Appendix E. Noise and Vibration Impact Assessment

Vales Point Solar Project

Sunset Power International (trading as Delta Electricity)

Noise and vibration impact assessment

IA155900_04 | Final

3 November 2017

Vales Point Solar Project

Project No:	IA155900
Document Title:	Noise and vibration impact assessment
Document No.:	IA155900_04
Revision:	Final
Date:	3 November 2017
Client Name:	Sunset Power International (trading as Delta Electricity)
Client No:	Client Reference
Project Manager:	Thomas Muddle
Author:	Raymond Sim
File Name:	J:\IE\Projects\04_Eastern\IA155900\21 Deliverables\Acoustics\Reporting\IA155900_NIA_RPT1_RevD_Final.docx

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 7, 177 Pacific Highway
North Sydney NSW 2060 Australia
PO Box 632 North Sydney
NSW 2059 Australia
T +61 2 9928 2100
F +61 2 9928 2500
www.jacobs.com

Document history and status

Revision	Date	Description	By	Review	Approved
0	18/09/2017	Draft for Client review	R Sim	B Ison	08/09/2017
1	03/11/2017	Final	B Ison	R Sim	03/11/2017

Contents

Executive Summary

Jacobs Group (Australia) Pty Ltd was engaged by Sunset Power International Pty Ltd (Trading as Delta Electricity) (Delta) to assess the noise impacts from the construction and operation of the proposed Vales Point Solar facility and investigate appropriate noise control options to ensure impacts are in compliance with relevant noise goals.

The proposal is to develop a large scale solar photovoltaic generation facility and associated infrastructure near the existing Vales Point Power Station in the local government areas of Lake Macquarie and the Central Coast.

Background noise monitoring was undertaken at two locations near the project site. The first monitoring location is at the south east corner of the ash dam site, near the intersection of Ruttleys Road and Pacific Highway. This site was selected to characterise the background noise environment at properties affected by Pacific Highway traffic noise. The second monitoring location was conducted at the north western boundary of the ash dam, adjacent to Summerhayes Road.

Construction activities associated with the proposed Vales Point Solar facility will only be undertaken during standard daytime period. The construction noise impacts at residential receivers in Noise Catchment Areas 1, 3, 4 and 5 are predicted to be within the project noise management levels. However, construction noise impacts at residential receivers in Noise Catchment Area 2, on Summerhayes Road, are predicted to exceed the project noise management level.

Construction road traffic impacts are not expected to result in an increase in ambient road traffic noise influence within the surrounding environment. Construction vibration impacts are considered unlikely to exceed structural and human annoyance vibration limits due to the intervening distances between the project site and surrounding receivers.

Based on the predicted noise levels, the surrounding receivers are unlikely to be highly noise affected. Standard noise mitigation measures have been recommended for implementation where feasible and reasonable. Mitigation measures will minimise impacts at the surrounding residential receivers. However, it is unlikely that implementation of all feasible and reasonable noise mitigation measures would reduce noise levels to below the construction noise criteria under all circumstances.

Predicted noise levels during normal operation of the solar facility show that that there will be minimal noise impacts on receivers in NCAs 1, 3, 4 and 5. In fact, at all surrounding receptors in NCAs 1, 3, 4 and 5, noise from the solar facility will be within the Industrial Noise Policy daytime and evening criteria.

Unmitigated operational noise impacts are predicted to comply with the INP daytime and evening noise criteria at most receivers in NCA 2 except for three residences, 305 Summerhayes Road and 325 Summerhayes Road. Exceedances of up to 5dB(A) at the worst impacted property were identified during adverse whether conditions should a single axis tracking system be selected with noise levels considered able to be readily mitigated to achieve noise criteria.

1. Introduction

1.1 The Proposal

Sunset Power International Pty Ltd trading as Delta Electricity (Delta) are seeking to develop a large scale solar photovoltaic generation facility and associated infrastructure in the local government areas (LGA) of Lake Macquarie and the Central Coast (the project). The project would be located within the land holding of the existing Vales Point Power Station and specifically on the rehabilitated area of the Vales Point Ash Dam (VPAD) The project is a State significant development (SSD) under the *State Environmental Planning Policy (State and Regional Development) 2011*. As a SSD, an application for the project is required to be submitted under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979*. The NSW Minister for Planning (or the Minister's delegate) is the consent authority.

The project area covers approximately 80 hectares (Ha) of land. Key components of the project are:

- Construction and operation of up to 55 megawatt (MW) capacity solar facility delivering an annual output of approximately 110 gigawatt hours (GWh);
- Installation of approximately 220,000 solar panel modules supported by either steel piles or concrete ballasted footings;
- Installation of ancillary electrical control equipment and switchyard for distribution;
- Connection to the National Electricity Market (NEM) via a short 33 kV transmission line (mainly overhead with some underground cabling) to the Vales Point Zone Substation;
- Approximately 100 full time equivalent (FTE) jobs during a 12 to 18 month construction program; and
- An estimated 30 year design life with ongoing employment for up to five people.

1.2 Locality

The project is to be located on existing rehabilitated areas of the Vales Point Ash Dam (VPAD) associated with the operation of the Vales Point Power Station as shown in Figure 1.1. The Ash Dam extends across the LGA boundary of Lake Macquarie and Central Coast. The project site is entirely within the existing property boundary of the Vales Point Power Station. The proposed project would connect to the existing Ausgrid substation located on the corner of Ruttleys Road and Construction Road to the north of the ash dam site.

The Vales Point coal fired power station and Vales Point Ash Dam (VPAD) are located at the southern end of Lake Macquarie on the NSW Central Coast. The station is owned and operated by Delta and has an installed capacity of 1320 MW. The VPAD consists of a series of operational and closed landfill cells. The closed cells, or ponds, have been capped with soil and rehabilitated with grasses. The rehabilitated area is relatively flat and provides a substantial area for the construction of a utility scale solar field.

The VPAD is located in the southern section of the Vales Point Power Station property. The proposed project will be sited on the rehabilitated areas of the VPAD situated west of the Pacific Highway with a northern boundary at Ruttleys Road. To the east of the site is Mannering Bay which is a natural water body that flows into Lake Macquarie. The southern boundary of the VPAD is Wyee Road, at Doyalson.

Figure 1.1 | Site location

1.3 Scope and Objectives

The purpose of this report is to provide a Noise and Vibration Impact assessment for the Vales Point Solar Project that addresses the Secretaries Environmental Assessment Requirements for the EIS which includes:

> *The EIS must address the following specific issues: Noise – including an assessment of the construction noise impacts of the development in accordance with the Interim Construction Noise Guideline (ICNG) and operational noise impacts in accordance with the NSW Industrial Noise Policy (INP), and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria;*

The objectives of this study were to:

1) Establish noise level design goals (criteria) for environmental noise emissions at potentially noise affected sensitive receivers surrounding the site;
2) Determine all acoustically significant plant required for the construction and operation of the facility to predicted noise at the nearest potentially affected noise sensitive receivers within the vicinity of the solar facility; and
3) From results of the noise predictions, assess noise levels from proposed construction and future operations relative to the noise criteria at the nearest potentially affected receivers.

Specific acoustic Terminology is used within this report. An explanation of common terms is included in Appendix A.

1.4 Relevant guidelines

The noise and vibration guidelines for construction and operations are based on the publications managed by the New South Wales (NSW) Environment Protection Authority (EPA). The EPA guidelines applicable to this assessment include:

- Construction Noise – Interim Construction Noise Guideline (DECC 2009); and
- Operational Noise – Industrial Noise Policy (OEH 2000).

1.5 Proposed infrastructure for solar facility

A description of the likely infrastructure required for the operation of the solar facility is provided in the Environmental Impact Statement (EIS) document prepared by Jacobs.

The key infrastructure components of the proposal include:

- Approximately 220,000 solar panels (photovoltaic) modules;
- Subject to selected technology, approximately 1,392 Single-axis tracking panel motors;
- Up to 12 power conversion stations (PCS) consisting of integrated inverters/transformer units dispersed throughout the solar development footprint; and
- 600 meter, above ground 33kV feed to the existing 33kV Vales Point Substation crossing under Ruttleys Road using existing pipeline culvert due to existing overhead lines in the vicinity.

1.6 Construction

Construction of the proposed solar facility would potentially be completed in the following steps:

- Pre-construction and site investigations, such as geotechnical assessment to inform how the panels are mounted and secured;
- Detailed design and procurement of materials;
- Site establishment and preparation for construction, including fencing, earthworks, set out and construction of access roads and sediment and erosion controls;

- Delivery of materials and equipment;
- Installation of the foundations or driven piles;
- Installation of underground cabling;
- Assembly of the panel frames and mounts;
- Installation of the Inverter / transformer units;
- Installation of 33 kV transmission line;
- Substation works to connect the solar facility to the existing substation;
- Testing and commissioning of the solar facility; and
- Removal of temporary construction facilities and completion of restoration works.

2. Existing noise environment

A baseline survey of existing ambient noise levels has been undertaken in the study area to determine existing levels of background noise to characterise the noise environment at the project site.

2.1 Noise monitoring locations

Noise monitoring locations were selected to be representative of the noise environments affecting residential properties near the ash dam. These noise affecting residential properties were assigned to Noise Catchment Areas (NCAs) based on location and expected noise catchment characteristics. The 2 noise monitoring locations and NCAs are detailed below and indicated in Figure 2.1:

1. Logger location 1 – at the south east corner of the ash dam site, near the intersection of Ruttleys Road and Pacific Highway. This site was selected to characterise the background noise environment at properties affected by Pacific Highway traffic noise; and

2. Logger location 2 – at the north western boundary of the ash dam, adjacent to Summerhayes Road.

2.2 Noise monitoring methodology

In order to characterise the existing acoustical environment of the area unattended noise monitoring were conducted between the dates of Friday 28 June and Saturday 5 August 2017.

Logger locations were selected with consideration to other noise sources which may influence readings and security issues for noise monitoring equipment.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10}, L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary for definitions in Appendix A).

Operator attended noise measurements were carried out during the day time period on Tuesday 30 May 2017, during satisfactory meteorological conditions of wind speeds less than 5 metres per second and nil precipitation. Attended monitoring was undertaken at the logger locations detailed in Section 2.4. Attended measurements of ambient noise were completed during the noise logging survey to determine the various noise sources that influence the existing noise environment. During each attended measurement the observer noted the various noise sources and the contributing noise level.

2.3 Instrumentation

Long-term unattended noise monitoring was carried out using two Acoustic Research Labs Environmental Noise Loggers, Type NGARA (serial numbers 8780BA and 8780BD), fitted with microphone windshields. Calibration of the loggers was checked prior to and following measurements using a B&K Calibrator. Drift in calibration did not exceed 0.5 dB(A), satisfactory for ambient noise measurements.

Instrument sets were calibrated by a NATA accredited laboratory and comply with Australian Standard AS-1259: *Sound Level Meters*.

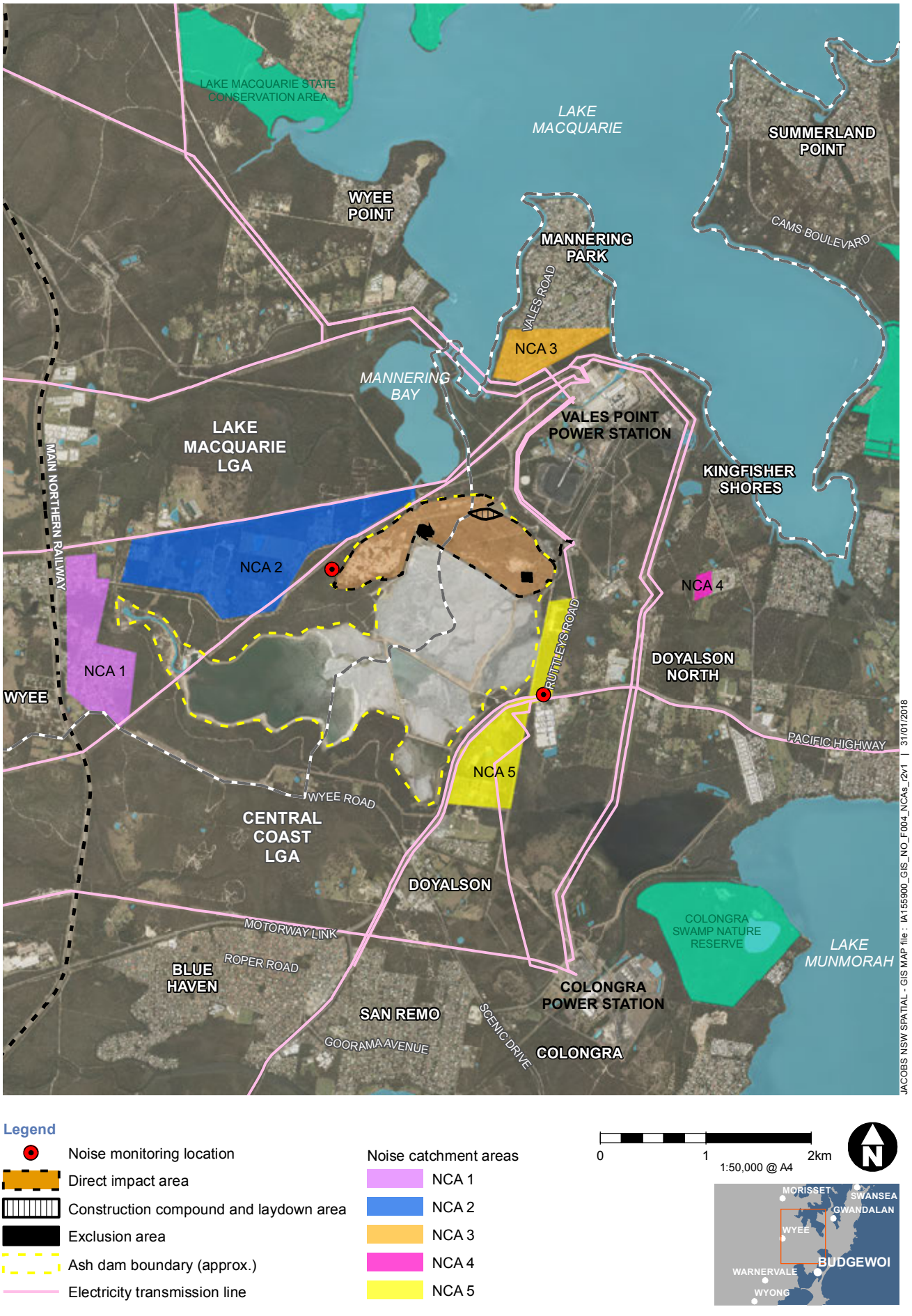


Figure 2.1 | Noise monitoring locations and noise catchment areas

2.4 Operator attended noise measurement results

The results of the attended background noise monitoring at the noise logger locations undertaken on 28 June 2017 are presented in Table 2.1.

Table 2.1 : Attended measured noise levels

Location	Date / time	Measured noise levels – dB(A)			Comment
		L_{Aeq}	L_{A90}	L_{Amax}	
Logger location 1 Ruttleys Road	28/06/2017 9:30am	57.6	53.2	69.4	Pacific Highway traffic: 55 - 70 dB(A) Ruttleys Road traffic: 50 - 60 dB(A) Birds: 60-70 dB(A) Dozer operations at the ash dam: 35 - 40 dB(A) Pacific Highway and heavy vehicles on Ruttleys Road were the dominant noise sources at this location.
Logger location 2 Summerhayes Road	28/06/2017 10:00am	39.0	37.3	48.1	Distant traffic (Pacific Highway / Wyee Road): 35-38 dB(A) Birds: 40 - 50 dB(A) Construction noise (off site): 35 - 45 dB(A) Distant traffic noise was the dominant noise source at this location and was a continuous noise throughout the measurement

The measured attended noise levels presented in Table 2.1 are consistent with the results of the unattended noise monitoring.

2.5 Unattended noise monitoring results

A summary of the unattended continuous noise monitoring, performed during the INP defined time periods is presented in Table 2.2. Detailed results at the monitoring location are presented in graphical format in Appendix B. The graphs show measured values of L_{A1}, L_{A10}, L_{A90} and L_{Aeq} for each 15-minute monitoring period.

Table 2.2 : Unattended noise monitoring results

Location	Measurement descriptor	Measured Noise Level – dB(A) re 20 µPa		
		Daytime 7.00 am - 6.00 pm	Evening 6.00 pm - 10.00 pm	Night-time 10.00 pm - 7.00 am
Logger location 1 Ruttleys Road	L_{Aeq}	59.5	57.4	55.1
	RBL (Background)	51.6	47.7	32.4
Logger location 1 Summerhayes Road	L_{Aeq}	43.8	37.7	37.1
	RBL (Background)	33.0	32.2	29.5

Notes: *All values expressed as dB(A) and rounded to nearest 1 dB(A);*

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

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

At logger location 1, the measured long term noise levels of 52 dB(A) L_{A90} daytime, 48 dB(A) L_{A90} evening and 32 dB(A) L_{A90} night-time are considered representative of the existing background noise levels at residential properties located along the Pacific Highway. Analysis of the audio recording shows that daytime noise levels are dominated by traffic noise, however traffic numbers drop substantially during evening and night time hours, when the noise environment is dominated by distant traffic and the power station.

At logger location 2, the noise environment is primarily influenced by continuous distant traffic noise and a low constant “humming” noise from the power station. The measured long term noise levels of 33 dB(A) L_{A90} daytime, 32 dB(A) L_{A90} evening and 30 dB(A) L_{A90} night-time show a very quiet suburban location generally unaffected by local noise sources.

3. Effects of meteorology on noise levels

3.1 Wind effects

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the noise source. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. Where the source to receiver wind component at speeds of up to 3 m/s occur for 30% or more of the time in any seasonal period (during the day, evening or night), then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

The INP Section 5.3 Wind Effects states:

> *"Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source to receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 percent of the time or more in any assessment period in any season."*

An analysis of wind speed and direction has not been undertaken as part of this study. However, noise from the Vales Point Solar Facility has been assessed using both calm and enhanced 2 m/s winds (from the source to all receptors).

3.2 Temperature inversions effect

The NSW INP states that temperature inversions need only be considered for the night-time noise assessment period (10.00 pm to 7.00 am).

The INP states:

> *"Temperature inversions occur during E, F and G stability categories. These three categories are considered to represent weak, moderate and strong inversions respectively. For noise-assessment purposes, only moderate and strong inversions are considered significant enough to require assessment."*

> *"In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. Class F relates to stable conditions, such as those that occur when the sky is clear, the winds are light and an inversion is present. The intermediate classes B, C, D and E relate to intermediate dispersion conditions. A seventh class, G, has also been defined to accommodate extremely stable conditions such as might be found in arid rural areas."*

An analysis of the occurrence of each stability class has not been conducted. However, to provide for a conservative 'worst case' assessment, noise modelling of day and evening operations at the solar facility allows for a temperature inversion (i.e. Pasquil Stability Category F – see Table 5) or alternatively strong winds from the source to the receptor.

With regard to construction noise impacts, as all construction works will be undertaken during the day period (when the likelihood of temperature inversions is significantly reduced), construction noise from the facility has only been modelled under Pasquil Stability Category C (i.e. intermediate dispersion conditions).

4. Noise objectives

4.1 Construction noise objectives

The following sections detail the applicable site specific construction noise objectives based on the NSW Environment Protection Authority's *Interim Construction Noise Guideline*.

Due to the intervening distances between the project site and the surrounding receivers, vibration from construction activities is considered to not have any impacts on surrounding receivers. Therefore, construction vibration is not assessed in this report.

4.1.1 Recommended standard construction hours

The *Interim Construction Noise Guideline* (ICNG, 2009) provides guidance for the assessment of construction noise. It establishes noise management levels according to the hours in which construction may take place. The ICNG recommended standard hours for construction are:

- Monday to Friday: 7 am to 6 pm;
- Saturday: 8 am to 1 pm; and
- No work on Sundays or Public Holidays

The ICNG acknowledges that the following activities could be undertaken outside the recommended standard construction hours, assuming all feasible and reasonable mitigation measures are implemented to minimise the impacts to any surrounding sensitive land uses:

- The delivery of oversized plant or structures that police or other authorities determine requires special arrangements to transport along public roads;
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm;
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours;
- Public infrastructure works that shorten the length of the proposal and are supported by the affected community;
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours; and
- Works which maintain noise levels at receivers to below the noise management levels outside of the recommended standard construction hours.

Outside of standard construction hours is also addressed by the ICNG with a strong justification required and a lower noise management level compared with standard hours.

4.1.2 Construction noise management levels

The ICNG states that the potential for construction noise impacts can be assessed by comparing the predicted noise at the assessment locations with the noise management levels provided by the ICNG. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the noise management levels.

Table 4.1 details the ICNG construction noise management levels for residential receivers including for works outside of standard hours.

Table 4.1 : Construction noise management level at residential receivers

Time of day	Management level $L_{Aeq(15min)}$	How to apply
Recommended standard hours (SH): Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected Rating Background Level (RBL) + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOH) - All other times including Public Holidays	Noise affected Rating Background Level (RBL) + 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Table 4.2 details the construction noise management levels for non-residential land uses. No separate criteria for out-of-hours construction works is provided for non-residential sensitive receivers as it is assumed that the buildings would be vacated during the evening and night time.

Table 4.2 : Construction noise management level at non-residential sensitive land use

Land use	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level – 45 dB(A)
Hospital wards and operating theatres	Internal noise level – 45 dB(A)
Place of worship	Internal noise level – 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level – 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level – 60 dB(A)
Industrial premises	External noise level – 75 dB(A)
Offices, retail outlets	External noise level – 70 dB(A)

Source: ICNG 2009

Noise sensitive non-residential receivers including educational, medical and places of worship are located within the study area. Internal criteria of 45 dB(A) $L_{Aeq(15\text{-}minute)}$ apply for these receiver types. However, as the building envelopes of these receivers is not known, an external to internal correction of 10 dB has been adopted to provide an external construction noise criterion of 55 dB(A) $L_{Aeq(15\text{-}minute)}$. This level is generally accepted as typical of a standard building façade with windows open.

4.1.3 Project specific construction noise management levels

Based on Table 4.1 and Table 4.2, the project specific noise management levels for construction activities at surrounding receivers are presented in Table 4.3 below. It is understood that construction activities of the proposed solar facility will only be conducted during standard daytime hours, the noise management levels specified below are of the ICNG recommended standard hours only.

Table 4.3 : Project specific noise mangement levels

Receiver	ICNG standard hours Noise management level, L_{Aeq} - dB(A)	Highly affected noise management level, L_{Aeq} - dB(A)
Residential receivers north of project NCAs 1, 2 and 3	47	75
Residential receivers south of project NCAs 4 and 5	63	75
Place of worship, classrooms at school and other educational institutions	45 Internal (or 55 external)	n/a
All industrial premises	70	n/a
All offices and retail outlets	65	n/a

4.2 Construction traffic noise objectives

Application notes for the *NSW Road Noise Policy* (RNP), (DECCW, 2011) state the following (http://www.epa.nsw.gov.au/noise/roadnoiseappnotes.htm):

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

The Roads and Maritime Services (RMS) *Construction Noise and Vibration Guideline* (CNVG) notes that this guidance also applies to traffic noise associated with construction activities.

4.3 Operational noise criteria

The noise limits for the operational noise emissions from the proposed Vales Point Solar Facility are derived from the EPA's *NSW Industrial Noise Policy* (INP). The INP provides criteria for the assessment of noise impacts associated with industrial activities. It aims to balance the need for industrial activity with the desire for a quiet environment within the community.

The noise emission from any industrial activity should be controlled to avoid impacting upon the acoustic amenity of nearby receivers. Responsibility for the control of noise emission in New South Wales is vested in Local Government and the EPA.

The EPA oversees the INP, released in January 2000 which provides a framework and process for deriving noise criteria. The INP criteria for industrial noise sources (e.g. mechanical plant) have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short-term; and
- Maintaining noise level amenity for particular land uses for residents and sensitive receivers in other land uses.

4.3.1 Assessing Intrusiveness

For assessing intrusiveness, the background noise generally needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) over any 15-minute period, of the source should not be more than 5 dB(A) above the measured Rated Background Level (RBL).

4.3.2 Assessing Amenity

The amenity criterion is based on land use and associated activities (and their sensitivity to noise emission). The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. The criteria relate only to other industrial-type noise sources and do not include road, rail or community noise. The existing noise level from industry is to be measured, and if it approaches the criterion, then noise levels from new industrial-type noise sources (including air-conditioning plant) need to be designed so that the cumulative effect does not produce total noise levels that would significantly exceed the criterion. For areas of high road traffic, there are further considerations that influence the selection of the noise criterion.

4.3.3 Area Classification

The INP classifies the noise environment of the subject area as “Suburban”. The INP characterises the “Suburban” noise environment as an area that:

- Has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry;
- Decreasing noise levels in the evening period (1800-2200); and
- Evening ambient noise levels defined by the natural environment and infrequent human activity.

4.3.4 Project Specific Criteria

Having defined the area type, the processed results of the unattended noise monitoring have been used to generate project specific noise criteria in accordance with INP principles. The project specific noise levels are the most stringent of the Intrusive and Amenity criteria and are shown in bold in Table 4.4 below.

Table 4.4 : INP criteria for operational noise emissions to sensitive receivers

Receiver	Time of day	Noise Level dB(A) re 20 µPa				
		ANL[1] (period)	Measured RBL $L_{A90(15min)}$[2]	Measured $L_{Aeq(15min)}$	INP criteria	
					Intrusive Measured RBL + 5 dB(A) $L_{Aeq(15min)}$	Amenity $L_{Aeq(period)}$[3]
Residential receivers north of project - NCAs 1, 2 and 3	Day	55	33	44	**38**	55
	Evening	45	32	38	**37**	45
	Night	40	30	37	**35**	40
Residential receivers south of project - NCAs 4 and 5	Day	55	52	60	57	**55**
	Evening	45	48	57	52	**45**
	Night	40	32	55	**37**	40
Industrial receivers - NCA5	When in use	-	-	-	**-**	**70**

Note 1: ANL Acceptable Noise Level for a suburban area

Note 2: RBL Rating Background Level

Note 3: Assuming existing noise levels unlikely to decrease

The facility will be operational for 24 hours, 7 days a week. Conservative noise objectives, assessed at the nearest residential receivers to the project have been established to be:

- Residential receivers north of the project (NCAs 1, 2 and 3) – **38 dB(A) $L_{Aeq,15min}$** daytime, **37 dB(A) $L_{Aeq,15min}$** evening and **35 dB(A) $L_{Aeq,15min}$** night time.
- Residential receivers south of the project (NCAs 4 and 5) – **55 dB(A) $L_{Aeq,15min}$** daytime, **45 dB(A) $L_{Aeq,15min}$** evening and **37 dB(A) $L_{Aeq,15min}$** night time.

4.4 Sleep disturbance criteria

As the construction works will only be undertaken during the day period there will be no sleep disturbance or night time noise impacts as a result of these works.

Similarly, during normal operation of the solar facility there will be minimal noise impacts during the night period as the associated infrastructure will be under minimum / no load. Consequently, noise from the solar facility has not been assessed to sleep disturbance and night time noise criteria.

5. Construction noise assessment

This section details the assessment of the construction impacts from the proposed Vales Point Solar Facility. Construction noise impacts predicted at nearest residential receivers have been assessed against the adopted NSW ICNG noise management levels.

5.1 Construction noise impact

5.1.1 Construction stages

To assess the potential noise and vibration impacts during construction, a number of scenarios comprising typical plant and equipment have been developed based on the indicative staging information as outline in the SEE document and repeated in Section 2.4. These are summarised in Table 11.

It is understood that all construction works are proposed to be undertaken during standard daytime periods (7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturdays).

Table 5.1 : Construction stages and equipment sound power levels

Stage	Scenario	Equipment	No. of plant in 15 min period	Individual equipment maximum LAeq sound power level – dB(A)
1	Site preparation, clearing & demolition	Excavator	2	107
		Bulldozer 28 tonne	1	107
		Chainsaw	2	117[1,2]
		Tree mulcher	1	115
		Light vehicle	2	94
		Dump truck	1	106
2	Establish site compound, access roads & delivery of materials	Hand tools	2	94
		Excavator	2	107
		Light vehicle	3	94
		Delivery trucks / semi-trailers	3	100[2]
		Bulldozer 28 tonne	1	107
		DPU / plate compactor	2	103
		Grader	1	107
		Roller 18 tonne	1	102
		Asphalt paver & tipper lorry	1	108
		Bobcat	1	104
		Telehandler	2	105
		Mobile crane	1	106
3	Installation of foundation	Piling rig	1	114[1,2]
		Bobcat	1	104
		Crane	2	106
		Excavator	2	107
		Concrete vibrating needle	2	103
		Concrete agitator truck (discharging)	1	103
		Concrete agitator (low to mid revs)	1	107

Stage	Scenario	Equipment	No. of plant in 15 min period	Individual equipment maximum LAeq sound power level – dB(A)
4	Installation of underground cabling	Vermeer trencher	2	105
		Cable laying trailer & tractor	2	103
		Loader	2	110
5	Assembly of panel frames, mounts & transformer units	Telehandler	2	105
		Generator	2	99
		Compressor	1	93
		Hand tools	2	94
		Ratchet gun	4	94
		Mobile crane	1	106
6	Site rehabilitation / removal of temporary construction facility	Light vehicle	2	98
		Excavator	2	106
		Bulldozer 28 tonne	1	107
		Loader	1	110
		Dump truck	2	106
		Semi-trailer	1	104

NOTE 1: Denotes "annoying" item of equipment as defined in the ICNG (i.e. contains characteristics such as impulsiveness, tonality etc.), and as such includes a +5 dB penalty adjustment to predictions.

NOTE 2: Overall SWL assumes a maximum duration of 7.5 minutes operation in any 15 minute period.

5.1.2 Construction noise assessment methodology

Prediction of construction noise impacts from the proposed Vales Point Solar facility has been undertaken through the use of the SoundPLAN noise propagation modelling software (Version 7.4).

The most significant factors in determining the level of noise received from construction activities are the receiver's distance from the project site, shielding, ground absorption and source heights. The parameters used and values adopted in the noise modelling are presented in Table 5.2 below.

Table 5.2 : Construction nosie modelling parameters

Parameter	Input data
Facade corrections	Standard façade correction +2.5 dB(A)
Buildings	· Footprints taken from aerial photography · Typical building heights have been estimated from Google Street-view and site inspections as follows: per floor 3 m, pitched roof 2.5 m · Number of floors taken from Google Street-view and site inspections
Terrain	2 metres ground contours from Ausimage.
Ground surface / absorption	The agricultural land surrounding the site has been conservatively modelled with a ground cover factor of 0.5 representative of 'mixed' ground.
Source heights	Construction plant and equipment heights are modelled to be 2 metres above ground
Sources	All equipment has been modelled as point sources and all equipment have been modelled to operate simultaneously.
Receiver heights	Ground floor receivers have been placed at an elevation of 1.5 m and first floor receivers at an elevation of 4.5 m.

Parameter	Input data
SoundPLAN module	CONCAWE industrial module
Met condition	Neutral meteorological condition has been modelled as construction activities will only be conducted during standard daytime period.

5.1.3 Predicted construction noise impacts

Table 5.3 presents the predicted noise levels associated with each stage of works along with a comparison with the relevant construction noise management level (refer Table 4.1 and Table 4.2). The assessment is limited to receivers located within the NCAs identified in Figure 2.1. Predicted noise levels have been based on continuous operation of the noise sources identified for each construction stage. Predictions are therefore considered to represent the highest potential noise impacts. The noise levels outlined in Table 5.3 and Table 5.4 would typically be short-term, lasting for the duration of the construction period when works are conducted in the vicinity of each receiver.

The results presented in Table 5.3 indicate that construction activities would be unlikely to exceed the construction noise management levels at residential receivers in NCAs 1, 3, 4 and 5, but has the potential to impact on residential receivers in NCA 2. The predicted noise levels indicate that the surrounding residences would not be highly noise affected by the construction activities.

Table 5.4 presents the predicted noise impacts from construction works on nearby industrial receivers in NCA 5. The predicted impacts show that the construction activities are well within the noise management levels for industrial receivers.

Table 5.3 : Predicted construction noise levels at residential receivers (standard hours only)

NCA	Predicted range of construction noise level L_{Aeq} – dB(A)	Standard hours			"Highly noise affected" L_{Aeq} – dB(A)		
		Noise management level dB(A)	Exceedance dB(A)	Compliance	Noise management level dB(A)	Exceedance dB(A)	Compliance
Stage 1 - Site preparation, clearing & demolition							
NCA 1	27-33	47	-	Yes	75	-	Yes
NCA 2	**30-67**	**47**	**Up to 20**	**No**	75	-	Yes
NCA 3	36-42	47	-	Yes	75	-	Yes
NCA 4	37-38	63	-	Yes	75	-	Yes
NCA 5	37-40	63		Yes	75	-	Yes
Stage 2 - Establish site compound, access roads & delivery of materials							
NCA 1	22-28	47	-	Yes	75	-	Yes
NCA 2	**25-62**	**47**	**Up to 15**	**No**	75	-	Yes
NCA 3	32-37	47	-	Yes	75	-	Yes
NCA 4	32-33	63	-	Yes	75	-	Yes
NCA 5	32-36	63		Yes	75	-	Yes
Stage 3 - Installation of foundation							
NCA 1	23-29	47	-	Yes	75	-	Yes
NCA 2	**26-63**	**47**	**Up to 16**	**No**	75	-	Yes
NCA 3	32-37	47	-	Yes	75	-	Yes
NCA 4	33-34	63	-	Yes	75	-	Yes
NCA 5	33-36	63		Yes	75	-	Yes
Stage 4 - Installation of underground cabling							
NCA 1	18-24	47	-	Yes	75	-	Yes
NCA 2	**22-53**	**47**	**Up to 6**	**No**	75	-	Yes

NCA	Predicted range of construction noise level L_{Aeq} – dB(A)	Standard hours			"Highly noise affected" L_{Aeq} – dB(A)		
		Noise management level dB(A)	Exceedance dB(A)	Compliance	Noise management level dB(A)	Exceedance dB(A)	Compliance
NCA 3	27-32	47	-	Yes	75	-	Yes
NCA 4	28-29	63	-	Yes	75	-	Yes
NCA 5	28-31	63		Yes	75	-	Yes
Stage 5 - Assembly of panel frames, mounts & transformer units							
NCA 1	21-27	47	-	Yes	75	-	Yes
NCA 2	**23-61**	**47**	**Up to 14**	**No**	75	-	Yes
NCA 3	30-35	47	-	Yes	75	-	Yes
NCA 4	31-32	63	-	Yes	75	-	Yes
NCA 5	31-34	63		Yes	75	-	Yes
Stage 6 - Site rehabilitation / removal of temporary construction facility							
NCA 1	21-27	47	-	Yes	75	-	Yes
NCA 2	**23-61**	**47**	**Up to 14**	**No**	75	-	Yes
NCA 3	30-35	47	-	Yes	75	-	Yes
NCA 4	31-32	63	-	Yes	75	-	Yes
NCA 5	31-34	63		Yes	75	-	Yes

Note 1: A retirement village has been identified in NCA 4 and has been assessed against the residential noise management level

Note 2: Exceedances are highlighted in bold

Table 5.4 : Predicted construction noise levels at industrial receivers (standard hours only)

NCA	Predicted range of construction noise level LAeq – dB(A)	Standard hours		
		Noise management level dB(A)	Exceedance dB(A)	Compliance
Stage 1 - Site preparation, clearing & demolition				
NCA 5	40-55	70	-	Yes
Stage 2 - Establish site compound, access roads & delivery of materials				
NCA 5	35-50	70	-	Yes
Stage 3 - Installation of foundation				
NCA 5	35-51	70	-	Yes
Stage 4 - Installation of underground cabling				
NCA 5	30-43	70	-	Yes
Stage 5 - Assembly of panel frames, mounts & transformer units				
NCA 5	33-49	70	-	Yes
Stage 6 - Site rehabilitation / removal of temporary construction facility				
NCA 5	33-49	70	-	Yes

5.2 Construction traffic noise assessment

Construction vehicle movements have the potential to generate temporary adverse noise impacts along access routes which use public roads as vehicles deliver materials to and from the proposal site.

Detailed information regarding construction-related traffic volumes and access routes was not available at the time of this assessment. Therefore, a number of assumptions have been made for the purposes of assessing construction traffic noise impacts.

It is assumed that the number of vehicle movements is estimated to be an average daily total of 25 heavy vehicles and 50 light vehicles. The peak construction traffic during single hour has been assumed to be 50% of the average daily total (i.e. 12.5 heavy vehicles and 25 light vehicles). Construction traffic is assumed to get to the site using Pacific Highway and Ruttleys Road.

As the proposed works will only be conducted during daytime period, all construction vehicle movements would take place during standard daytime construction hours. For the purposes of this assessment, an estimation of the traffic noise level increases on selected roads from construction traffic has been made. An assumption has been made that existing peak hour volumes account for 10 percent of daily traffic volumes.

Existing road traffic volumes have been sourced from the Roads and Maritime Services website and *Chain Valley Colliery Modification 2 - traffic assessment* (prepared by EMM, dated 12 May 2015). Existing traffic volumes are provided below in Table 5.5.

Table 5.5 : Assumed existing traffic volumes

Road	Daily traffic	Daytime 15 hour (7am to 10pm) [3]
Pacific Highway	20,324 (northbound 10,926 and southbound 9,398)[1]	18,292 (10% HV)
Ruttleys Road	8,507[2]	7,656 (8% HV)

NOTE 1: Daily traffic volume derived from RMS website, Traffic Volume Viewer

NOTE 2: Daily traffic volume derived from Chain Valley Colliery Modification 2 - traffic assessment (prepared by EMM, dated 12 May 2015)

NOTE 3: Daytime 15 hour traffic assumed to be 90% of daily traffic

The *Construction Road Traffic Noise Estimator component* of the RMS Construction Noise Estimator was utilised to assess potential impacts arising from construction traffic. Existing traffic inputs were added as below with volumes extracted from RMS website on Pacific Highway and Ruttleys Road, and additional traffic generated during construction was estimated based on the anticipated workforce on a per hour basis. Based on these inputs it was found that additional noise arising from construction traffic are unlikely to result in changes of more than 2 dB(A) above existing noise levels.

JACOBS

Transport Roads & Maritime Services

Construction Road Traffic Noise Estimator

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

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

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

	Day	Night
Noise criteria (residences)	60	55
Existing speed	90	90
Speed during construction	90	90

	Day (7am to 10pm)		Night (10pm to 7am)		Worst Case 1-hour Day		Worst Case 1-hour Night	
Existing traffic	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
Direction (1)	8850	983	914	102	1080	120	180	20
Direction (2)	7613	846	914	102	1080	120	180	20
Additional traffic								
Direction (1)	10	5	0	0	10	5	5	2
Direction (2)	10	5	0	0	10	5	5	2

	Day	Night
Change in noise levels (dBA)	0.0	0.0
Mitigation level (dBA)	60	55
Is the change in noise level greater than 2.0 dBA?	No	No
Require consideration of additional mitigation measures?	No	No
Mitigation distance (m)		

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

Mitigation Measures

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

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

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

Calculating noise level at the receiver

Distance to receiver (m)		
Direction (1)	35	
Direction (2)	35	
	Day	Night
Predicted noise levels (dBA) @ 1m from the façade	68.0	60.6

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

Figure 5.1 : Construction road traffic noise assessment - Pacific Highway

Transport Roads & Maritime Services

Construction Road Traffic Noise Estimator

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

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

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

	Day	Night
Noise criteria (residences)	60	55
Existing speed	80	80
Speed during construction	80	80

	Day (7am to 10pm)		Night (10pm to 7am)		Worst Case 1-hour Day		Worst Case 1-hour Night	
Existing traffic	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
Direction (1)	3704	412	383	43	1080	120	150	20
Direction (2)	3186	354	383	43	1080	120	150	20
Additional traffic								
Direction (1)	10	5	0	0	10	5	5	2
Direction (2)	10	5	0	0	10	5	5	2

	Day	Night
Change in noise levels (dBA)	0.0	0.0
Mitigation level (dBA)	60	55
Is the change in noise level greater than 2.0 dBA?	No	No
Require consideration of additional mitigation measures?	No	No
Mitigation distance (m)		

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

Mitigation Measures

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

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

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

Calculating noise level at the receiver

Distance to receiver (m)	
Direction (1)	120
Direction (2)	120

	Day	Night
Predicted noise levels (dBA) @ 1m from the façade	56.6	49.3

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

Figure 5.2 : Construction road traffic noise assessment - Ruttleys Road

5.3 Construction vibration

The major potential sources of vibration from the proposed construction activities are during pile driving/boring and the use of a vibratory roller. These vibration intensive activities will be assessed in this section. As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 5.6. The safe working distances are quoted for both “cosmetic” damage (refer British Standard BS 7385) and human comfort (refer to British Standard BS 6472). The safe working distances must be complied with at all times, unless otherwise approved by the relevant authority.

Table 5.6 : Recommended safe working distances for vibration intensive plant

Plant item	Rating/description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (EPA vibration guideline)
Vibratory roller	<50 kN (typically 1-2 t)	5 metres	15 metres to 20 metres
	<100 kN (typically 2-4 t)	6 metres	20 metres
	<200 kN (typically 4-6 t)	12 metres	40 metres
	<300 kN (typically 7-13 t)	15 metres	100 metres
	>300 kN (typically 13-18 t)	20 metres	100 metres
	>300 kN (> 18 t)	25 metres	100 metres
Vibratory pile driver	Sheet piles	2 metres to 20 metres	20 metres
Pile boring	≤ 800 mm	2 metres (nominal)	n/a

Note: Table data reproduced from RMS Construction Noise Guideline

The safe working distances presented in Table 5.6 are indicative only and will vary depending on the particular item of plant and local geotechnical conditions. They apply to typical buildings under typical geotechnical conditions.

The nearest building to the project site has been identified to be the residence at 325 Summerhayes Road. The separation distance between the proposed works and the nearest residential building is approximately 150 metres.

5.3.1 Cosmetic damage assessment

The separation distance between the proposed works and the nearest receiver is much larger than the indicated safe working distances for cosmetic damage in Table 5.6. Based on this observation, cosmetic damage is unlikely to occur during vibration intensive activities such as pile driving/boring or the use of a vibratory roller. Therefore, construction vibration is assessed to comply with the vibration criteria for cosmetic damage.

5.3.2 Human comfort vibration assessment

In relation to human comfort (response), the safe working distances in Table 5.6 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted (refer British Standard BS 6472 1).

That said, vibration is unlikely to be perceptible during vibration intensive activities due to the separation distance being larger than the safe working distances for human response in Table 5.6. Hence, construction vibration is assessed to comply with the vibration criteria for human comfort.

6. Construction noise management measures

Without mitigation, noise levels from some construction activities have been predicted to exceed the noise management levels (RBL + 10dBA) nominated in the guidelines at receivers in NCA 2. Noise levels at all surrounding residential receivers are below the highly noise affected level (< 75dBA).

This section details pre-construction and construction phase management and mitigation measures designed to reduce and control potential noise levels to where feasible to achieve the adopted noise management levels at nearest receivers. The measures recommended have been developed applying the predicted impacts, adjacent receivers and land use, duration of works and potential for works outside of standard construction hours. The management measures have been informed from guidance provided in the ICNG which promotes principles of best management practice and community notification of likely noise impacts.

It will be important for the contractor to undertake all reasonable and feasible measures to reduce noise impacts and minimise impact potential through programming works to minimise duration and liaise with affected landowners and local communities throughout the construction program. All Contractors commissioned by the client to undertaken construction works associated with the Project are recommended to adhere to all noise management and mitigation measures recommended.

6.1 Management measures

During the planning and scheduling of construction works, the predicted noise levels should be considered in establishing work site locations, construction techniques and on site practices.

Construction works should adopt Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA) practices as addressed in the ICNG. BMP includes factors discussed within this report and encouragement of a project objective to reduce noise emissions. BATEA practices involve incorporating the most advanced and affordable technology to minimise noise emissions. The following principles and proactive noise management measures are to be considered for implementation:

- Fixed and mobile construction plant and equipment shall be located to maximise separation distance from nearest noise sensitive and residential receivers.
- Construction plant shall be orientated away from nearest receivers and where feasible be located to take advantage of on-site buildings and structure with potential to impede noise propagation.
- Where practical, simultaneous operation of dominant noise generating plant shall be managed to reduce noise impacts, such as operating at different times or increasing the distance between the plant.
- Where measured construction noise levels at nearest receivers exceed the adopted ICNG construction noise management levels, acoustic screens are to be implemented where feasible during all construction works. Acoustic screens may be constructed from either a layer of 10 kg/m^2 loaded vinyl (product name Wavebar from Pyrotek Noise Control) or minimum 9 mm thick plywood hoarding. Gaps at joints of the acoustic screen are to be sealed by overlapping the loaded vinyl or plywood, or with silicon mastic on the plywood hoarding.
- Potential noise impact reduction of up to 6 dB(A) is achievable where acoustic screens are located within 5 metres of the construction works, be at least 1.8 metres in height and provide a solid facade impeding line of sight to nearest receivers – any gaps negate noise reduction performance. Where it is feasible to install 3 metres high screens, noise impact reduction of up to 10 dB(A) is achievable.
- Where possible and in compliance with occupational safety and health standards, reversing beepers on trucks would be replaced with low pitch non-tonal beepers (quackers). Alternatives to reversing beepers include the use of spotters and designing the site to reduce the need for reversing may assist in minimising the use of reversing beepers.
- Ensure that all works comply with the start and finish times.
- As a minimum all residences within 200 metres radius of the project site should be notified of potential construction works at least 2 weeks prior to the commencement of works.
- Construction noise management practices are to be provided to all staff and contractors and be included during site inductions and daily tool-box talks. The tool-box talks should include as a minimum, the

permitted hours of construction work, work site locations, site ingress/egress and the required noise management measures for each construction phase.

6.2 Monitoring of construction works

This section details the noise monitoring strategy for construction works during standard construction hours.

Monitoring of construction noise is recommended to confirm construction noise levels at nearest receivers, especially receivers in NCA 2:

- At the commencement of construction works for the verification of predicted construction noise levels and confirm requirement for noise management and mitigation measures.
- In response to justified adverse community response or complaint to construction noise.

As a minimum attended noise monitoring should be undertaken at the commencement of construction works at a representative nearest residential receivers.

All noise monitoring should be undertaken by suitably qualified practitioners with consideration to guidance provided in the ICNG and relevant regulatory and statutory guidelines.

6.2.1 Measurement of construction noise

To determine the influence of construction noise at a receiver it is important to, where practical, to record a measurement of the construction noise alone or with minimal ambient influence from extraneous sources such as road traffic.

A background noise level measurement should be undertaken, where feasible, at a representative location where construction noise is not a dominant influence or during any period where construction works are not occurring. The background noise level can be applied to quantify potential construction noise influence in measured ambient noise levels.

All measurements should be undertaken for a minimum continuous period of 15 minutes and record the period L_{Aeq}, L_{A90}, L_{A10}, L_{A1} and L_{AMax} noise descriptors. Dependent upon the influence of construction noise the following correction factors may be applied to determine construction noise influence at the measurement location:

- Where the construction noise was clearly dominant over background noise during the monitoring period the meter reading is recorded without correction.
- Where construction noise was just audible above the background during the monitoring period the meter L_{Aeq} reading minus a value of 3 dB will be recorded.
- Where the construction noise was inaudible above the background during the monitoring period the meter L_{Aeq} the meter reading minus a value of 10 dB will be recorded.

Correction factors are only to be applied where construction noise is a continuous influence during the measurement period.

6.3 Non-compliance / complaint response

Non-conformances for noise during construction works may include:

- Exceedance of adopted receiver specific construction noise management levels; triggering the requirement for noise management measures; or
- Justified community complaints relating to noise.

The construction works shall be immediately assessed to review operation of noise generating plant, required construction activity and current on and off site noise mitigation measures in place.

Any non-conformances and subsequent corrective actions shall be resolved with consideration to the Project's Community Consultation Strategy. The Environment Manager and Site Supervisor shall determine where corrective action is required and implement necessary mitigation measures.

All adopted noise mitigation measures will be updated in work method statements and identified as part of routine tool-box talks to inform staff of current construction noise issues and required mitigation measures.

Consistent with the noise mitigation measures presented in this report; examples of corrective actions to be implemented by the Environment Manager include:

- Implementing alternative construction methodologies utilising low noise or low vibration generating plant.
- Replacing excessively noisy equipment.
- Fitting additional acoustic controls, such as acoustic screens, to minimise emissions from machinery.
- Increasing separation distance between noise generating plant and nearest sensitive receivers.
- Consider respite periods where construction noise impacts include potential tonal, low frequency or impulsive annoying characteristics at nearest receivers.

7. Operational noise assessment

7.1 Methodology

In order to determine the acoustical impact of the proposed solar facility, a computer model incorporating all significant noise sources; the closest potentially affected residential properties, and the intervening terrain has been prepared.

The computer model was prepared using the SoundPLAN noise propagation modelling software (Version 7.4) Industrial Module which allows the use of various internationally recognised noise prediction algorithms. The CONCAWE algorithm, which is suitable for the assessment of large industrial plants, has been selected for this assessment because it also enables meteorological influences to be assessed.

The parameters used and values adopted in the noise modelling are presented in Table 7.1 below.

Table 7.1 : Operational nosie modelling parameters

Parameter	Input data
Facade corrections	Standard façade correction +2.5 dB(A)
Buildings	· Footprints taken from aerial photography · Typical building heights have been estimated from Google Street-view and site inspections as follows: per floor 3 m, pitched roof 2.5 m · Number of floors taken from Google Street-view and site inspections
Terrain	2 metres ground contours from Ausimage.
Ground surface / absorption	The agricultural land surrounding the site has been conservatively modelled with a ground cover factor of 0.5 representative of 'mixed' ground.
Source heights	Construction plant and equipment heights are modelled to be 2 metres above ground
Sources	All equipment has been modelled as point sources and has been modelled to operate simultaneously.
Receiver heights	Ground floor receivers have been placed at an elevation of 1.5 m and first floor receivers at an elevation of 4.5 m.
SoundPLAN module	CONCAWE industrial module
Met condition	Neutral meteorological condition, adverse wind condition (2 m/s wind) and temperature inversion condition (2 m/s wind and Pasquil Stability Class F) have been modelled for the operational noise assessment.

7.2 Equipment sound power levels

The L_{Aeq} sound power levels of plant and equipment from the proposed operations are given in Table 7.2 below.

Table 7.2 : Operational equipment sound power levels

Plant and equipment	Individual equipment Sound power level LAeq – dB(A)	Source height above ground level (metre)
1,392 x tracker panel motors	74	2.6
Tracking Panels Power inverter and transformer system (PCS) - unmitigated	98	2.6
Fixed Panels Power inverter and transformer system (PCS) - unmitigated	96	2.6

NOTE 1: Data provided by Delta

Potential noise impacts of both a fixed panel system and tracking panel system have been assessed. For the tracking system, noise outputs from a synchronised system (where all panels move simultaneously) and an unsynchronised system (where panel movements occur randomly) were considered. The difference in noise levels from these systems was found to be negligible (<1dB), however the marginally louder unsynchronised system has been used for the tracking system noise model.

During the night period the tracker panel motors will not be operating and there will be minimal / zero load on the inverters corresponding to minimal noise impacts. Hence, the operational noise of the inverters and transformers has only been assessed against the more conservative evening INP noise criteria.

7.3 Predicted operational noise impacts

Table 7.3 presents the predicted noise levels associated with the facility's operations along with a comparison with the relevant operational noise criteria (refer Table 4.4). The assessment is limited to receivers located within the NCAs identified in Figure 2.1.

Table 7.3 : Predicted operational noise levels at residential receivers (Day and Evening)

NCA	Predicted range of noise levels*		Noise criteria $L_{Aeq(period)}$ Day / Evening	Predicted exceedance?	
	Fixed panels	Tracking panels		Fixed panels	Tracking panels
1	1 to 19	2 to 21	38 / 37	-	-
2	10 to 37	**12 to 42**	**38 / 37**	-	**Yes**
3	14 to 28	15 to 31	38 / 37	-	-
4	14 to 24	15 to 26	55 / 45	-	-
5	18 to 26	20 to 28	55 / 45	-	-
Industrial	20 to 32	22 to 34	70	-	-

* Includes all meteorological conditions

These results show that under all meteorological conditions, exceedances of the INP noise criteria may occur at properties within NCA 2 where tracking panels are installed. That is residential buildings located on Summerhayes Road and Rodgers Road. Further analysis of noise levels within this NCA is presented in Table 7.4 with predicted operational noise levels of all receivers' in all NCAs presented in Appendix D. Modelled operational noise contours for fixed and tracking systems under all scenarios are provided in Appendix F.

Table 7.4 : Predicted operational noise levels individual receivers within NCA 2

Name	Criteria		Fixed			Tracking		
	Day	Evening	Neutral	Adverse Wind	Inversion	Neutral	Adverse Wind	Inversion
Rodgers_Rd_6	38	37	13	20	20	16	22	22
Rodgers_Rd_25	38	37	10	16	16	12	19	19
Rodgers_Rd_43	38	37	13	20	19	15	22	22
Summerhayes_Rd_115	38	37	15	21	21	17	24	24
Summerhayes_Rd_133	38	37	16	22	22	18	25	24
Summerhayes_Rd_149	38	37	17	23	23	19	25	25
Summerhayes_Rd_171	38	37	18	24	24	20	26	26
Summerhayes_Rd_171	38	37	18	24	24	21	27	26
Summerhayes_Rd_263	38	37	24	30	29	28	32	32
Summerhayes_Rd_305	38	37	31	35	34	36	**39**	**38**
Summerhayes_Rd_325	38	37	34	37	37	**40**	**42**	**42**
SummerHayes_Rd_285	38	37	29	33	32	32	36	36

*__Bold__ indicates a potential exceedance of daytime and evening noise criteria

These more detailed results show that within NCA 2, there are two properties where unmitigated noise levels may exceed INP noise criteria by up to 5dB(A) at the worst impacted property. Contributions from onsite noise sources at the most affected property under the worst case meteorological conditions has been set out below:

Table 7.5 : Noise contributions at 325 Summerhayes Road

On site noise source	Noise level contribution dB(A)	
	Unmitigated level	5dB reduction
Tracking motors	16	16
PCS-08	18	13
PCS-11	19	14
PCS-07	20	15
PCS-10	20	15
PCS-06	21	16
PCS-09	22	17
PCS-05	23	18
PCS-12	25	20
PCS-04	25	20
PCS-01	34	29
PCS-03	38	33
PCS-02	38	33
TOTAL noise level	**42**	**37**

Table Table 7.5 results show that where the noise level contribution from the transformer / inverter units can be reduced by 5dB(A), noise levels at the most affected property would comply with INP criteria. A 5dB(A) reduction from PCS-01, PCS-02 and PCS-03 only would result in a marginal (0.2dBA) exceedance.

8. Operational noise management measures

Without mitigation, noise levels from the power transformer / inverter units (PCS) may result in exceedances at two properties on Summerhayes Road. The results of noise modelling presented in Section 7 show that where the noise output of these units can be reduced by 5dB(A), compliance at these properties would be expected under all meteorological conditions.

It is recommended that all PCS units are housed within an acoustic enclosure or that acoustic screening between the unit and receivers on Summerhayes Road is provided which ensures a minimum of 5dB(A) sound reduction.

A typical acoustic enclosure for this type of equipment is expected to provide a minimum noise reduction in the order of 15 to 20dB(A). Site specific engineering restrictions may reduce the level of attenuation that is possible, however a reduction of 5dB(A) is a very small margin and is expected to be easily achievable.

9. Conclusion

This report presents the results of the assessment of potential noise impacts associated with the construction and operation of the proposed Vales Point Solar project.

9.1 Construction noise

Construction noise levels during all six stages are predicted to be within the noise management levels at residential receivers in NCAs 1, 3, 4 and 5, but predicted to exceed the noise management levels at residences in NCA 2. Whilst the exceedances at within NCA 2 is predicted to be up to 20 dB, it is likely that any noise impacts will be able to be managed given the short term localised nature of the works.

Based on the predicted noise levels the surrounding residential receivers are unlikely to be highly noise affected.

Standard noise mitigation measures have been recommended for implementation where feasible and reasonable. Mitigation measures will minimise impacts at the surrounding residential receivers. However, it is unlikely that implementation of all feasible and reasonable noise mitigation measures would reduce noise levels to below the construction noise criteria under all circumstances.

9.2 Operational noise

Predicted noise levels during operation of the solar facility using unmitigated equipment show that that there may be an exceedance of noise criteria of up to 5dB(A) under adverse meteorological conditions.

It has been recommended that the PCS units are housed within acoustic enclosures or otherwise screened from Summerhayes Road which offer a minimum of 5dB(A) noise reduction. Under these conditions, noise levels at all nearby receivers are expected to comply with noise criteria.

10. Disclosure

This report has been prepared by Jacobs Group (Australia) Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

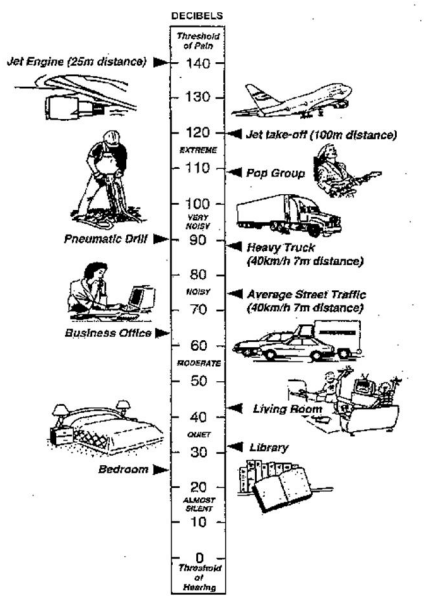
This report is for the exclusive use by Sunset Power International Pty Ltd. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from Jacobs Group (Australia).

Jacobs Group (Australia) disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

Appendix A. Acoustic Terminology

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

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



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

Sound power Level (SWL)

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

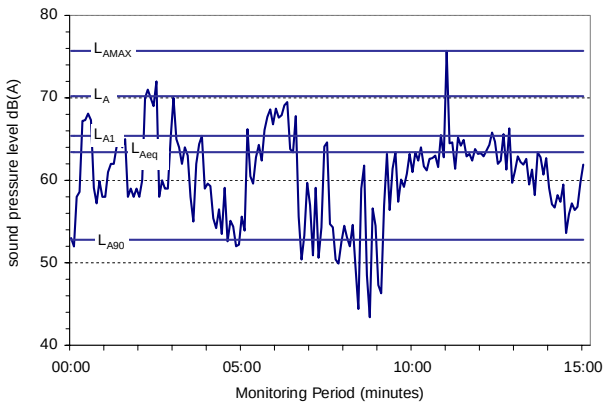
Sound Pressure Level (SPL)

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

Statistic noise levels

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

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



Key descriptors:

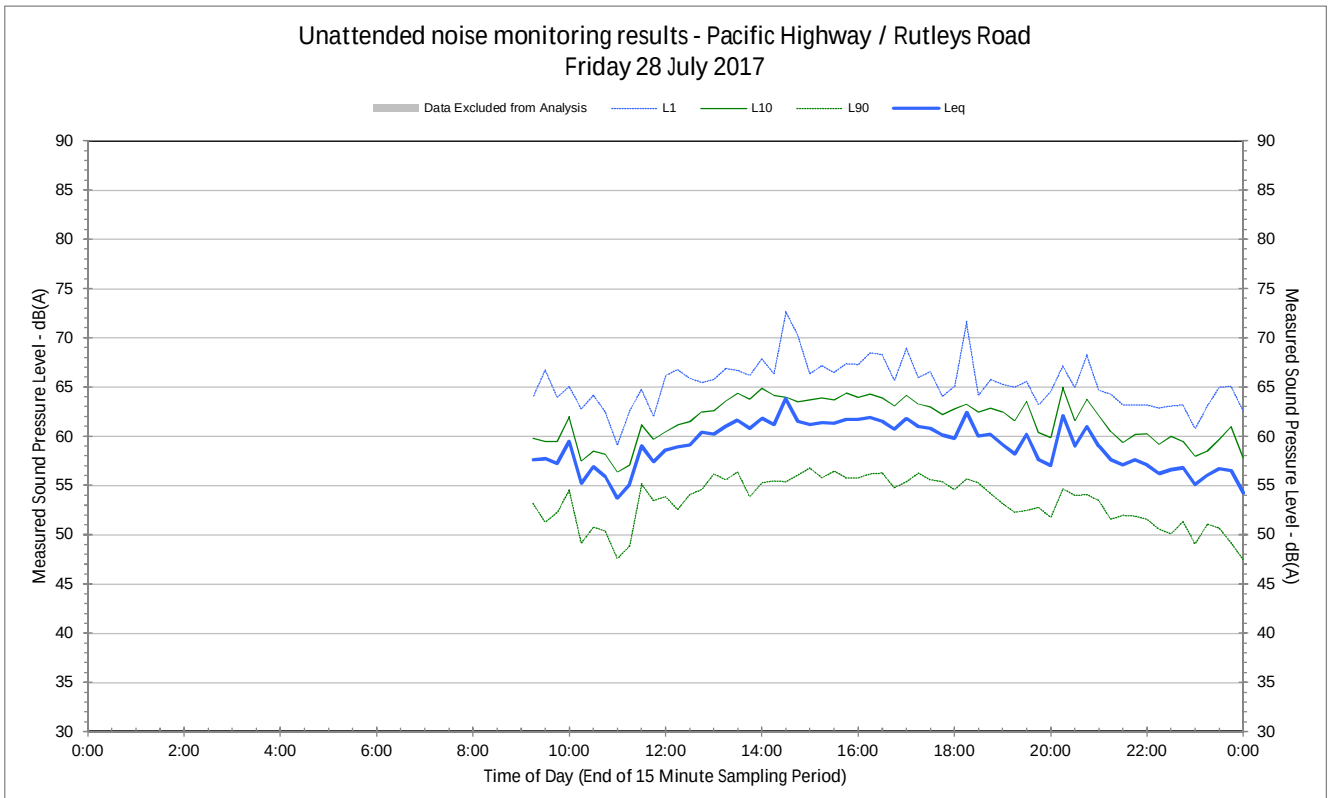
L_{Amax} Maximum recorded noise level.

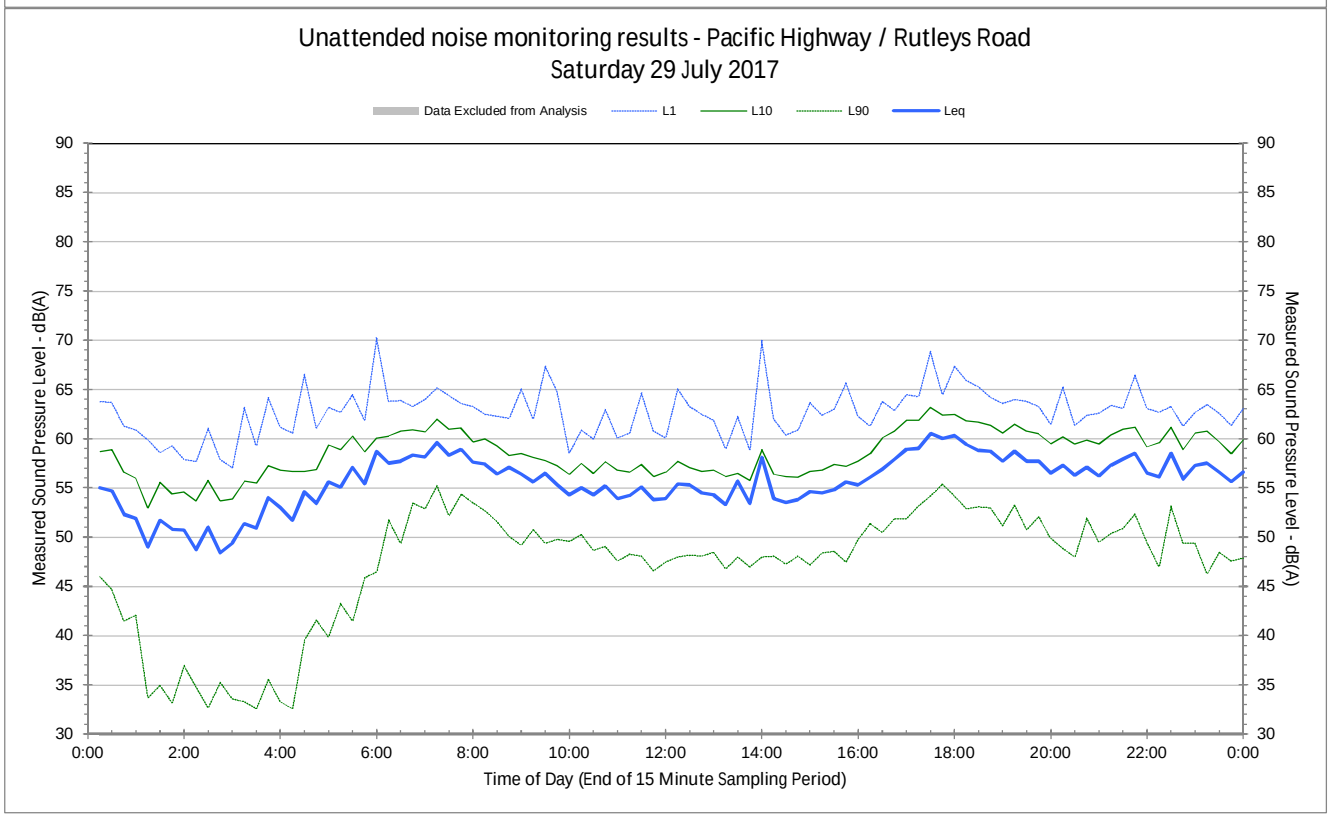
L_{A1} The noise level exceeded for 1% of the 15 minute interval.

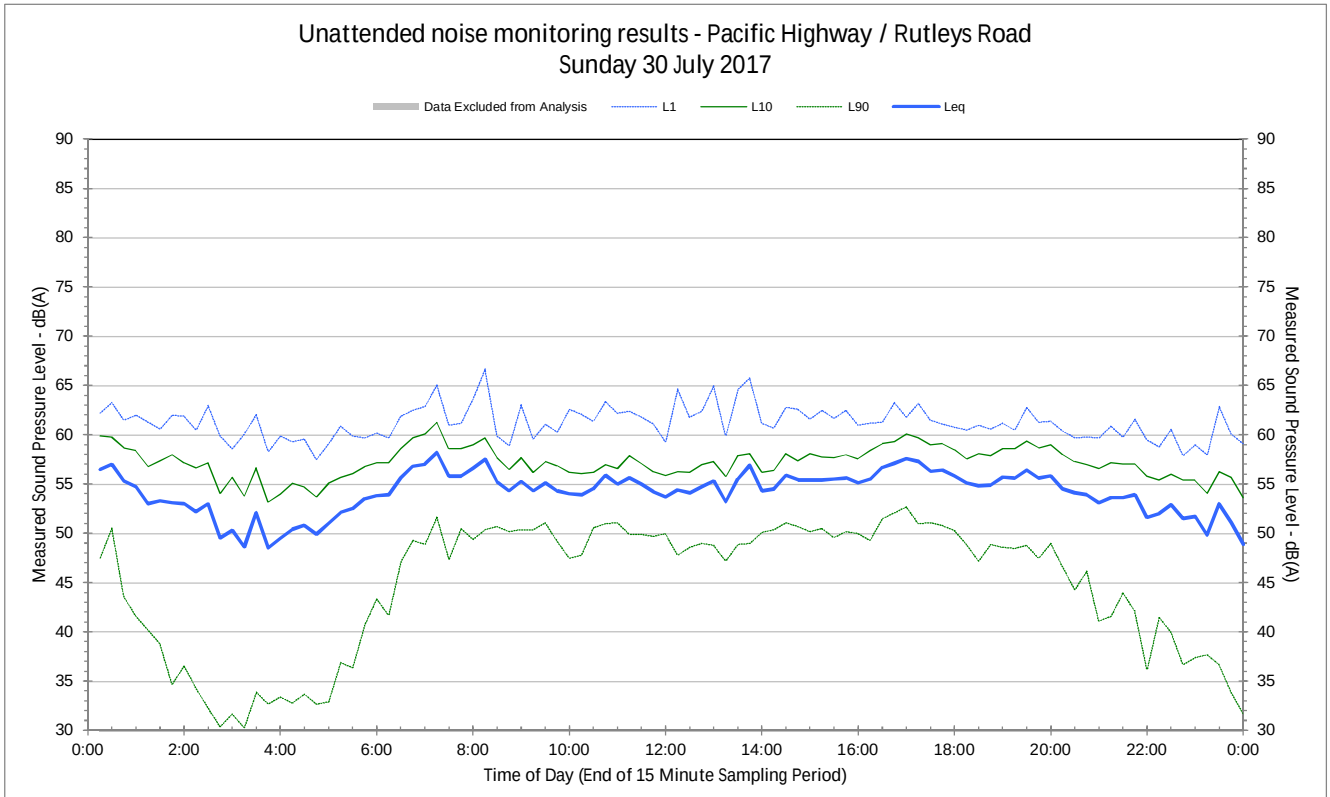
	L_{A10} Noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level. L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound. L_{A90} Noise level exceeded for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).
Threshold	The lowest sound pressure level that produces a detectable response (in an instrument/person).
Tonality	Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 2 to 5 dB(A) penalty is typically applied to noise sources with tonal characteristics

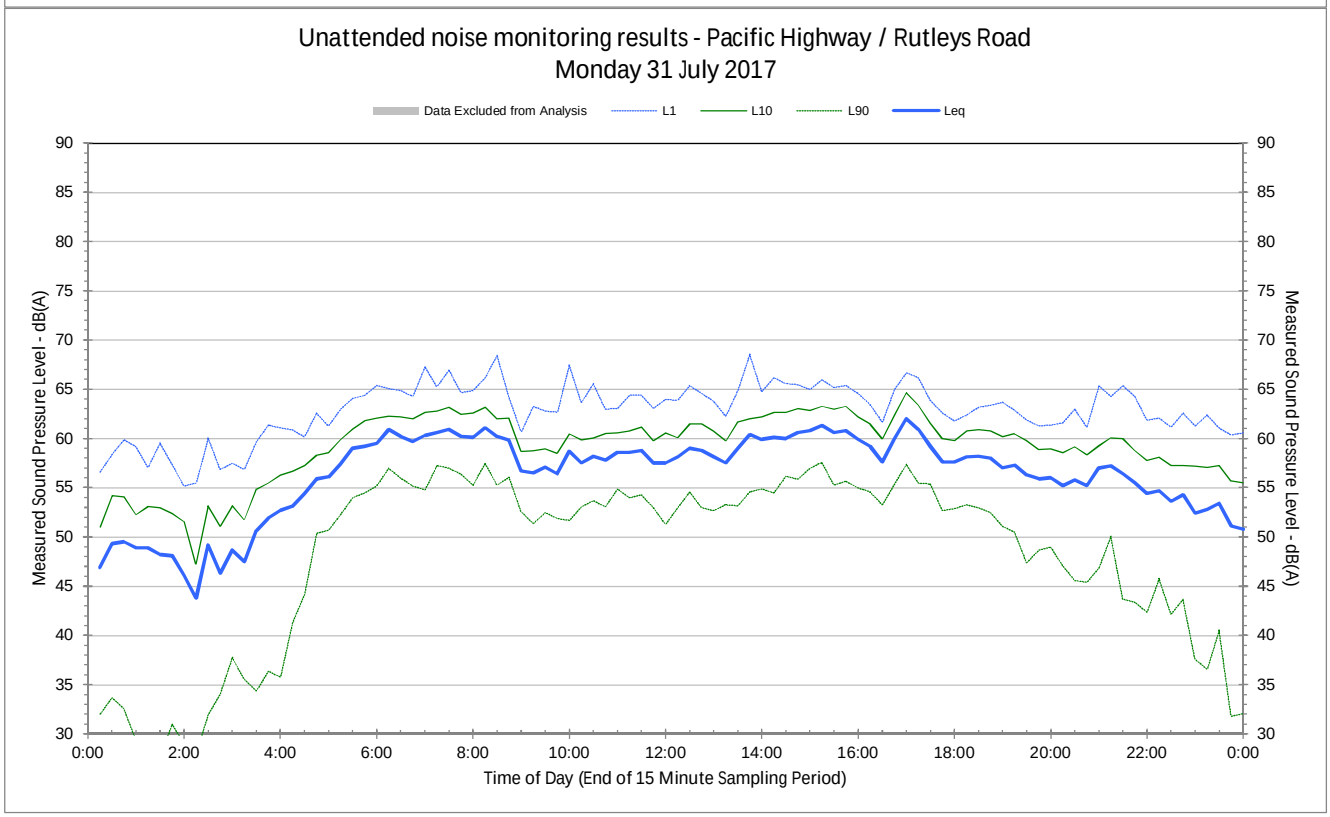
Appendix B. Detailed noise monitoring results

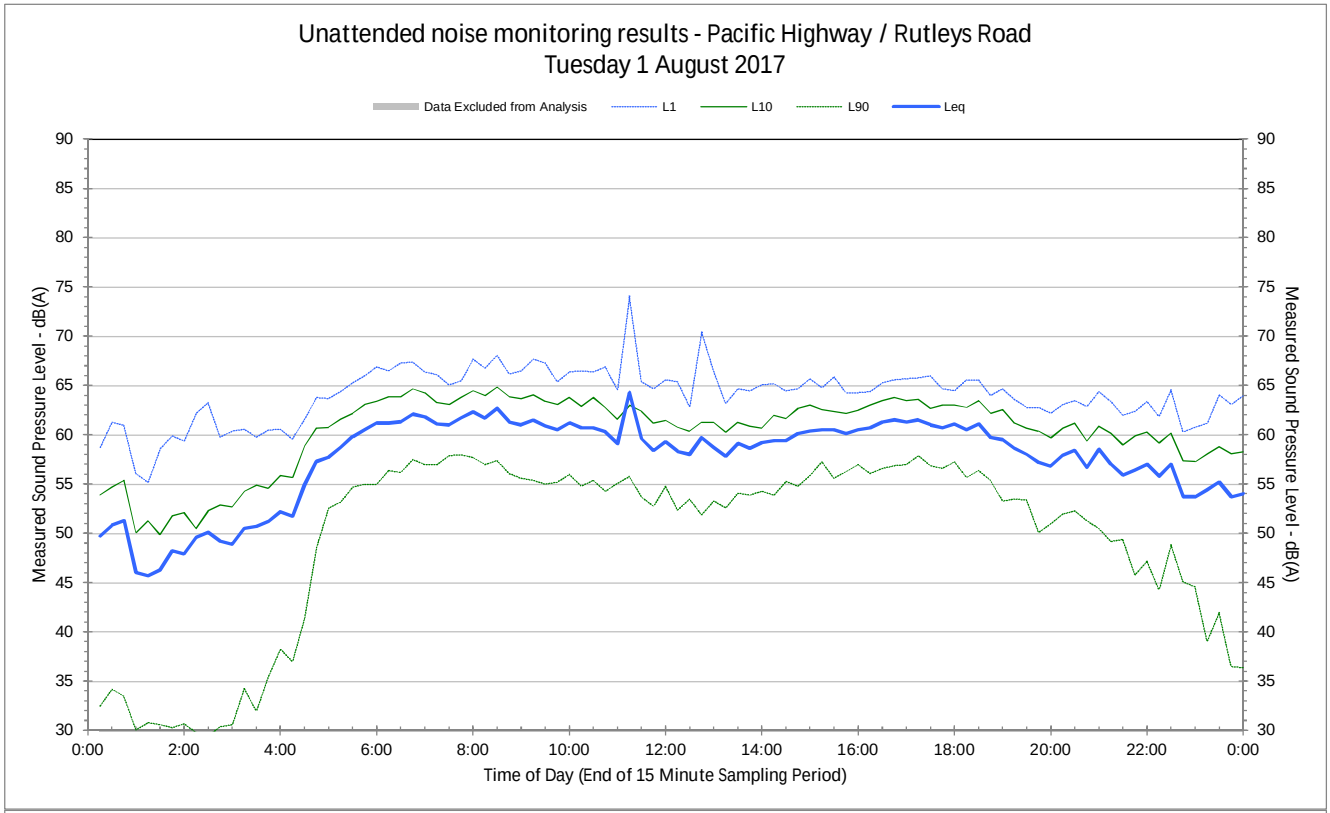
B.1 Location 1 – Pacific Highway / Ruttleys Road

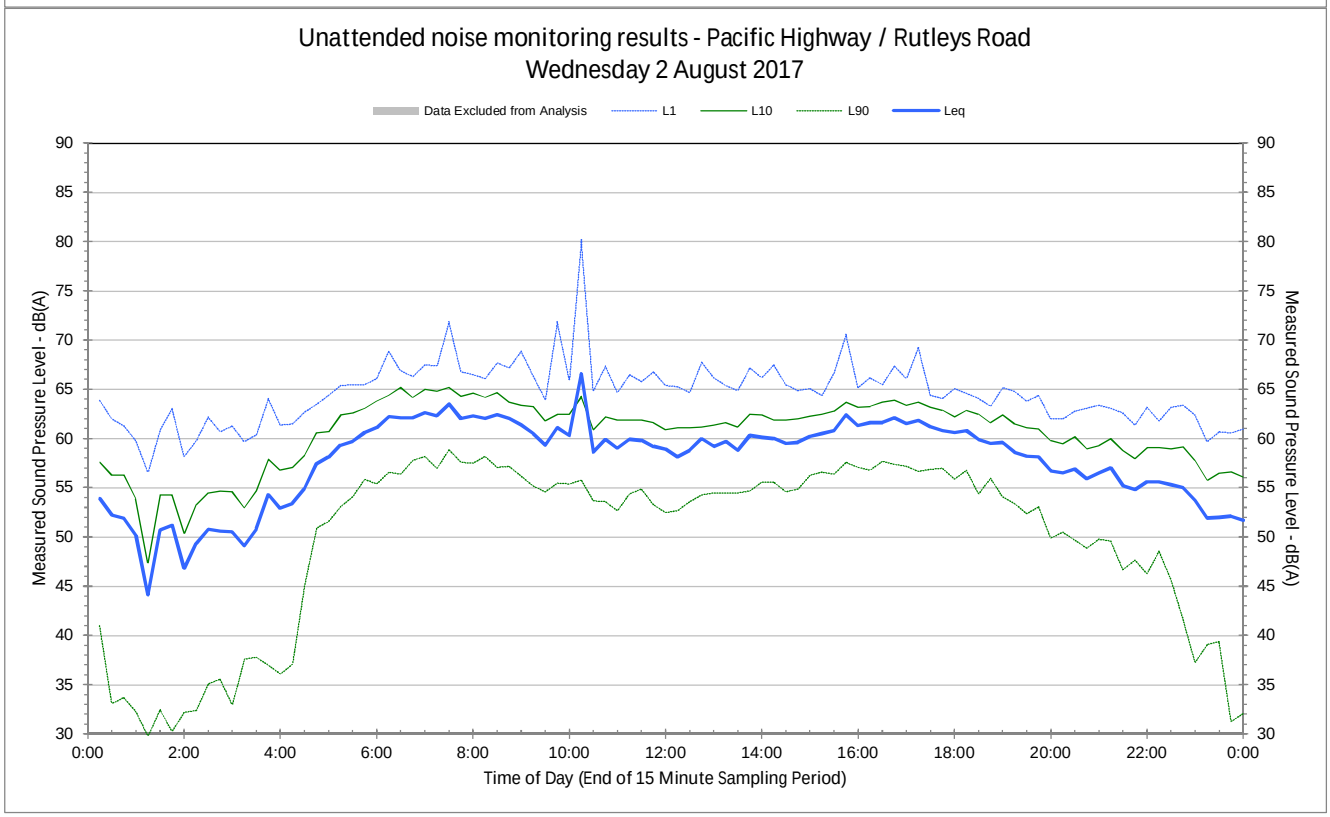


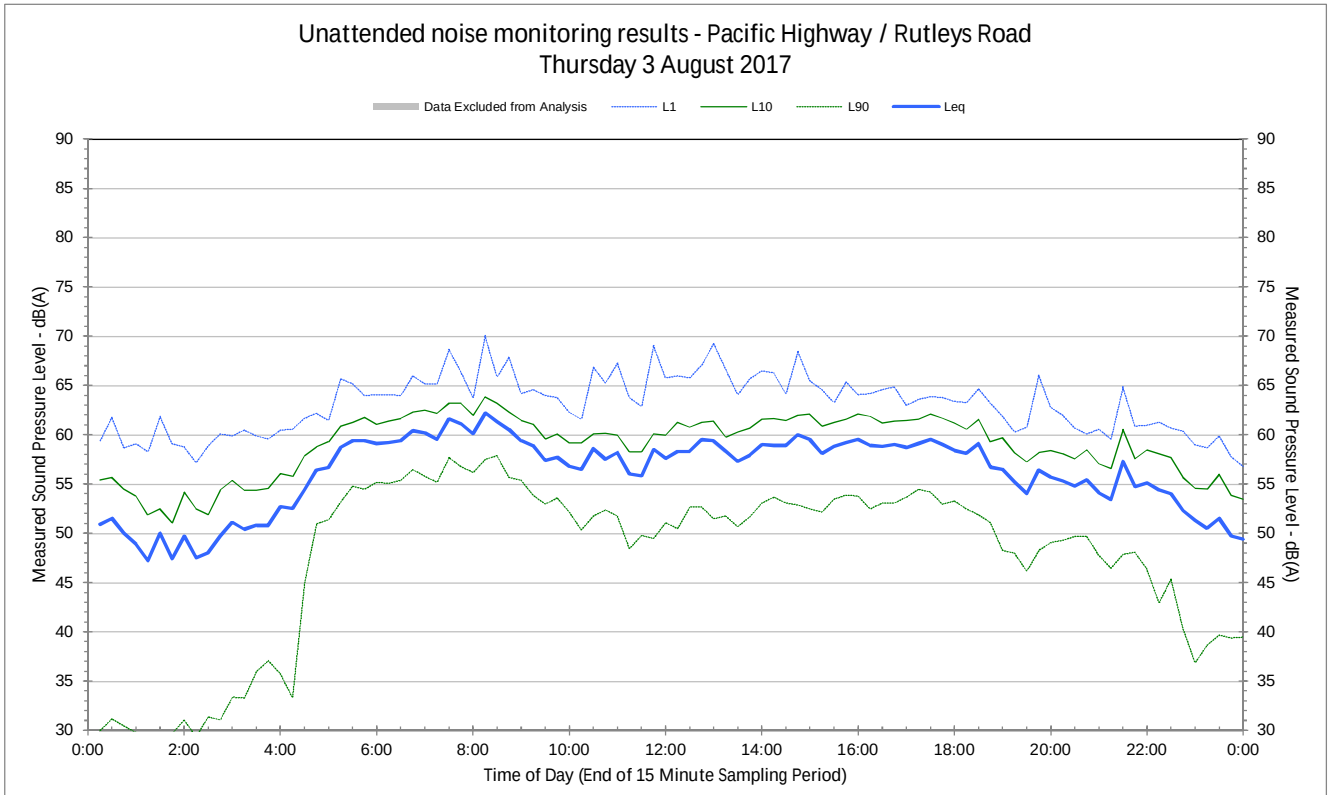


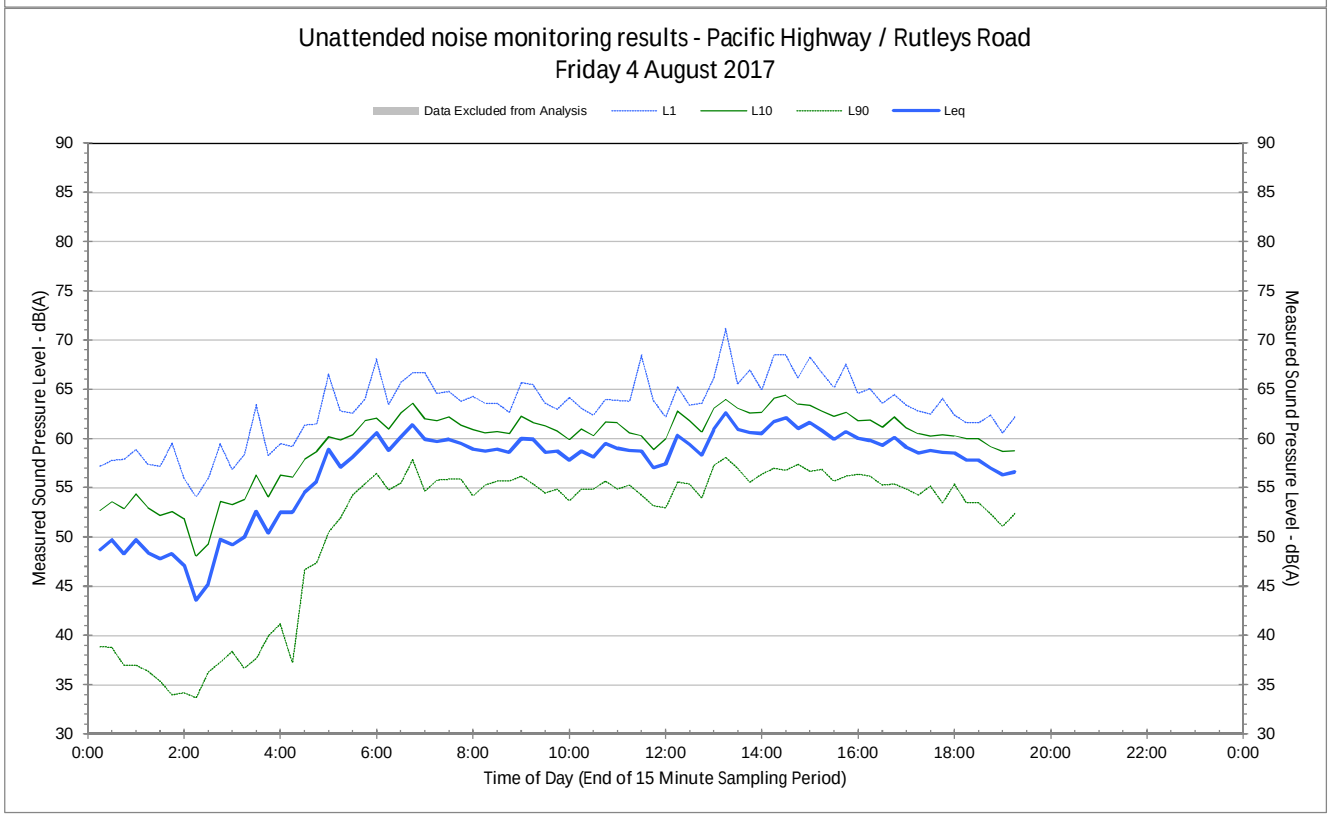

Unattended noise monitoring results - Pacific Highway / Rutleys Road
Sunday 30 July 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
30
35
40
45
50
55
60
65
70
75
80
85
90


Unattended noise monitoring results - Pacific Highway / Rutleys Road
Monday 31 July 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
30
35
40
45
50
55
60
65
70
75
80
85
90

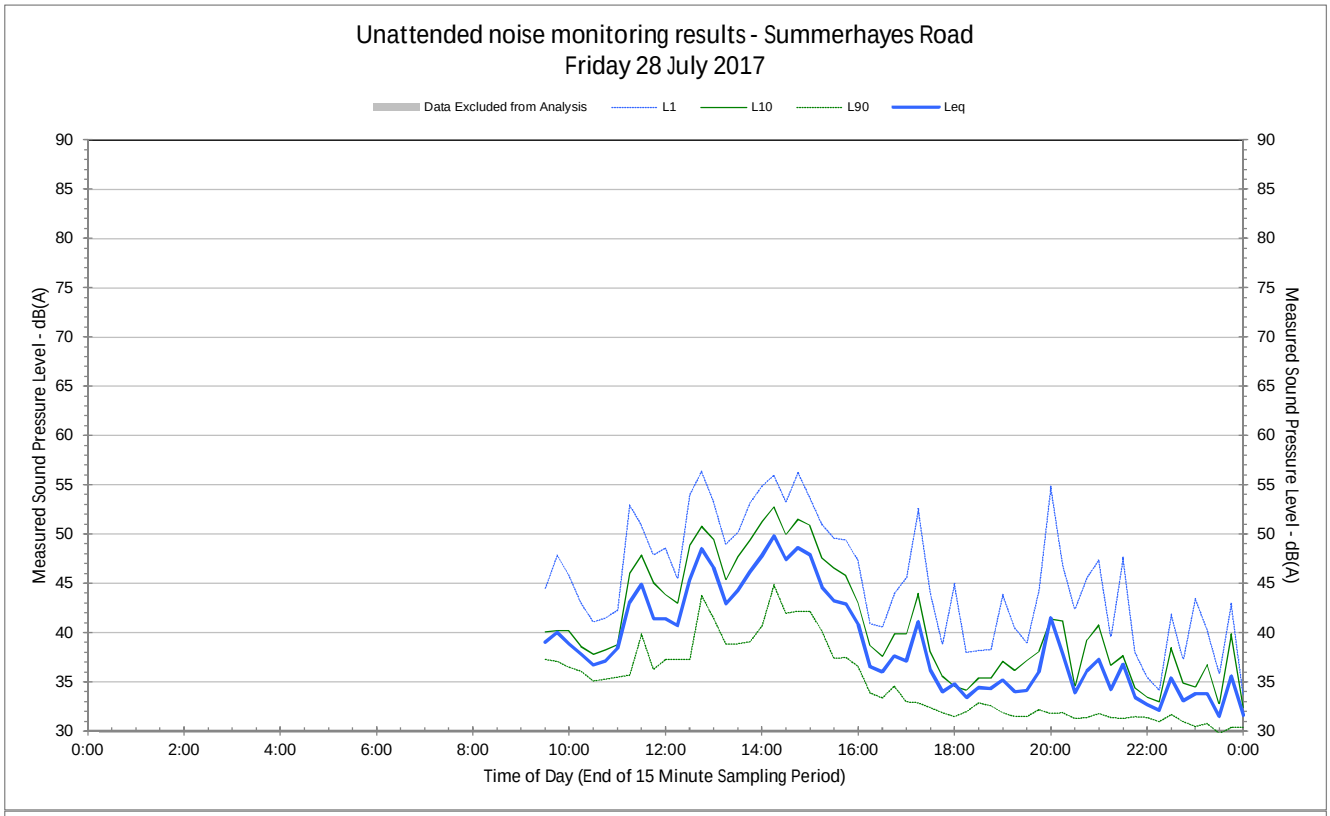

Unattended noise monitoring results - Pacific Highway / Rutleys Road
Tuesday 1 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

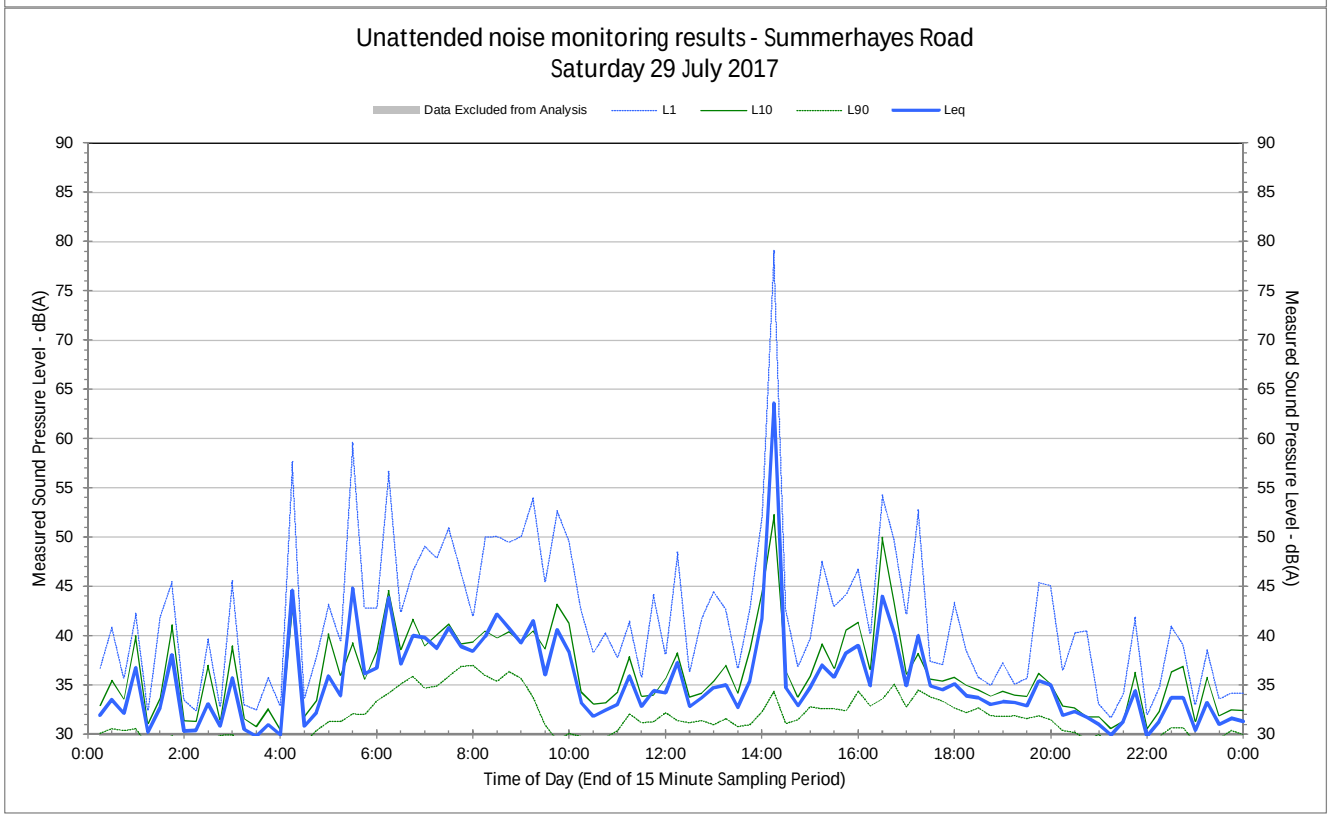

Unattended noise monitoring results - Pacific Highway / Rutleys Road
Wednesday 2 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

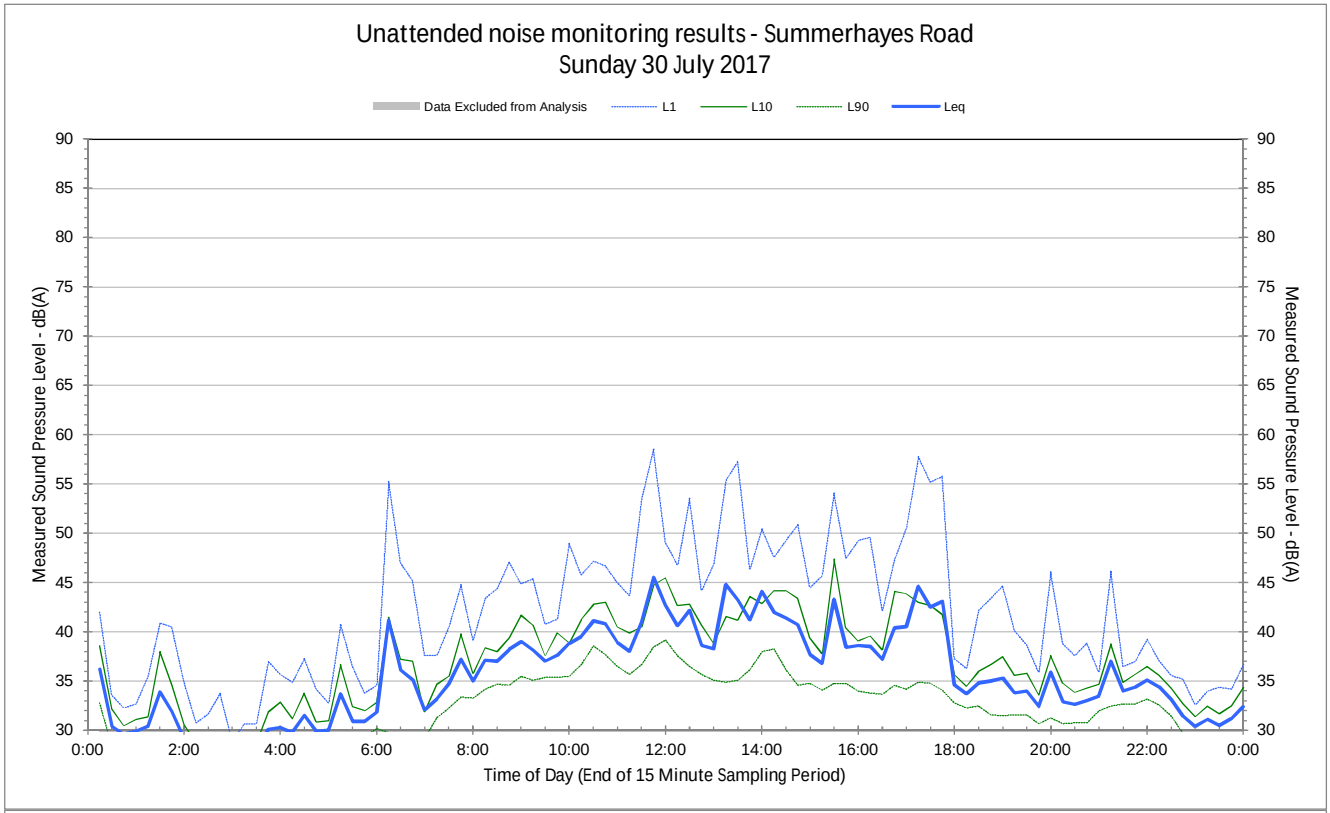

Unattended noise monitoring results - Pacific Highway / Rutleys Road
Thursday 3 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Measured Sound Pressure Level - dB(A)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sampling Period)

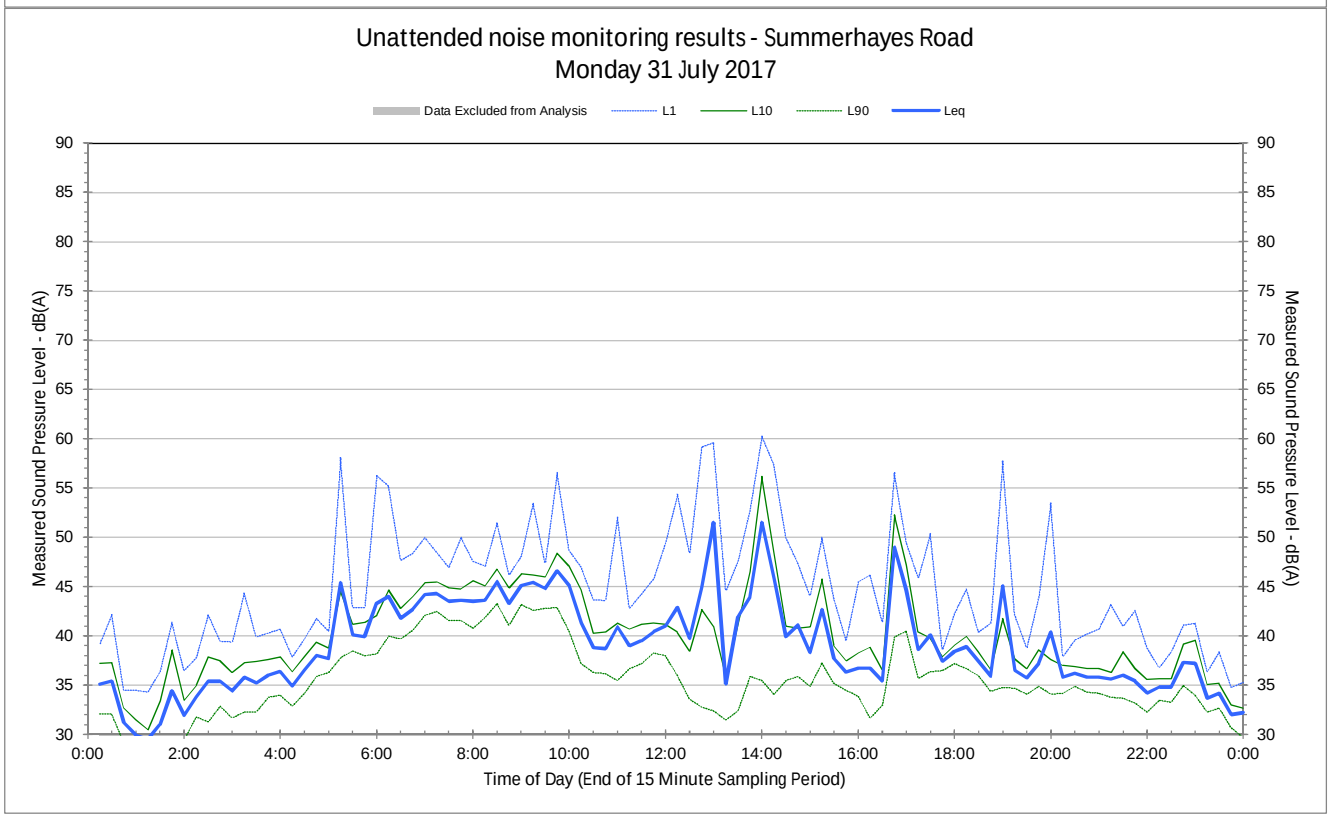

Unattended noise monitoring results - Pacific Highway / Rutleys Road
Friday 4 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Measured Sound Pressure Level - dB(A)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sampling Period)

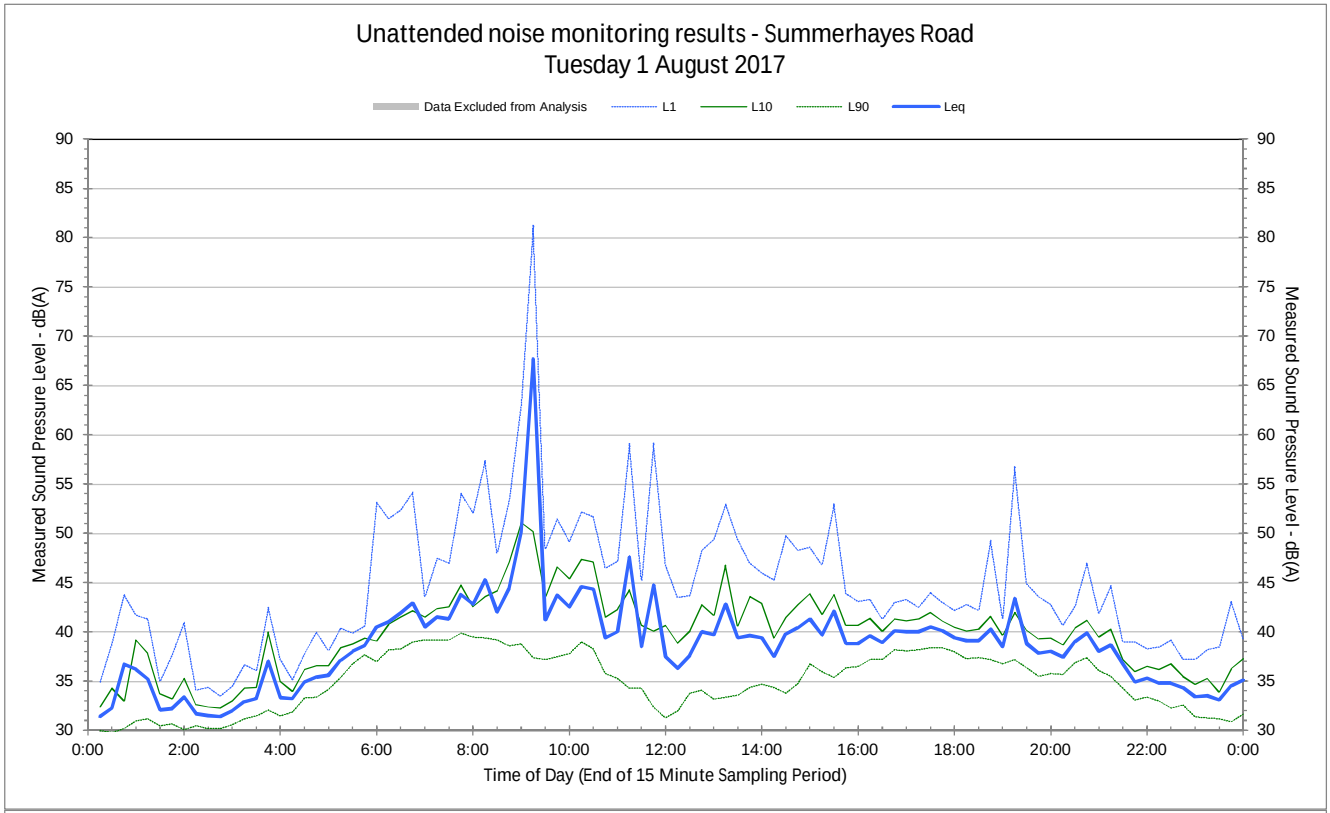
B.2 Location 2 – Summerhayes Road

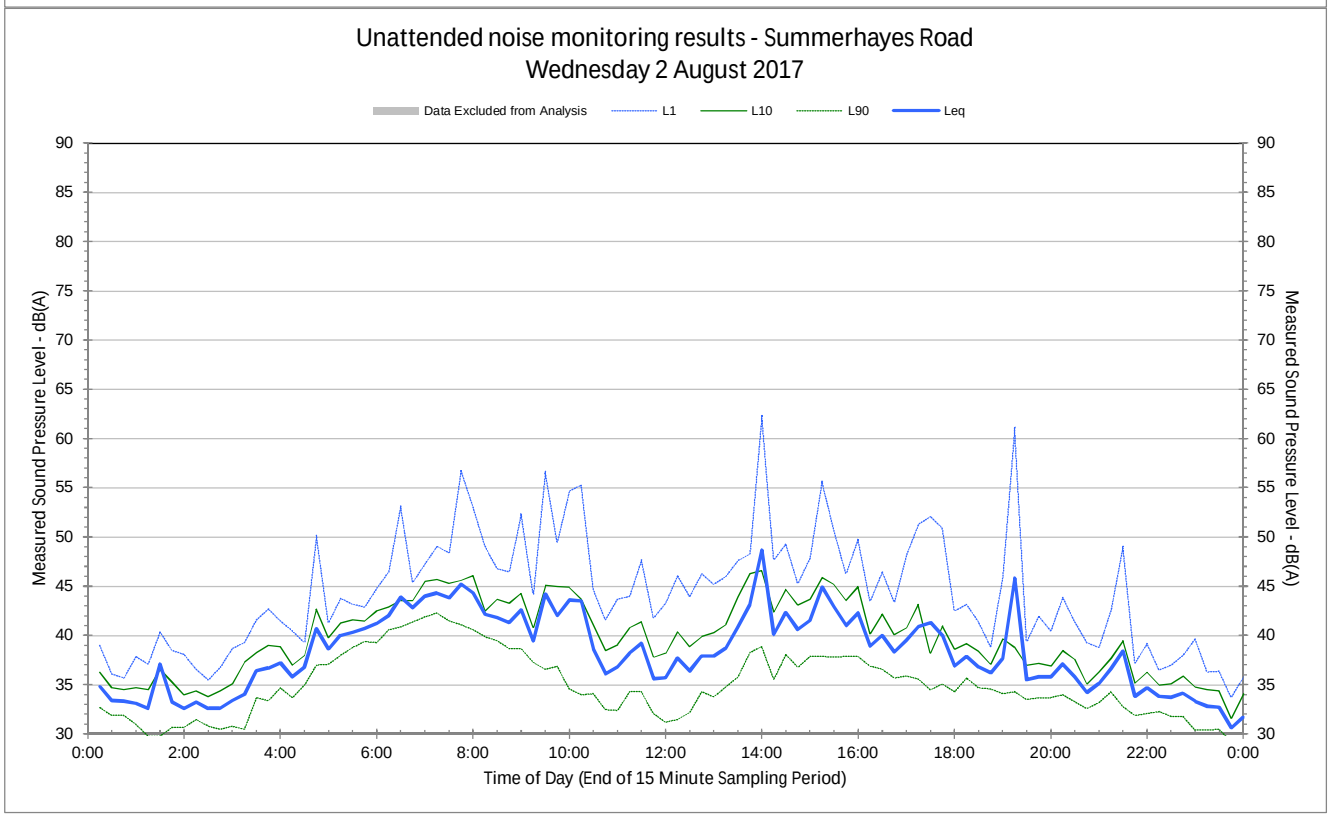


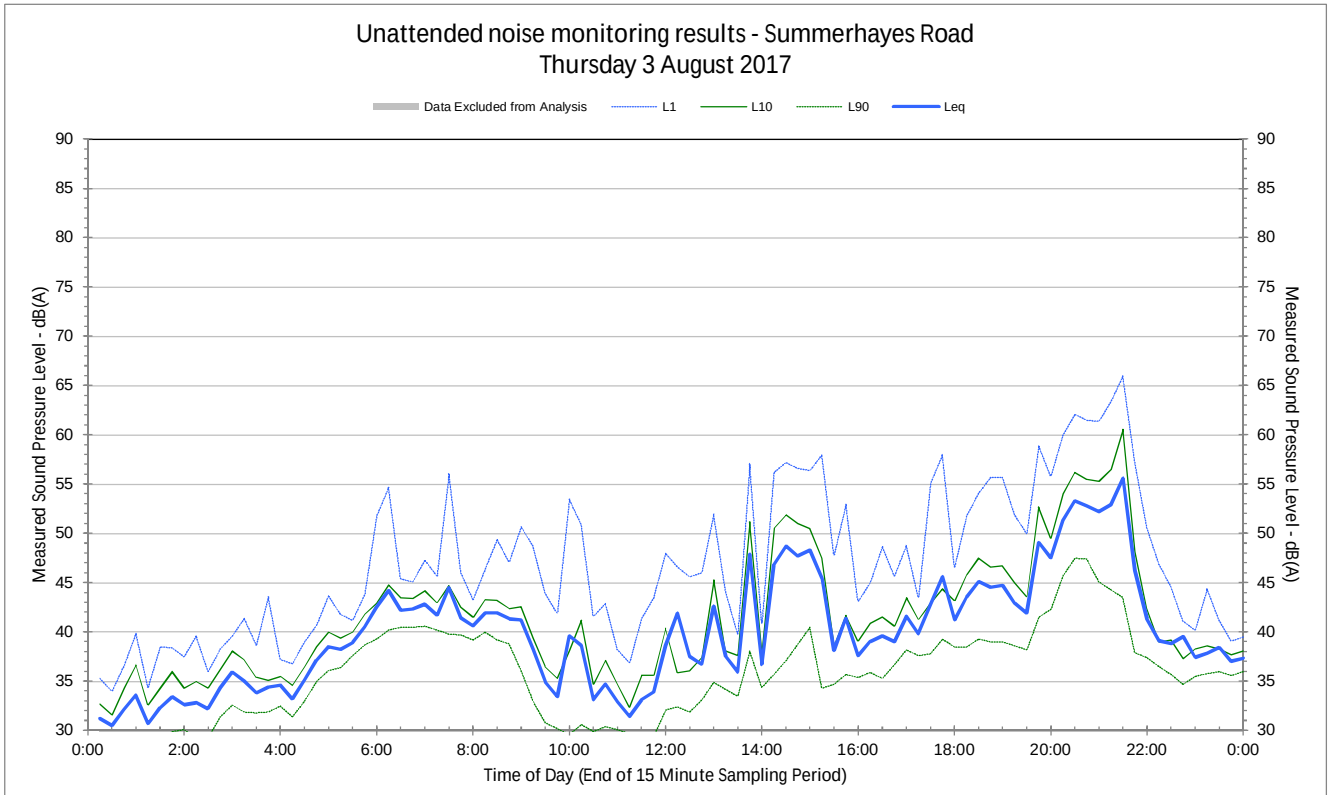


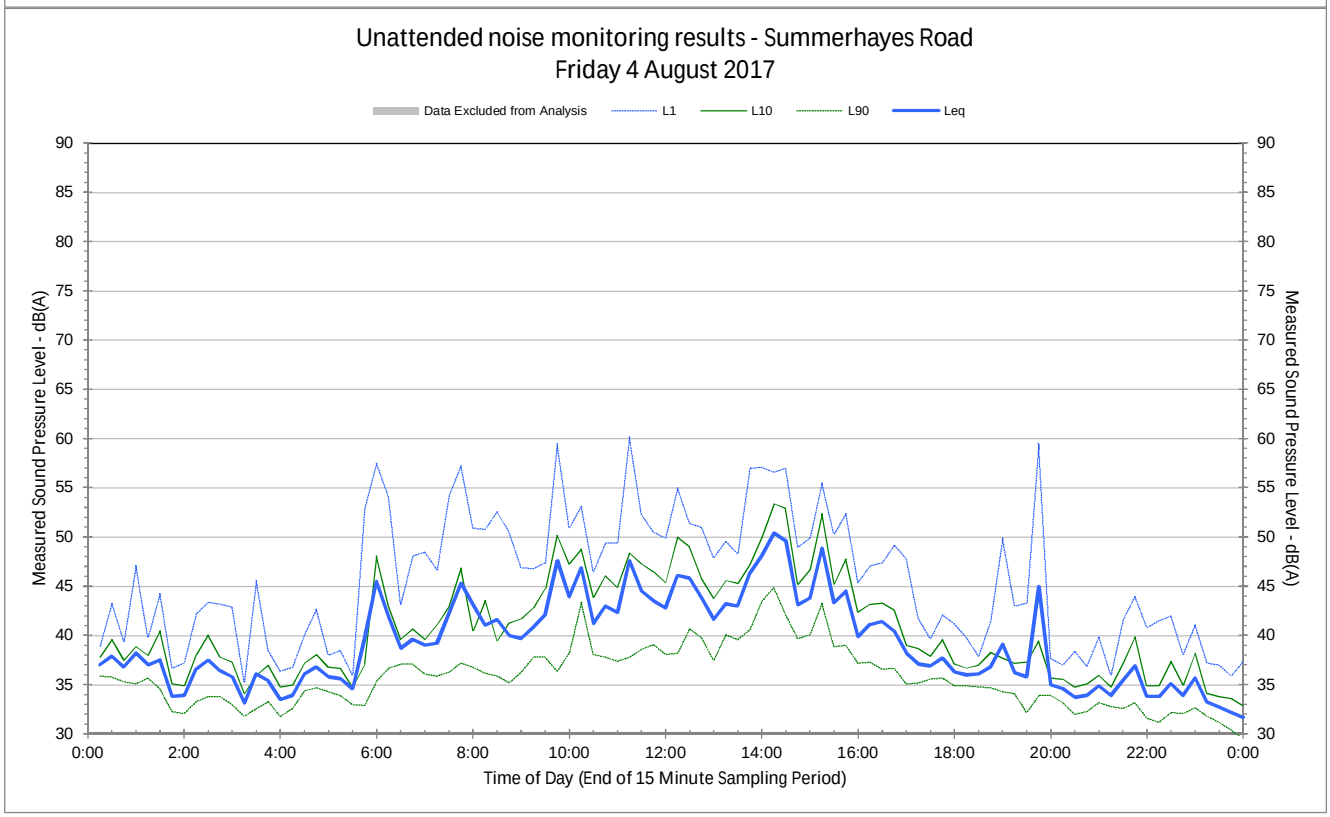

Unattended noise monitoring results - Summerhayes Road
Sunday 30 July 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)

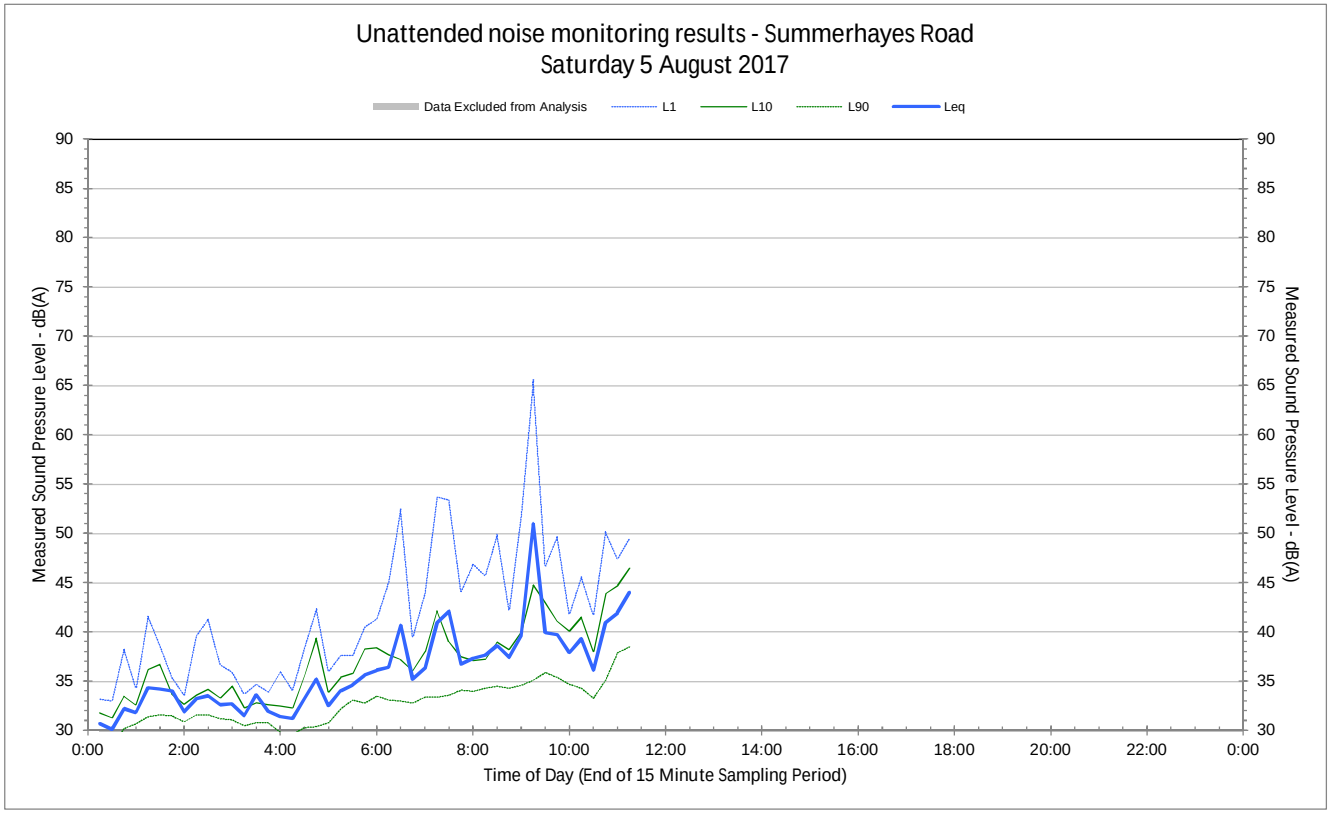

Unattended noise monitoring results - Summerhayes Road
Monday 31 July 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Summerhayes Road
Tuesday 1 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Summerhayes Road
Wednesday 2 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Summerhayes Road
Thursday 3 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Measured Sound Pressure Level - dB(A)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Summerhayes Road
Friday 4 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Measured Sound Pressure Level - dB(A)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - Summerhayes Road
Saturday 5 August 2017
Data Excluded from Analysis
L1
L10
L90
Leq
Measured Sound Pressure Level - dB(A)
Measured Sound Pressure Level - dB(A)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sampling Period)

Appendix C. Detailed predicted construction noise results

No.	NCA	Name (StreetName_StreetNo.)	Usage	Predicted construction noise impacts – dB(A) (Standard Hours)					
				Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
1	1	Boikonumba_Rd_33	RES	27.1	22.2	22.9	18.2	20.7	20.8
2	1	Boikonumba_Rd_35	RES	30.6	25.7	26.4	21.6	24.2	24.3
3	1	Bukkai_Rd_1	RES	30.7	25.8	26.5	21.7	24.3	24.4
4	1	Bukkai_Rd_1A	RES	30.6	25.7	26.4	21.6	24.2	24.3
5	1	Bukkai_Rd_3	RES	30.8	25.9	26.6	21.7	24.4	24.5
6	1	Bukkai_Rd_7	RES	31	26.1	26.8	21.9	24.6	24.7
7	1	Bukkai_Rd_9	RES	33.1	28.2	28.9	24.1	26.7	26.8
8	1	Bukkai_Rd_11	RES	30.4	25.5	26.2	21.5	24	24.1
9	1	Bukkai_Rd_13	RES	31.2	26.3	27	22.1	24.8	24.9
10	1	Bukkai_Rd_15	RES	31.3	26.3	27	22.1	24.8	24.9
11	1	Bukkai_Rd_17	RES	31.4	26.4	27.1	22.2	24.9	25
12	1	Bukkai_Rd_19	RES	31.5	26.6	27.3	22.3	25.1	25.2
13	1	Bukkai_Rd_21	RES	31.4	26.5	27.2	22.3	25	25.1
14	1	Darlingup_Rd_52	RES	31.5	26.6	27.3	22.4	25.1	25.2
15	1	Darlingup_Rd_54	RES	31.7	26.8	27.5	22.6	25.3	25.4
16	1	Tuggarah_St_15	RES	30.3	25.3	26	21.3	23.8	23.9
17	1	Tuggarah_St_17	RES	30.3	25.4	26.1	21.3	23.9	24
18	1	Tuggarah_St_19	RES	30.4	25.5	26.2	21.4	24	24.1
19	2	Rodgers_Rd_6	RES	33.8	28.9	29.6	24.8	27.4	27.5
20	2	Rodgers_Rd_6	RES	34.3	29.4	30.1	24.8	27.9	28
21	2	Rodgers_Rd_25	RES	29.7	24.8	25.5	22.4	23.3	23.4
22	2	Rodgers_Rd_43	RES	32.8	27.9	28.6	23.6	26.4	26.5

No.	NCA	Name (StreetName_StreetNo.)	Usage	Predicted construction noise impacts – dB(A) (Standard Hours)					
				Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
23	2	Summerhayes_Rd_115	RES	35.8	30.8	31.5	26.7	29.3	29.4
24	2	Summerhayes_Rd_133	RES	37	32.1	32.8	27.8	30.6	30.7
25	2	Summerhayes_Rd_149	RES	38.3	33.4	34.1	29	31.9	32
26	2	Summerhayes_Rd_171	RES	40.3	35.4	36.1	30.7	33.9	34
27	2	Summerhayes_Rd_171	RES	40.4	35.5	36.2	30.9	34	34.1
28	2	Summerhayes_Rd_263	RES	48.1	43.2	43.9	37.8	41.7	41.8
29	2	Summerhayes_Rd_305	RES	58.9	54	54.7	46.3	52.5	52.6
30	2	Summerhayes_Rd_325	RES	67.1	62.1	62.8	52.8	60.6	60.7
31	2	SummerHayes_Rd_285	RES	54.6	49.7	50.4	42.9	48.2	48.3
32	3	Griffith_St_4	RES	37.9	33	33.7	29.3	31.5	31.6
33	3	Griffith_St_34	RES	36	31.1	31.8	26.8	29.6	29.7
34	3	Griffith_St_2	RES	39.5	34.5	35.2	29.9	33	33.1
35	3	Griffith_St_6	RES	36.3	31.4	32.1	27.2	29.9	30
36	3	Griffith_St_8	RES	37.2	32.3	33	28.3	30.8	30.9
37	3	Griffith_St_10	RES	37.5	32.6	33.3	28.6	31.1	31.2
38	3	Griffith_St_10	RES	38.5	33.6	34.3	29	32.1	32.2
39	3	Griffith_St_12	RES	37.8	32.9	33.6	28.9	31.4	31.5
40	3	Griffith_St_14	RES	37.4	32.4	33.1	28.7	30.9	31
41	3	Griffith_St_14	RES	37.7	32.8	33.5	28.7	31.3	31.4
42	3	Griffith_St_16	RES	37.7	32.7	33.4	28.7	31.2	31.3
43	3	Griffith_St_18	RES	37.6	32.7	33.4	28.6	31.2	31.3
44	3	Griffith_St_20	RES	37.6	32.7	33.4	28.5	31.2	31.3
45	3	Griffith_St_20	RES	38.2	33.3	34	28.5	31.8	31.9
46	3	Griffith_St_22	RES	37.5	32.6	33.3	28.4	31.1	31.2

No.	NCA	Name (StreetName_StreetNo.)	Usage	Predicted construction noise impacts – dB(A) (Standard Hours)					
				Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
47	3	Griffith_St_24	RES	37.2	32.3	33	28.2	30.8	30.9
48	3	Griffith_St_24	RES	37.8	32.9	33.6	28.2	31.4	31.5
49	3	Griffith_St_26	RES	37	32.1	32.8	28.2	30.6	30.7
50	3	Griffith_St_28	RES	36.9	32	32.7	28	30.5	30.6
51	3	Griffith_St_30	RES	37	32.1	32.8	28	30.6	30.7
52	3	Griffith_St_32	RES	36.9	32	32.7	27.9	30.5	30.6
53	3	Griffith_St_36	RES	36.7	31.8	32.5	27.6	30.3	30.4
54	3	Griffith_St_38	RES	36.6	31.7	32.4	27.5	30.2	30.3
55	3	Griffith_St_38	RES	37.2	32.3	33	27.5	30.8	30.9
56	3	Kenneth_Pl_7	RES	41.1	36.2	36.9	32.3	34.7	34.8
57	3	Kenneth_Pl_9	RES	41.5	36.6	37.3	32.4	35.1	35.2
58	3	Kenneth_Pl_11	RES	40.4	35.5	36.2	31.8	34	34.1
59	3	Kenneth_Pl_11	RES	41.1	36.2	36.9	31.8	34.7	34.8
60	3	Kenneth_Pl_13	RES	40.5	35.6	36.3	31.7	34.1	34.2
61	3	Kenneth_Pl_15	RES	39	34	34.7	29.8	32.5	32.6
62	3	Kenneth_Pl_17	RES	39.1	34.2	34.9	29.9	32.7	32.8
63	3	Kenneth_Pl_19	RES	37.1	32.2	32.9	27.6	30.7	30.8
64	3	Kenneth_Pl_19	RES	37.8	32.9	33.6	27.6	31.4	31.5
65	3	Vales_Rd_117	RES	38.3	33.4	34.1	29.7	31.9	32
66	3	Vales_Rd_117	RES	38.9	34	34.7	29.7	32.5	32.6
67	3	Vales_Rd_119	RES	39.3	34.4	35.1	27.8	32.9	33
68	3	Vales_Rd_119	RES	40.1	35.2	35.9	30	33.7	33.8
69	3	Vales_Rd_148	RES	38	33.1	33.8	29.4	31.6	31.7
70	3	Vales_Rd_150	RES	38.2	33.3	34	29.6	31.8	31.9

No.	NCA	Name (StreetName_StreetNo.)	Usage	Predicted construction noise impacts – dB(A) (Standard Hours)					
				Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
71	4	Tall_Timbers_Rd_150	OAC	37.3	32.3	33	27.9	30.8	30.9
72	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
73	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
74	4	Tall_Timbers_Rd_150	OAC	37.1	32.2	32.9	27.5	30.7	30.8
75	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
76	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.9	30.9	31
77	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
78	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.4	30.9	31
79	4	Tall_Timbers_Rd_150	OAC	37.2	32.3	33	27.4	30.8	30.9
80	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.4	30.9	31
81	4	Tall_Timbers_Rd_150	OAC	38.1	33.2	33.9	28.5	31.7	31.8
82	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.4	30.9	31
83	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.4	30.9	31
84	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.7	30.9	31
85	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
86	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
87	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.3	30.9	31
88	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
89	4	Tall_Timbers_Rd_150	OAC	37.3	32.4	33.1	27.5	30.9	31
90	5	Pacific_Hwy_140	IND	39.6	34.6	35.3	30	33.1	33.2
91	5	Ruttleys_Rd_464	IND	54.9	50	50.7	43	48.5	48.6
92	5	Pacific_Hwy_130	RES	37.1	32.2	32.9	27.8	30.7	30.8
93	5	Pacific_Hwy_170	RES	40.4	35.5	36.2	30.9	34	34.1

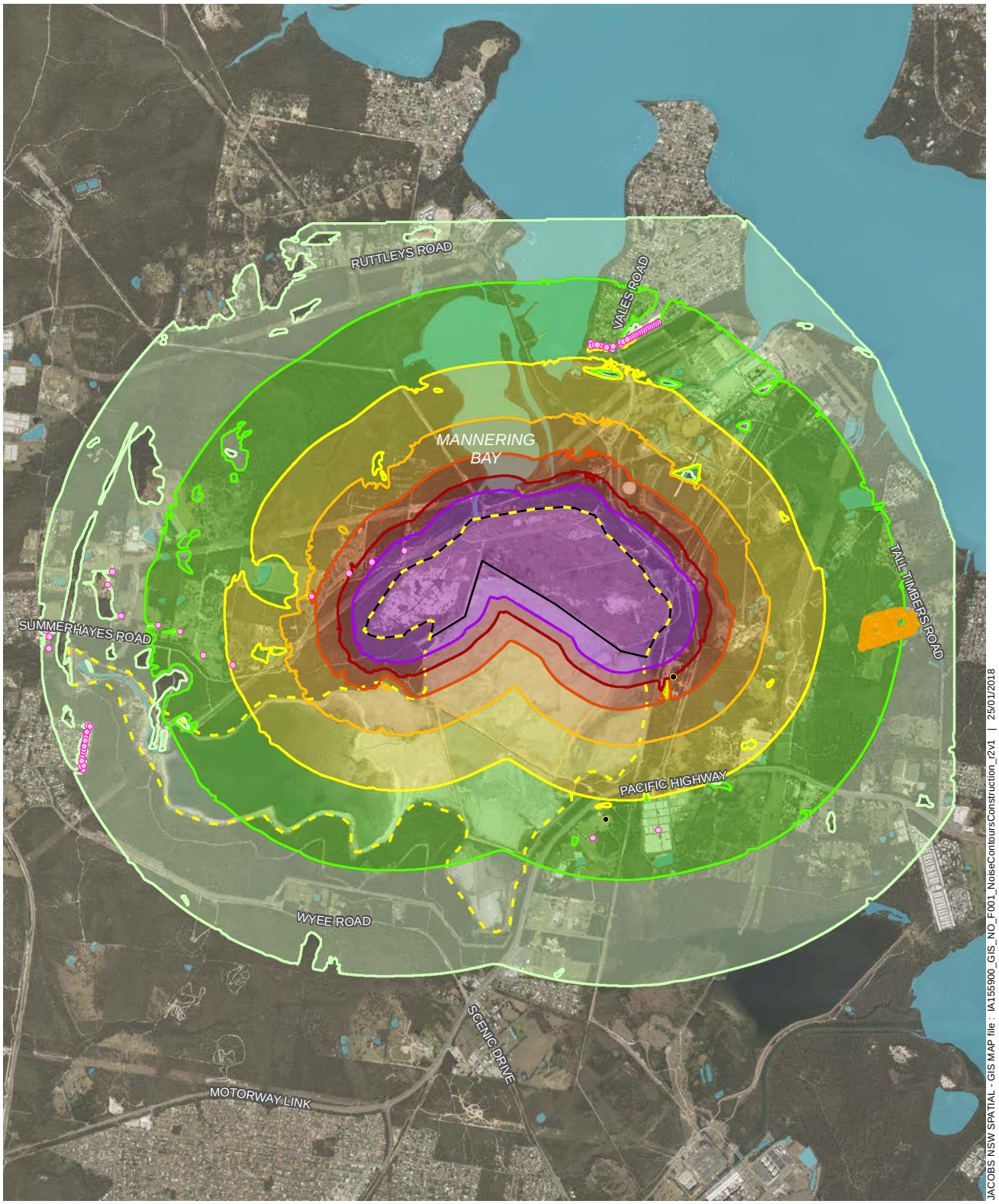
JACOBS

Appendix D. Detailed predicted operational noise results

Name	Criteria		NCA	Predicted noise levels $L_{Aeq(period)}$ dB(A)					
				Fixed			Tracking		
	Day	Evening		Neutral	Adverse Wind	Inversion	Neutral	Adverse Wind	Inversion
Boikonumba_Rd_33	38	37	1	1	8	9	2	9	9
Boikonumba_Rd_35	38	37	1	10	17	17	12	19	19
Bukkai_Rd_1	38	37	1	10	17	17	13	19	20
Bukkai_Rd_1A	38	37	1	10	17	17	13	19	20
Bukkai_Rd_3	38	37	1	10	17	17	13	20	20
Bukkai_Rd_7	38	37	1	11	17	17	13	20	20
Bukkai_Rd_9	38	37	1	12	19	19	14	21	21
Bukkai_Rd_11	38	37	1	8	15	15	12	18	18
Bukkai_Rd_13	38	37	1	11	18	18	13	20	20
Bukkai_Rd_15	38	37	1	11	18	18	13	20	20
Bukkai_Rd_17	38	37	1	11	18	18	13	20	20
Bukkai_Rd_19	38	37	1	11	18	18	13	20	20
Bukkai_Rd_21	38	37	1	11	18	18	13	20	20
Darlingup_Rd_52	38	37	1	11	18	18	13	20	20
Darlingup_Rd_54	38	37	1	11	18	18	14	20	20
Tuggarah_St_15	38	37	1	10	17	17	13	19	20
Tuggarah_St_17	38	37	1	10	17	17	13	19	20
Tuggarah_St_19	38	37	1	10	17	17	13	19	20
Rodgers_Rd_6	38	37	2	13	20	20	16	22	22
Rodgers_Rd_25	38	37	2	10	16	16	12	19	19
Rodgers_Rd_43	38	37	2	13	20	19	15	22	22
Summerhayes_Rd_115	38	37	2	15	21	21	17	24	24
Summerhayes_Rd_133	38	37	2	16	22	22	18	25	24
Summerhayes_Rd_149	38	37	2	17	23	23	19	25	25
Summerhayes_Rd_171	38	37	2	18	24	24	20	26	26
Summerhayes_Rd_171	38	37	2	18	24	24	21	27	26
Summerhayes_Rd_263	38	37	2	24	30	29	28	32	32
Summerhayes_Rd_305	38	37	2	31	35	34	36	39	38
Summerhayes_Rd_325	38	37	2	34	37	37	40	42	42
SummerHayes_Rd_285	38	37	2	29	33	32	32	36	36
Griffith_St	38	37	3	19	25	25	22	28	28
griffith_St_34	38	37	3	18	24	24	21	27	27
Griffith_St_2	38	37	3	19	25	25	22	28	28
Griffith_St_6	38	37	3	18	25	24	21	27	27
Griffith_St_8	38	37	3	19	25	25	22	28	27
Griffith_St_10	38	37	3	19	25	25	22	28	27
Griffith_St_12	38	37	3	19	25	25	22	28	27
Griffith_St_14	38	37	3	19	25	24	22	28	27
Griffith_St_16	38	37	3	19	25	24	21	28	27
Griffith_St_18	38	37	3	18	25	24	21	28	27
Griffith_St_20	38	37	3	18	25	24	21	28	27
Griffith_St_22	38	37	3	18	25	24	21	27	27
Griffith_St_24	38	37	3	18	25	24	21	27	27
Griffith_St_26	38	37	3	18	24	24	21	27	27
Griffith_St_28	38	37	3	18	24	24	21	27	27
Griffith_St_30	38	37	3	18	24	24	21	27	27
Griffith_St_32	38	37	3	18	24	24	21	27	27
Griffith_St_36	38	37	3	18	24	24	20	27	26
Griffith_St_38	38	37	3	18	24	24	20	27	26

Name	Criteria		NCA	Predicted noise levels $L_{Aeq(period)}$ dB(A)					
				Fixed			Tracking		
	Day	Evening		Neutral	Adverse Wind	Inversion	Neutral	Adverse Wind	Inversion
Kenneth_Pl_7	38	37	3	22	28	28	25	31	30
Kenneth_Pl_9	38	37	3	22	28	27	24	30	30
Kenneth_Pl_11	38	37	3	20	26	26	23	29	28
Kenneth_Pl_13	38	37	3	20	26	25	23	29	28
Kenneth_Pl_15	38	37	3	20	26	25	23	29	28
Kenneth_Pl_17	38	37	3	20	26	25	23	29	28
Kenneth_Pl_19	38	37	3	14	20	19	15	21	20
Vales_Rd_117	38	37	3	18	24	24	19	25	25
Vales_Rd_119	38	37	3	18	24	24	20	26	26
Vales_Rd_148	38	37	3	18	24	23	20	26	26
Vales_Rd_150	38	37	3	19	26	25	22	28	28
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	17	24	23	20	26	26
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	14	20	20	15	21	21
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Tall_Timbers_Rd_150	55	45	4	16	23	22	19	25	25
Pacific_Hwy_130	55	45	5	18	25	24	20	27	26
Pacific_Hwy_170	55	45	5	20	26	26	22	28	28
Ruttleys_Rd_464	70		5	28	32	31	29	34	33
Pacific_Hwy_140	70		5	20	26	25	22	28	27

Appendix E. Predicted construction noise contours



Legend

Direct impact area

Ash dam boundary

Noise sensitive receivers

Residential Old Age Care Industrial

Noise contours (dB)

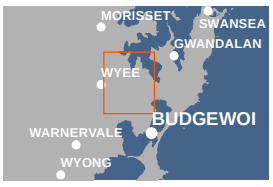
30 40 50 60

35 45 55

0 1 2km

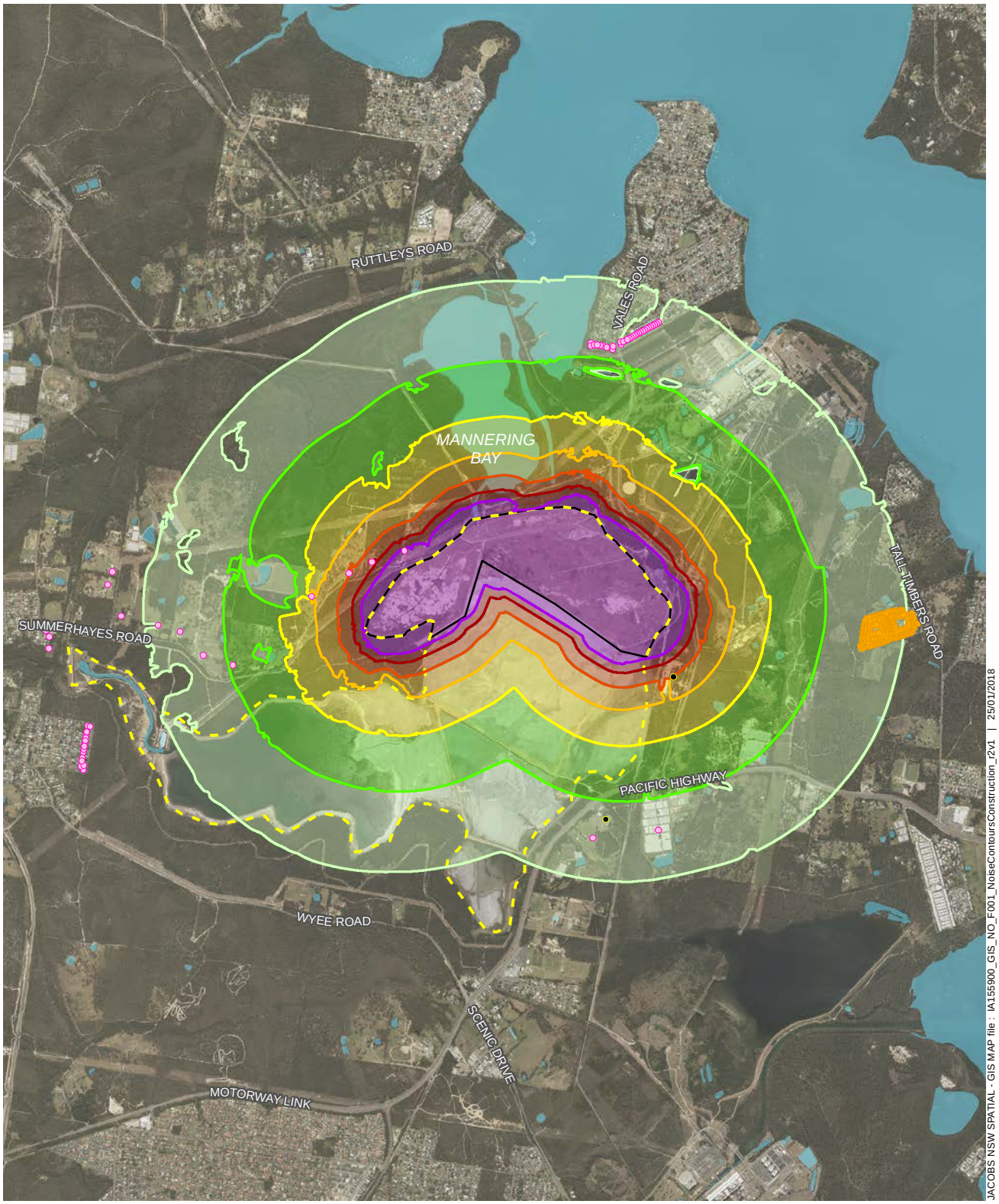
1:40,000 @ A4

N



E.1 | Construction stage 1

Appendix E. Predicted construction noise contours



Legend

Direct impact area

Ash dam boundary

Noise sensitive receivers

Residential

Old Age Care

Industrial

Noise contours (dB)

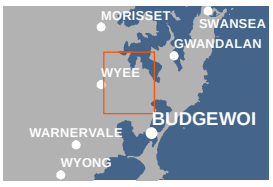
30 40 50 60

35 45 55

0 1 2km

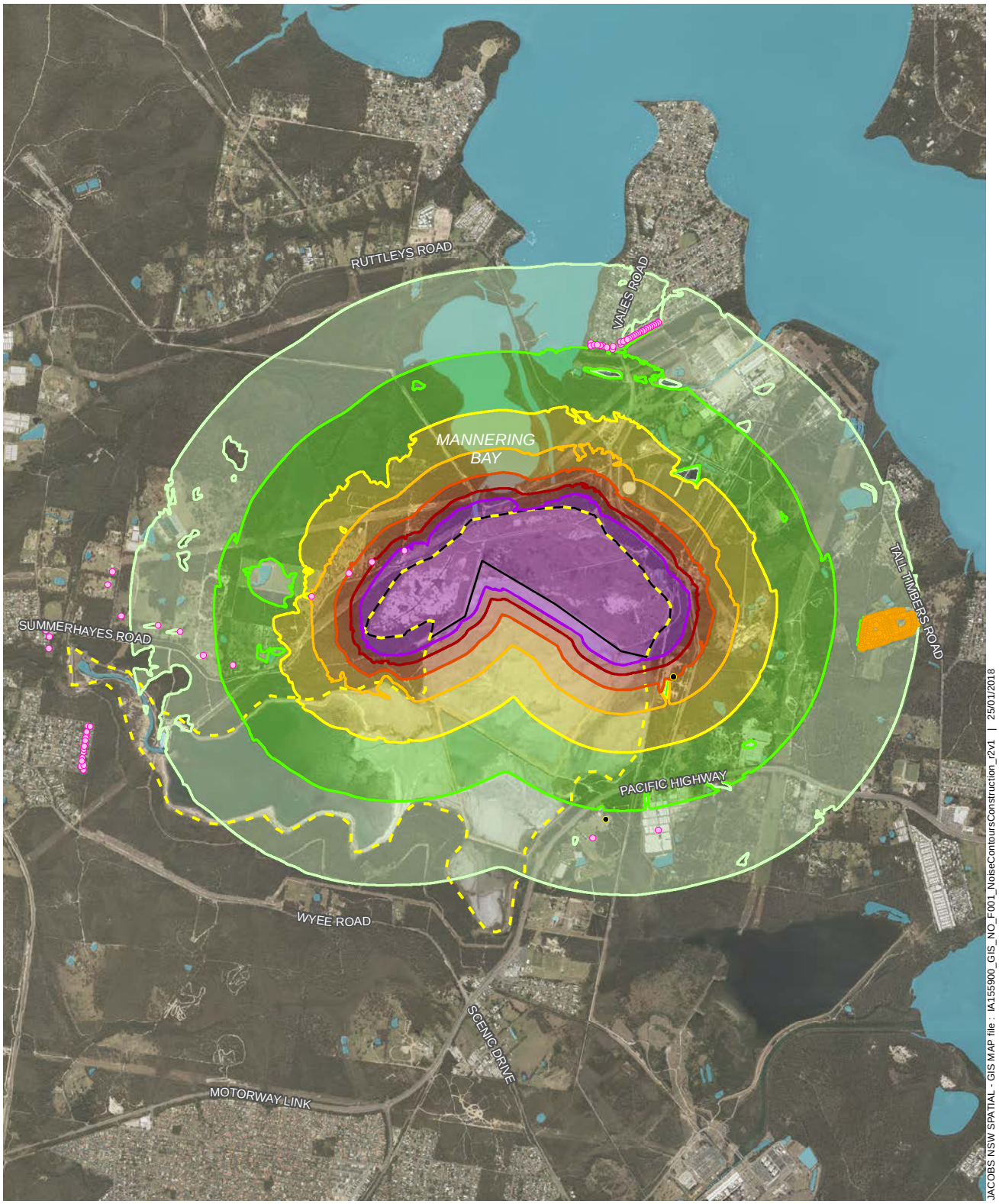
1:40,000 @ A4

N



E.2 | Construction stage 2

Appendix E. Predicted construction noise contours



Legend

Direct impact area

Ash dam boundary

Noise sensitive receivers

Residential

Old Age Care

Industrial

Noise contours (dB)

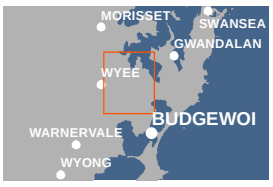
30 40 50 60

35 45 55

0 1 2km

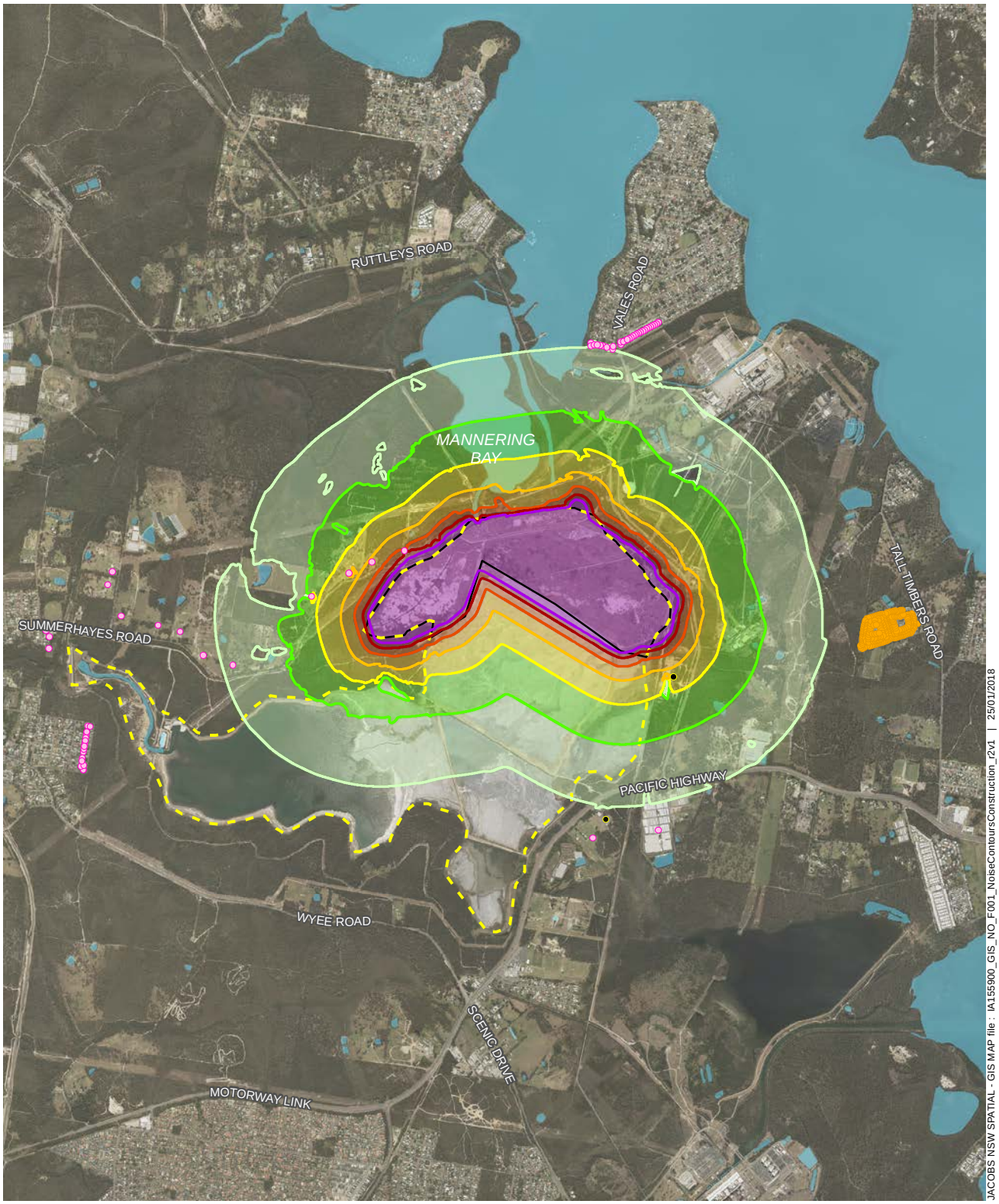
1:40,000 @ A4

N



E.3 | Construction stage 3

Appendix E. Predicted construction noise contours



Legend

Direct impact area

Ash dam boundary

Noise sensitive receivers

Residential

Old Age Care

Industrial

Noise contours (dB)

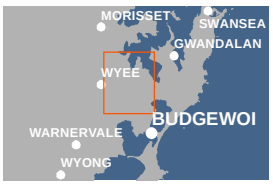
30 40 50 60

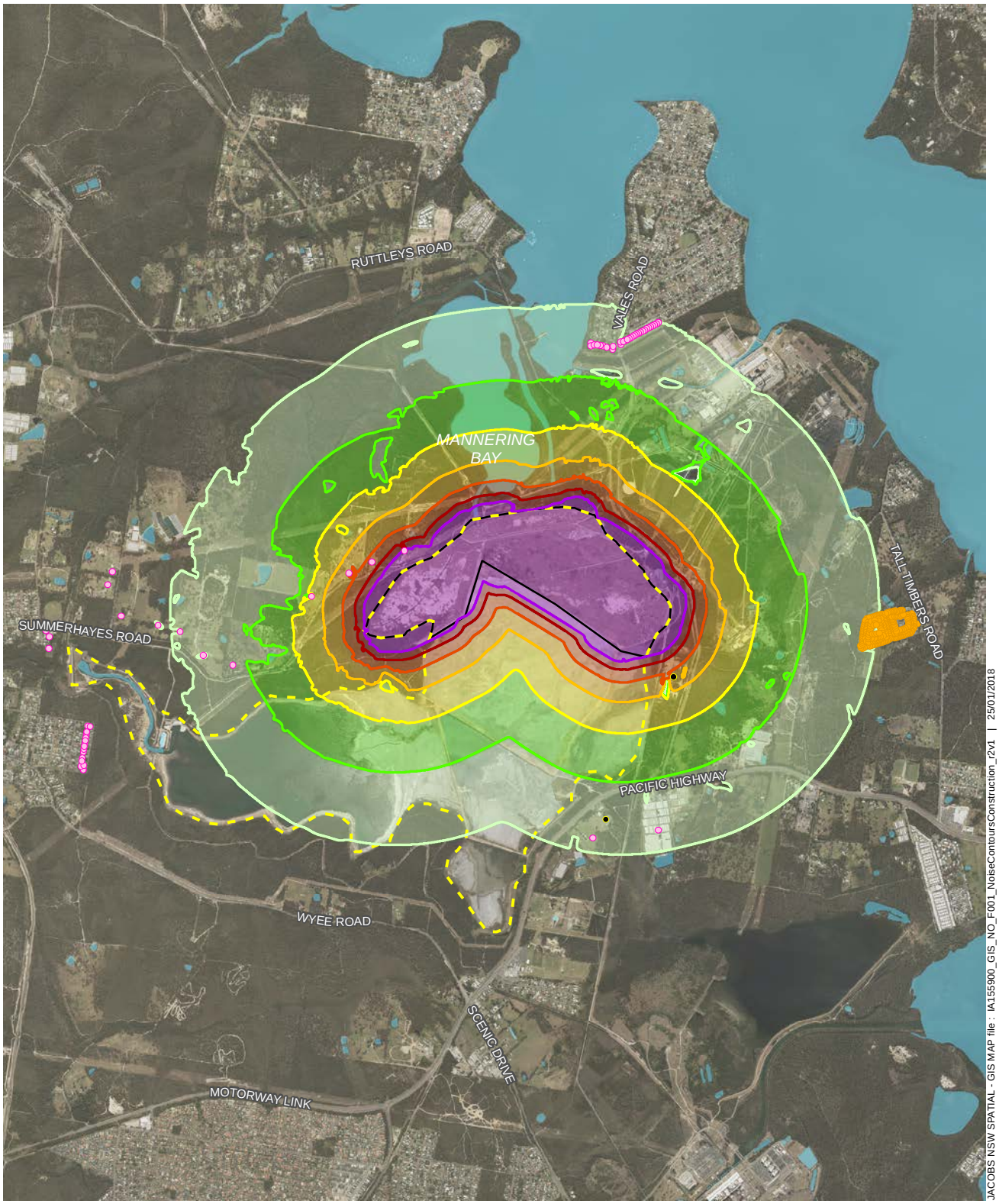
35 45 55

0 1 2km

1:40,000 @ A4

N





Legend

Direct impact area

Ash dam boundary

Noise sensitive receivers

Residential

Old Age Care

Industrial

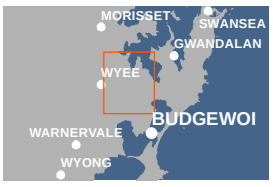
Noise contours (dB)

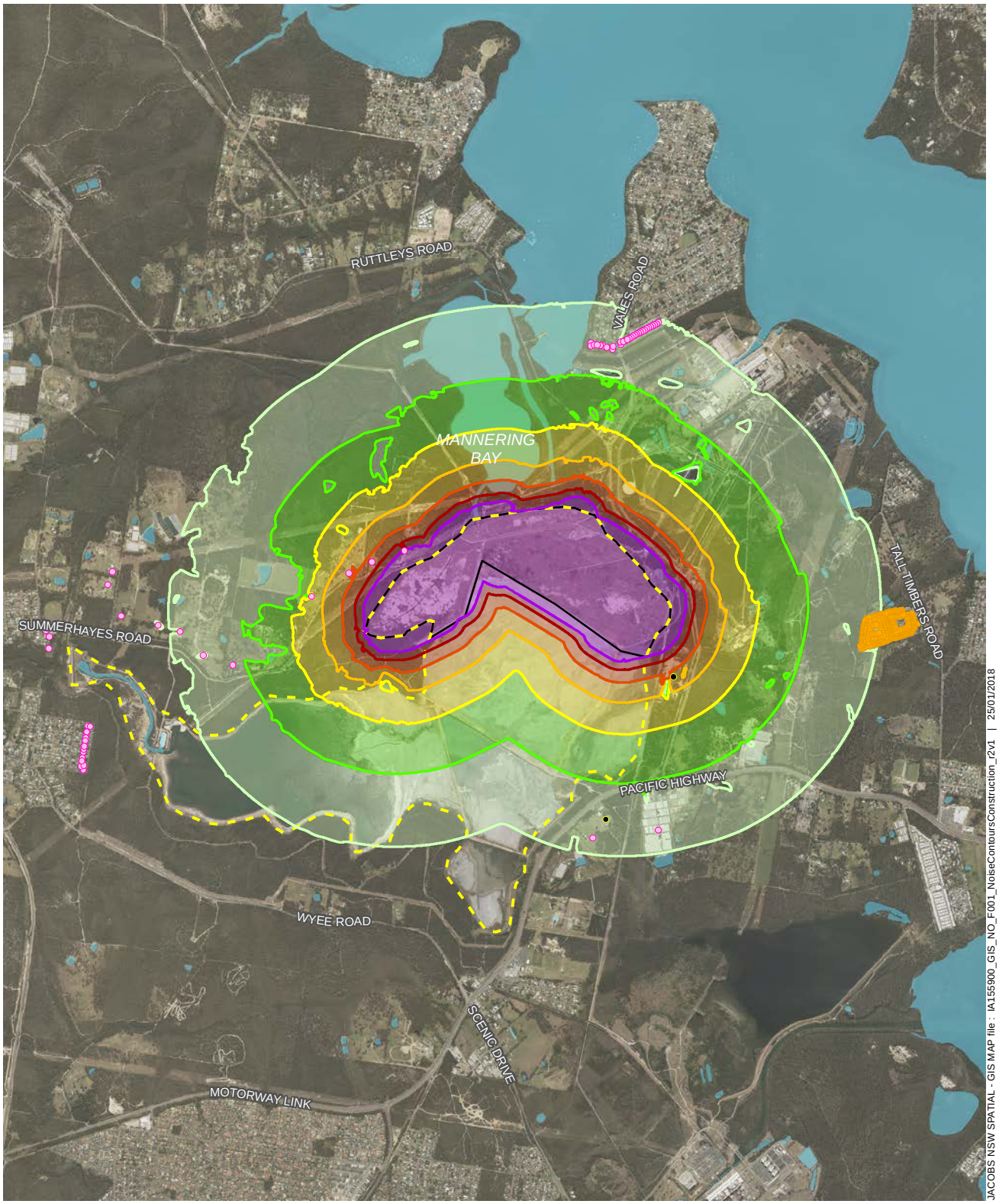
30 40 50 60

35 45 55

0 1 2km

1:40,000 @ A4





Legend

Direct impact area

Ash dam boundary

Noise sensitive receivers

Residential

Old Age Care

Industrial

Noise contours (dB)

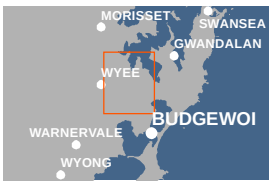
30 40 50 60

35 45 55

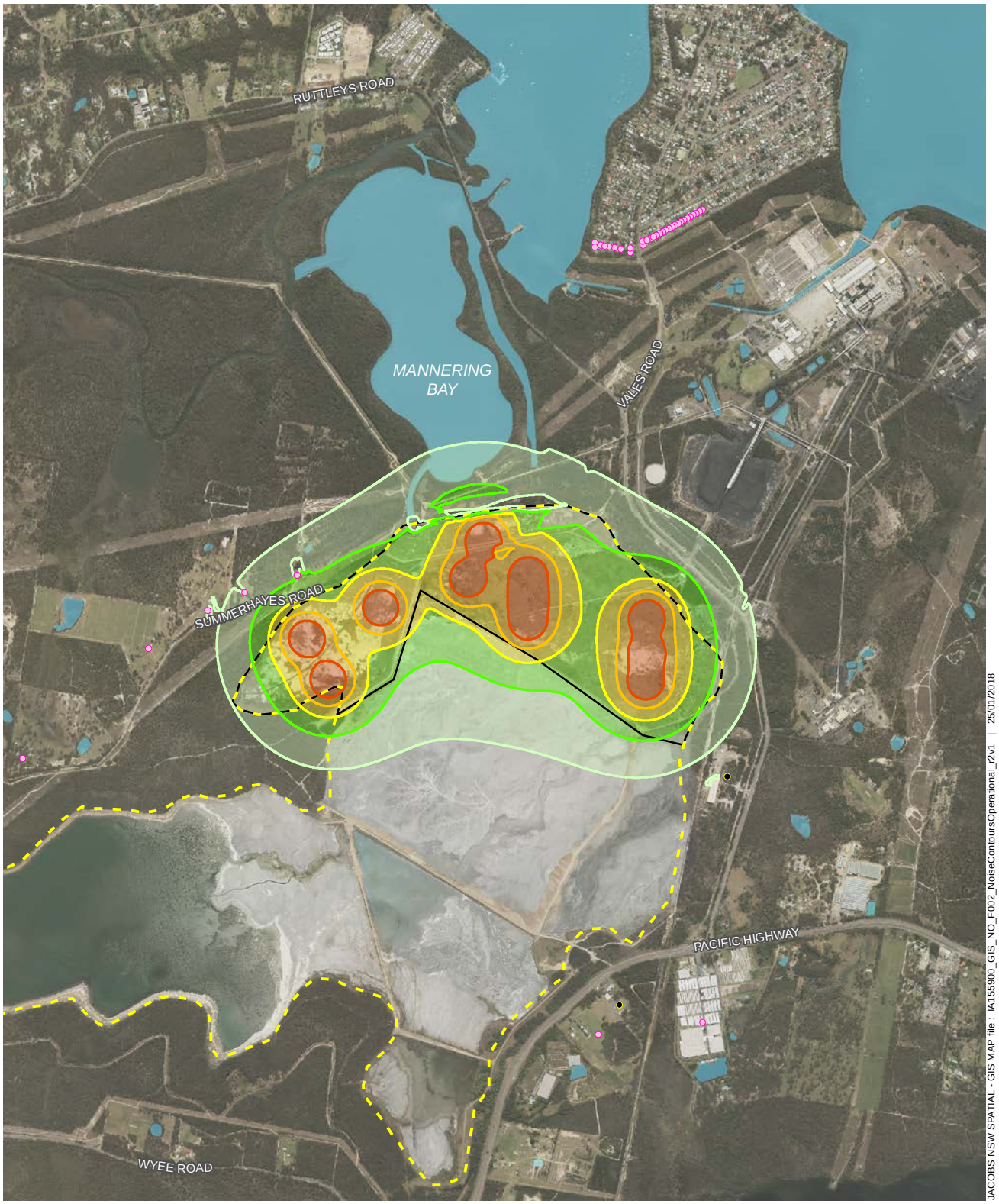
0 1 2km

1:40,000 @ A4

N



Appendix F. Predicted operational noise contours



JACOBS NSW SPATIAL - GIS MAP file : IA155900_GIS_NO_F002_NoiseContoursOperational_r2v1 | 25/01/2018

Legend

Direct impact area

Ash dam boundary

0 0.5 1km

1:25,000 @ A4

Noise sensitive receivers

Residential

Industrial

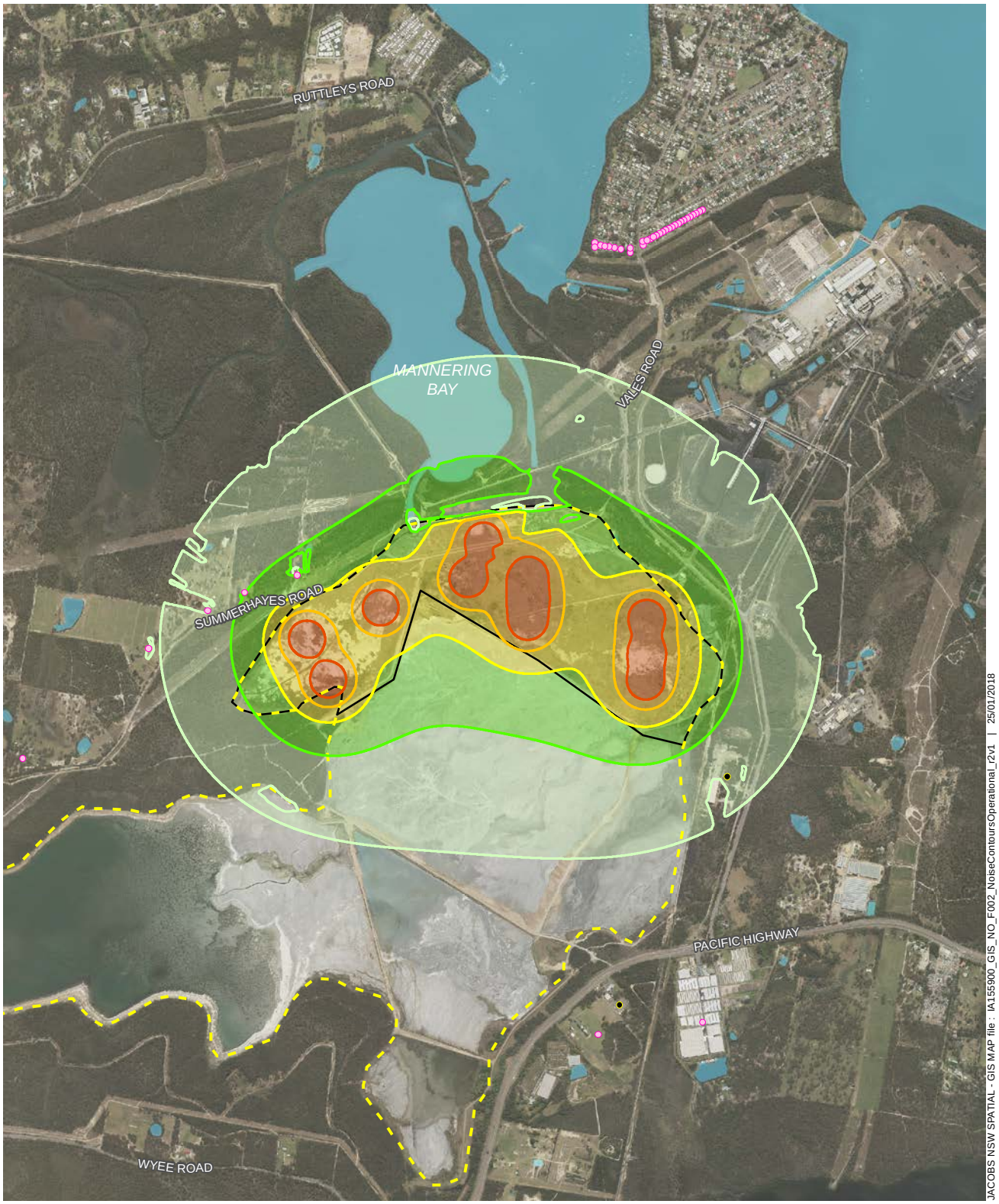
Noise contours (dB)

30 40 50

35 45

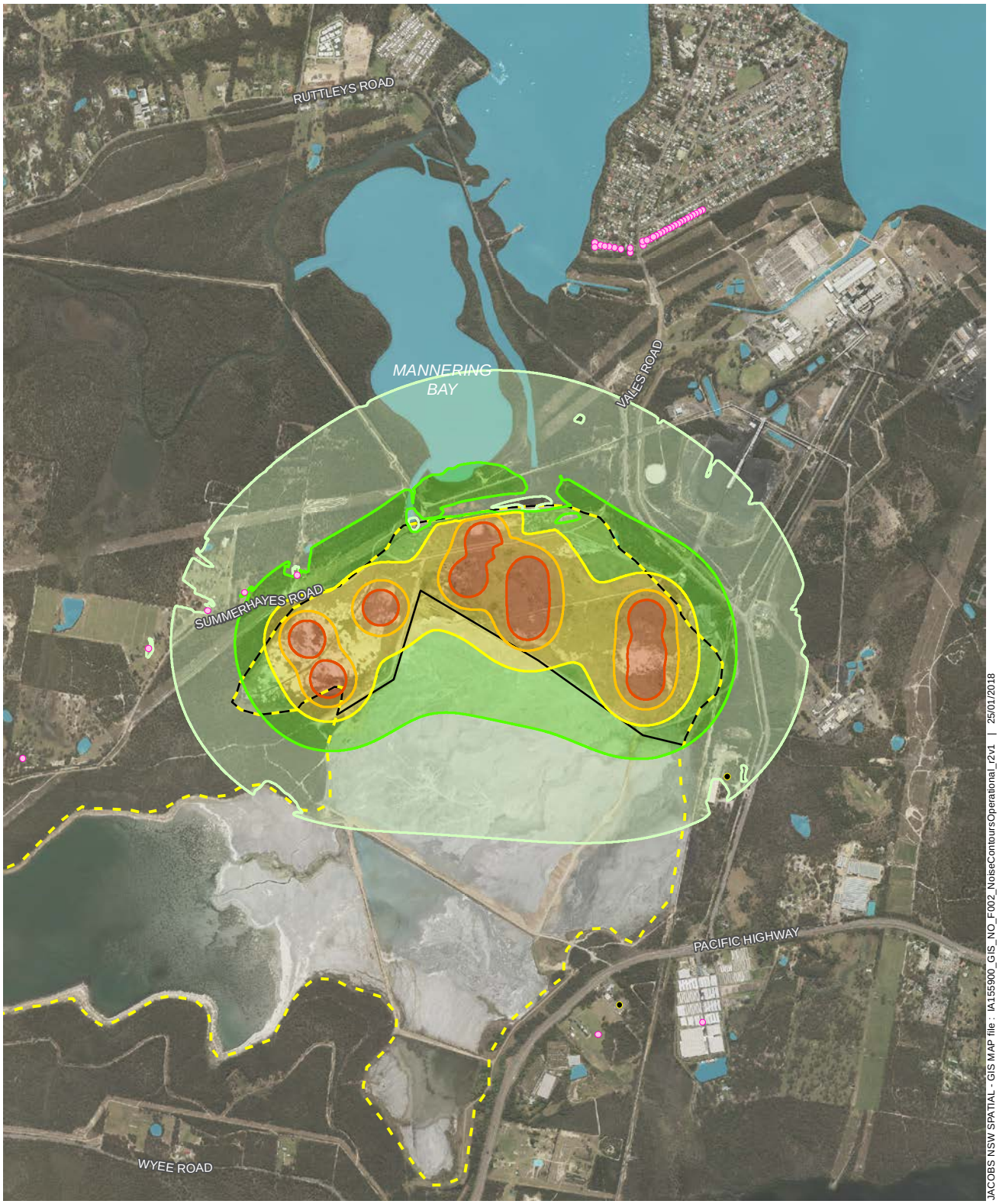
F.1 | Fixed panels - operational noise impacts during neutral meteorological condition

Appendix F. Predicted operational noise contours



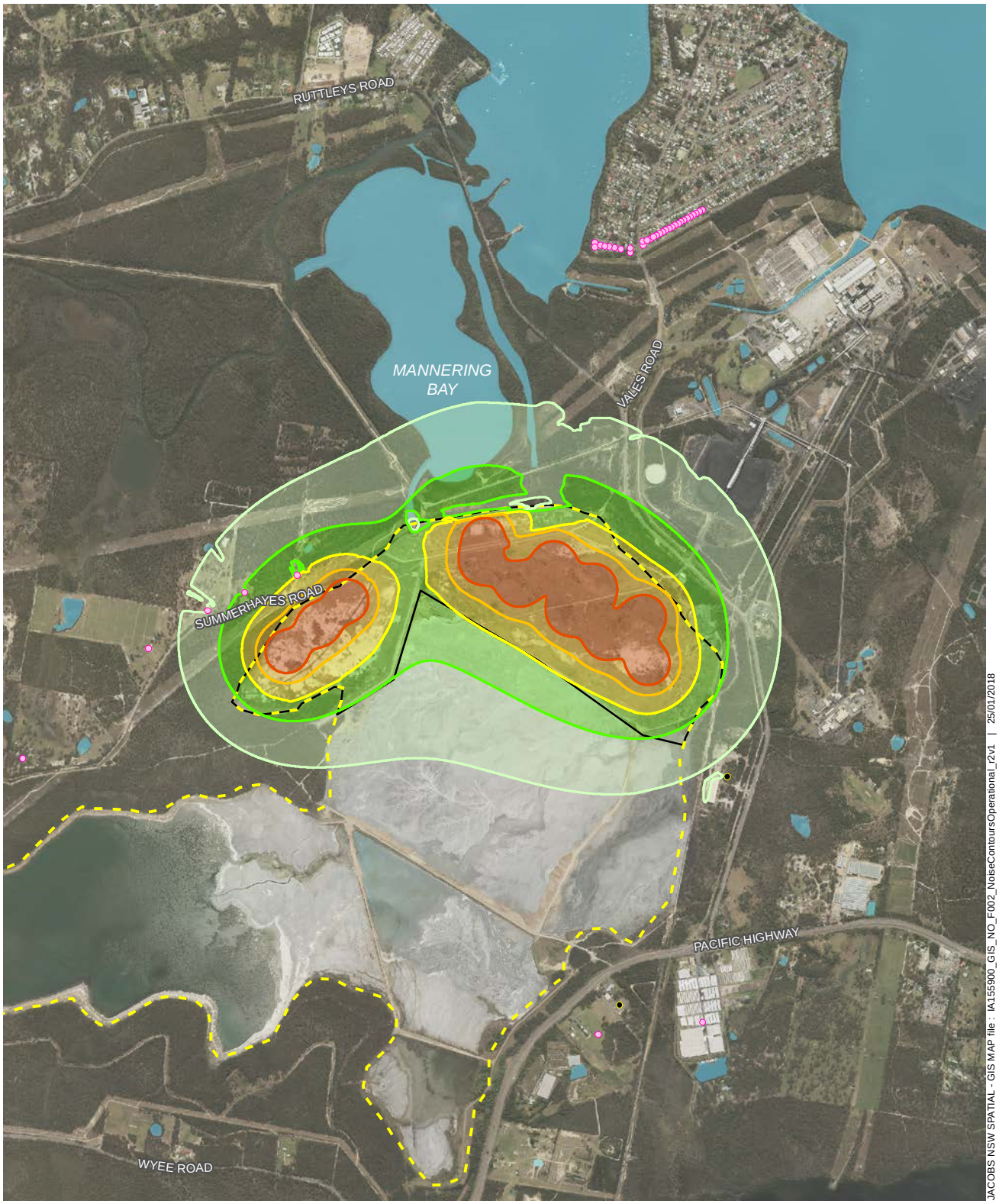
F.2 | Fixed panels - operational noise impacts during adverse wind condition

Appendix F. Predicted operational noise contours



F.3 | Fixed panels - operational noise impacts during temperature inversion condition

Appendix F. Predicted operational noise contours

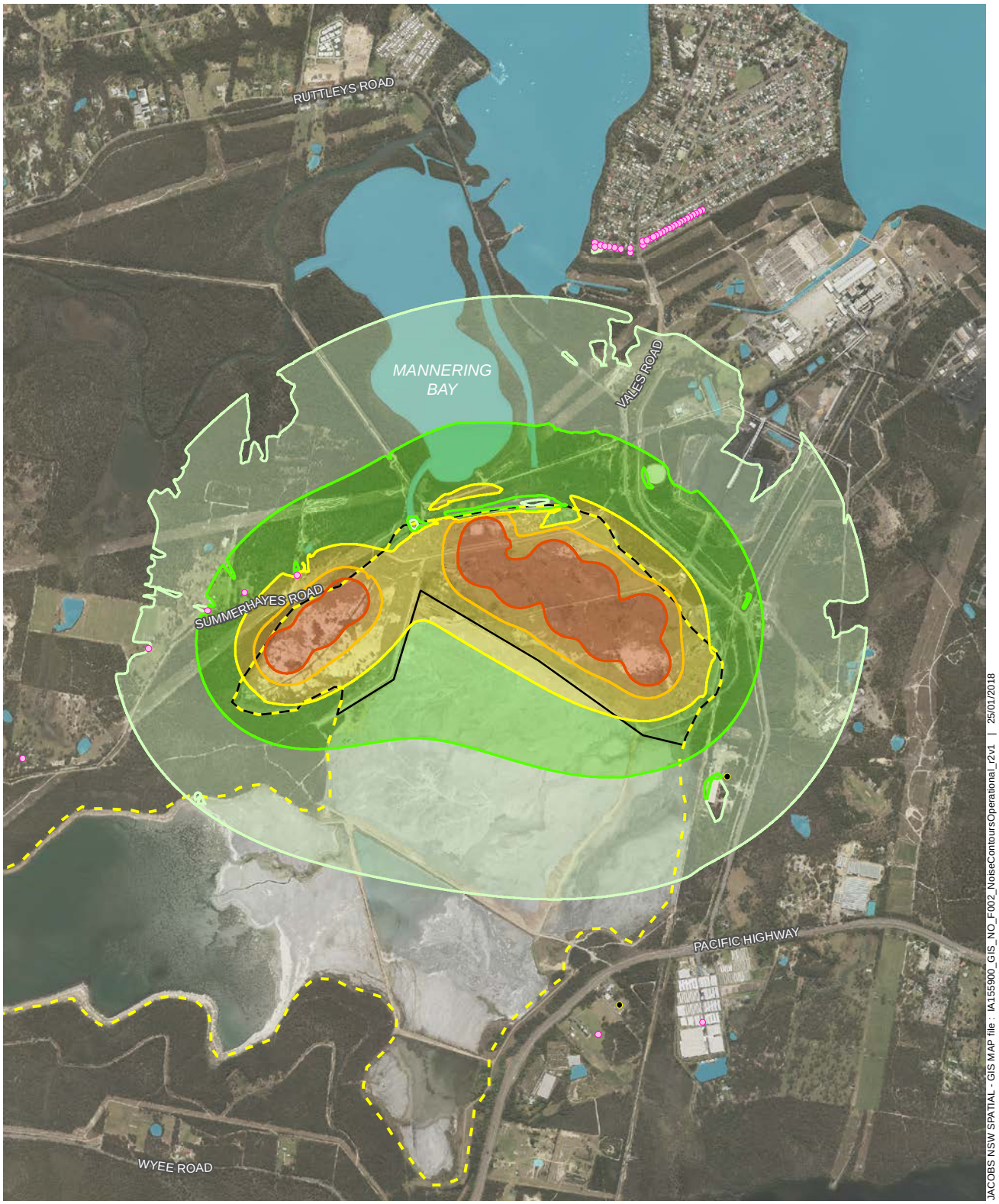


F.4 | Tracking panels - operational noise impacts during neutral meteorological condition

Appendix F. Predicted operational noise contours

F.5 | Tracking panels - operational noise impacts during adverse wind condition

Appendix F. Predicted operational noise contours



F.6 | Tracking panels - operational noise impacts during temperature inversion condition

Appendix F. Predicted operational noise contours