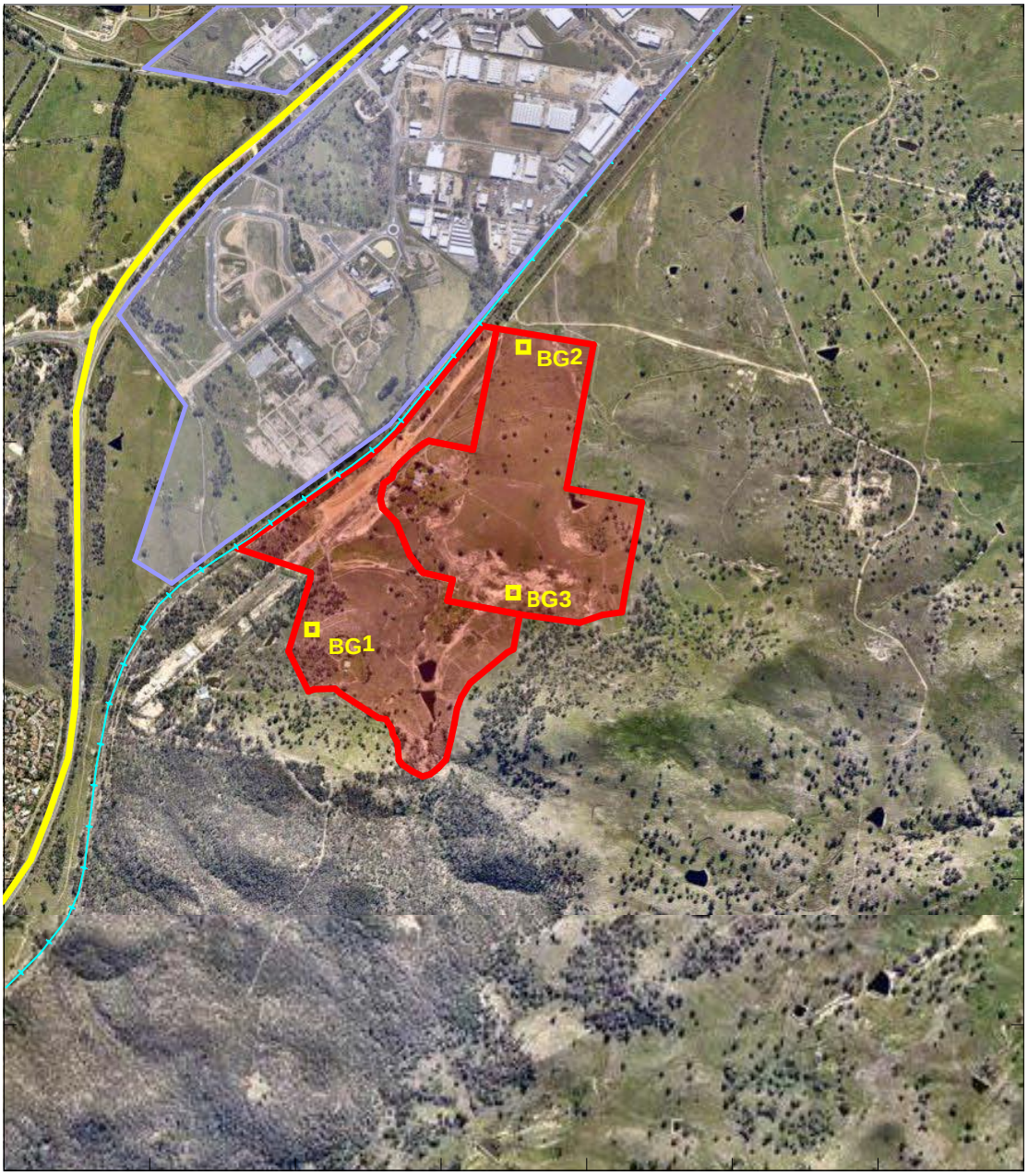
Industrial noise was also noted at BG1, BG2 and BG3, with industrial noise most prominent at BG2 during the day and lower during the evening and night. Tonal reversing alarms and to a lesser extent broadband reversing alarms from the Mugga Lane RMC and Hume Industrial Area were clearly audible at all locations during the day, evening and night.

Heavy vehicle movements on roads within the Hume Industrial Area and within industrial premises are difficult to distinguish as locations cannot be accurately defined for a particular premises. Acceleration, braking and other noise emission from heavy vehicles may also occur on public roads.

Aircraft movements were observed to be generally low in level (less than 43 dB(A)) and were not observed to pass directly over the site.

The noise environment varied over the area of the site with more industrial noise being noted at BG2, close to the Hume Industrial Area. At BG3, noise levels were generally noted to be lower than the other locations, due to the offset of the road and limited shielding by topography. At BG1, the background noise levels were observed to be similar to BG2 where road traffic noise dominates the noise environment.

The long term noise monitoring results appear to be in general agreement with the attended noise monitoring results. Road traffic noise from the Monaro Highway is the dominant source across the site and industrial noise is a lesser contributor.



4.2 Meteorology

The propagation of noise is influenced by meteorological conditions, primarily wind speed, wind direction, temperature and relative humidity all affect the propagation of noise and are considerations for potential noise impacts.

On an annual basis, the prevailing wind direction follows a northwest-southeast axis. In general, calmer winds originating from the southeast quadrant and strong winds from the northwest. There are two distinct seasonal patterns comprising summer/autumn and winter/spring. The stronger winds from the

northwest dominate during the months of winter and spring while the opposite is the case for summer and autumn.

There is significant chance of medium to strong temperature inversions occurring during cooler months. Temperature inversions may increase the noise level received by receptors from distant noise sources.

Further details on the site's meteorology are provided in **Appendix C**.

4.3 Topography

The surrounding terrain is gently undulating with steeper slopes emerging near ridgelines, prominent towards the southwest of the site. To the north and west of the site is the City of Canberra, with an elevation of between 580m and 700m above sea level. **Figure 4-1** shows a pseudo 3-dimensionsal representation of the terrain in the area of the site and surrounds.

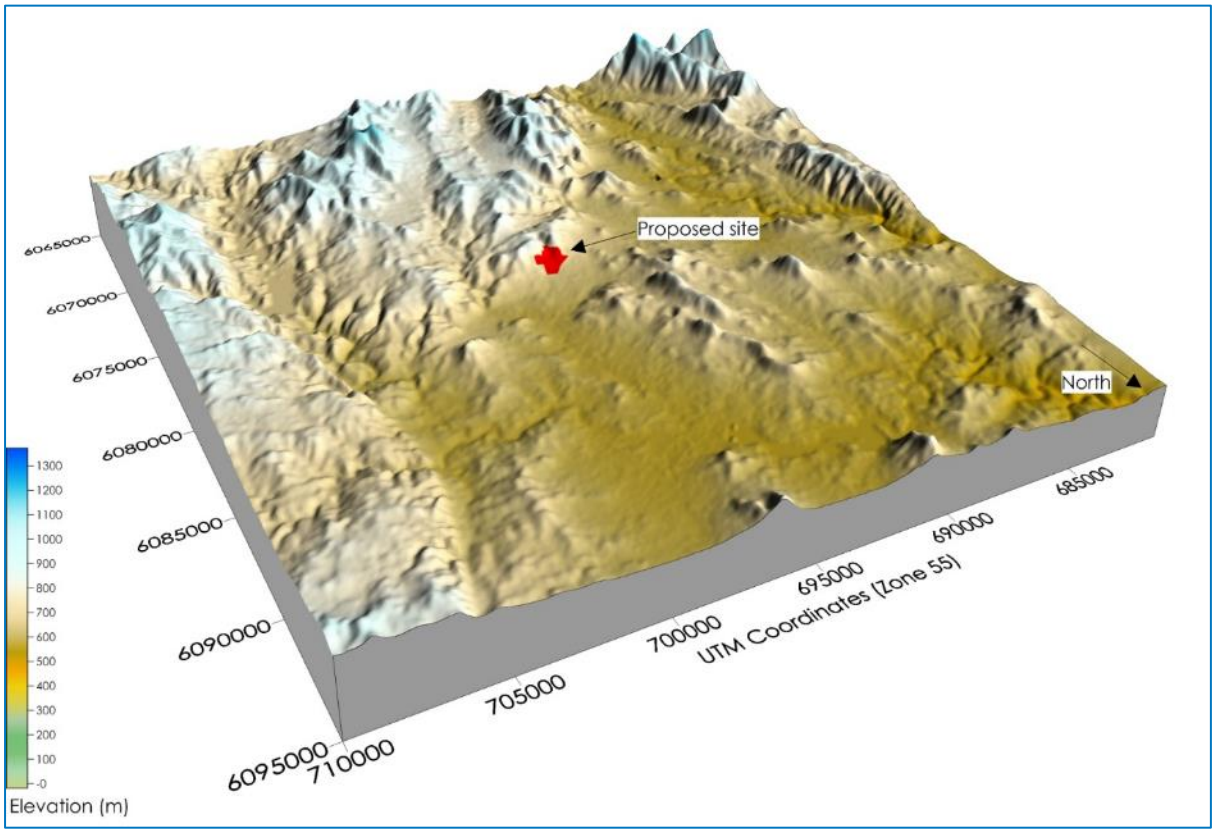


Figure 4-1: Pseudo 3-dimension plot of topography in study area

5 AIRCRAFT NOISE

5.1 Introduction

The South Jerrabomberra site lies approximately 10km to 12km from the end of the main north-south runway (Runway 35/17) of Canberra Airport. The site does not currently lie directly underneath the direct approach or departure paths for Runway 35/17. The location of the proposed site and the airport is presented in **Figure 5-1**.

Canberra Airport is currently a major passenger and freight terminal, which operates 24 hours a day with no curfew. As part of its development and growth, additional routes and air traffic are proposed to occur in the future. The 2014 *Preliminary Draft Master Plan* (PDMP) (**Canberra Airport, 2014**) proposes that the no curfew is imposed and the airport remains able to operate over 24 hours.

Aircraft noise can be a significant source of adverse impact on acoustic amenity for noise sensitive land uses. It can be the source of significant community complaints if not suitably addressed for changes in land use or new developments. By means of land use planning, the chance of adverse community reaction to aircraft noise can be reduced by restricting land use or placing controls on building specifications so that an appropriate level of acoustic amenity is preserved.

A number of submissions relating to potential impacts from aircraft noise were raised with the South Tralee rezoning project. Supporting information for the assessment was sourced from the following documents:

- *Canberra Airport Preliminary Draft Masterplan* (PDMP) (**Canberra Airport, 2014**)
- *Aviation White Paper* (**Australian Government, 2009)**
- South Tralee Noise Review (**Renzo, Tonin, 2010**)
- Planning Report: Draft Queanbeyan Local Environmental Plan (South Tralee) 2012, (**Department of Planning and Infrastructure, 2012)**

Further detail on these documents is presented in **Appendix D**.

Figure 5-1: Proposed Site and Airport Location

5.2 Assessment Methodology

The assessment of aircraft noise was carried out using the following publications:

- *NSW Department of Planning Section 117 Ministerial Direction Chapter 3.5 "Development Near Licensed Aerodromes."*
- *AS 2021 – Acoustics – Aircraft Noise Intrusion – Building Siting and Construction.*
- Queanbeyan City Council *Aircraft Noise Assessment Guidelines.*

The Aviation White Paper and Ministerial Direction 3.5 confirm that the ANEF scheme currently provides the preferred land use planning tool for aircraft noise.

The criteria for building acceptability for the proposed land use of the site as defined by AS 2021 is presented in **Table 5-1**. The indoor design sound levels as described in AS 2021 for the relevant proposed land uses are presented in **Table 5-2**. **Table 5-1** shows that residential development is acceptable within the proposed South Jerrabomberra rezoning area.

Table 5-1: Building Site Acceptability Based on ANEF Zones

Building Type	ANEF Zone of Site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF

Table 5-2: Indoor Design Sound Levels for Determination of Aircraft Noise Reduction

Building Type	Activity	Indoor Design Sound Level, dB(A)
Houses, home units, flats, caravan parks	Sleeping area, dedicated lounges	50
	Other habitable spaces	55
	Bathrooms, toilets, laundries	60

In addition, AS 2021 states:

"The actual location of the 20 ANEF contour is difficult to define accurately, mainly because of variation in aircraft flight paths. Because of this, the procedure of Clause 2.3.2 may be followed for building sites outside but near to the 20 ANEF contour."

The proposed site currently lies outside of the 20 ANEF contour and closest site boundary is approximately 150m away from the 20 ANEF Ultimate Practical Capacity (UPC) contour. In consideration that the site lies close to the 20 ANEF contour, aircraft noise levels were assessed for proposed sensitive buildings as an indicative assessment of the potential for adverse impact on internal noise levels.

5.3 Assessment

5.3.1 ANEF Contours

The Australian Noise Exposure Forecast (ANEF) is a noise prediction system for use with land use planning in the vicinity of airports. Its primary objective as a planning tool is to ensure appropriate land use developments near to airports.

Figure 5-2 and **Figure 5-3** shows the current 20 and 25 ANEF contours, as supplied by QCC in relation the region and the site. **Figure 5-2** also shows the UPC 20 ANEF contour at Canberra Airport as stated in the PDMP.

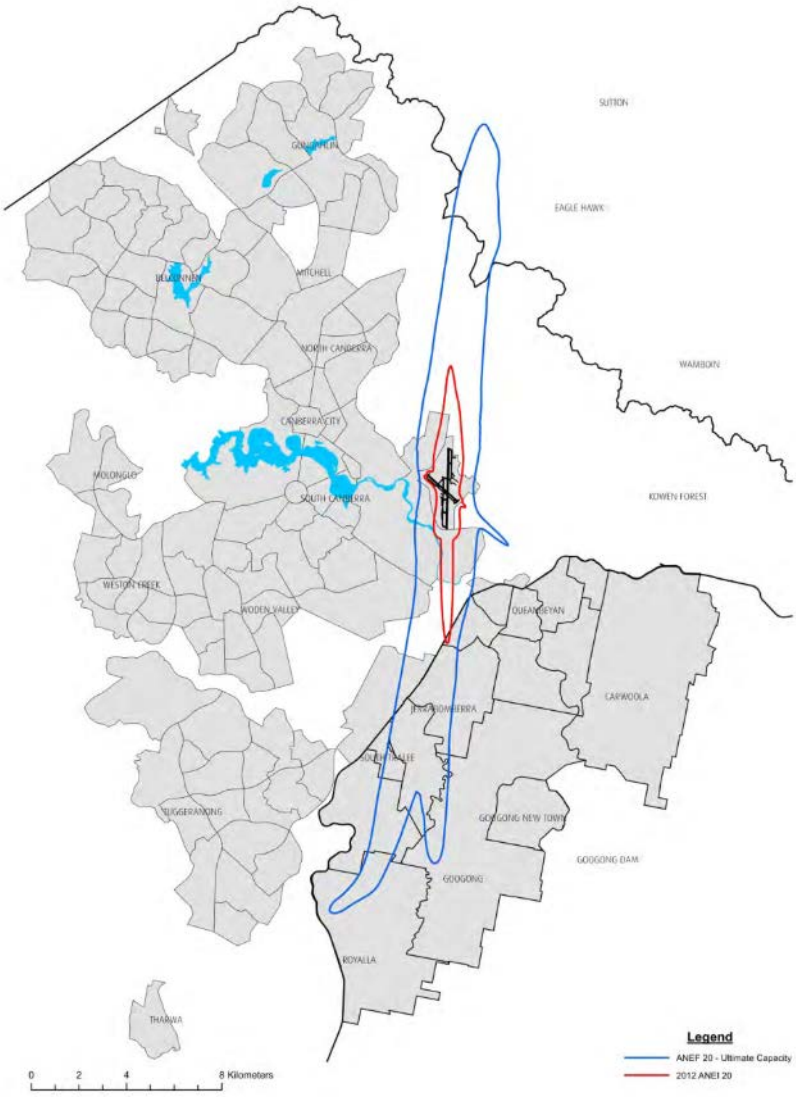


Figure 5-2: Comparison of 2012 20 ANEF and 20 ANEF UPC [From Canberra Airport Preliminary Draft Master Plan 2014]

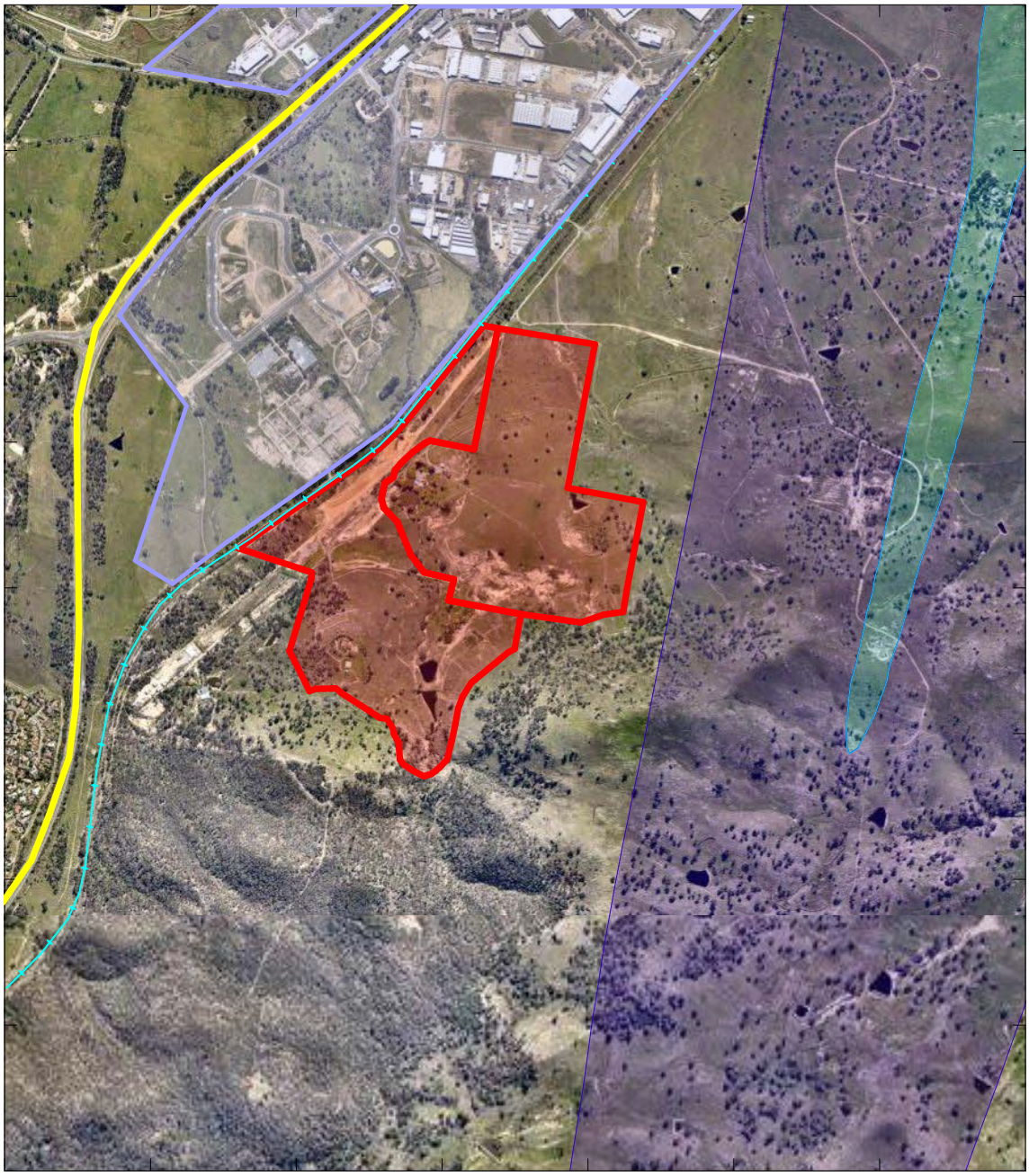


Figure 5-3: 20 and 25 ANEF Contours

5.3.2 Predicted aircraft movements

Categorised aircraft movement data was not available in the PDMP. The UPC is stated in the PDMP as being 282,000 fixed wing movements. It is expected that as the airport traffic increase and the demand for international flights increases, more wide body aircraft would utilise the airport. Therefore when

considering potential noise impacts both domestic and international style aircraft have been considered.

5.3.3 Indicative AS 2021 Calculations

In order to gauge the potential impact of aircraft noise from Canberra Airport on any sensitive land use, indicative calculations according to the method in AS 2021 were performed for locations within the site.

The calculations assume that the flight path taken is that which travels closest to the site as illustrated in **Figure 5-4**. The representative assessment locations are shown in **Figure 5-5**.

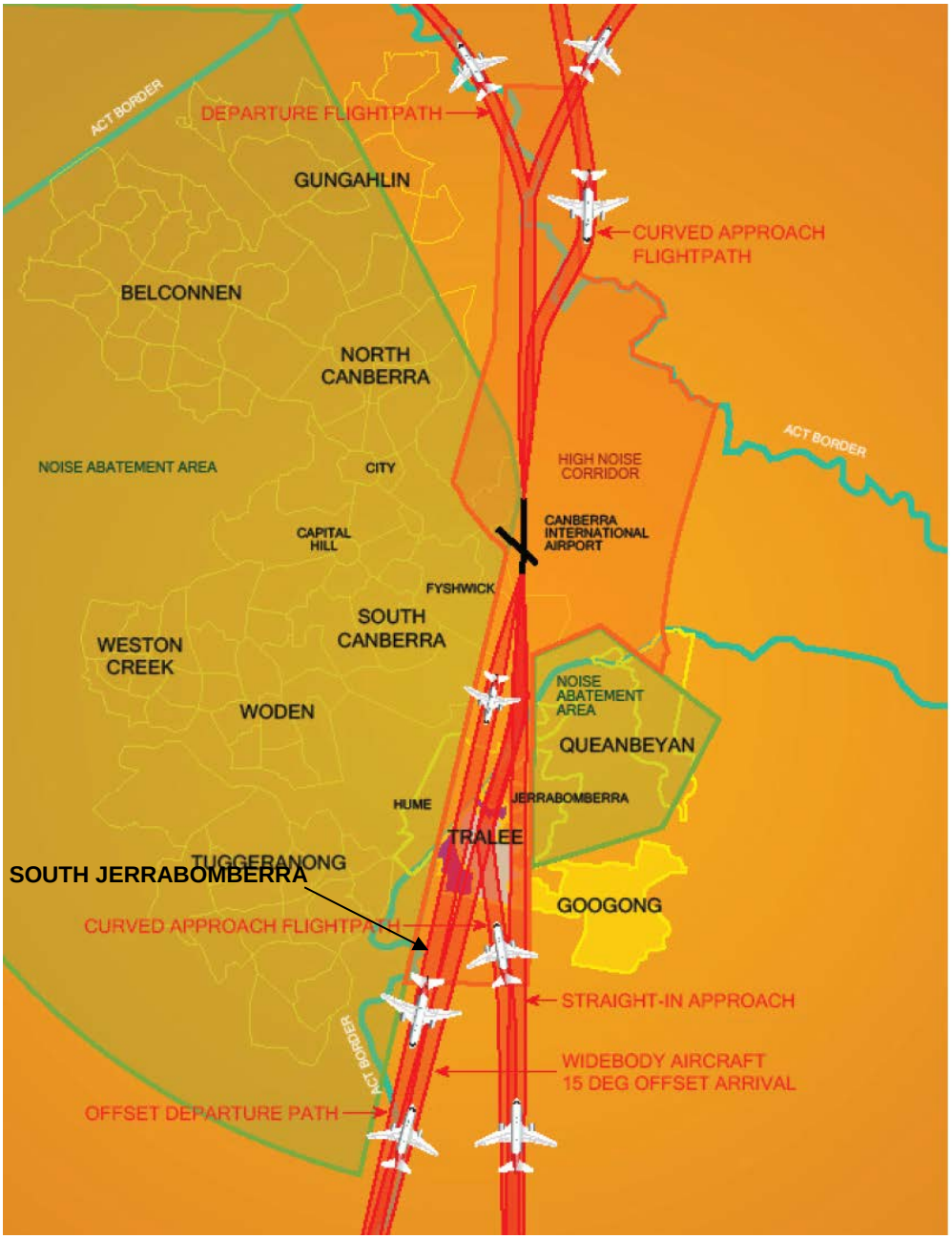


Figure 5-4: Aircraft Flight Paths [Source: Canberra Airport Masterplan 2009]

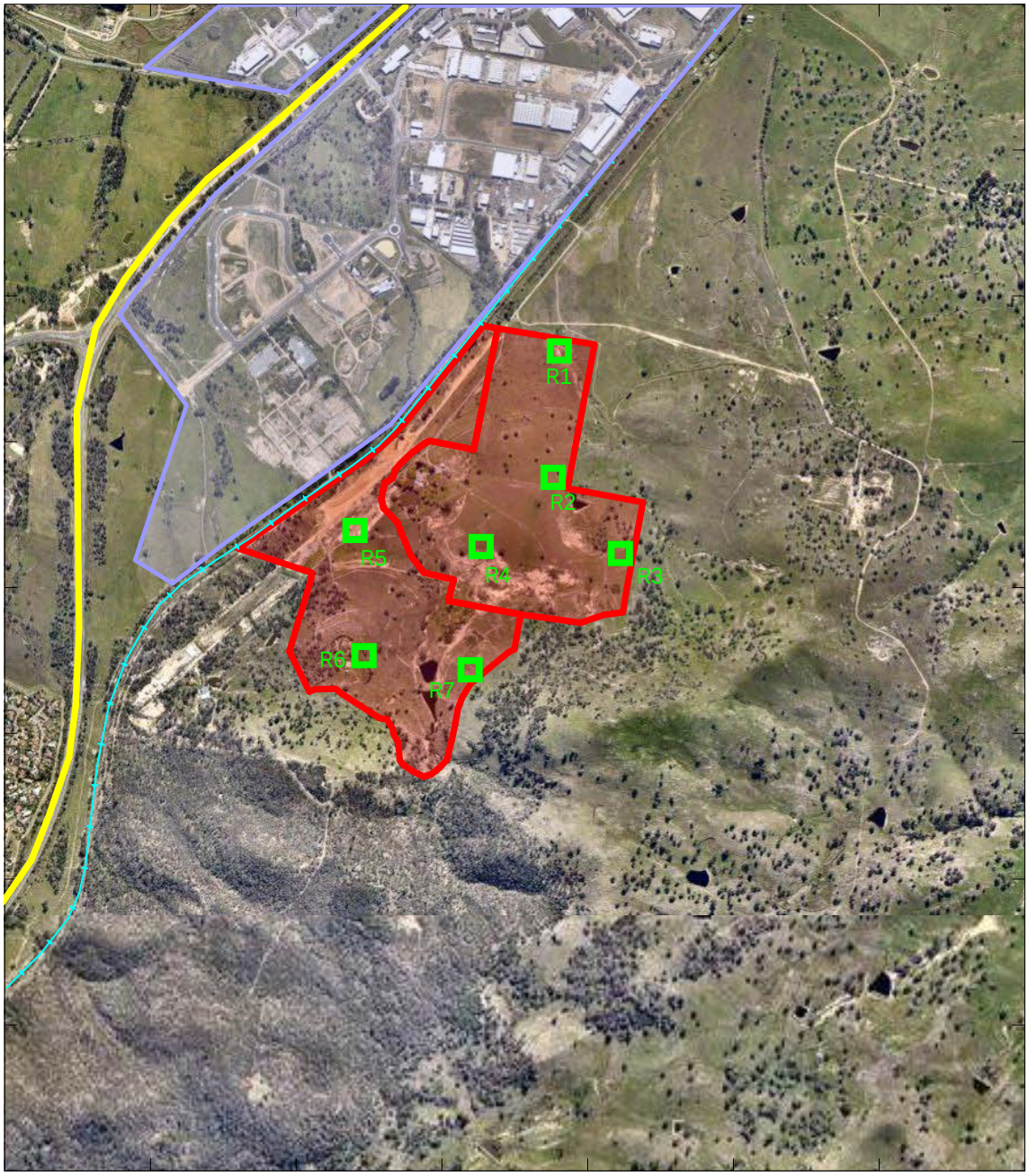


Figure 5-5: Representative Aircraft Noise Calculation Locations

Table 5-3 presents the calculated L_{max} aircraft noise levels for arrival and departure at each location for Boeing 747-400 and Airbus A320, Boeing 737-300 and 737-400. The Boeing 747-400 noise levels are intended to represent wide body international style aircraft, which are the loudest aircraft. The Airbus A320 represents the typical domestic style aircraft which use the Airport most frequently. The most stringent indoor criteria for aircraft noise levels is L_{max} 50 dB(A).

Table 5-3: Calculated Aircraft Noise Levels

Receiver	Calculated Aircraft Noise Level, L_{max}, dB(A)			
	747-400		A320/737-300	
	Landing	Take Off	Landing	Take Off
R1	63	71	56	64
R2	67	73	59	65
R3	73	76	63	67
R4	63	71	55	64
R5	62	67	<54	61
R6	<62	67	<54	61
R7	64	71	56	64

Table 5-3 shows that there is potential for noise events greater than L_{max} 70 dB(A) at five of the seven locations for take offs and at one location for landings for 747-400 style aircraft. For domestic style aircraft, the noise levels are lower with the greatest calculated level being L_{max} 67 dB(A) for take offs at R3.

5.3.1 Discussion

AS 2021 states that areas outside of the ANEF 20 are deemed acceptable for residential development. However it also states that aircraft noise impacts may also occur near the ANEF 20 as the line is difficult to accurately define. In consideration of this, indicative aircraft noise calculations were performed.

The indicative calculated aircraft noise levels show that there is potential for noise intrusion above the acceptable limits to occur across the site. The calculations are indicative only and serve to indicate the risk of aircraft noise impacts occurring across the site.

As the assessment has indicated that aircraft noise intrusion above acceptable levels may occur, a specific assessment of aircraft noise impacts on internal amenity should be conducted at the Development Application (DA) stage of the development to demonstrate that proposed constructions would provide the required acoustic performance.

Individual aircraft noise levels have reduced over time and are expected to continue to decrease. From this, the maximum noise level created by an individual aircraft may reduce. However, whilst individual aircraft noise levels may reduce, the volume of aircraft is likely to continue to increase with more aircraft noise events occurring. Therefore it is important to consider the impacts on noise amenity from an increase in aircraft volumes in planning for land use.

Due to the potential for internal noise impacts, complaints may arise from a newly established community as a result of aircraft noise if future occupiers are not fully informed of the potential impacts. An undesirable outcome is where occupants reside in an area where the acoustic amenity is not as they would have expected.

5.4 Recommendations

Residential land use is deemed acceptable for the proposed site and no restriction is deemed necessary on the location of residential properties due to aircraft noise.

An aircraft noise intrusion assessment specific to each proposed sensitive development within the South Jerrabomberra site should be conducted as part of the DA stage of the development. The assessment should provide an assessment of aircraft noise impacts in accordance with AS 2021 and demonstrate that any proposed sensitive development would meet the internal noise requirements.

The assessment and specific design advice should be provided by an experienced acoustic specialist.

6 INDUSTRIAL NOISE

6.1 Introduction

Industrial land use was identified as a source of noise for proposed sensitive receivers within the site. The main sources of industrial noise were observed to come from the Hume Industrial Area and Mugga Lane RMC, which are located within the ACT. Noise emissions from ACT industrial zones are controlled by the ACT Environment Protection regulation (2005).

The Hume Industrial Area is partially developed and in order to avoid future land use conflicts an indicative assessment has been conducted to identify future industrial noise impacts associated with a fully developed industrial area.

6.2 Assessment Methodology

The ACT and NSW industrial noise policies were considered in the assessment of potential industrial noise conflicts. Acceptable levels of industrial noise at the proposed sensitive uses were defined by the NSW *Industrial Noise Policy* (INP) (**EPA, 2000**).

The NSW and ACT industrial noise guidance are described further in **Appendix E**.

The INP noise amenity goal has been referenced as the limiting criteria to protect the acoustic amenity of the proposed rezoning. The amenity goals were considered accounting for the existing level of industrial noise and the potential for increases in industrial noise from future development in the Hume Industrial Area.

6.3 Industrial Noise Criteria

The existing noise environment was characterised at representative locations within the rezoning site. These results are detailed in **Section 4.1**.

Future residential receivers could be classed as either urban or suburban. Receivers closer to the Hume industrial area could be classed as urban due to the presence of "urban hum," from commercial and industrial premises close to the proposed site and its proximity to a major road.

The suburban receiver type could also apply for receivers to the rear or east of the site. In this case the noise environment may include infrequent human activity, local traffic flows and some limited commerce or industry consistent with a suburban type receiver.

Based on the background noise levels recorded and the proposed rezoning for suburban residential land use, it is desirable for the acoustic amenity to aspire to a suburban type receiver. The suburban receiver amenity goals presented in **Table 6-1**.

Table 6-1: INP Amenity Noise Criteria

Receiver Type	Time Period[2]	Acceptable Noise Level $L_{Aeq,period}$ dB(A)	Existing Level of Industrial Noise $L_{Aeq,period}$ dB(A)[1]	Project Specific Acceptable Noise Level $L_{Aeq,period}$ dB(A)
Residential (Suburban)	Day	55	<39	55
	Evening	45	<35	45
	Night	40	<33	40

Note: 1. Existing level of industrial noise is based on the greatest estimated industrial noise level as measured. Where the time period applies when in use or all of the time, the greatest industrial noise level was used.

2. Time periods are defined as: Day (7.00am-6.00pm Monday to Saturday and 8.00am-6.00pm Sundays and Public Holidays), Evening (6.00pm-10.00pm), Night (10.00pm-7.00am, unless preceding a Sunday or Public Holiday).

6.4 ACT Noise Standards

Industrial noise from existing and future developments in the ACT are subject to the Environmental Protection Regulation (2005) as described in the *Noise Environment Protection Policy* (Noise EPP) (**ACT Government, 2010**). The EPP establishes noise standards for industrial land uses in the ACT adjacent the NSW border.

Where the Hume Industrial Area borders NSW Land, the current site zoning falls under the category of "all other NSW land" as described in Table 2.1, Schedule 2 of the Regulation. The ACT noise standards are summarised in **Table 6-2**.

Table 6-2: ACT Noise Standards for Hume Industrial Area

Site	Noise Standard	
	Day	Night
Industrial use surrounded by other industrial use	65	55
Industrial use bordering NSW Land[1]	55	45

Note: 1. Noise standard is calculated as the arithmetic average between Zone A and Zone G.

6.4.1 Existing Industrial Noise Sources

Existing Industrial noise sources in the ACT include:

- Asphalt plant
- Landscaping supply companies
- Joinery companies
- Pre-mix concrete batching plant
- Logistics and distribution companies
- Mobile plant and equipment hire companies
- Heavy vehicle movements
- Material and product loading/unloading
- Waste management facilities
- Mugga Lane Resource Management Centre (RMC)
- Truck maintenance facilities
- Reversing alarms on mobile plant and heavy vehicles
- Holcim Cooma Road Quarry
- Potential mixed use land uses in South Tralee

The attended and unattended measurements established that whilst industrial noise is audible, existing industrial noise levels do not exceed the amenity criteria.

It was observed during the attended monitoring surveys that tonal reversing alarms were audible at all times (day, evening and night) across the site. These noise sources are often identified as sources of complaint especially when occurring at night.

6.4.2 Future Industrial Noise

The majority of industrial activity in the Hume Industrial Area is located to the north east of the zone. The majority of the south western (Hume West) area was still undeveloped at the time of completing this assessment.

To provide a simulation of potential future noise emission from the Hume Industrial Area a noise calculation was undertaken based on the ACT regulation and the extents of the industrial area. The information contained within the Territory Plan Part B3: Industrial Land Use Policies (**ACT Government 2014**) indicated that similar land uses would be developed within the existing Industrial Area and Hume West.

6.4.3 Indicative Noise Calculation

A noise calculation was made to determine future industrial noise emissions from the Hume Industrial Area based on a worst case-scenario where all lots have been developed and are emitting their maximum allowable noise levels in accordance with the ACT Environment Protection Regulation.

Consistent with the South Tralee noise assessment, a similar prediction methodology has been applied, which includes the following assumptions:

- The Hume Industrial Area is divided into lots 200m by 200m.
- Each lot is assumed to be compliant at the lot boundary with the applicable ACT Noise Standard.
- The limits at each lot boundary are $L_{10(day)}$ 65 dB(A) and $L_{10(night)}$ 55 dB(A).
    - Sources are assumed to be pseudo steady state and to be equivalent to $L_{eq(day)}$ 62 dB(A) and $L_{eq(night)}$ 52 dB(A) and $L_{eq(day)}$ 52 and $L_{eq(night)}$ 42for lots bordering NSW land.
- Lots within the industrial area have a noise source with a sound power level L_{eq} 109 dB(A) for day and L_{eq} 99 dB(A) for night. Lots bordering NSW land have a noise source with a sound power level L_{eq} 99 dB(A) for day and L_{eq} 89 dB(A) for night. The frequency spectrum assumed is a typical industrial source.
- Terrain contours at 10m intervals (as supplied by QCC).
- Each source is located 4m from the ground.
- Each receiver is located 1.5m from the ground.
- Noise contours were produced using a 10m grid spacing.
- Calm, isothermal conditions.
- Ground type is assumed to be hard in industrial areas and soft between source and receivers.

Noise levels were modelled using the CadnaA noise modelling software utilising the *ISO 9613: Attenuation of Sound Propagation Outdoors* algorithm. Contour plots of the predicted noise levels are presented in **Figure 6-1** for day/evening and **Figure 6-2** for night.

The predicted noise levels are indicative only and serve to indicate the potential risk of industrial noise impacts from a fully developed Hume Industrial Area. Additional screening would be provided by residential structures, industrial buildings and other structures in between the source and receiver. The noise predictions have conservatively considered all sources to be operating concurrently.

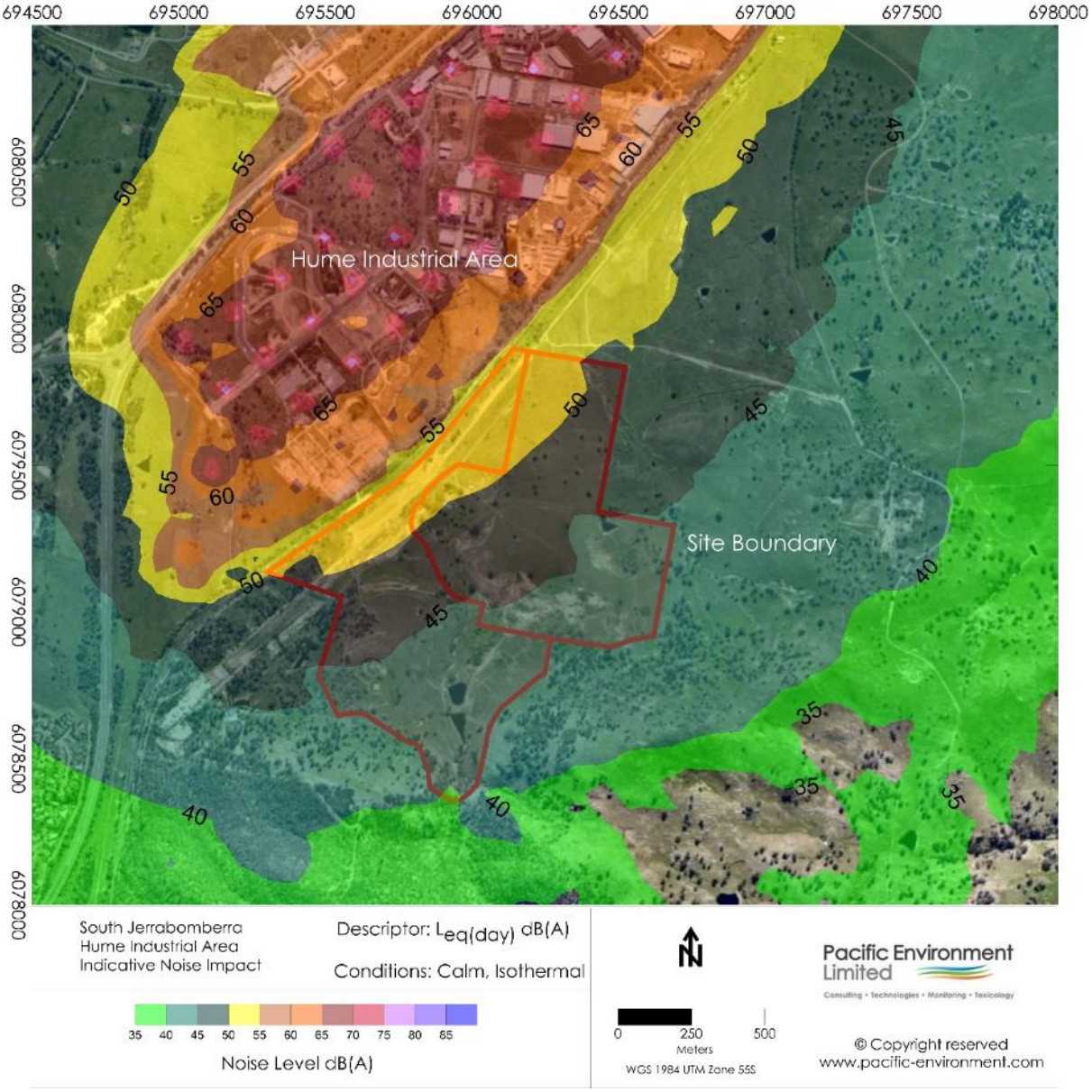


Figure 6-1: Indicative Industrial Noise Contour – Day

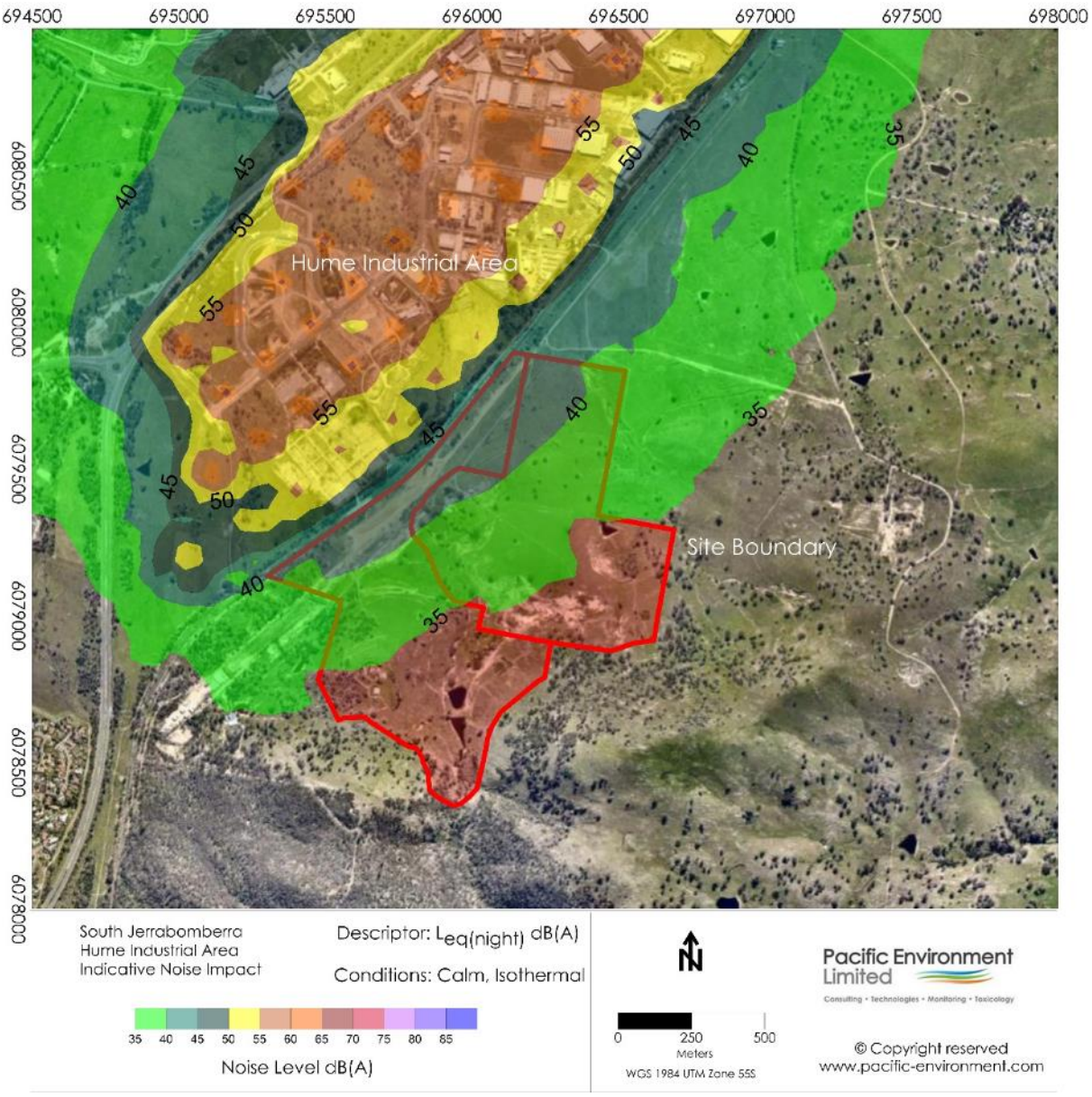


Figure 6-2: Indicative Industrial Noise Contour – Night

It can be seen from the noise contour plots that there is potential for adverse noise impacts from the Hume Industrial Area at the site. The amenity criteria are expected to be exceeded up to approximately 290m from the boundary of the site during both the day time and night time periods.

Noise sensitive developments could be developed outside of the $L_{eq(night)}$ 40 dB(A) contour without specific considerations for industrial noise. Noise sensitive developments could also occur inside the $L_{eq(night)}$ 40 dB(A) contour, however they would require additional acoustic considerations in order to meet the required amenity noise levels.

Consideration should also be made when developing the South Tralee site for the potential for industrial noise emission impacting proposed residential areas in South Jerrabomberra.

Shielding from new buildings located in the western side of the site would provide additional noise mitigation. For the purposes of conservatism, these were not considered in the indicative model.

Preference should be given to multi-level buildings placed between the Hume Industrial Area and low rise residential developments to the east.

6.5 Sleep Disturbance

There is potential for sleep disturbance effects to occur as a result of industrial noise sources within the Hume Industrial Area. A typical maximum noise event could equate to an L_{max} event of 120 dB(A) typically associated with maximum noise level events such as truck engines starting, air brake release or impact noise.

A sleep disturbance screening criterion is discussed in the INP Application Notes which recommends it to be set at $L_{A1,1min}$ = RBL+15 dB(A). Above this level, sleep disturbance is not guaranteed and a further analysis is required.

The provisions to mitigate maximum noise levels detailed in **Section 6.6** are considered to be suitable for protecting sensitive receivers from maximum noise level events associated with the Hume Industrial Area.

6.6 Discussion and Mitigation

The industrial noise assessment has used indicative worst-case modelling to determine the possible extent of future industrial noise. The assessment has indicated that impacts could occur up to 290m from the site boundary under a worst-case scenario and indicates that a buffer zone should be established in order to reduce the risk of incompatible land uses.

Noise sensitive development (including residential) would not be prohibited within the buffer zone, however it should be demonstrated during the DA stage that any development would provide adequate protection of external and internal noise amenity from potential future industrial noise from a fully developed Hume Industrial Area. This can be demonstrated by undertaking an acoustic assessment with reference to the amenity and intrusive noise criteria in the NSW *Industrial Policy* and the ACT *Noise Environment Protection Policy.*

The extent of the buffer zone could be altered following additional design detail such as multi-storey buildings to shield industrial noise from noise sensitive developments. Any proposed alteration of the buffer zone should be fully justified and demonstrate that future incompatible land uses conflict would not occur or place unreasonable limits on the development of existing industrial land in the Hume Industrial Area.

Preference should be given to multi-level or taller buildings in the west of the site towards the boundary with the Hume Industrial Area. Internal layouts of these buildings should be designed so as to minimise the exposure of sensitive areas to noise sources from the west and north west.

The ISEPP contains a number of useful figures which illustrate acoustic design considerations for building locations, orientations and internal layouts. These have been reproduced in **Appendix F**.

Such land use, design and planning considerations could include:

- Orientating sensitive areas of buildings away from noise sources.
- Using non-sensitive buildings to shield sensitive residential areas (such as back yards) and buildings.
- Using continuous facades on buildings to provide shielding to external areas and sensitive rooms.
- Construction of solid boundary fences on lots to assist noise shielding in external areas.
- Avoiding large, flat hard surfaces on opposite buildings or next to sensitive buildings or land use where noise can reflect off these surfaces.
- Using natural topographical features to assist in noise shielding.

- Use of civil works and retaining walls when levelling lots as noise barriers to maximise shielding in direction of noise source.
- Building multi-level buildings in front of lower height buildings. This could be applied on the western side of the site to provide shielding from industrial and transport noise sources.

6.7 Recommendations

To minimise potential land use conflict between the Hume Industrial area and the proposed South Jerrabomberra rezoning the following recommendations are made:

- A buffer zone should be established where residential development within the zone is designed to protect against industrial noise impacts from the Hume Industrial Area.
- The potential for industrial noise should be considered and assessed at the DA stage for the development and appropriate controls should be incorporated in the proposed development designs. Any residential development within the night time L_{Aeq} 40 dB(A) contour buffer zone of the Hume Industrial Area should be assessed for industrial noise with reference to the NSW INP.
- The proposed buffer zone distance could be subject to change following design measures that reduce the propagation of industrial noise to noise sensitive areas within the site.
- Planning layouts and building design should consider the direction of potential industrial noise sources for the proposed sensitive land uses.

7 ROAD TRAFFIC NOISE

7.1 Introduction

Road traffic noise is a potential issue for sensitive residential land use at the South Jerrabomberra site. This includes the existing Monaro Highway, Isabella Drive, heavy vehicles traffic within the Hume Industrial Area and future roads within the South Jerrabomberra and South Tralee developments. Future growth is also expected from the development of employment lands north of the site.

The potential new road links into the site and South Tralee area are described in the Structure Plan (**QCC, 2013**) and are also considered in the *Queanbeyan City Council TRACKS model – Part 1 South Jerrabomberra Network Transportation Assessment Report* (**TDG, 2014**). The main arterial roads under consideration are the access road arrangements concerning Tompsitt Drive, Isabella Drive or Sheppard Street. An additional link to Googong along the proposed Dunns Creek Road was also considered. local roads servicing residences and linking to the arterial roads were also considered.

7.2 Assessment Methodology

Road noise criteria are defined within the RNP (**EPA, 2011**). The policy defines absolute and relative increase noise criteria which should be achieved at sensitive receivers. In the RNP, sensitive receivers are defined as residential properties, places of worship, passive and active recreation areas, hospitals, childcare facilities, aged care facilities, mixed use developments and educational facilities.

The noise criteria for sensitive land uses are defined according to the road type and project type. The two road type categories are defined as either freeway, motorway arterial and sub-arterial road, or a local road. The noise level criteria are summarised in **Table 7-1**.

Table 7-1: RNP Road Traffic Noise Criteria

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)	
		Day (7.00am to 10.00pm	Night (10.00pm to 7.00am)
Freeway/arterial/sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq,15hr}$ 55 (external)	$L_{Aeq,9hr}$ 50 (external)
	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)
Local Roads	Existing residences affected by noise from new local road corridors	$L_{Aeq,1hr}$ 55 (external)	$L_{Aeq,1hr}$ 50 (external)
	Existing residences affected by additional traffic on existing local roads generated by land use developments		

Additional noise impact criteria is contained within the *Development near rail corridors and busy roads – interim guideline* (**DoP, 2008**). This provides guidance for new sensitive developments and the potential for road noise impacts to be controlled at the planning stage. The guideline is based on the requirements of the *State Environmental Planning Policy (Infrastructure)* (ISEPP).

Clause 102 of the ISEPP states that the guideline should be used where:

[A] development for any of the following purposes that is on land in or adjacent to a road corridor for a freeway, a tollway or a transit way or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data available on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration: building for residential use, a place of public worship, a hospital, an educational establishment or childcare centre.

Clause 102 also provides the following noise level limits for residential properties as follows:

If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded:

- *In any bedroom in the building : 35dB(A) at any time 10pm–7am*
- *Anywhere else in the building (other than a garage, kitchen, bathroom or hallway): 40dB(A) at any time.*

The guideline is intended for where vehicular traffic flow is around 40,000 AADT (Annual Average Daily Traffic), however it is considered to provide best practice guidance for roads with lesser traffic volumes.

7.3 Proposed Road Layouts

The access configuration for the site has not yet been finalised. The access configuration information was taken from the *Queanbeyan City Council TRACKS model – Part 1 South Jerrabomberra Network Transportation Assessment Report* (**TDG, 2014**). The report proposed five options for access as follows:

- Option 1 – One access via Tompsitt Drive (single lane dual carriageway).
- Option 2 – One access via Tompsitt Drive (dual lane dual carriageway).
- Option 3 – Two access via Tompsitt Drive (single lane dual carriageway) and Sheppard Street (via a connection to existing road).
- Option 4 – Two accesses via Tompsitt Drive (single lane dual carriageway) and Isabella Drive (via a connection to existing road)
- Option 5 – Three accesses via Tompsitt Drive (single lane dual carriageway) and Isabella Drive (via a connection to existing road) and Sheppard Street (via a connection to existing road).

QCC have indicated that the developer with option over the land and QCC view a connection to Sheppard Street as currently the most favourable. The ACT Government has indicated that they do not support a connection to Sheppard Street.

In the long term, a connection with Dunns Creek Road and the main site access road is proposed. Correspondence with QCC indicated that where this occurs, Option 4 is the most favourable.

The road layout options consider the development of surrounding land including:

- Residential and commercial developments at South Tralee
- Commercial developments at Poplars
- Commercial development at Environa and North Tralee
- Residential development at South Jerrabomberra (Forest, Morrison and Tralee Station (Walsh))

7.4 Assessment

The noise from existing roads has been quantified by noise measurement at site, as detailed in **Section 4.1.** The background noise environment was observed to be generally controlled by road traffic noise from the Monaro Highway and to a lesser extent other roads in the vicinity. It is noted that other ambient noise sources may have influenced the measured noise levels. The measured road traffic noise levels are summarised in **Table 7-2**

Table 7-2: Measured Road Traffic Noise Levels

Location	Noise Level, dB(A)[1,2]	
	Day - $L_{Aeq,15hr}$	Night - $L_{Aeq,9hr}$
BG1	49	44
BG2[3]	50	45
BG3	47	42

Note: 1. Noise monitoring conducted in the free-field. In accordance with the RNP, a +2.5 dB correction is added to the measured noise levels.
2. Day is 7.00am to 10.00pm and Night is 10.00pm to 7.00am.
3. Includes valid data from both logging occurrences.

The major existing road noise sources were identified as primarily the Monaro Highway and to a lesser extent Isabella Drive, Mugga Lane and internal roads within the Hume Industrial Area. From **Table 7-2** it can be seen that the existing noise levels across the site are well within the allowable RNP noise limits for residential properties.

The ISEPP guidelines state that the internal noise level in any bedroom should not exceed $L_{Aeq,9hr}$ 35 dB(A) where developments are adjacent to and impacted by roads with 40,00 AADT or greater. In consideration that the site is not directly adjacent to the Monaro highway, assessment against the ISEPP criteria has not been conducted.

Best practice planning for noise amenity suggests that controls such as orientation, offset, using non-sensitive structures as barriers and land use planning near road corridors can be effective ways to control road traffic noise. **Figure 2-5** and **Figure 7-1** show the layout of the proposed roads and connections with existing roads. These connecting roads are likely to carry more traffic than local intra suburban roads and would be classified as sub-arterial roads.

Using the modelled traffic volume data for the AM and PM peaks contained within the traffic report (**TDG, 2014**), the projected flows in 2031 were determined on the roads within the site. The roads were split into sections which are indicated in **Figure 7-1**.

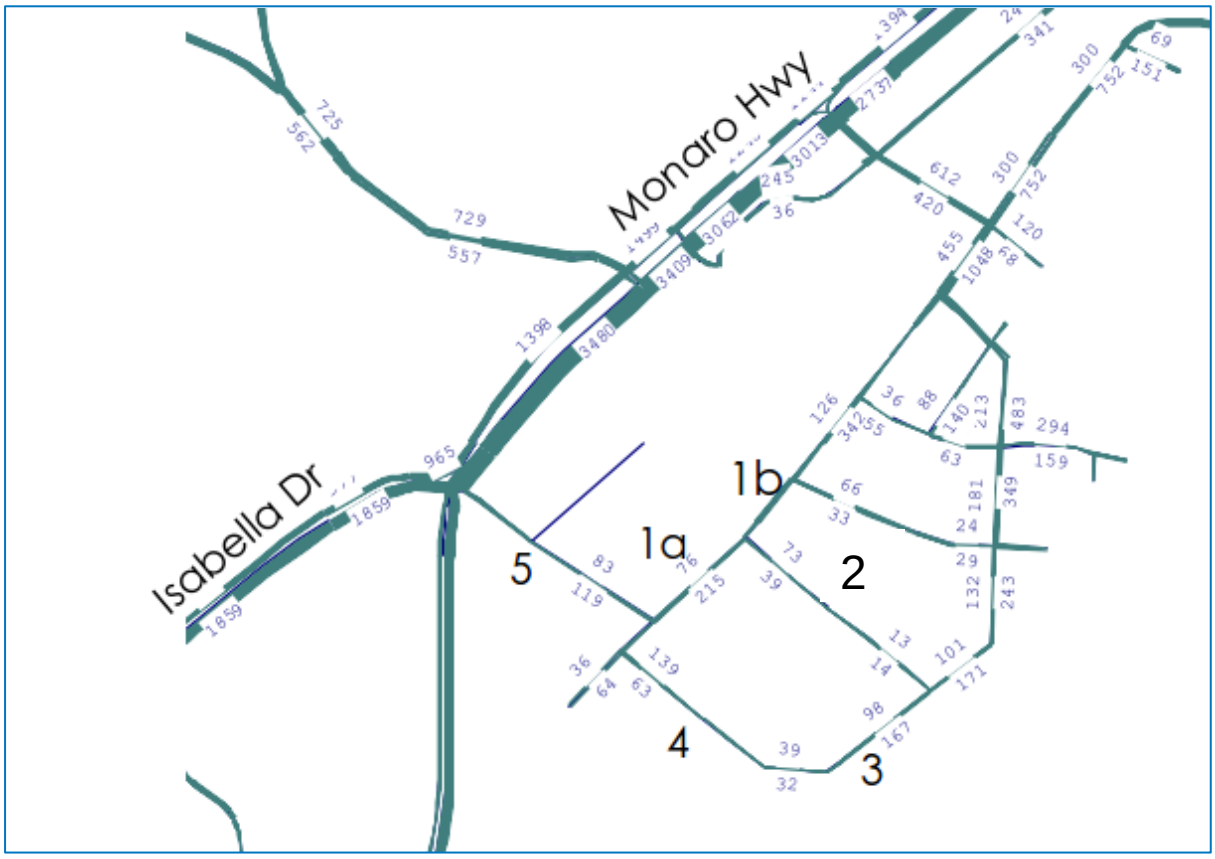


Figure 7-1: Proposed Road Layout in South Jerrabomberra [source TDG 2014]

The 2031 projected traffic volumes on these sections of road for each of the access options are presented in **Table 7-2**.

Table 7-3: Projected Traffic Volumes

Option	Section	AM Peak		PM Peak	
		North	South	North	South
1,2 & 3	1a	171	38	81	181
	1b	307	67	144	320
	2	65	14	71	38
	3	138	32	102	174
	4	122	27	60	132
4	1a	374	345	371	411
	1b	447	268	315	460
	2	87	18	47	93
	3	96	23	84	132
	4	164	36	77	174
	5	431	294	339	424
5	1a	145	62	76	215
	1b	259	65	126	324
	2	67	15	39	73
	3	104	30	98	167
	4	155	29	63	139
	5	123	42	119	83
Max flows per section	1a	374	345	371	411
	1b	447	268	315	460
	2	87	18	71	93
	3	138	32	102	174
	4	164	36	77	174
	5	431	294	339	424

The peak AM and PM volumes in **Table 7-2** indicate that the annual average daily traffic (AADT) would be less than 20,000 for all of the road sections. Therefore the ISEPP guidelines are not applicable, however the provisions of the RNP would still apply.

A road traffic noise intrusion assessment should be conducted for all proposed residences located directly adjacent the proposed arterial road sections at the DA stage with reference to the RNP and relevant road noise intrusion and internal building noise standards including *AS 3671 Acoustics - Road traffic noise intrusion – Building siting and construction* and *AS 2107 Recommended design sound levels and reverberation times for building interiors*.

The connection to Dunns Creek Road is not expected to significantly affect the receivers within the site as there is not direct line of sight to receivers. Furthermore, the receivers with potential to experience noise impacts from Dunns Creek Road are closer to the 20 ANEF and therefore are more likely to be considered for noise mitigation to protect against aircraft noise. It is considered that this level of mitigation would be sufficient to protect against road traffic noise impacts associated with Dunns Creek Road.

7.5 Recommendations

Future road traffic noise impacts on potential residential receivers at the South Jerrabomberra site would need to be assessed. This report has indicated that some impacts may be expected, depending on the access option selected and location of receivers. In light of this the following recommendations are made:

- Road traffic noise intrusion assessment should be conducted for all proposed residences along the sub-arterial/arterial roads at the DA stage.
- Assessments should include an assessment of day and night traffic volumes, to be determined following prediction of future traffic volume data.
- Protection of internal and external noise amenity from road traffic sources should be considered as part of the design process.
- The requirement for additional mitigation can be considered in conjunction with the requirements for any industrial, rail and aircraft noise mitigation.
- Road designs should include consideration of noise generating properties such as surface and geometry.

8 RAIL NOISE AND VIBRATION

8.1 Introduction

The Goulburn to Bombala rail line is an over ground railway that runs to the north of the site between the site and Hume Industrial Area. The line is not currently used, however the use of the line could be reinstated, where sufficient justification from the owners is provided. The rail line could be used for either freight or passenger services. There are currently no rail services operating on the line.

8.2 Assessment Methodology

Rail noise is assessed in accordance with the Rail Infrastructure Noise Guideline (EPA 2013) RING and ISEPP guidelines. Rail vibration is considered in both these documents which specify the NSW EPA's vibration guideline (**EPA, 2006**). Further detail on these documents is provided in **Appendix G**.

A summary of the applicable criteria is presented in **Table 8-1**.

Table 8-1: Summary of Rail Noise Assessment Criteria

Area of Site	Applicable Document	Land Use	Time of Day[1]	Noise Criteria[2] dB(A)
Adjacent to Rail Corridor	ISEPP	Residential (internal -sleeping areas)	Night	L_{eq} 35
		Residential (internal – all other habitable areas)	Anytime	L_{eq} 40
All other areas	RING	Residential (external)	Day	L_{eq} 65 L_{max} 85
			Night	L_{eq} 60 L_{max} 85
		Open space (external - passive use, e.g. parkland, bush reserves)	When in use	L_{eq}65
		Open space (external - active use , .g. sports field, golf course)	When in use	L_{eq}65

Note: 1.Day is defined as 7.00am to 10.00pm and night as 10.00pm to 7.00am.
2. Noise levels are calculated for Day (7.00am to 10.00pm) $L_{eq,15hr}$ dB(A) and Night (10.00pm to 7.00am) $L_{eq,9hr}$ dB(A) unless otherwise stated. Fast time weighting is applicable to L_{eq} and L_{max} noise levels.

8.3 Noise Assessment

For a reinstated railway line, the rail line operator would have a requirement to meet external rail noise limits at sensitive receivers. However, the resultant internal levels may not meet the noise goals in the ISEPP without additional mitigation. By adopting the ISEPP guidelines for noise and vibration sensitive developments, the potential for unacceptable impacts to occur is minimised.

The assessment of potential noise sensitive land uses adjacent to the rail corridor would be assessed according to the ISEPP at the DA stage. The guidelines state the following:

- A rail noise assessment is required for noise sensitive developments located within 40m of a rail line for passenger and freight services at speeds of 80 km/h or more.
- Standard noise mitigation (Category 2 in Appendix C of ISEPP) is considered to provide adequate noise mitigation for receivers 40 to 80m from a rail line for passenger and freight services at speeds of 80 km/h or more.

The standard noise mitigation includes façade, glazing and roofing constructions and is based on receivers having no or limited acoustic shielding from the rail line. Shielding in the form of topography, barriers or intervening structures, can reduce rail noise levels and should be accounted for when considering this requirement.

8.4 Vibration Assessment

Where vibration sensitive development are proposed within 60m of the rail corridor, it is recommended that a specific rail vibration assessment is carried out. For developments further than 60m from the rail corridor, adverse vibration impacts are not considered likely.

8.5 Recommendations

The assessment of rail noise and vibration impacts indicated that impacts may occur where residential receivers are located within with 60 metres of the rail track. Where this occurs the following recommendations are made:

- Where vibration sensitive developments are located within 60m of the rail line, a vibration assessment should be performed.
- Where noise sensitive developments are proposed within 40m of the rail line a noise assessment should be conducted.

Where noise sensitive developments are proposed between 40 and 80m from the rail line, Category 2 building constructions in Appendix C of ISEPP should be considered, unless it can be demonstrated that potential rail noise is sufficiently shielded or mitigated.

9 CONCLUSION

A noise assessment was conducted to examine the potential constraints and risks associated with rezoning the parcel of land currently known as Forest, Morrison and Walsh located in the South Jerrabomberra area, NSW.

The assessment reviewed the existing and potential impacts from aircraft, industrial, road traffic and rail noise in addition to rail vibration on proposed residential receivers.

The existing noise environment was determined using long-term unattended and short-term attended measurement. The results of the monitoring determined that road traffic noise was the dominant noise source. All measured noise sources were generally below the acceptable limits and existing sources were not identified as significant risks for noise impact.

The assessment generally took a worst-case approach to identify the potential constraints when potential noise sources are fully developed. This approach attempts to negate noise issues arising from adjacent incompatible land use conflicts in the future.

Overall the assessment indicated that the most significant risks associated with adverse noise impact on any potential residential development is from industrial noise. The least significant risk of noise impact is rail noise as the line is not currently operational and unlikely to be reinstated.

The indicative worst-case assessment indicated that industrial noise impacts fully from a developed Hume Industrial Area may require the implementation of a noise buffer zone. The extent of the buffer zone could be consistent with the predicted $L_{Aeq(night)}$ 40 dB(A) noise contour as predicted in the worst case noise modelling. Within the buffer zone, noise sensitive development should be appropriately designed to consider the potential for industrial noise impact. The extent of the zone could be reduced using a variety of measures provided that it can be demonstrated during the DA stage that potential industrial noise impacts are appropriately controlled. All other noise aspects are expected to be able to be controlled by suitable planning considerations.

A summary of the recommendations are as follows:

- Residential land use is deemed acceptable on the site and no restriction is deemed necessary on the location of residential properties due to aircraft noise.
- Aircraft noise intrusion assessment in accordance with AS 2021 should be conducted for all proposed residential and noise sensitive developments at the DA stage to confirm that the constructions meet the required acoustic performance.
- Building layouts, orientations and designs should be optimised to protect both external and internal amenity from external noise sources included aircraft noise, industrial noise and road traffic noise.
- The potential for industrial noise should be considered and assessed at the DA stage for the development and appropriate controls should be incorporated in the proposed development designs. Any residential development within the night time L_{Aeq} 40 dB(A) contour buffer zone of the Hume Industrial Area should be assessed for industrial noise with reference to the NSW INP.
- Road traffic noise intrusion assessment should be conducted at the DA stage for all residential dwellings and sensitive developments along the planned sub-arterial/arterial roads.
- A rail vibration assessment should be carried out for proposed vibration sensitive development within 60m of the rail line.
- A rail noise assessment should be carried out for proposed noise sensitive development within 40m of the rail line.
- Where noise sensitive developments are proposed between 40 and 80m from the rail line, Category 2 building constructions in Appendix C of ISEPP should be considered, unless it can be demonstrated that potential rail noise is sufficiently shielded or mitigated.

- The specification of any mitigation measure for buildings should be considered with the requirement for mitigation from other noise sources.
- Where new or more detailed information becomes available, this should be used to revise assessments and mitigation requirements.

10 REFERENCES

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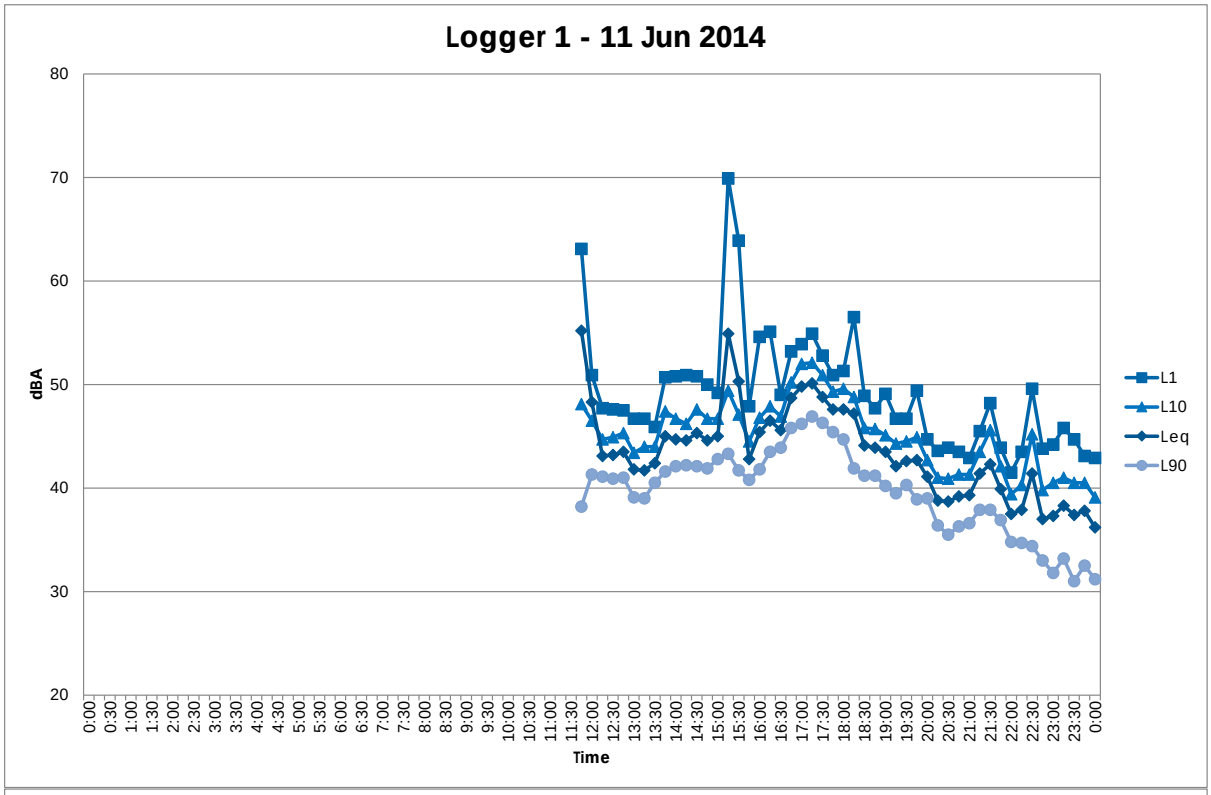
Appendix A NOISE MONITORING RESULTS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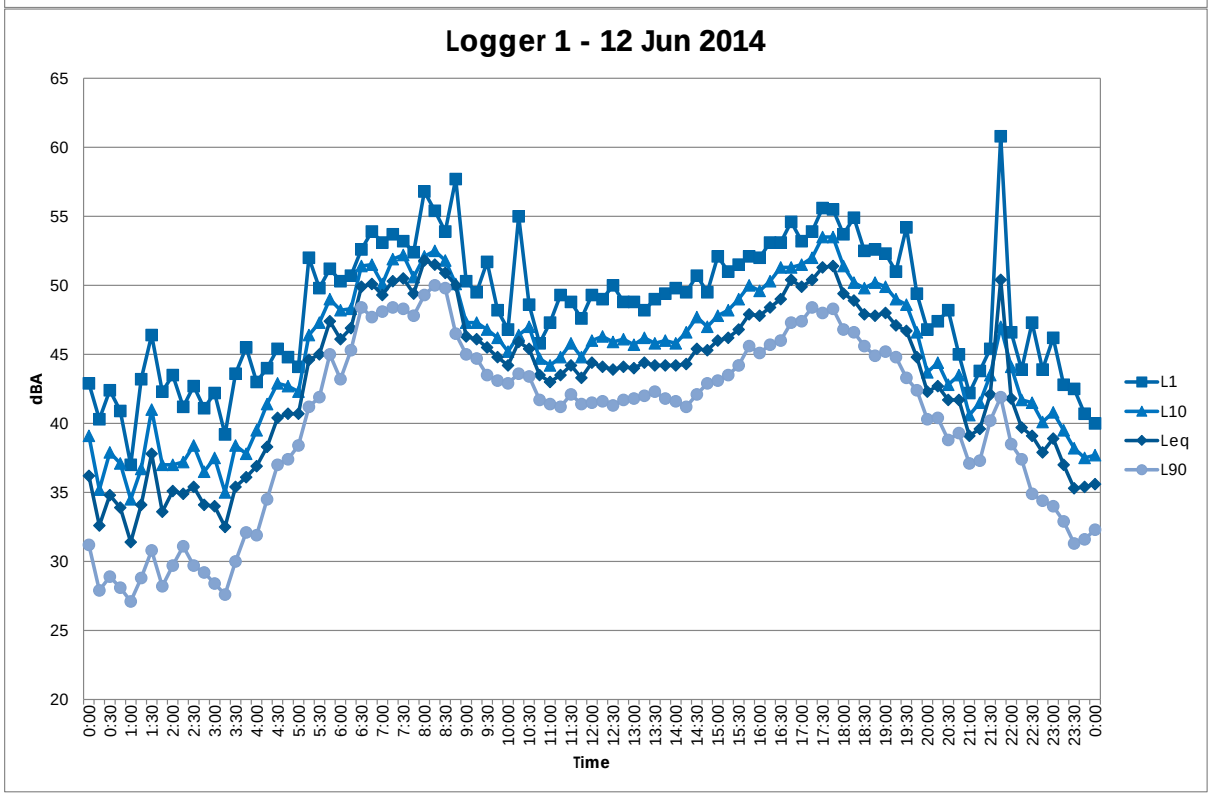
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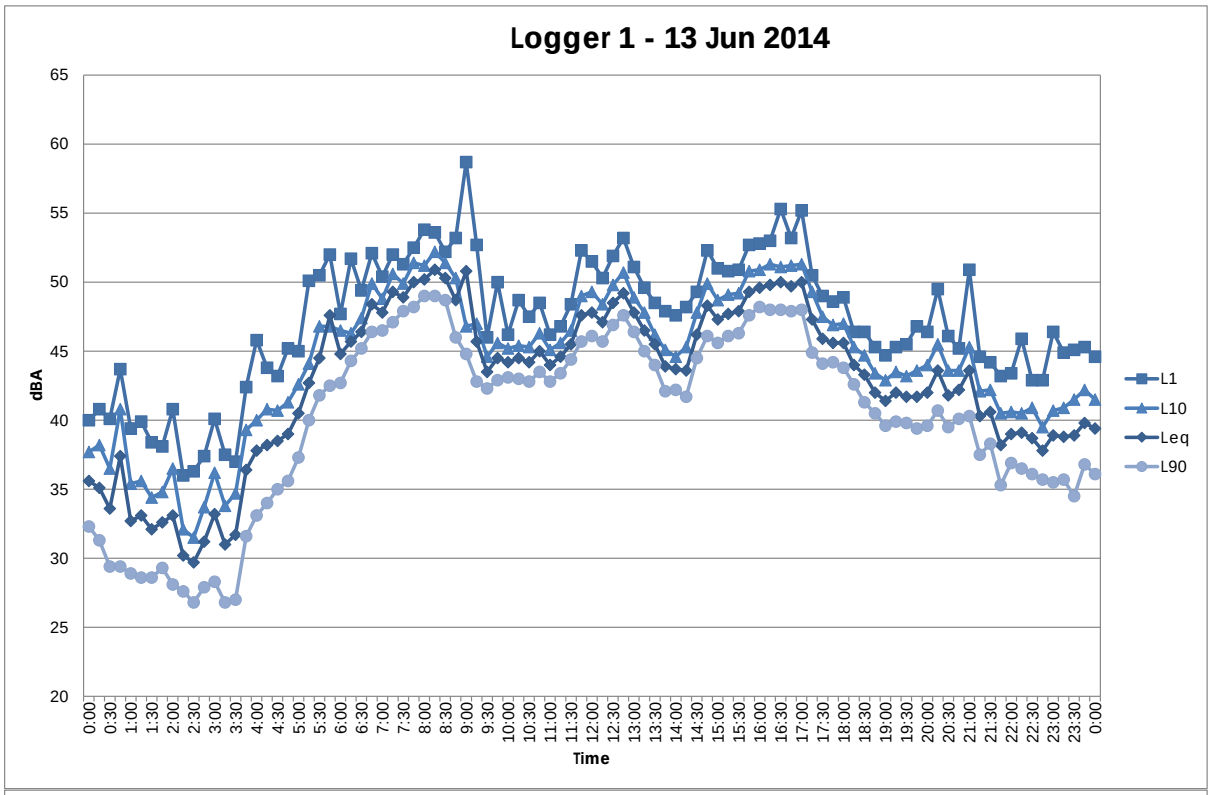
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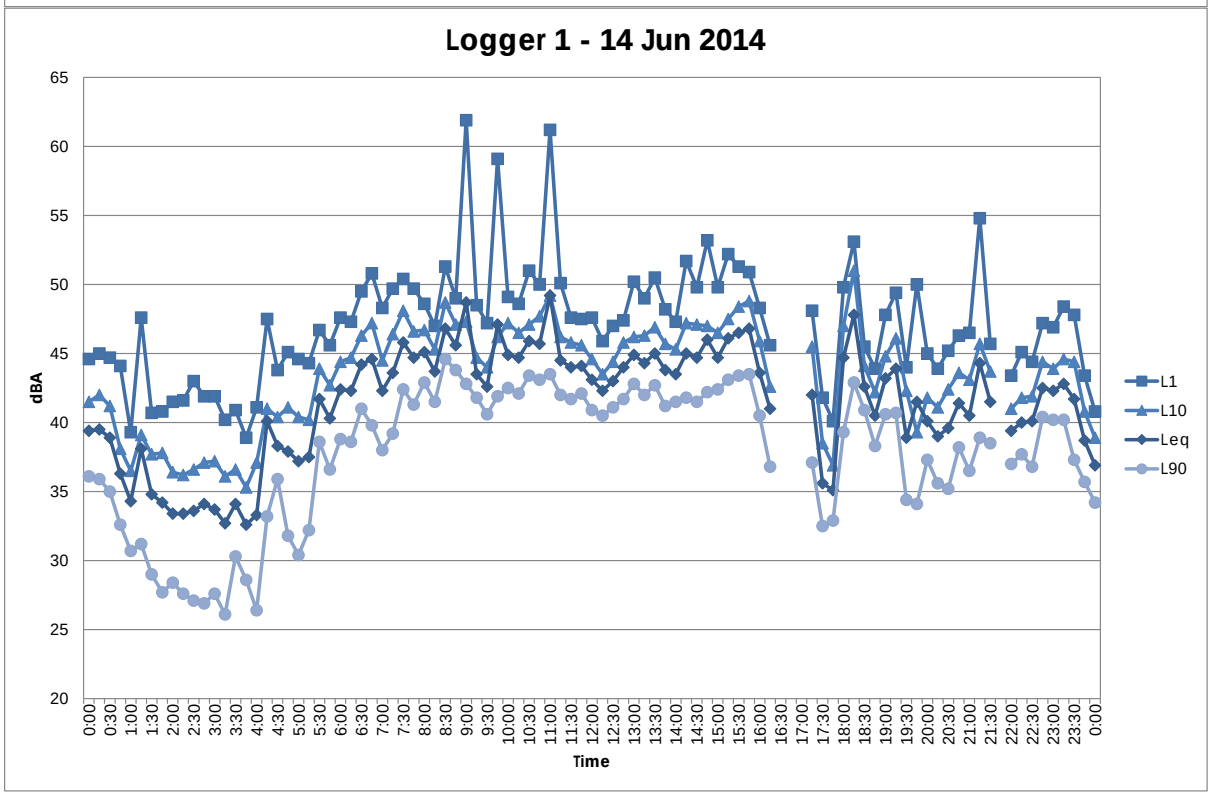
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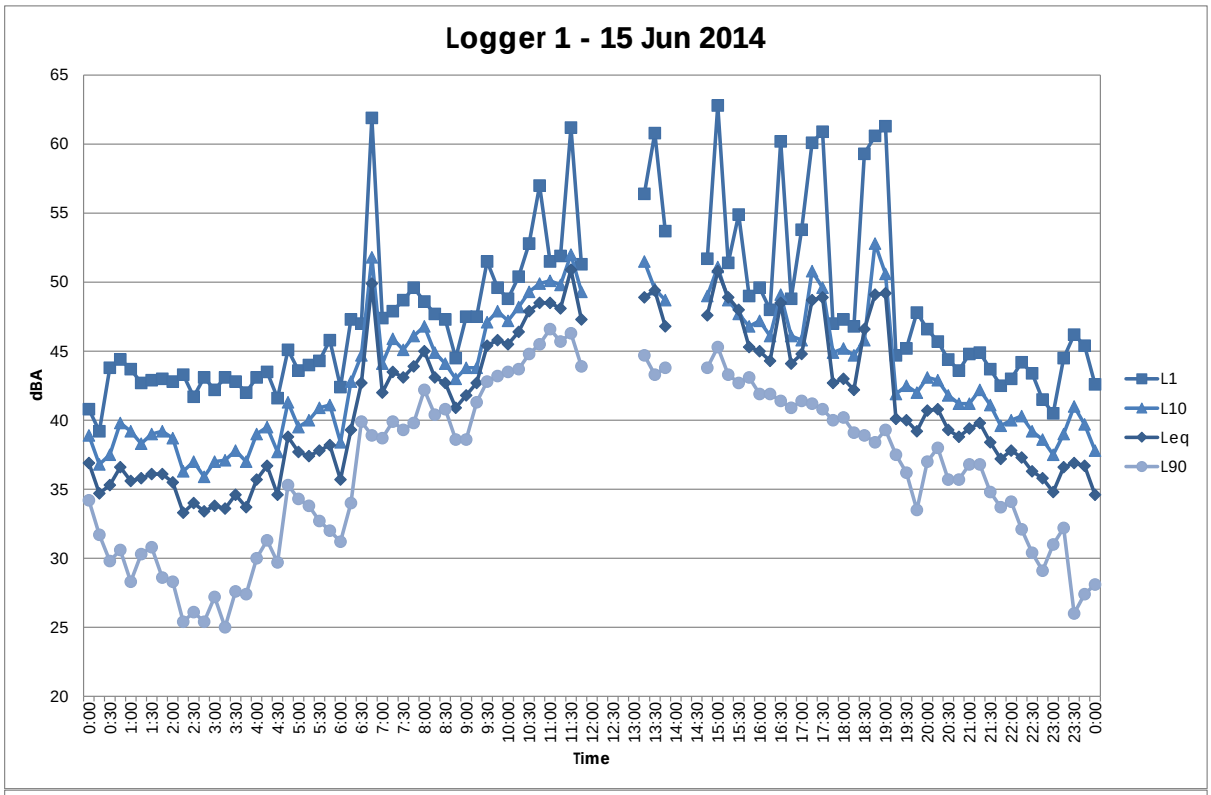
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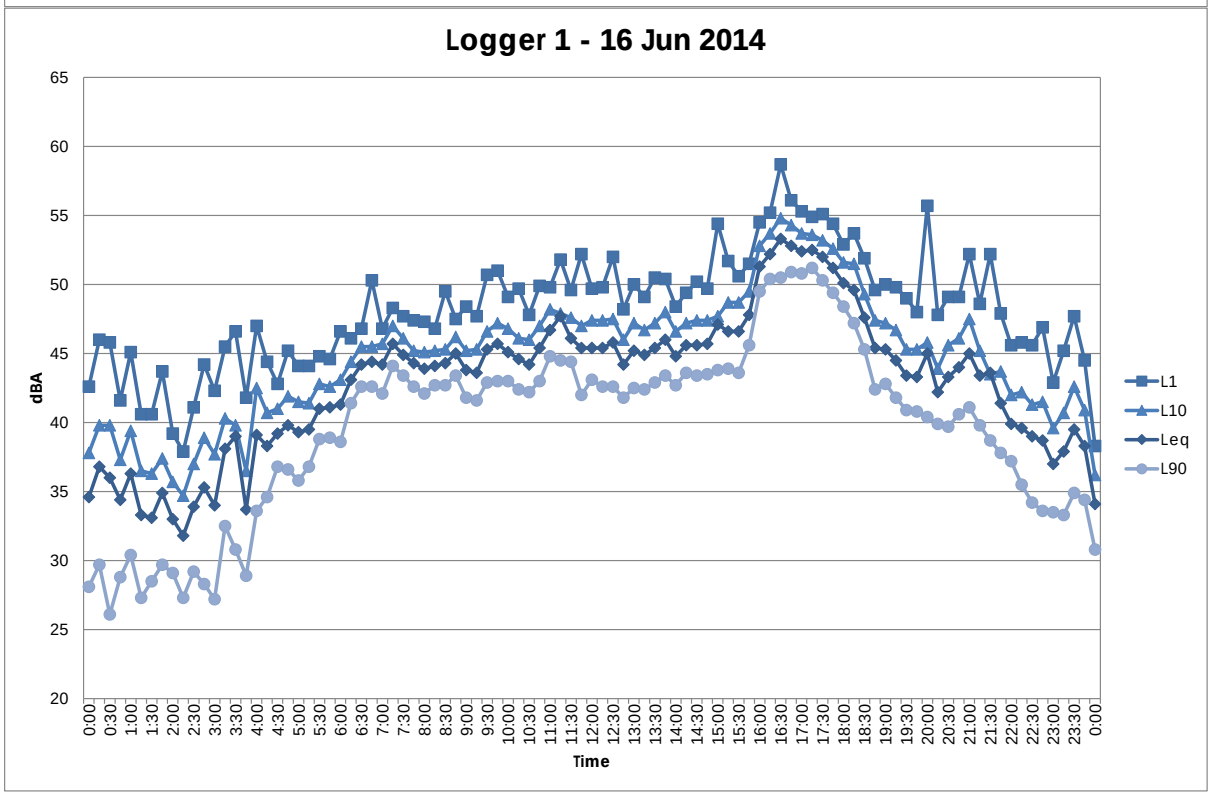
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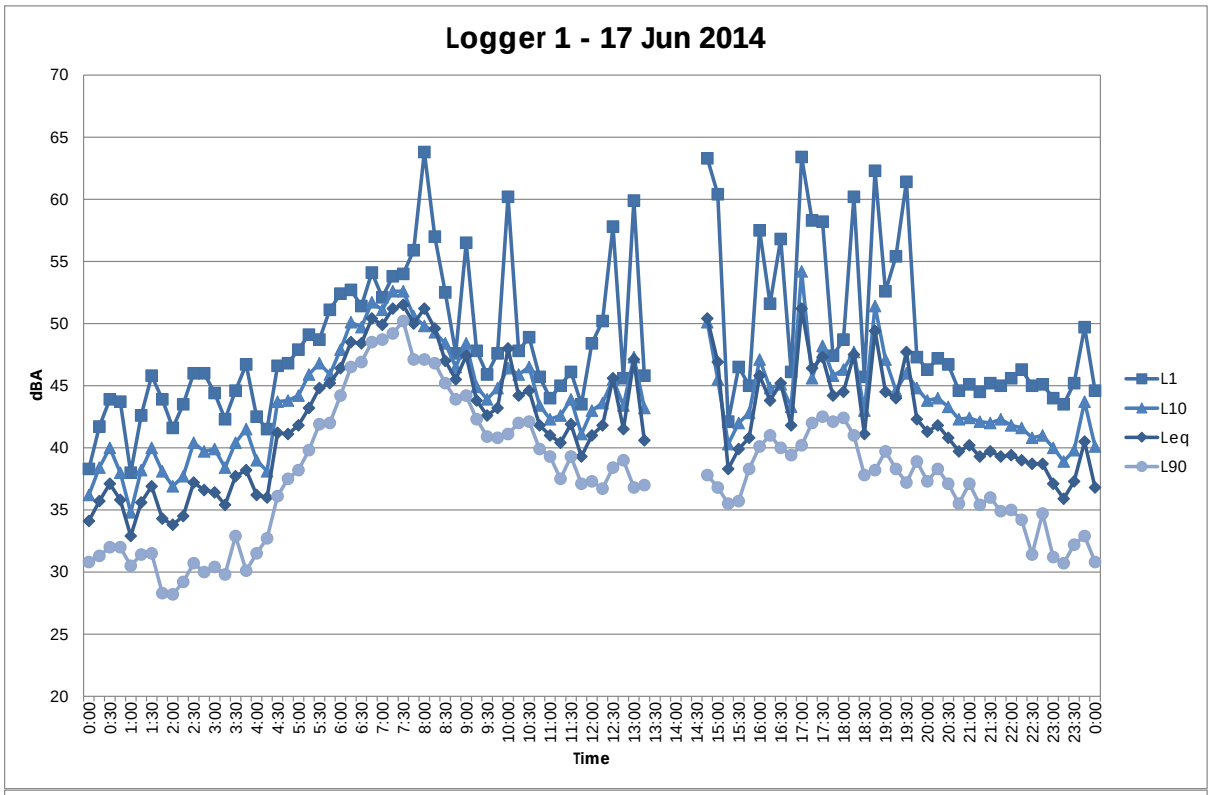
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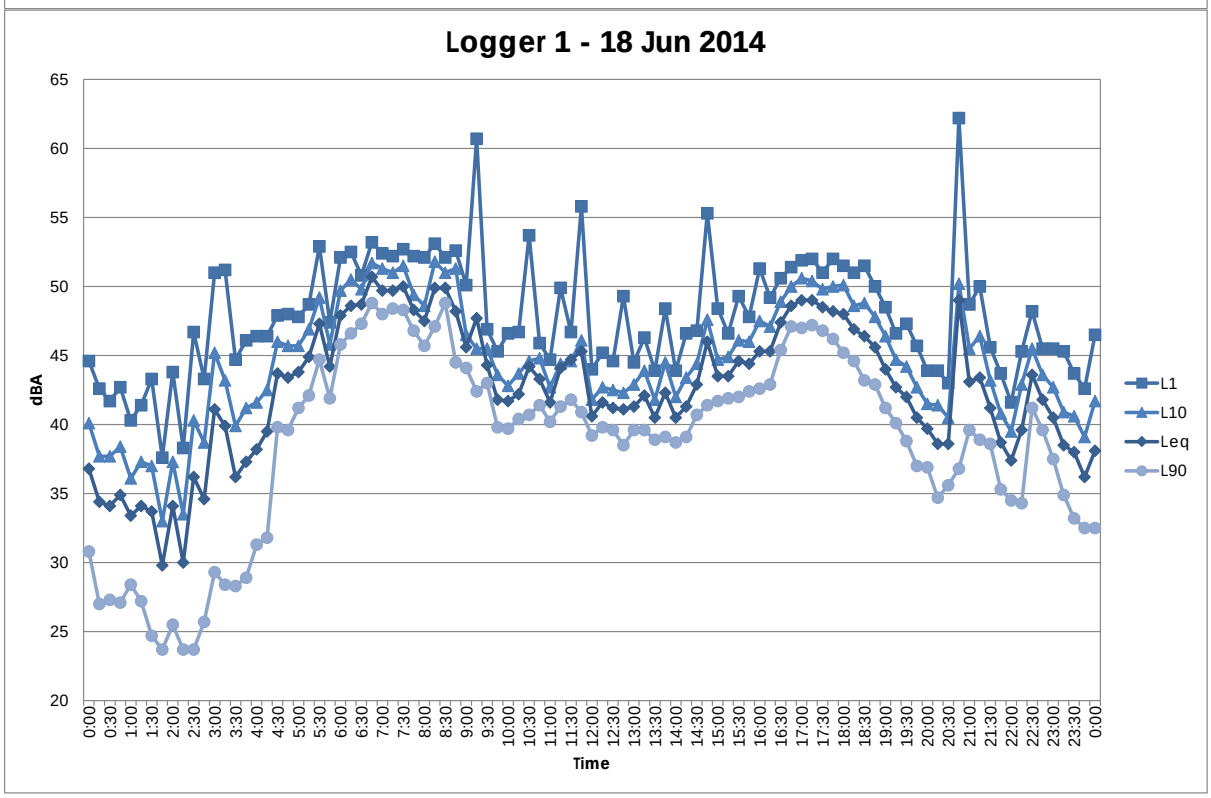
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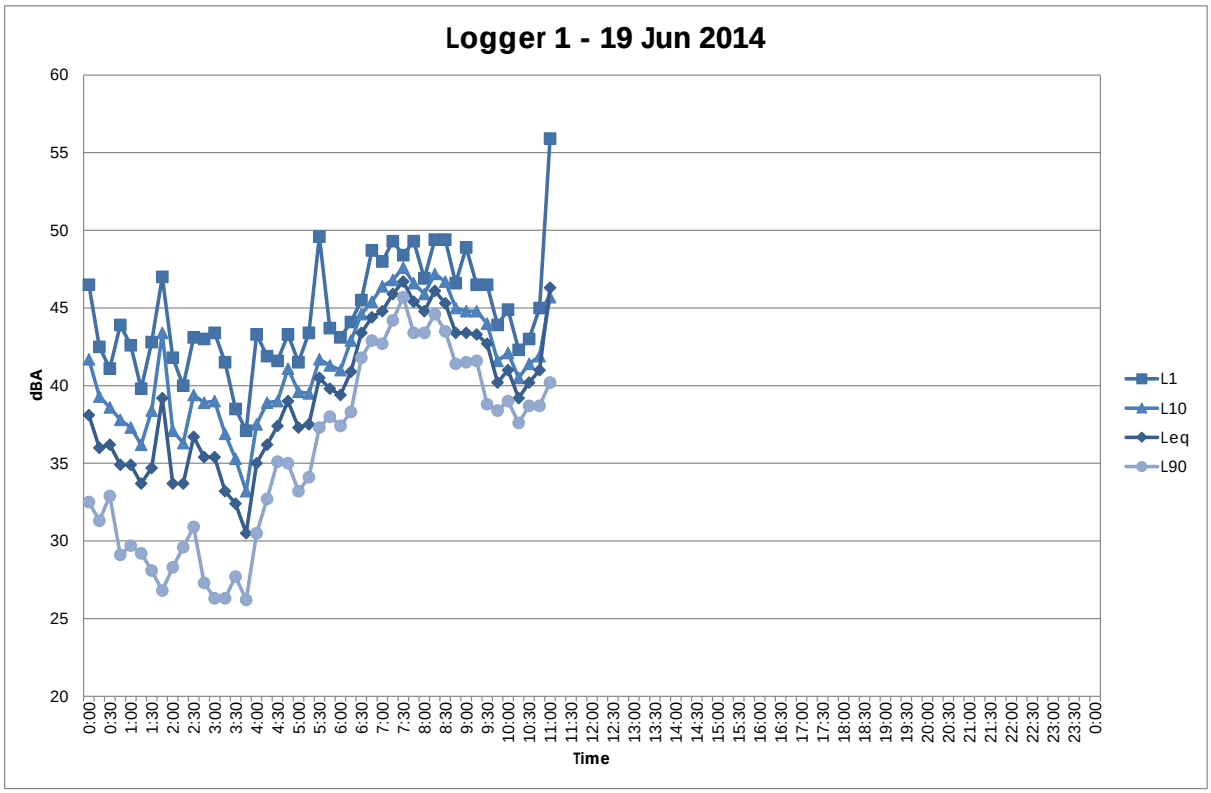
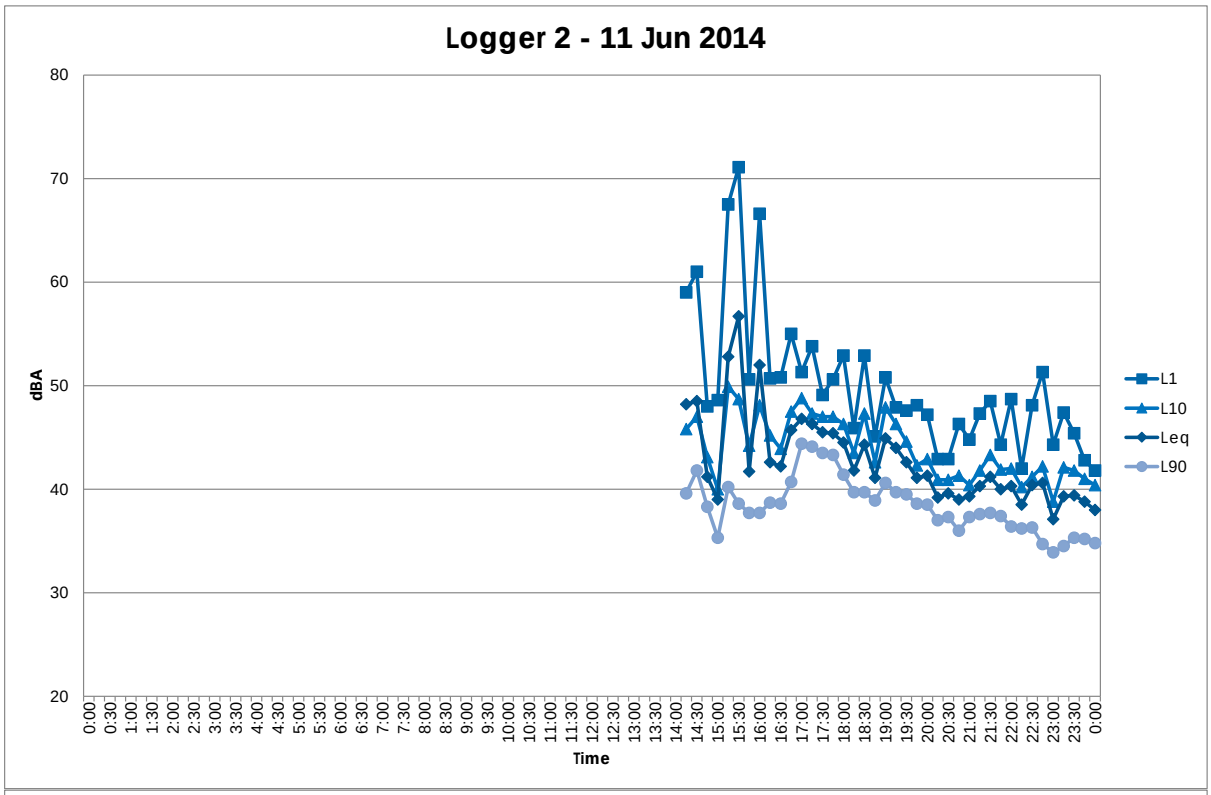


Monitoring Summary for BG1

Date	Day		Evening		Night	
	L_{eq}	ABL	L_{eq}	ABL	L_{eq}	ABL
11/06/14	48	40	42	36	42	28
12/06/14	48	41	46	38	41	28
13/06/14	48	43	42	37	39	27
14/06/14	45	39	42	35	40	27
15/06/14	47	40	43	34	39	27
16/06/14	48	42	45	38	42	30
17/06/14	46	37	44	35	43	25
18/06/14	46	39	44	35	39	27
19/06/14	44	39	-	-	-	-
Log Average	47	-	44	-	41	-
RBL	-	40	-	36	-	27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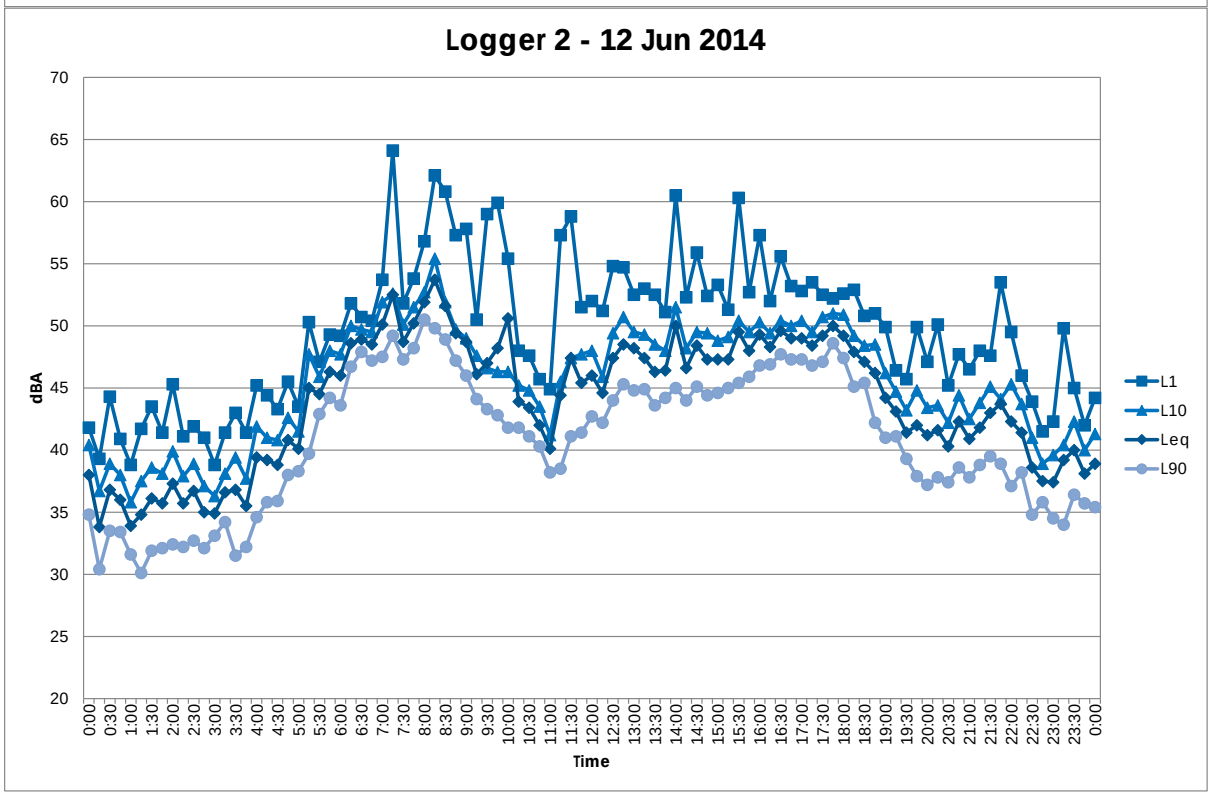
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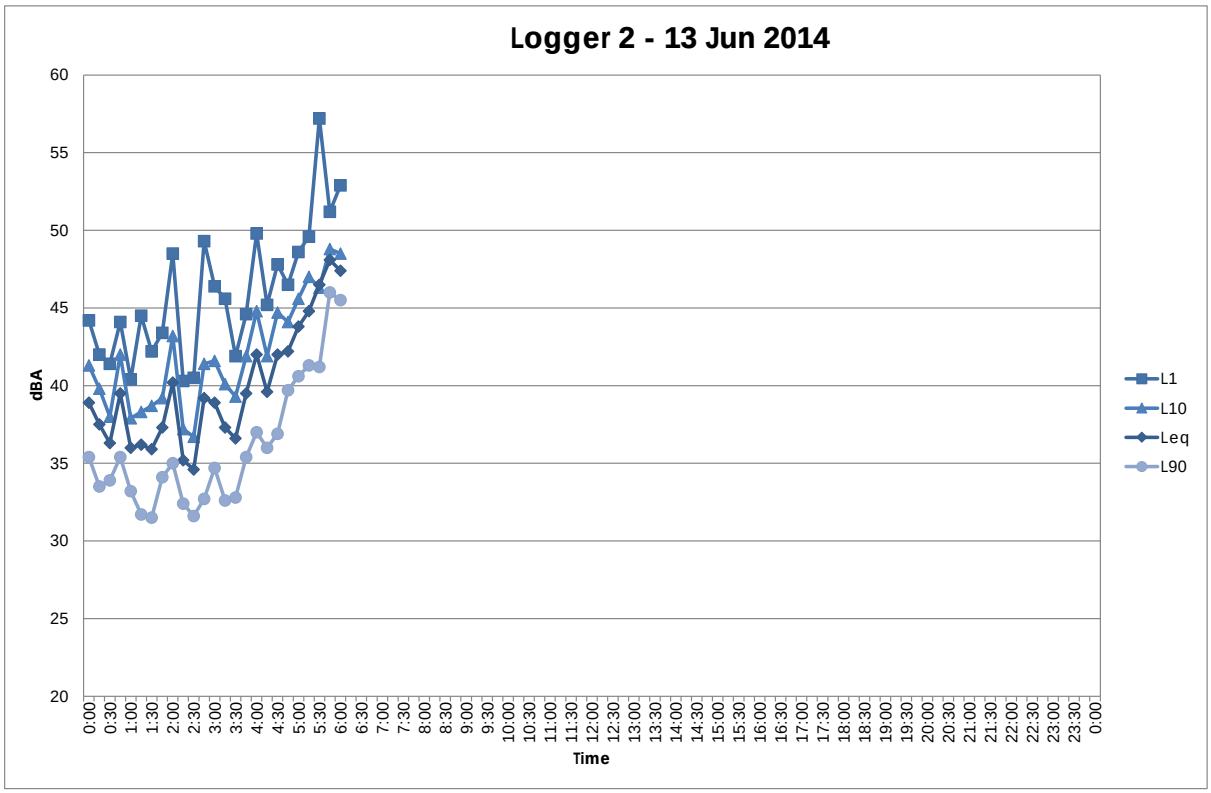
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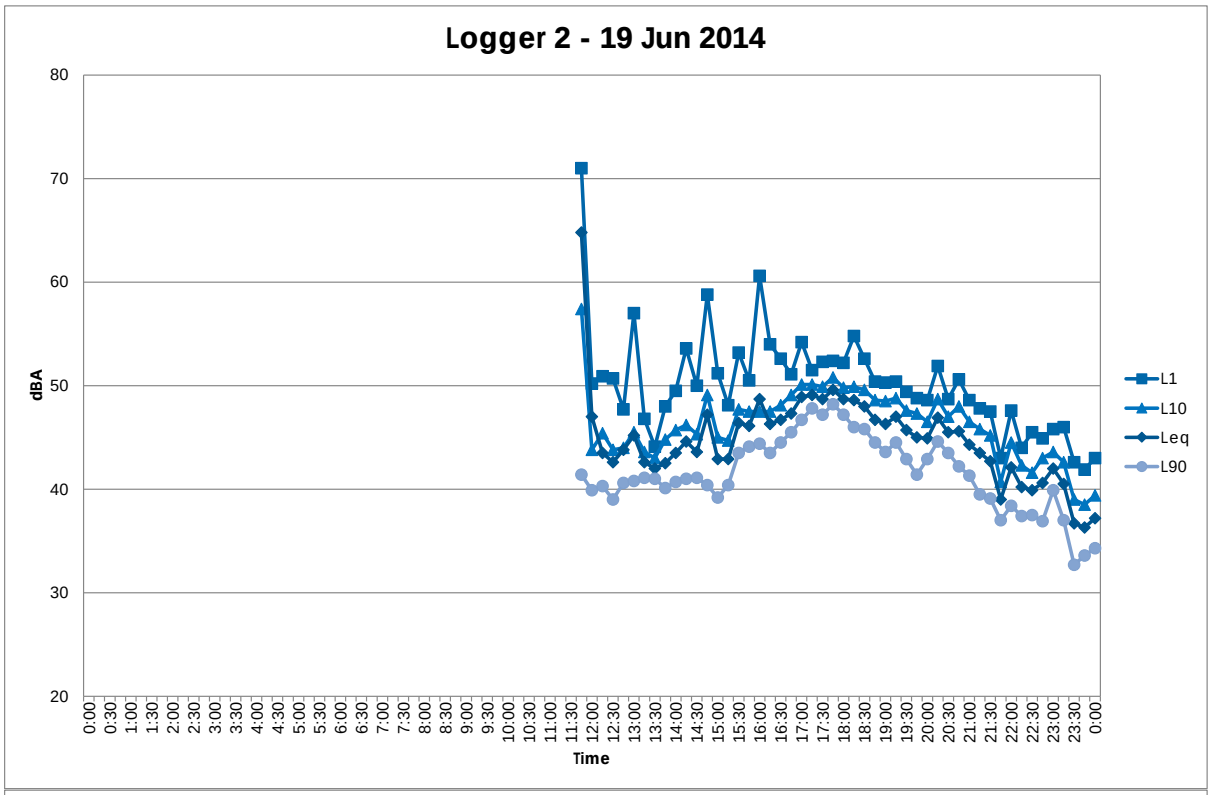
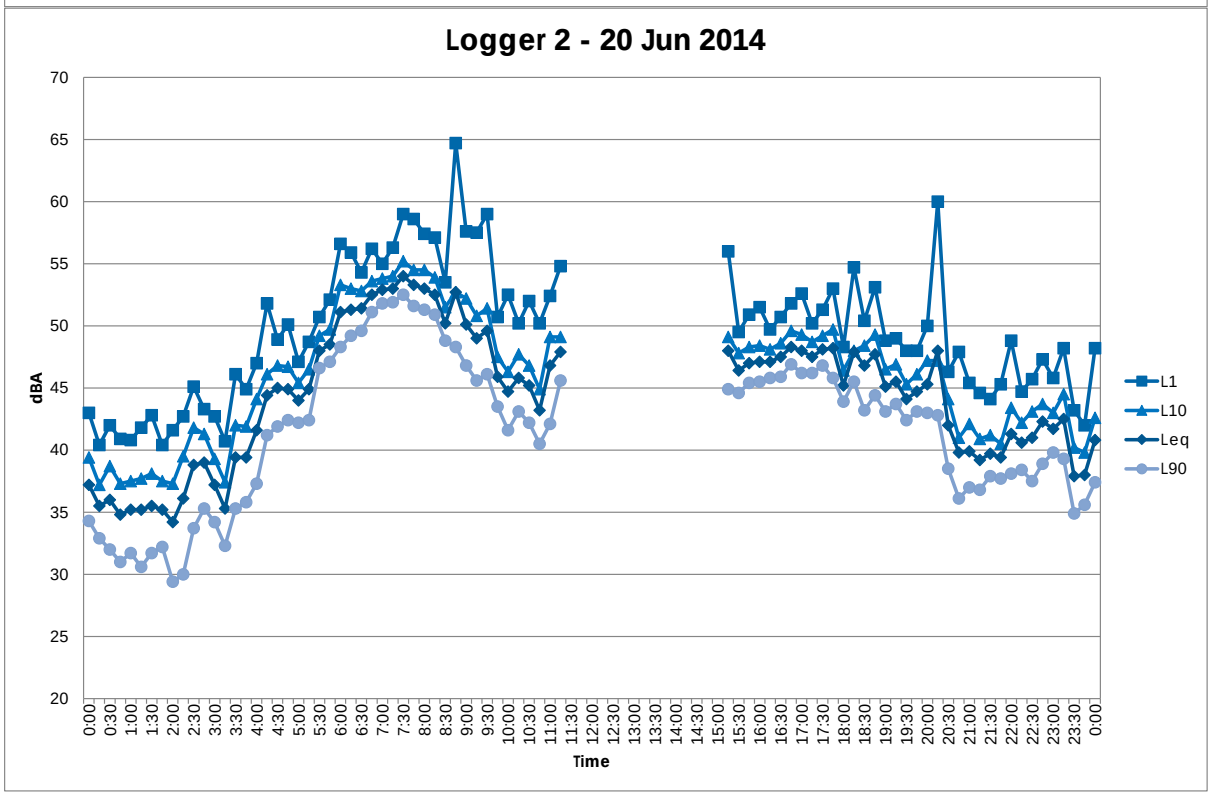

Logger 2 - 19 Jun 2014
dBA
Time
L1
L10
Leq
L90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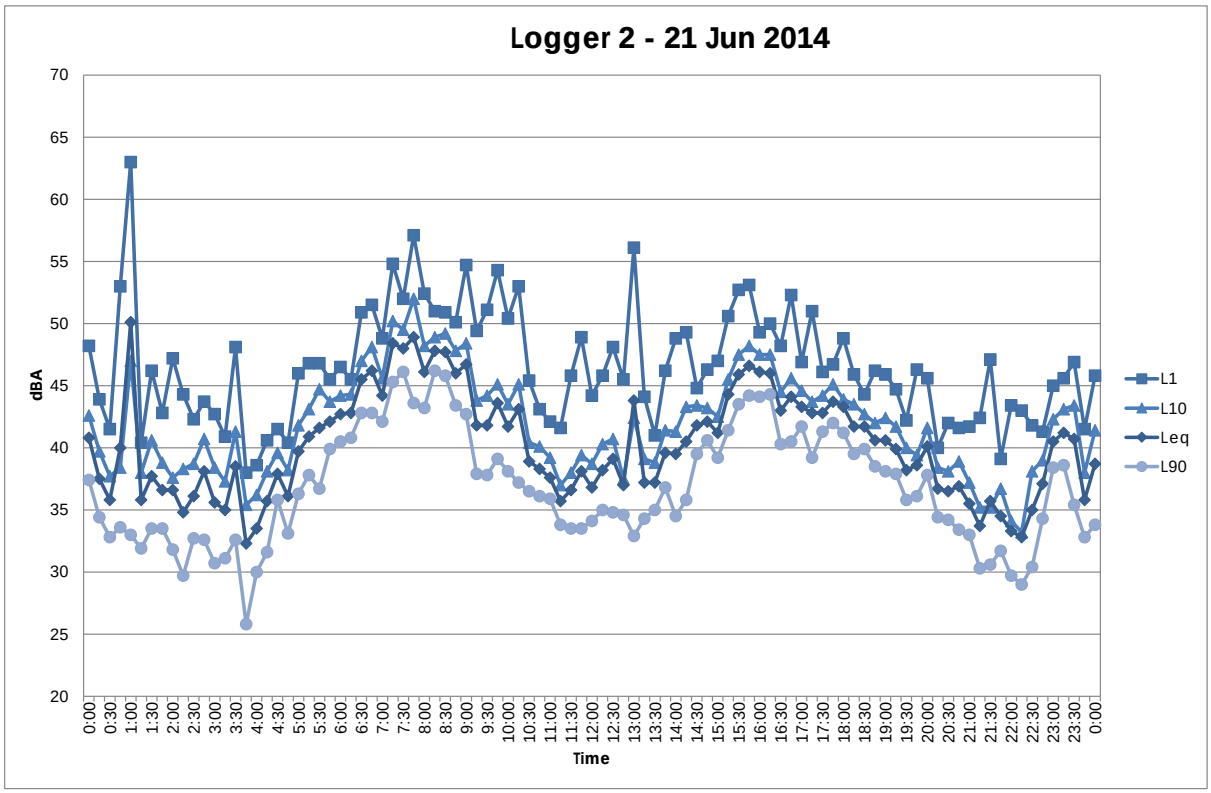
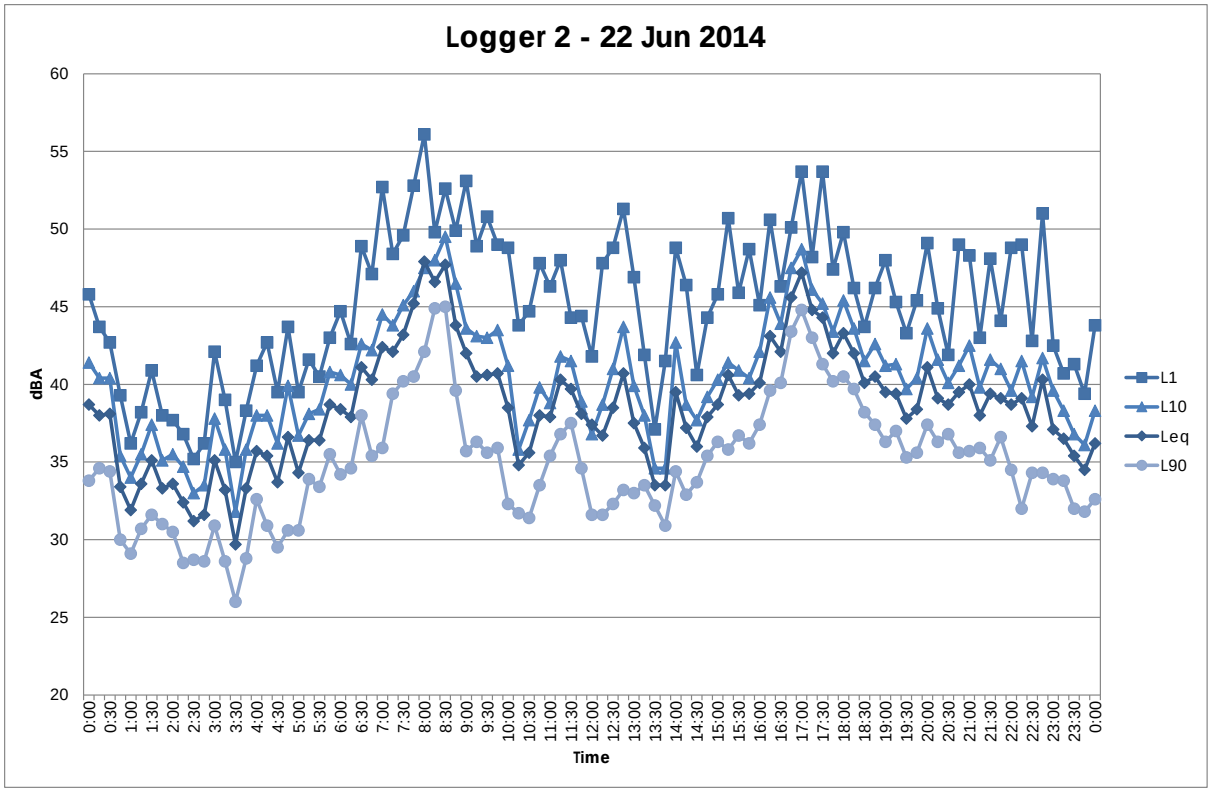
Time
L1
L10
Leq
L90


Logger 2 - 21 Jun 2014
dBA
Time
L1
L10
Leq
L90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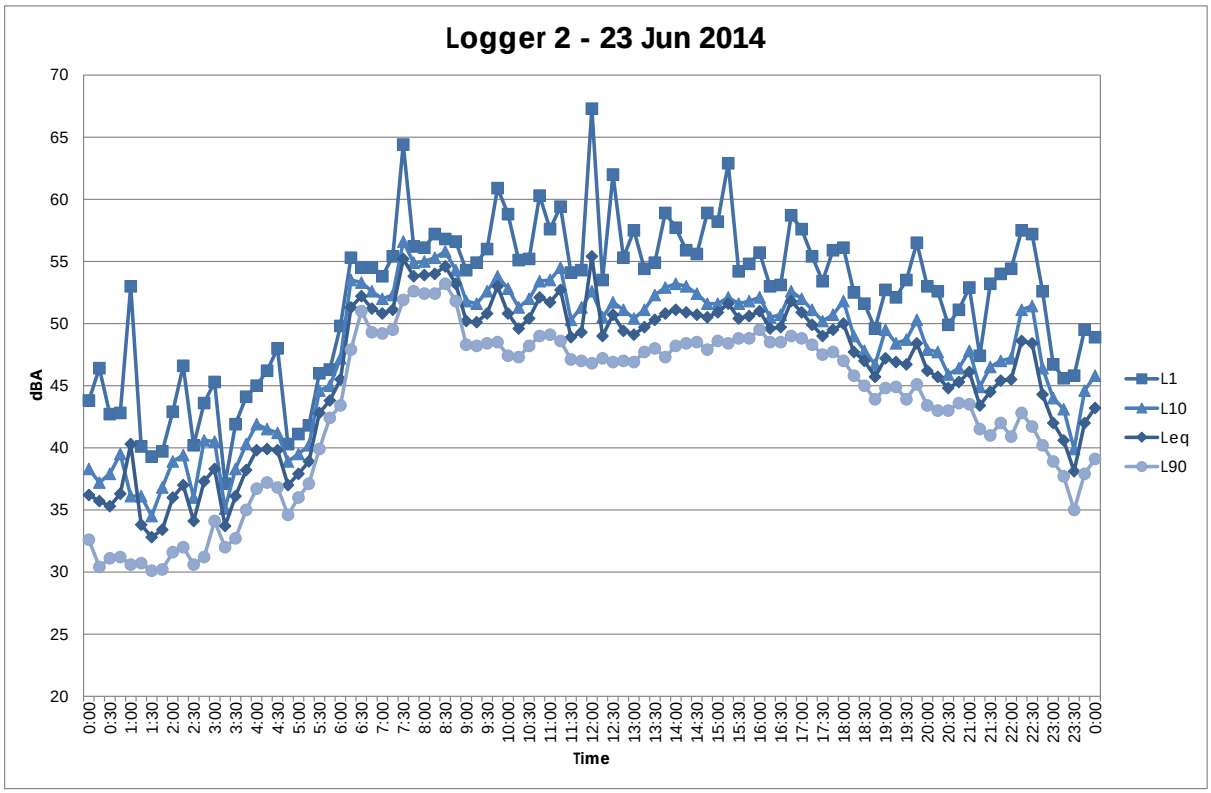
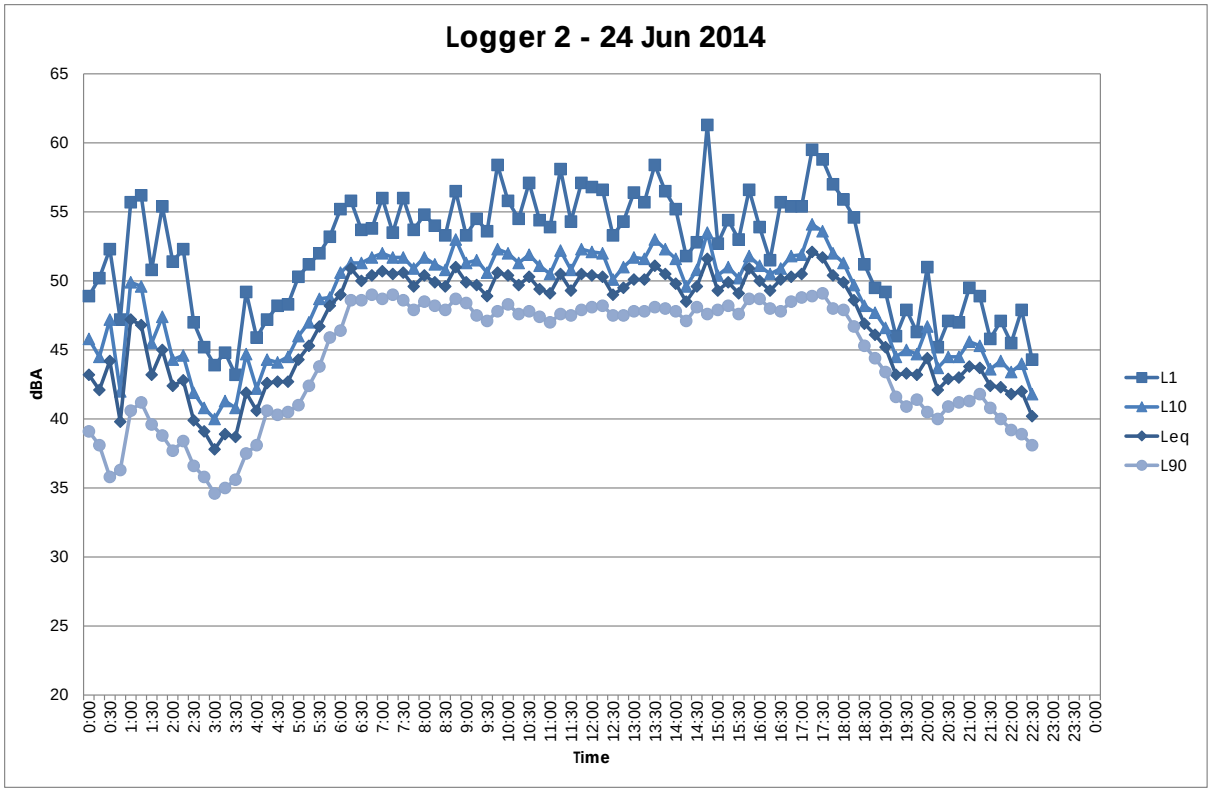
dBA
Time
L1
L10
Leq
L90

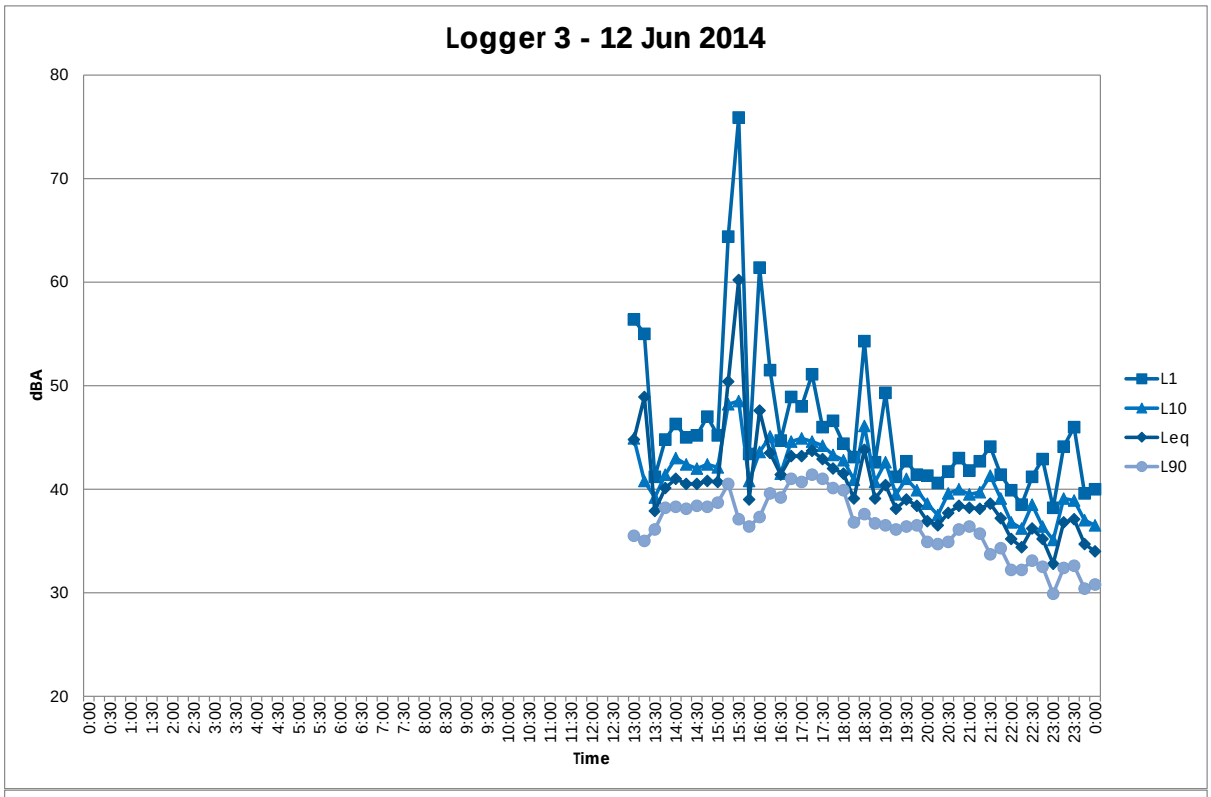

Logger 2 - 23 Jun 2014
dBA
Time
L1
L10
Leq
L90

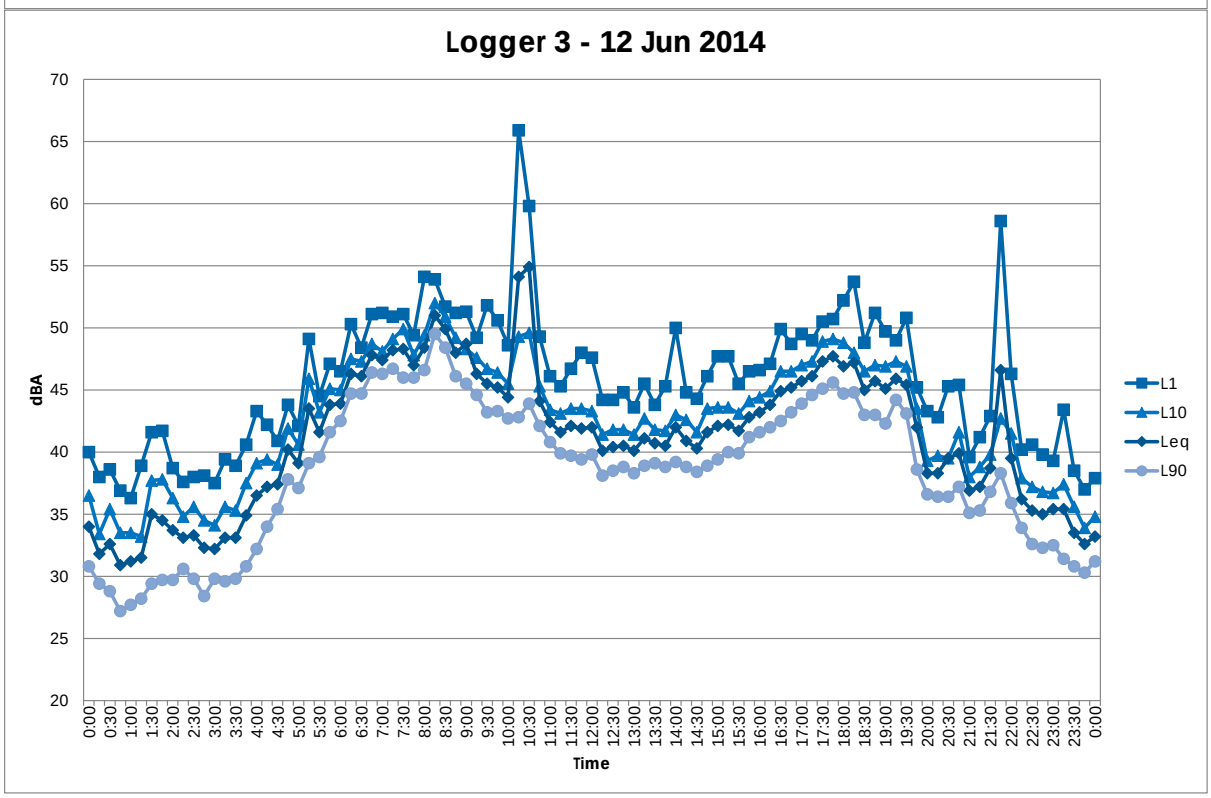

Logger 2 - 24 Jun 2014
dBA
Time
L1
L10
Leq
L90

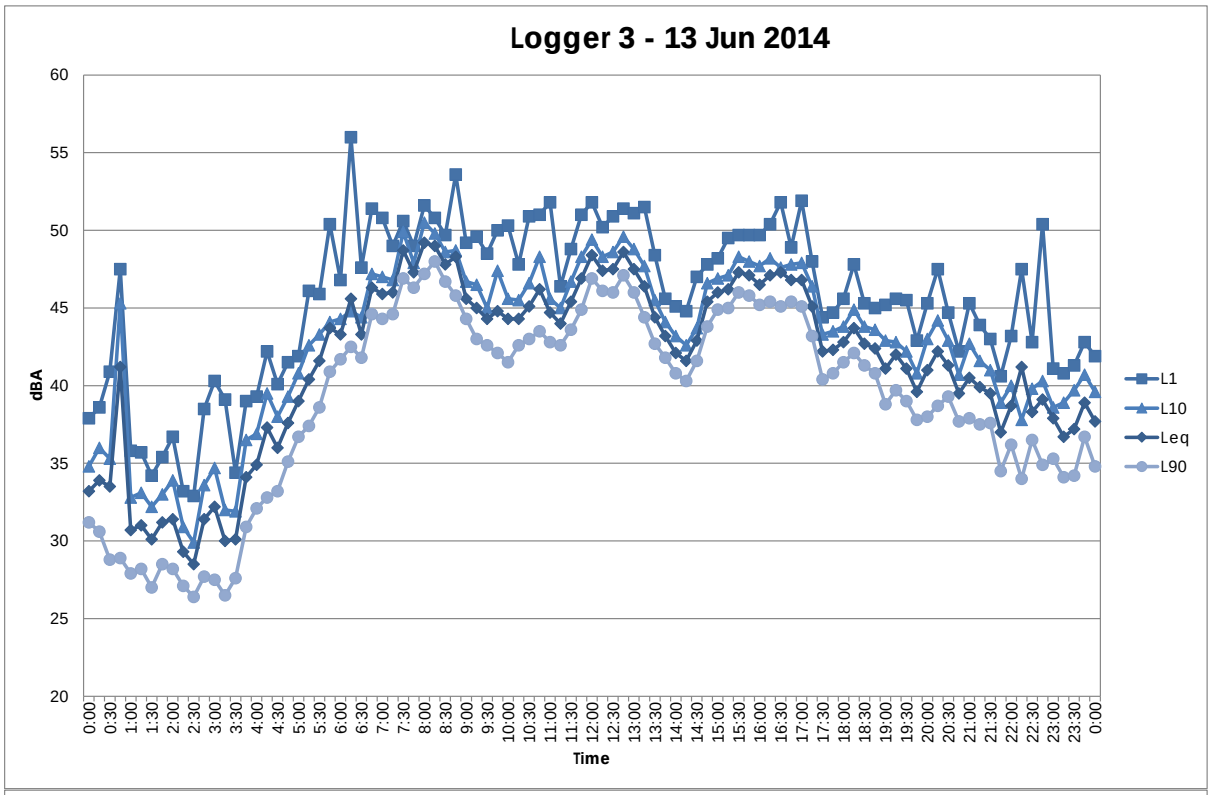
Monitoring Summary for BG2

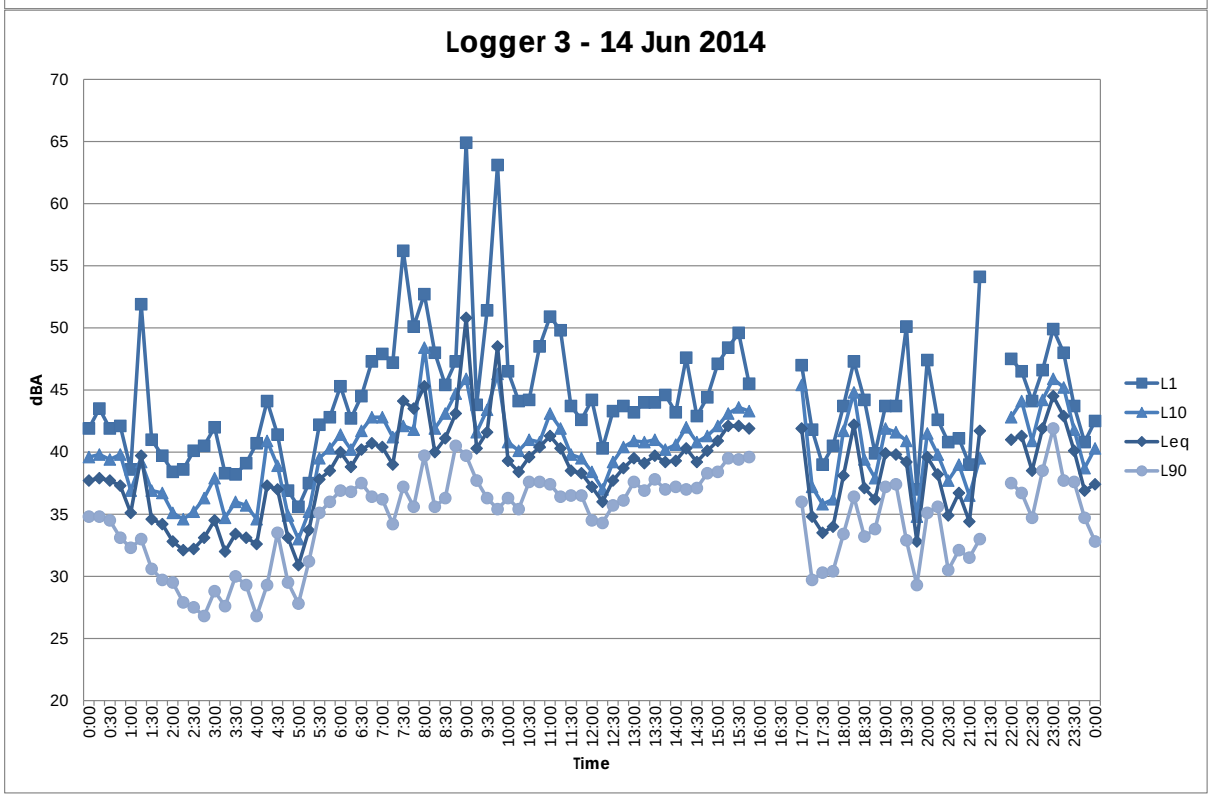
Date	Day		Evening		Night	
	L_{eq}	ABL	L_{eq}	ABL	L_{eq}	ABL
11/06/14	49	38	42	37	42	32
12/06/14	49	41	44	37	41	32
19/06/14	52	40	46	39	45	31
20/06/14	49	42	45	37	41	31
21/06/14	44	34	39	30	37	29
22/06/14	42	32	40	35	43	31
23/06/14	51	47	46	41	46	36
24/06/14	50	48	44	40	41	38
Log Average	49	-	43	-	42	-
RBL	-	40	-	37	-	31

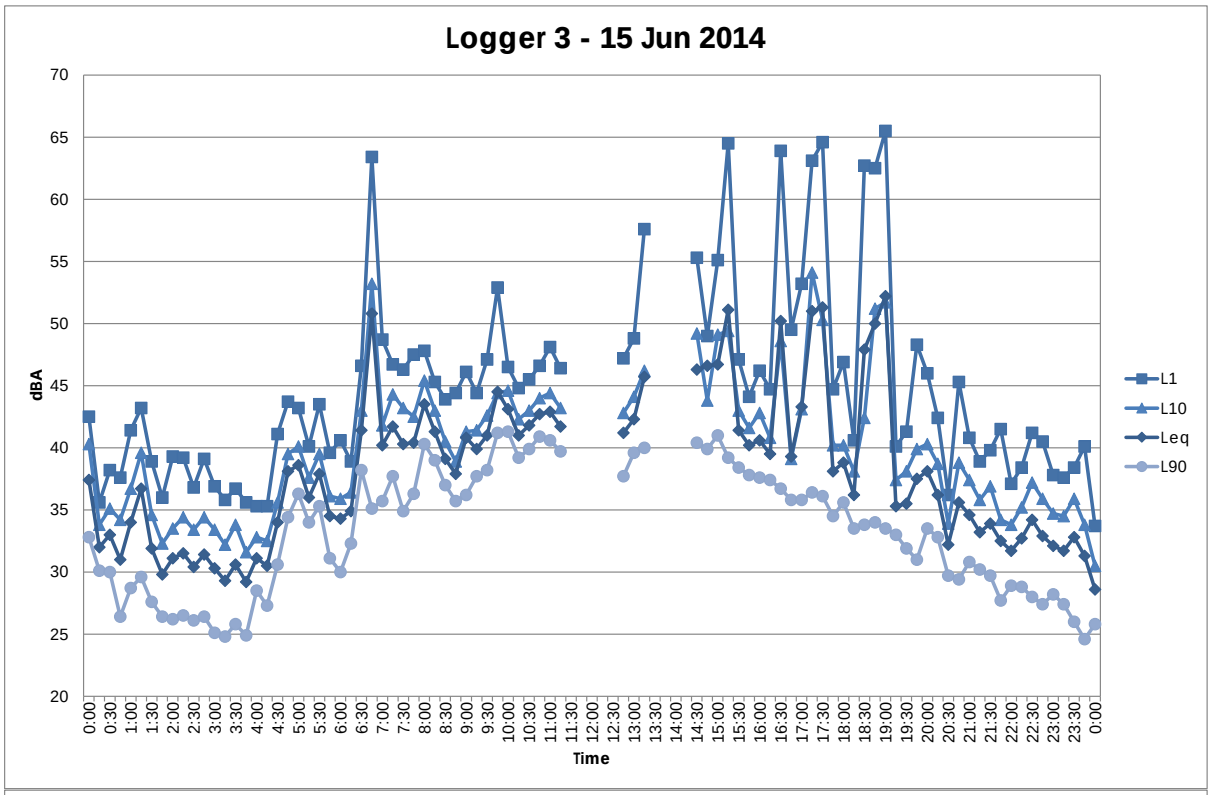
Note: Grey text indicates period excluded (adverse weather).

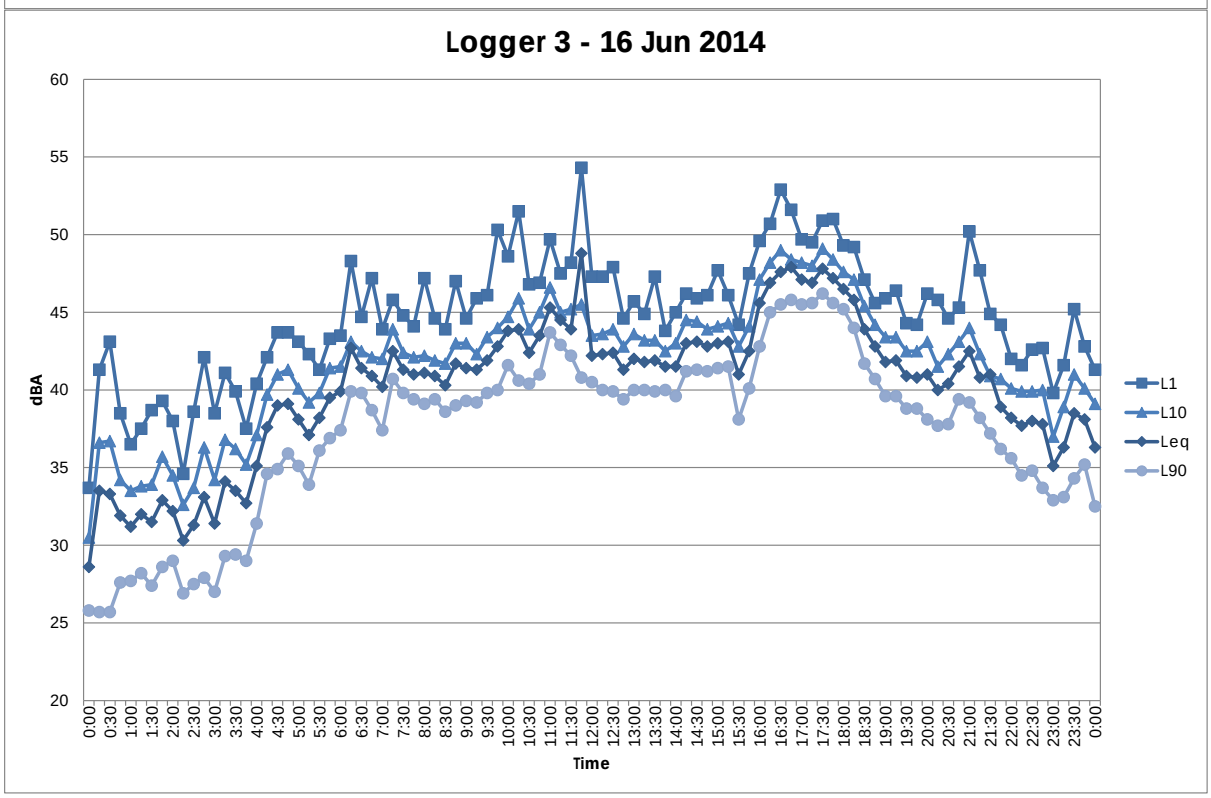

Logger 3 - 12 Jun 2014
dBA
Time
L1
L10
Leq
L90

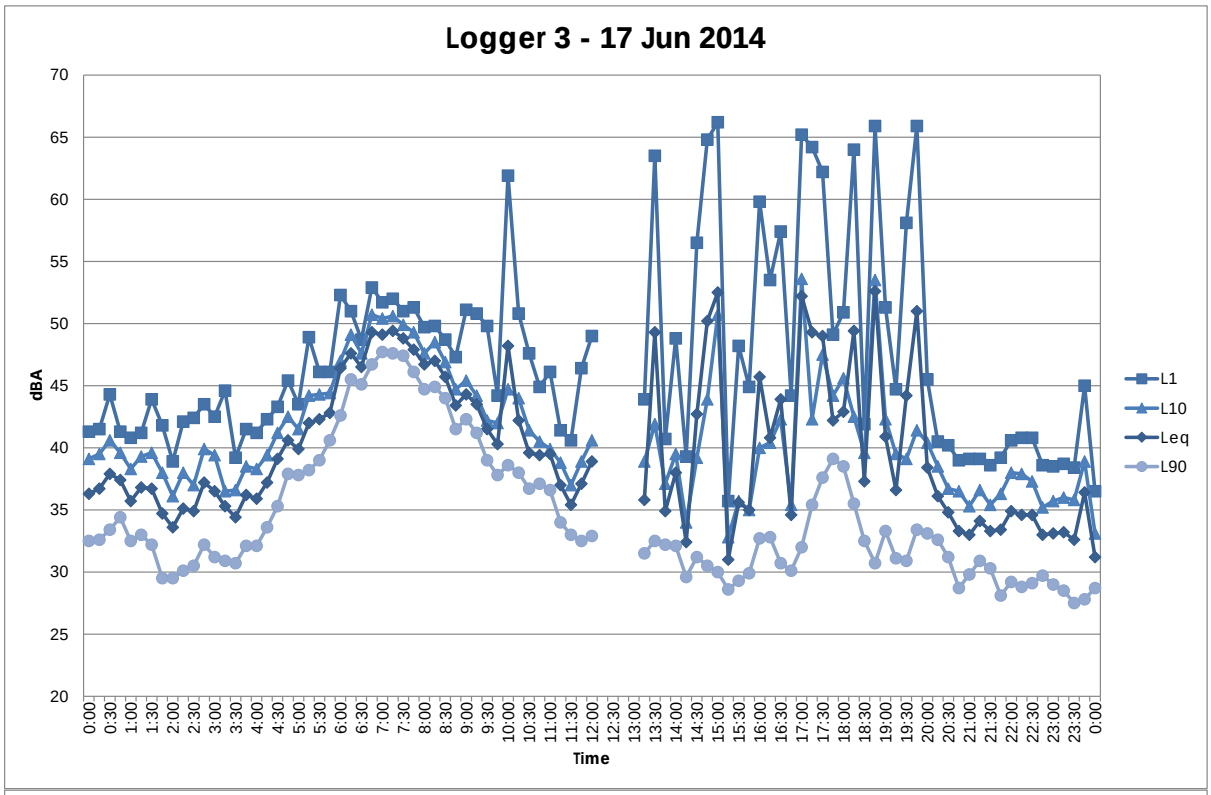

Logger 3 - 12 Jun 2014
dBA
Time
L1
L10
Leq
L90

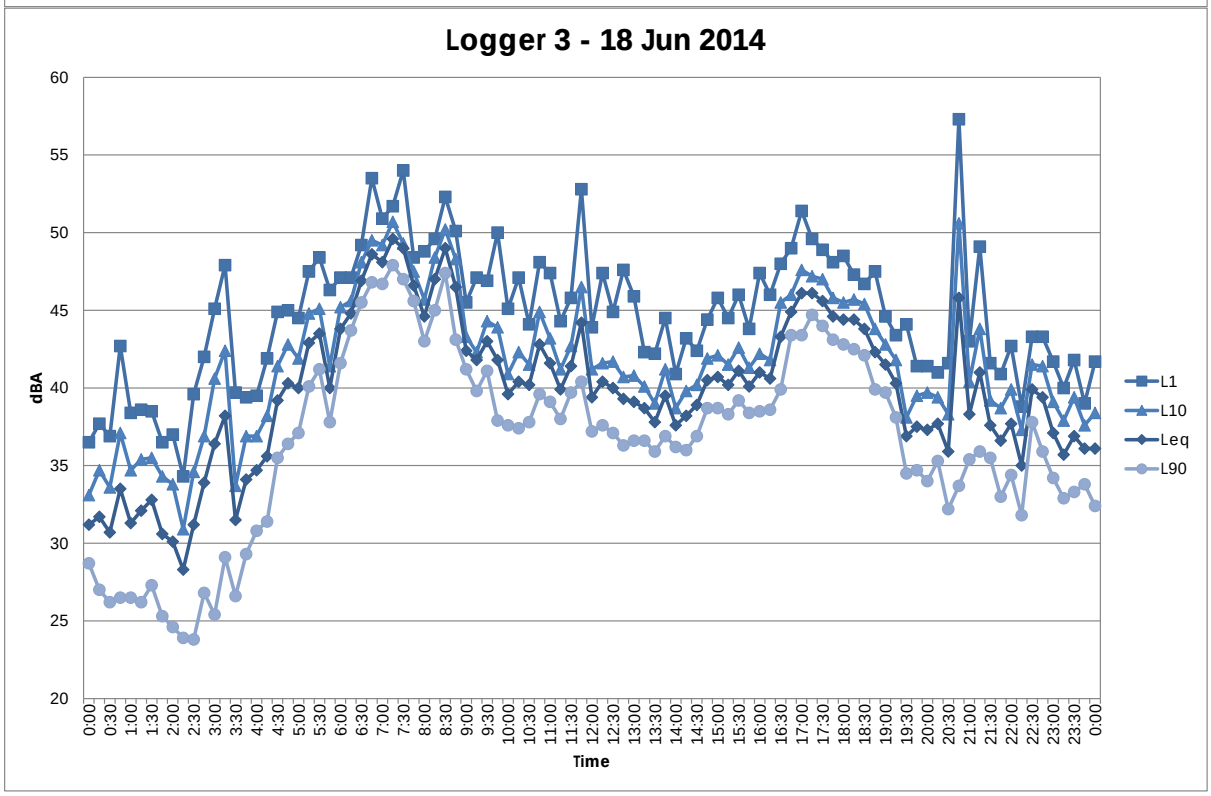

Logger 3 - 13 Jun 2014
dBA
Time
L1
L10
Leq
L90

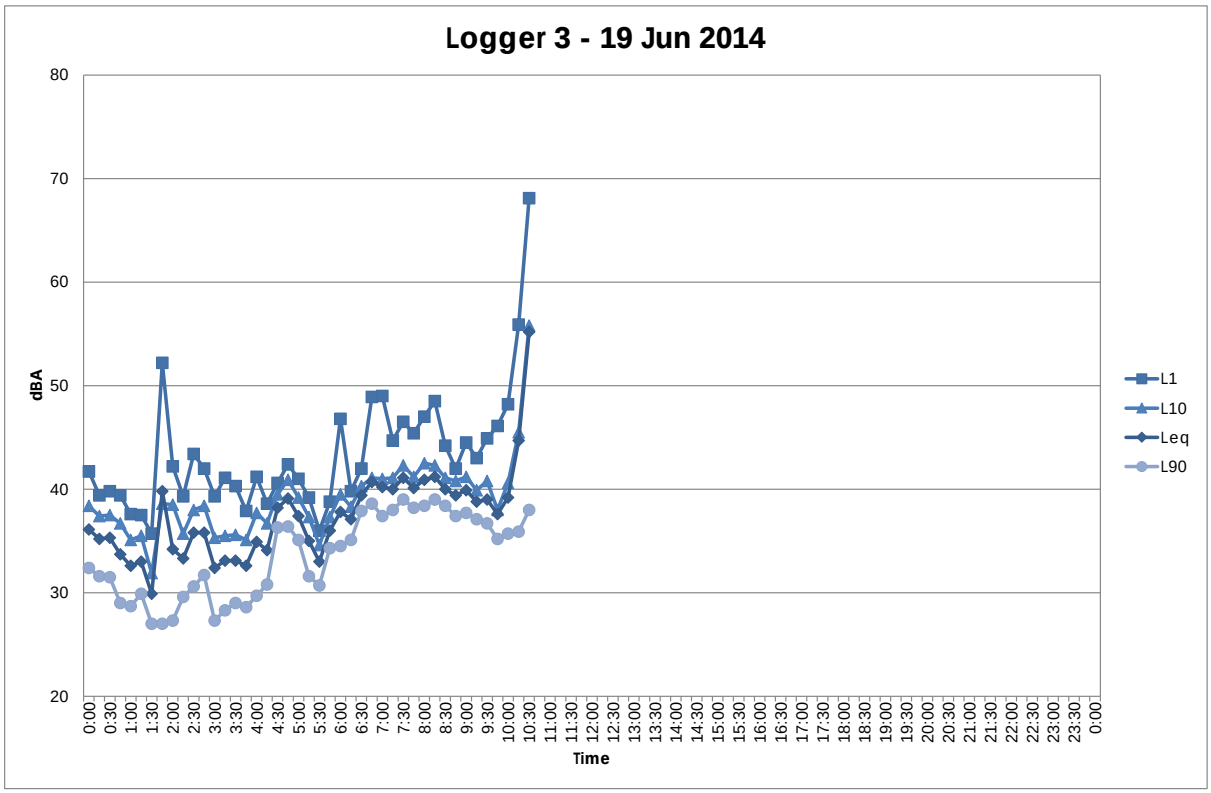

Logger 3 - 14 Jun 2014
dBA
Time
L1
L10
Leq
L90


Logger 3 - 15 Jun 2014
dBA
Time
L1
L10
Leq
L90


Logger 3 - 16 Jun 2014
dBA
Time
L1
L10
Leq
L90


Logger 3 - 17 Jun 2014
dBA
Time
L1
L10
Leq
L90


Logger 3 - 18 Jun 2014
dBA
Time
L1
L10
Leq
L90



Monitoring Summary for BG3

Date	Day		Evening		Night	
	L_{eq}	ABL	L_{eq}	ABL	L_{eq}	ABL
12/06/14	49	36	39	34	40	29
12/06/14	47	39	43	36	39	27
13/06/14	46	42	41	37	37	28
14/06/14	42	34	39	31	39	26
15/06/14	45	36	44	29	36	26
16/06/14	44	39	42	37	41	31
17/06/14	46	30	45	29	40	25
18/06/14	44	37	41	33	37	28
19/06/14	45	36	-	-	-	-
Log Average	45	-	42	-	39	-
RBL	-	37	-	34	-	28

Note: Grey text indicates period excluded (adverse weather).

Appendix B ATTENDED NOISE MEASUREMENTS

Table 10-1: Attended Noise Measurement Results

Date and Time	Location	Measured Noise Level dB(A)				Comments
		$L_{A1,15min}$	$L_{A10,15min}$	$L_{A90,15min}$	$L_{Aeq,15min}$	
11/6/14 11.56am	BG1	50	47	42	45	Noise environment dominated by road traffic noise from Monaro Highway. Other noise sources included occasional bangs and tonal reversing alarms just audible from Mugga Lane RMC, and bird calls. Industrial noise not discernable from road traffic noise.
11/6/14 2.10pm	BG2	50	47	41	44	Noise environment generally dominated by road traffic noise with significant contribution from industrial noise from Hume. Industrial noise estimated at L_{Aeq} <40 dB(A). Sources included bangs, grinding/circular saw, reversing alarms (tonal and broadband), aggregate on chutes and a hiss from asphalt plant and a PA system with speech clearly audible from the Hume Industrial Area. Trucks movements were also audible but not discernable from general road traffic noise. Industrial noise sources noted observed to emanate from premises on Alderson Place and Saw Mill Circuit.
11/6/14 1.07pm	BG3	43	39	35	38	Noise environment consisted of distant road traffic noise from Highway, occasional industrial noise from Hume and Mugga Lane RMC. Industrial noise from Hume included bangs, tonal reversing alarms. Truck movements not discernable from road traffic noise. Noise sources from Mugga Lane included distant tonal reversing alarms, bangs and track clack from dozer on tip. Estimated industrial noise contribution <35 dB(A). Aeroplane arrival flyover observed L_{AFmax} 43 dB(A).
11/6/14 8.50pm	BG1	44	41	37	39	Noise environment dominated by road traffic noise from Highway. Other sources included occasional bang from Hume (L_{Amax} 38 dB(A)), aircraft flyover take off (L_{Amax} 43 dB(A)), occasional frog calls (noted in the 2kHz and 3.15 kHz 1/3 octave bands, <35 dB(A)). Landing noise (reverse thrusting) noted from Airport (L_{Amax} 39 dB(A)).
11/6/14 7.50pm	BG2	47	44	38	42	Noise environment dominated by road traffic noise from Highway. Other sources included occasional bang from Hume (L_{Amax} 48 dB(A)), aircraft flyover take off (noted in the 2kHz and 3.15 kHz 1/3 octave bands, <35 dB(A)). Industrial noise estimated to be <35 dB(A).
11/6/14 8.21pm	BG3	41	39	36	38	Noise environment dominated by road traffic noise from Highway. Truck movements at intersection with Highway also audible. Truck compression brakes observed at L_{Amax} 37-41 dB(A). Occasional frog calls (noted in the 2kHz and 3.15 kHz 1/3 octave bands, <30 dB(A)).
12/6/14 1.59am	BG1	44	39	30	36	Ambient noise environment controlled by road traffic noise and distant road traffic noise/urban hum in absence of vehicles passing on Highway. Other industrial noise noted during gaps in traffic in distance, estimated at <30 dB(A) including distant just audible reversing alarms.
12/6/14 12.38am	BG2	42	38	34	36	Ambient noise environment controlled by road traffic noise and distant road traffic noise/urban hum in absence of vehicles passing on Highway. Other industrial noise noted during gaps in traffic in distance from the north north west in direction of Hume, estimated at <32-33 dB(A) including distant just audible reversing alarms. Industrial sources included steady state compressor or fan noise from direction of Downer plant and nearby premises
12/6/14 1.11am	BG3	36	34	30	32	Noise environment controlled by road traffic noise and distant road traffic noise/urban hum in the absence of cars passing on Highway. Just audible reversing alarms and industrial noise/truck movements audible (<28 dB(A)). Truck compression brakes L_{Amax} 29- 37 dB(A) on Monaro Highway. Frogs also noted at low level.

Appendix C METEOROLOGY ANALYSIS

C.1 WIND SPEED AND DIRECTION

The Canberra Airport automatic weather station (AWS) meteorological data have been reviewed for five consecutive years (2010 to 2014 – to date). Summary statistics for the wind data, including wind speed and percentage of 'calms' (winds less than 0.5 m/s), are shown in **Table 10-2**.

Table 10-2: Wind data – summary statistics

Year	Average wind speed (m/s)	Calm periods (%)
2010	3.1	9.6%
2011	3.3	8.0%
2012	3.5	8.1%
2013	3.7	6.9%
2014	3.2	8.3%

The annual and seasonal wind roses 2013 are presented in **Figure 10-1**. On an annual basis, the prevailing wind direction follows a northwest-southeast axis. In general, calmer winds originating from the southeast quadrant and strong winds from the northwest. There are two distinct seasonal patterns comprising summer/autumn and winter/spring. The stronger winds from the northwest dominate during the months of winter and spring while the opposite is the case for summer and autumn.

The wind data for 2013 were found to be generally representative of the larger data set in terms of average wind speed, percentage of calms and was therefore chosen to represent the meteorology in the analysis.

C.2 CLIMATIC CONDITIONS

The Bureau of Meteorology (BoM) collects climatic information in the vicinity of the study area. The Canberra Airport weather station has only been measuring data from 2008, therefore it does not provide a long enough dataset to characterise climatic condition. Alternatively, reference to the climatic information collected at Tuggeranong (Isabella Plains) automatic weather station (AWS) has been adopted and is presented in **Table 10-3** (**BoM, 2014**). This weather station is located 7km from the project site.

The annual average maximum temperature recorded at the site is 20.7C, the annual average minimum temperature is 6.9°C. The highest maximum temperature of 29.5°C is recorded in January, while the lowest minimum temperature of -0.2°C is recorded in July. The annual average humidity is 69% at 9am and 44% at 3pm. The annual average rainfall is 627 mm, falling throughout the year over approximately 98 raindays.

Table 10-3: Temperature, Humidity and Rainfall for Tuggeranong (Isabella Plains) BoM Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Daily Maximum Temperature (°C)													
Mean	29.5	27.9	25.2	21.0	16.5	13.0	12.3	14.1	17.6	20.6	24.1	26.9	**20.7**
Daily Minimum Temperature (°C)													
Mean	14.3	14.3	11.2	6.6	2.4	1.2	-0.2	0.8	3.8	6.3	9.8	12.0	**6.9**
9am Mean Relative Humidity (%)													
Humidity	61	68	70	69	78	83	82	73	65	60	62	59	**69**
3pm Mean Relative Humidity (%)													
Humidity	34	39	38	42	50	57	56	50	46	41	39	34	**44**
Rainfall (mm)													
Monthly mean	49	78	53	28	22	49	42	48	63	55	75	66	**627**
Raindays (Number)													
Mean no. of raindays	7	7	7	6	6	10	11	9	9	9	10	8	**98**

Station number: 070339; Commenced 1996; Status: Open; Elevation: 587 m AHD; Latitude: 35.42 °S; Longitude: 149.09 °E.
Source: **BoM (2014)**

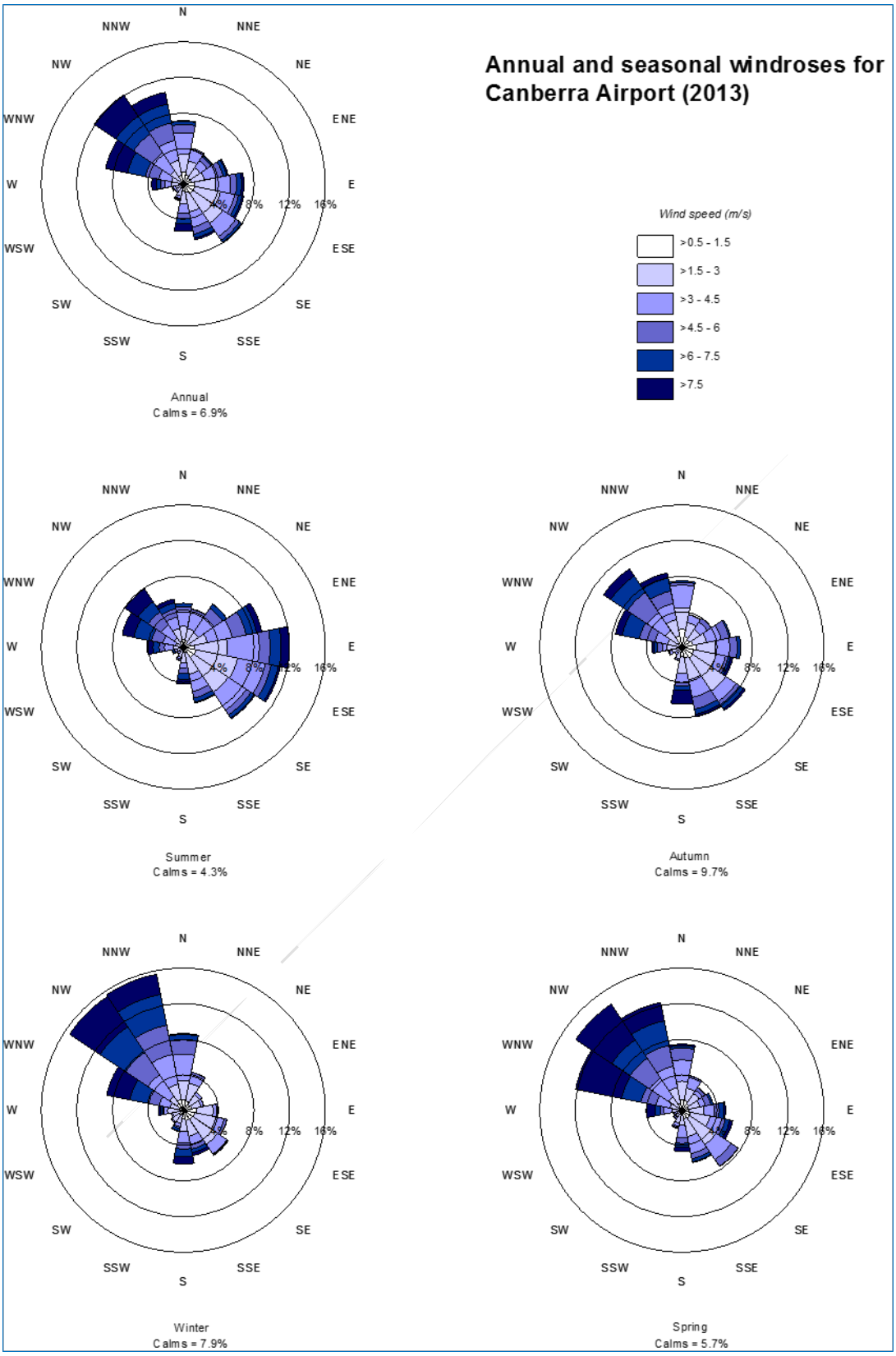


Figure 10-1: Annual and seasonal wind roses Canberra Airport AWS (2013)

Appendix D AIRCRAFT NOISE

D.1 NSW ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979, SECTION 117

Under Section 117 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (**NSW Government, 1979**) the NSW Planning Minister issued directions to local councils detailing requirements for inclusions to their Local Environment Plans (LEP). The Directions applied to all draft LEPs which were received prior to 1 July 2009. Direction 3.5 details requirements for LEPs for developments near licensed aerodromes.

The Direction states its objective, relevant to noise, as:

(1) (c)To ensure development for residential purposes or human occupation, if situated on land within the Australian Noise Exposure Forecast (ANEF) contours of between 20 and 25, incorporates appropriate mitigation measures so that the development is not adversely affected by aircraft noise.

Where the direction applies, the following requirements for draft LEPs, relevant to noise, apply:

(5) A draft LEP shall not rezone land:

(a) for residential purposes, nor increase residential densities in areas where the ANEF, as from time to time advised by that Department of the Commonwealth, exceeds 25, or
(b) for schools, hospitals, churches and theatres where the ANEF exceeds 20, or
(c) for hotels, motels, offices or public buildings where the ANEF exceeds 30.

(6) A draft LEP that rezones land:

(a) for residential purposes or to increase residential densities in areas where the ANEF is between 20 and 25, or
(b) for hotels, motels, offices or public buildings where the ANEF is between 25 and 30, or
(c) for commercial or industrial purposes where the ANEF is above 30, shall include a provision to ensure that development meets AS 2021 regarding interior noise levels.

D.2 AUSTRALIAN STANDARD AS 2021 – ACOUSTICS – AIRCRAFT NOISE INTRUSION – BUILDING SITING AND CONSTRUCTION

The Australian Standard provides a consistent method for assessing potential noise impacts associated with aircraft noise intrusion into buildings with noise sensitive uses and for use in planning land uses in the vicinity of airports.

The assessment for land use planning is based on the Australian Noise Exposure Forecast (ANEF) contours, which are produced by every major airport in the country. The standard states the ANEF is *"a single number index for predicting the cumulative exposure to aircraft noise in communities near aerodromes during a specified time period (normally one year)."* It is a complex descriptor and is based on a number of inputs including individual aircraft noise levels, the number, type and mix of aircraft, the spectral temporal and spatial aspects among others.

Using the ANEF contours, permitted land uses are determined to be either acceptable, conditionally acceptable or unacceptable. Where proposed areas are conditionally acceptable, the maximum noise levels should be calculated and the required level of mitigation for building constructions should be determined.

Table 10-4 provides a summary of building site acceptability based on ANEF zones. The acceptability of building sites is subject to a number of additional considerations when interpreting ANEF zones contained within the standard.

The actual location of the 20 ANEF contour is difficult to define accurately and therefore where development is proposed outside but near the ANEF, the level of aircraft noise may be considered in making planning decisions.

Table 10-4: Building Site Acceptability Based on ANEF Zones

Building Type	ANEF Zone of Site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Public Building	Less than 20 ANEF	25 to 30 ANEF	Greater than 30 ANEF
Commercial Building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light Industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other Industrial	Acceptable in all ANEF zones		

Where developments sites are either conditionally acceptable or are outside but close to the 20 ANEF contour, the development should ensure that maximum aircraft noise levels are not exceeded within a building. **Table 10-5** provides a summary of indoor design sound levels which are based on Australian experience.

Table 10-5: Indoor Design Sound Levels for Determination of Aircraft Noise Reduction

Building Type	Activity	Indoor Design Sound Level, dB(A)
Houses, home units, flats, caravan parks	Sleeping area, dedicated lounges	50
	Other habitable spaces	55
	Bathrooms, toilets, laundries	60
Hotels, motels, hostels	Relaxing, sleeping	55
	Social activities	70
	Service activities	75
Schools, universities	Libraries, study areas	50
	Teaching areas, assembly areas	55
	Workshops, gymnasia	75
Hospitals, nursing homes	Ward theatres, treatment and consulting rooms	50
	Laboratories	65
	Service Areas	75
Public Buildings	Churches, religious activities	50
	Theatres, cinemas, recording studios	40
	Court Houses, libraries, galleries	50
Commercial Buildings, offices and shops	Private offices, conference rooms	55
	Drafting, open offices	65
	Typing, data processing	70
	Shops, supermarkets, showrooms	75
Industrial	Inspection, analysis, precision work	75
	Light Machinery, assembly, bench work	80
	Heavy Machinery, warehouse, maintenance	85

The standard provides a method for predicting the aircraft noise levels and then comparison with the design level gives the Aircraft Noise Reduction (ANR). The ANR is the decibel level of reduction required for the internal noise level to meet the levels in **Table 10-5**. This is achieved by specifying building construction components to meet the ANR.

D.3 QUEANBEYAN CITY COUNCIL AIRCRAFT NOISE ASSESSMENT GUIDELINES

The QCC *Aircraft Noise Assessment Guidelines* assist designers of proposed residential dwellings in order to satisfy the provisions for aircraft noise intrusion in AS 2021. The guideline divides the ANEF contours into zones within the QCC area and provides recommendations for building construction in order to meet the requirements for internal noise levels in AS 2021. The most current version of the guidelines contains the ANEF contours from 2009.

The area covered by the guidelines does not currently contain the site as they are located just outside of the ANEF 20 contour.

D.4 CANBERRA AIRPORT PRELIMINARY DRAFT MASTER PLAN

The PDMP for Canberra Airport was released on 17 March 2014. This document is to replace the 2009 master plan.

The PDMP reiterates the importance of the airport remaining curfew free in conjunction with the ability to avoid noise sensitive persons unknowingly being exposed to noise impacts from aircraft movements through noise disclosure.

The airport operators are committed to a policy of noise disclosure about current and expected levels of aircraft noise.

The PDMP forecasted noise contours are based the Ultimate Practical Capacity (UPC) which its states as 282,000 fixed wing aircraft based on 24 hour a day operations.

The PDMP expresses the need to keep the airport operating 24 hours a day and not imposing restrictions on operations. It notes several groups (including QCC and the Jerrabomberra Residents Association) have requested that restrictions are imposed during the night.

The decision by the NSW Minister for Planning and Infrastructure on the rezoning of South Tralee is included in the PDMP and describes how sensitive land use has been allowed in this area with provisions and no restrictions were applied to airport operations.

Part of the provisions applied to the South Tralee development are 149 Certificates which notify prospective buyers of the aircraft noise in addition to Section 88B instruments on title that homes must be built to comply with Table 3.3 of AS 2021 indoor design sound levels, as shown in **Table 10-5** for residential properties, with external windows and door to be kept closed for compliance to be achieved.

An excerpt from the Aircraft Noise Ombudsman (ANO) is provided to reiterate the potential for noise impacts to occur outside of the 20 ANEF and that whilst the ANEF scheme is used for planning schemes, it may not provide adequate information in relation to actual noise impacts experience by those living in the vicinity of flight paths. It stresses the point that additional means of describing and presenting noise impacts should be used when informing the public about aircraft noise.

A number of aircraft noise abatement procedures are currently practised by the airport, including noise abatement areas which limits over flight at a certain height above ground level. The areas are proposed to be extended to include the Googong New Town, however no plans are in place to include the proposed site at South Jerrabomberra.

Other noise abatement procedures include preferred runway operations during the night, whereby arrivals are preferred on Runway 17 and departures on 35. The use of the 17/35 runway is preferred over the cross runway 12/30 for night freight carriers.

Standard Instrument Departures (SIDs) followed by Standard Terminal Arrival Routes (STARs) were implemented in order to accurately manage aircraft arrivals paths and provide accurate tracking of flight paths to permit compliance with the noise abatement areas.

Required Navigation Performance (RNP) systems are GPS based tools which allows aircraft to follow flight paths accurately. These technologies have currently been fitted to Qantas Boeing 737-800 and B767-300 aircraft and have been applied to arrivals on Runway 35. This system is proposed to be expanded to Runway 17.

In February 2013, additional approach procedures were implemented for the main north south runway. Where aircraft approach from the south or south west they are diverted further west away from Jerrabomberra and rural-residential areas of Fernleigh Park, Googong and Little Burra.

The PDMP also produced N60, N65 and N70 contours maps. These maps detail the number of events over a certain noise levels are predicted over a certain day. For example the N60 contour represents the total number of instances during the average day where a location is exposed to a noise event greater than 60 dB(A) from aircraft movements. Plots of single event noise levels from 737-800 and 787-300 were also included in the PDMP. These plots show noise events from these aircraft above 65 dB(A). The aircraft were chosen as the report states they represent the loudest and largest footprint of regular passenger and freight aircraft expected over the next five to 20 years. These plots are reproduced in the following sections.

A review of the PDMP was conducted by Wilkinson Murray (**WMPL, 2014**) found that the ANEF and N60, N65 and N70 contours in the PDMP were essentially the same as the one produced for the 2009 master plan. Whilst it recognised that the ANEF contours were based on the current Ultimate Practical Capacity (UPC), it raised questions of this practice relating to the aircraft types, flight paths, the reassessment of the airport capacity and the advances in modelling techniques since the contours were produced in 2008. The review states that these factors raise “significant concerns” over the applicability of the 2008 contours for current usage.

The PDMP is still in draft form and yet to be approved, which would allow updated contours to be generated, if required.

D.5 AVIATION WHITE PAPER

The *National Aviation White Paper* (**Australian Government, 2009**) makes comment on a number of issues relating to land use planning using the ANEF scheme. The paper comments that the ANEF scheme provides a useful system to guide land use planning around airports. It also makes a number of suggestions to improve the current ANEF scheme. These include:

- retain the current ANEF system in Airport Master Plans as a land use planning tool around leased federal airports;
- work to have all jurisdictions reflect the ANEF system in local planning regimes around airports and under flight paths;
- improve the technical processes and independence associated with assessment and scrutiny of ANEFs;
- work to improve planning controls for land use around airports to supplement the ANEF system with additional tools such as flight path location and activity diagrams, and single event contours based on decibels to assist planners and the public to better understand and take account of aircraft noise exposure patterns; and

- work closely with state and territory planning agencies to prevent noise sensitive developments, including schools and residences, in the vicinity of airports and under flight paths with increased focus on the preservation of existing greenfield sites and scrutiny of rezoning proposals for industrial and rural lands impacted by aircraft noise.

D.6 SOUTH TRALEE REZONING ASSESSMENT

As part of the planning assessment to rezone the South Tralee area, an aircraft noise impact assessment was completed (**Renzo Tonin, 2010**). The South Tralee site is bisected by the 20 ANEF contour and parts of the site lie within the 20 and 25 ANEF. The assessment considered a conservative approach and recognised that even though areas lay outside of the 20 ANEF, that the interior noise levels specified in AS 2021 should still be complied with and an assessment was made to this effect.

The assessment specified general measures which should be applied to building construction depending on the predicted level of aircraft noise in order to comply with the specifications in AS 2021. In addition, it was recognised that any redevelopment of the site should make potential buyers aware that the site is impacted by aircraft noise and as such made the following recommendations:

- All properties that are proposed on the site should have an assessment made in accordance with AS 2021.
- All sensitive land use proposed within the South Tralee area should be assessed according to AS 2021 at the development approval stage and consideration should be made for the QCC Aircraft Noise Assessment Guidelines.
- Adopting a "Buyers Advisory Policy" which informs potential buyers about the potential levels of aircraft noise and that special provision may be incorporated into the building design to reduce aircraft noise. If potential buyers are informed of noise impacts, it is suggested that there is less risk that complaints would arise where people have chosen to live near an aircraft flight corridor. It is suggested that this information is made available through a Section 149 Certificate under the EP&A Act. The policy should include as a minimum:
    - Information on aircraft flight path locations relative to the site, loudness in decibels [dB(A)] of individual flyover events and number of aircraft flyovers above 60 dB(A) during the night period and above 70 dB(A) during the day period based on the current available information available from Airservices Australia and Canberra Airport.; and
    - Description of the typical design requirements a residential property would require to achieve AS 2021 design noise levels at the development application stage.

Appendix E INDUSTRIAL NOISE GUIDANCE

E.1 NSW INDUSTRIAL NOISE GUIDANCE AND REGULATION

Industrial noise is assessed in NSW under the INP (**NSW EPA, 2000**). According to the INP, industrial noise is generally characterised as noise created by facilities including industrial premises, commercial premises, warehousing, maintenance and repair facilities and individual sources of industrial noise including ventilation equipment, machinery such as conveyors and mobile items of machinery or plant. It does not include noise from road, rail and air transportation (except where this occurs within a site boundary), construction, motor sport facilities or sources of noise covered by other regulations (domestic/neighbourhood noise).

The policy defines two methods for determining potential noise impacts using criteria. These are the intrusive criteria, which are designed to minimise the potential for short term intrusive noise and the amenity criteria which are defined to limit the amount of industrial noise within an area for specific land uses. These criteria are defined by the land use and existing industrial and background noise levels at noise sensitive receivers. It also requires an examination of the potential for sleep disturbance effects to be observed from short, high level noise events, where operations occur at night.

Intrusiveness Noise Criterion – The $L_{Aeq,15min}$ noise level within the day (7.00am to 6.00pm, 8.00am to 6.00pm Sundays and Public Holidays), evening (6.00pm to 10.00pm) or night time (10.00pm to 7.00am, 10.00pm to 8.00am Sundays and Public Holidays) assessment periods should not exceed the Rating Background Level (RBL), as defined by the INP, within that period by more than 5 dB(A). T

Amenity Noise Criterion – The maximum ambient L_{Aeq} noise level within the day, evening and night assessment period should not exceed the "acceptable noise levels" (ANL) published in the INP and reproduced in **Table 10-6** for applicable land uses.

The ANL is dependent on the relevant receiver type and area category for the residential receiver. The purpose of this noise goal is to provide an upper limit to industry related noise emissions and prevent industrial noise levels from creeping higher with each new successive industrial development.

Where the existing industrial noise level is close to the relevant deemed ANL, the project specific amenity noise criterion is then set lower than ANL so that the total level of industrial noise (i.e. new plus existing) does not exceed the deemed INP acceptable level. Adjustments to the ANL are presented in **Table 10-7**. On the other hand, where the existing level of industrial noise is higher than the INP acceptable level, then the project specific noise criterion is set 10dB(A) lower than the prevailing noise level if it is unlikely that the prevailing industrial noise level will reduce in the future. If it is likely that the overall noise level will reduce, then the project specific amenity criterion is set 10 dB(A) below the INP acceptable noise level.

Table 10-6: Recommended L_{Aeq} Noise Levels from Industrial Noise Sources, dB(A)

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended L_{Aeq} Noise Level dB(A) Acceptable	Recommended Maximum
Residential	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
School Classroom	All	Noisiest 1 hour period (when in use)	45 (external)	50 (external)
Hospital Ward -internal -external	All	Noisiest 1 hour period (when in use)	35 50	40 55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area	All	When in use	55	60
Commercial	All	When in use	65	70
Industrial	All	When in use	70	75

Note: 1. This table taken from Table 2.1 of the INP. It should be read in conjunction with the notes from Section 2.2.1 of the INP. Time periods are defined as: Day (7.00am-6.00pm Monday to Saturday and 8.00am-6.00pm Sundays and Public Holidays), Evening (6.00pm-10.00pm), Night (10.00pm-7.00am, unless preceding a Sunday or Public Holiday).
2. External noise criteria based on internal criteria + 10 dB, as recommended in the INP.

Table 10-7: Modification to ANL to Account for Existing Level of Industrial Noise

Total existing L_{Aeq} noise level from industrial sources dB(A)	Maximum L_{Aeq} noise level for noise from new sources alone, dB(A)
≥ Acceptable noise level plus 2	If existing noise level is *likely to decrease* in future: acceptable noise level minus 10 If existing noise level is *unlikely to decrease* in future: existing level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

Note: This table is a reproduction of Table 2.2 of the INP.

The INP includes provisions for certain characteristics of the noise emitted from an industrial premises. The characteristics include tonality, impulsiveness, intermittency or dominant low frequency content.

Generally an assessment of the acceptability for a proposed industrial development is carried out by first determining the existing background and industrial noise levels using a combination of long term and short term noise measurements. Using the existing levels, the criteria are defined and the most stringent of the intrusive or amenity criteria become the limiting criteria which any new development should meet. Noise levels from a proposed (or existing) facility are determined at the sensitive receivers and this level is compared with the criteria. Where the levels from the facility are below the criteria at the receivers, the noise levels are generally considered acceptable.

E.2 ACT INDUSTRIAL NOISE GUIDANCE AND REGULATION

Industrial noise in ACT is assessed according to *Noise Environment Protection Policy* (Noise EPP) (**ACT EPA, 2010**). The policy is designed to assist in the understanding of the Environment Protection Act 1997 (the Act) and Environment Protection Regulation 2005 (the Regulation) as they apply to noise.

The Noise EPP states *"Under the Regulation, the ACT is divided into noise zones based on land use policies defined by the Territory Plan. Noise standards apply to each zone. Except where otherwise permitted under the Regulation, an activity causes environmental harm if that noise exceeds the noise standard at the compliance point set either by the Regulation, an environmental authorisation or an approval."*

The ACT defines seven noise zones that relate to noise. The zones have noise standards set which they must meet during the day (7.00am to 10.00pm Monday to Saturday and 8.00am to 10.00pm Sundays and Public Holidays) and night (10.00pm to 7.00am Monday to Saturday and 10.00pm to 8.00am Sundays and Public Holidays).

In the case where two different noise zones meet, the average (rounded up to the nearest dB) is taken as the noise standard for that boundary.

The standards may be altered where an activity which is covered by an environmental authorisation or approval where specific noise conditions are set.

A summary of the noise standards is presented in **Table 10-8**. The noise standards are used by the ACT Planning and Land Authority (ACTPLA) in the assessment and planning of potential land use.

Table 10-8: ACT Noise Standards

Zone	Zone Type	Noise Standard $L_{A10,T}$ dB(A)[1]	
		Day	Night
A	Industrial Areas	65	55
B	City Centres and Town Centres	60	50
C	Land in group centres, corridor sites and office sites	55	45
D	Land in a commercial C4 zone (other than city, town or group centres)	50	35
E	Land (other than city, town or group centres) in a restricted access recreation zone or a broadacre zone	50	40
F	Land (other than city, town or group centres) in a commercial C5 zone, a TSZ2 services zone a community facility zone or a leisure and accommodation zone	Same as the noise standard for the adjoining noise zone with the loudest noise standard for the time period	
G	All other land, other than in the Central National Area (Fairburn)	45	35

Note: 1.Based on the ACT Noise Measurement Manual (**ACT, 2009**) and the Noise EPP, it is inferred that the noise levels are assessed as $L_{A10,T}$ dB(A) where T is no less than 5 minutes and no greater than 15 minutes.

In the case where noise generated within the ACT is received in NSW, the Noise EPP states:

"To the extent that noise generated in the ACT affects persons in NSW, the Act should be administered so as to deliver equivalent protection to residents of both jurisdictions..."

"While NSW residents and businesses are not subject to ACT legislation as far as their noise generating activities are concerned, they may be affected by noise originating from the ACT. To provide them with protection from ACT noise, Schedule 2 of the Regulation establishes noise zones in NSW which are

equivalent to those in the ACT and enables NSW residents to be recognised as an 'affected person' under ACT legislation."

The equivalent land uses are presented in **Table 10-9**.

Table 10-9: Equivalent ACT and NSW Land Use for Noise Assessment Purposes

ACT Noise Zone	ACT Land	Equivalent NSW Land
A	Land in an industrial zone	Land in the Queanbeyan city industrial zone
B	Land in the city centre and town centres	Land in the Queanbeyan business zone
F	Land (other than city, town or group centres) in a commercial C5 zone, a TSZ2 services zone a community facility zone or a leisure and accommodation zone	Land in the Queanbeyan special uses zone
G	All other land, other than in the Central National Area (Fairburn)	All other NSW Land

Appendix F NOISE REDUCTION USING BUILDING LAYOUTS AND ORIENTATIONS

The following figures provide examples of building placement, orientation and internal layouts that can assist in protection the acoustic amenity of sensitive areas. These figures are sourced from the DoP *Interim Guideline for Developments near rail corridors and busy roads* (DoP, 2008) with additional contextual information added.

The design principles can be applied to road traffic, rail and industrial noise sources.

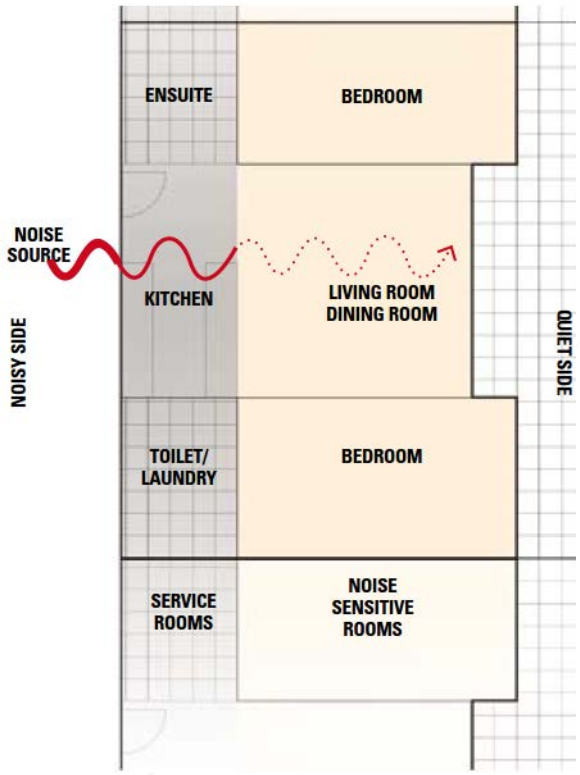


Figure 10-2: Internal Layout Placing Sensitive Areas of Quiet Side

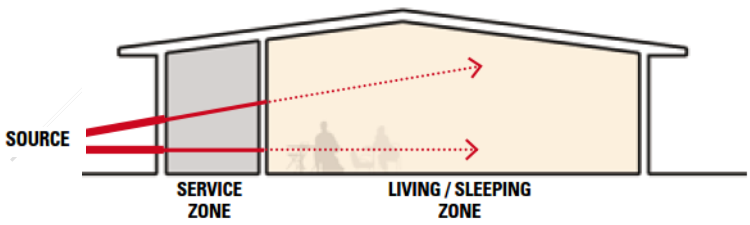


Figure 10-3: Single Storey Dwelling - Internal Layout Placing Sensitive Areas on Quiet SIde

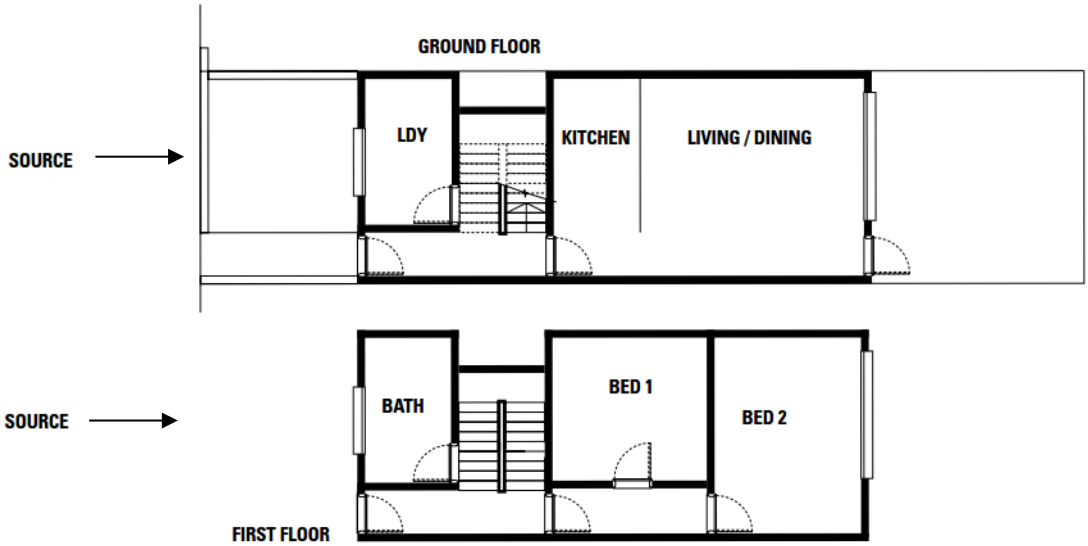


Figure 10-4: Double Storey House with Noise Sensitive Areas Located on Quiet Side

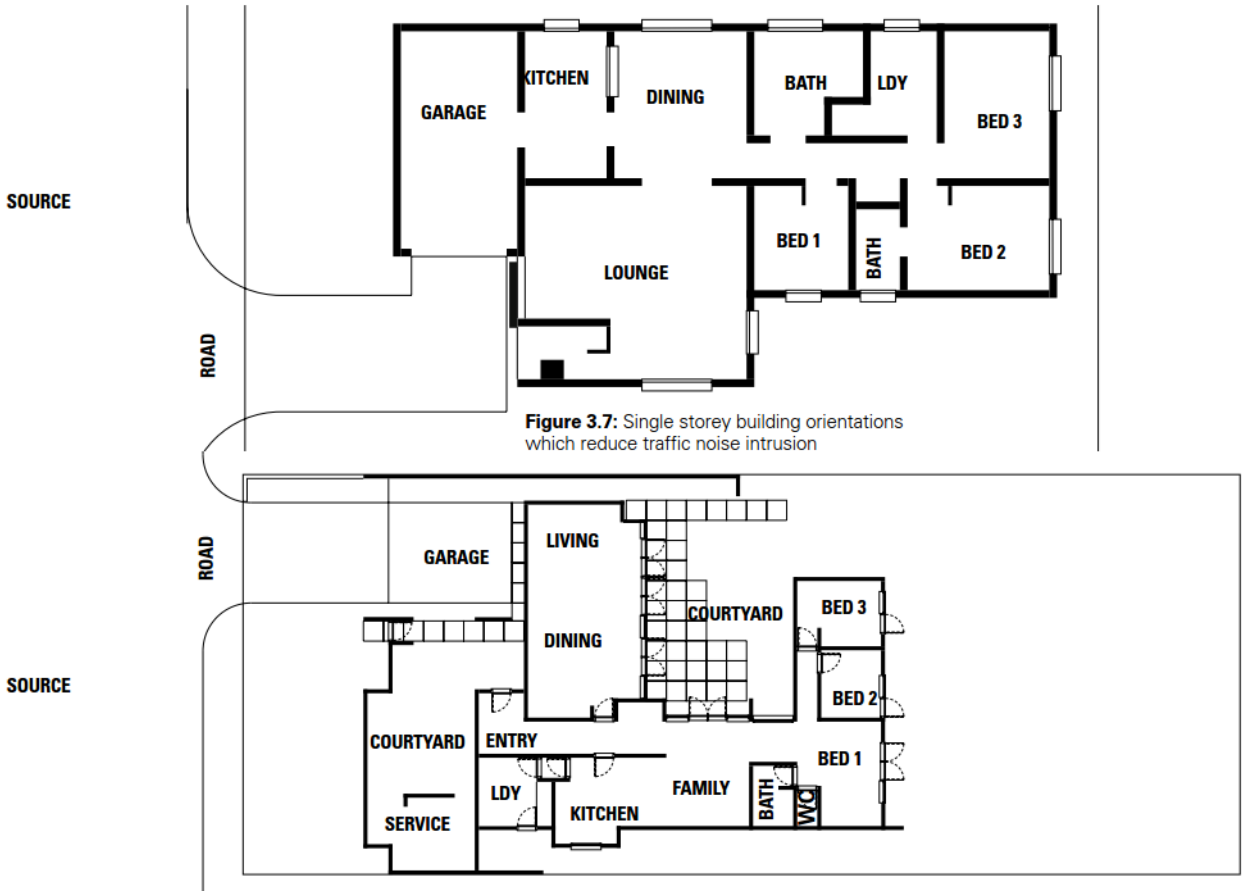


Figure 10-5: Single Storey Building Orientations and Internal Layouts

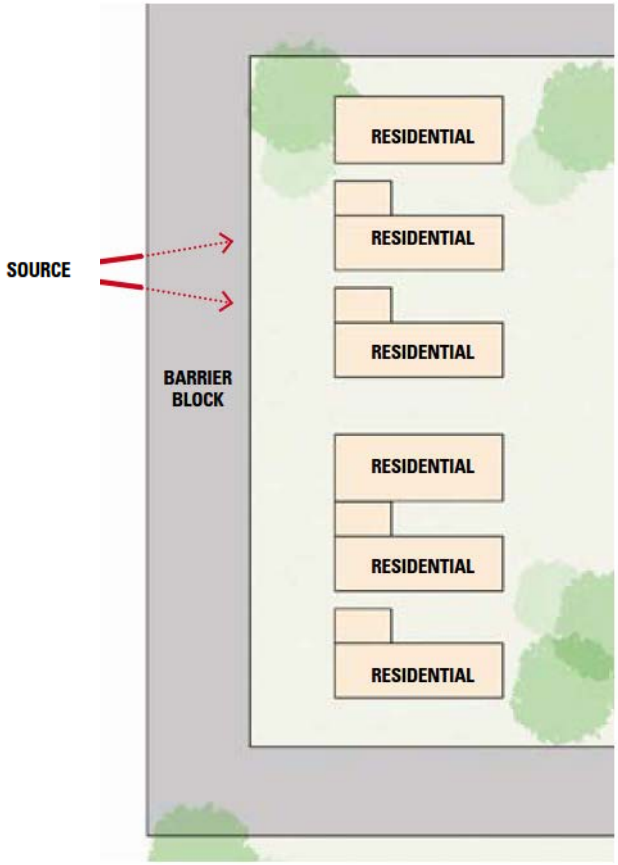


Figure 10-6: Example of Building Blocks as Noise Barriers

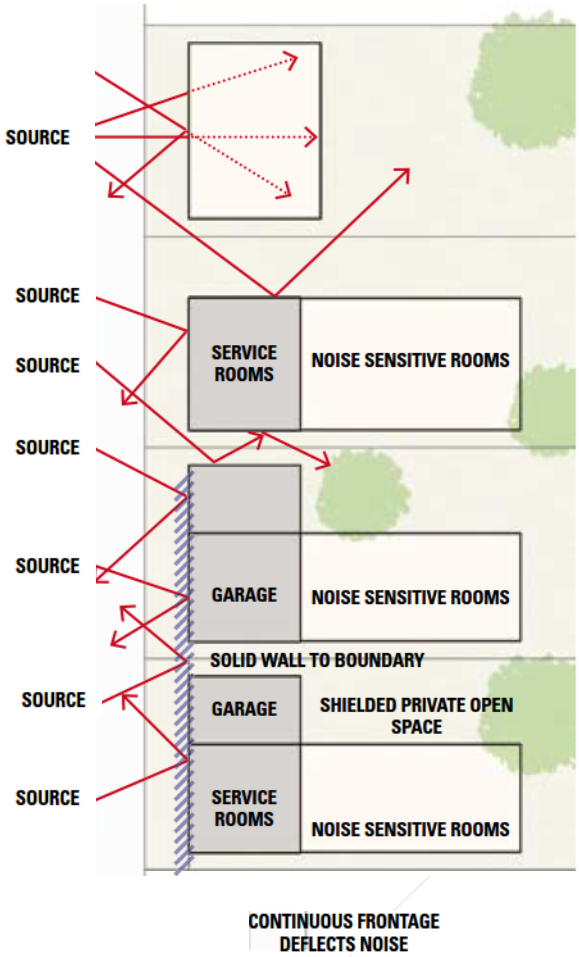


Figure 10-7: Example of Continuous Building Frontage as Noise Barrier to Reduce External Noise Levels at Rear of Properties

Appendix G RAIL NOISE AND VIBRATION GUIDANCE

G.1 RAIL NOISE

The RING sets out noise trigger levels for rail bound vehicles to limit noise impacts on sensitive land uses such as residences, schools or childcare, hospitals and places of worship. The guideline sets trigger levels for both L_{eq} and L_{max} descriptors to account for different noise emission characteristics of rail vehicles and their potential impact on residential land uses. For other sensitive uses, trigger levels are expressed in the L_{eq} descriptor. Where trigger levels are exceeded, mitigation measures should be designed to reduce impacts to within acceptable levels. Different noise level limits are set depending on the circumstances of the rail line. In this case the reinstated rail line would be assessed as a redeveloped rail line.

The guideline considers rail noise for developments or land uses that are not immediately adjacent or in an existing rail corridor.

Where developments are proposed in or near existing rail corridors, the Clause 87 of ISEPP states that for sensitive land use (residential dwelling, school or childcare centre, place of public worship or hospital), the noise and vibration impacts must be considered prior to approval being issued. For residential uses the ISEPP sets out noise level criteria during the day and night and for all other sensitive land uses, it states that it must be assessed to any guideline issued by the Department of Planning.

The NSW produced *Development near busy roads and rail corridors – Interim Guideline* (**NSW DoP, 2008**) to provide a consistent assessment method for sensitive land uses. The guideline sets out screening assessment procedures to determine if further detailed assessment is required to determine impacts.

For rail noise, a full acoustic assessment is required where development is proposed within specified offset distances to the rail corridor. **Table 10-10** provides a summary of the ISEPP assessment requirements.

Table 10-10: ISEPP Rail Noise Assessment Requirements

Type of Service	Speed	Offset from Rail Line (m)	
		Full Acoustic Assessment Required	Standard Mitigation Measures Required
Passenger	<80km/h	≤10	10>d≤60
Passenger	≥80km/h	≤25	25>d≤60
Passenger and Freight	<80km/h	≤25	25>d≤60
Passenger and Freight	≥80km/h	≤40	40>d≤80

Table 10-11 presents a summary of the different rail noise criteria applicable to the site.

Table 10-11: Summary of Rail Noise Assessment Criteria

Area of Site	Applicable Document	Land Use	Time of Day[1]	Noise Criteria[2] dB(A)
Adjacent to Rail Corridor	ISEPP	Residential (internal -sleeping areas)	Night	L_{eq} 35
		Residential (internal – all other habitable areas)	anytime	L_{eq} 40
		Educational Institutes (internal - including child care centres)	When in use	L_{eq} 40
		Places of Worship (internal)	When is use	L_{eq} 40
		Hospitals (internal -wards)	Anytime	L_{eq} 35
		Hospitals (internal - other noise sensitive areas)	Anytime	L_{eq} 40
All other areas	RING	Residential (external)	Day	L_{eq} 65 L_{max} 85
			Night	L_{eq} 60 L_{max} 85
		Schools, educational institutions and child care centres (internal)	When in use	$L_{eq,1hr}$ 45
		Places of worship	When in use	$L_{eq,1hr}$ 45
		Hospitals (internal -wards)	When in use	$L_{eq,1hr}$ 40
		Hospitals (internal – other uses)	When in use	$L_{eq,1hr}$ 65
		Open space (external - passive use, e.g. parkland, bush reserves)	When in use	L_{eq}65
		Open space (external - active use , .g. sports field, golf course)	When in use	L_{eq}65

Note: 1.Day is defined as 7.00am to 10.00pm and night as 10.00pm to 7.00am.
2. Noise levels are calculated for Day (7.00am to 10.00pm) $L_{eq,15hr}$ dB(A) and Night (10.00pm to 7.00am) $L_{eq,9hr}$ dB(A) unless otherwise stated. Fast time weighting is applicable to L_{eq} and L_{max} noise levels.

G.2 RAIL VIBRATION

Rail vibration is addressed in the ISEPP and RING which specify the guideline *Assessing Vibrating a Technical Guideline* as the applicable technical assessment guideline. Vibration impacts can be considered in terms of human comfort and building damage. Human comfort criteria assess the potential for annoyance to occur as a result of perceptible vibration. Building damage criteria assess the potential for superficial damage to occur in structures.

The ISEPP requires a detailed vibration assessment to be conducted for residential developments within 25m of a rail line where hard ground is present and for all other vibration sensitive buildings within 60m.

Train vibration is considered an intermittent source. The vibration guideline specifies the basis for assessment of intermittent vibration on humans is using the vibration dose value (VDV). The VDV provides a descriptor for a dose value of vibration accumulation over a day or night period which is time and frequency weighted to reflect dose response relationships in humans for intermittent vibration. The VDV is described in *British Standard BS 6472 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting*. **Table 10-12** provides a summary of the VDV criteria.

Table 10-12: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime[1]		Night Time[1]	
	Preferred Value	Maximum Values	Preferred Value	Maximum Value
Critical areas [2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1 Daytime is 7.00am to 10.00pm and night time is 10.00pm to 7.00am.

2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source BS 6472-1992.

For building damage, Australian Standard *AS 2187: Part 2-2006 Explosives – Storage and Use – Part 2: Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in *BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2* as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS 7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 10-13**. Rail vibration for the assessment of potential building damage can be considered as a transient source.

Table 10-13: Transient Vibration Guide Values for Minimum Risk of Cosmetic Damage

Type of Building	Peak Component particle velocity in frequency range of predominant pulse 4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures, Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	N/A
Unreinforced or light framed structures, Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard states that the guide values in **Table 10-13** relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

The British Standard goes on to state that "Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.