Eraring Power Station Battery Energy Storage System

Noise Impact Assessment Report

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Origin Energy Eraring Pty Ltd

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Executive Summary

Background

Origin Energy Eraring Pty Limited (Origin) owns and operates the Eraring Power Station (EPS) which is the largest power station in Australia, having a capacity of 2,880 megawatts (MW). Origin is seeking regulatory and environmental planning approval for the construction and operation of a grid-scale Battery Energy Storage System (BESS) with a discharge capacity of 700 MW and storage capacity of 2,800 megawatt hours (MWh) within the Origin landholding associated with the EPS (the Project). The Project area is located within the Local Government Area (LGA) of Lake Macquarie.

Jacobs on behalf of Origin is currently developing an Environmental Impact Statement (EIS) for the assessment of the Eraring Battery Energy Storage System in accordance with Part 4, Division 4.7 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This noise impact assessment report has been prepared to inform the EIS.

The Project would include construction and operation of:

- BESS compounds comprising of rows of enclosures housing lithium-ion type batteries connected to associated power conversion systems (PCS) and high voltage (HV) electrical reticulation equipment;
- A BESS substation housing high voltage transformers and associated infrastructure;
- Approximately 400 metres (m) of overhead 330 kilovolt (kV) transmission line connecting the BESS substation to the existing 330 kV TransGrid switchyard; and
- Ancillary infrastructure and facilities including safety protection systems and site ancillary facilities such as laydown areas and site offices.

The BESS compound is proposed to be constructed and commissioned in up to three stages.

Key features of the existing environment

The Project area is about 25 ha within an industrial area with the primary land use being energy generation. The Project area is located on a non-operational area in the southwestern portion of the Origin landholding associated with the EPS which has recently been rehabilitated. Historically, the land in the vicinity of the Project has been utilised for power generation and coal mining since the 1980's.

Land use in cardinal directions surrounding the Project site are as follows:

- To the north is the EPS, zoned as SP2 Infrastructure (Electricity Generating Works);
- To the west is land zoned predominately as E2 – Environmental Conservation and RU2 – Rural Landscape along Gradwells Road, Dora Creek;
- To the east and southeast is also zoned predominately as E2 – Environmental Conservation, with land along Border Street zoned as RU4 – Primary Production Small Lots and the land along Point Piper Road zoned as E4 – Environmental Living; and
- To the south is land predominately zoned as R2 – Low Density Residential and RE1 – Public Recreation associated with the Dora Creek township.

Technical Inputs

Noise emissions have been predicted to occur during the construction and operation of the Project.

Construction of each Project stage would be undertaken in four key phases as follows:

- Site establishment;
- Cut and fill to battery compound and transformer yard and establishment of pad;

- Structural works to support battery enclosures, inverters, transformers, building and transformer compounds and transmission structures; and
- Delivery, installation and electrical fit-out of components.

A fifth Project phase is also assessed in the NIA related to the use of an air track drill for establishment of transmission structure footings within the transmission line easement only. This fifth phase would be undertaken only during works associated with the first Project stage to be constructed and over short duration.

The construction noise levels have been estimated by developing an equipment inventory for each phase of construction works and applying an appropriate noise level for each piece of equipment from Jacobs' and other noise databases. The individual noise levels were then combined to form an overall sound power level for each phase of construction (detailed in Table 5.1). Likewise, any equipment that was predicted to be a source of vibration emissions was compared against vibration setback distances to determine the potential extent of vibration impacts resulting from the construction of the Project.

Operational noise impacts were predicted based on sound power levels of the individual BESS components, which were modelled in potential configurations to assess operational noise levels at receiving locations. Both the sound power levels and BESS configurations used in the assessment were developed on a representative basis, based on supplier datasheets and other inputs. Stages of Project delivery were individually assessed to understand the noise impacts as each Project stage is commissioned and enters operation.

Assessment of Impacts

Construction noise and vibration impacts

The construction of the Project will be undertaken in five phases. Construction Phases 2 and 5 have been identified as requiring mitigation of noise impacts. Without additional noise mitigation, noise from Phase 2 and Phase 5 is predicted to be up to 3 dB(A) above the relevant NMLs at Noise Catchment Area (NCA) 1, NCA 2 NCA 5, and up to 2 dB(A) above the NML at NCA 3. No noise levels were predicted to be above NMLs at the other NCAs.

Vibration impacts as a result of construction were estimated to be potentially capable of causing human comfort impacts up to 100m from the Project site, estimated to potentially cause cosmetic damage to buildings up to 25m away from the Project site, and possibly able to cause damage to heritage items at 45m from the Project site. However, no vibration sensitive receivers have been identified within these distances, consequently no vibration impacts from construction activities are expected.

Operational noise and vibration impacts

Operational noise levels for the full development of the Project based on available technologies under consideration are predicted to comply with all Project noise trigger levels (PNTL) while operating at full load during all time periods and meteorological conditions without the need to install any site-specific noise control attenuation treatments. However, it is noted that noise at one receiver will reach but not be higher than the PNTL under noise enhancing conditions.

The exact types, sizes and acoustic performance of individual noise sources will be determined during the Detailed Design phase. Depending on the variation in noise emissions of different plant components between different manufacturers' models, more or less noise attenuation may need to be applied to different types of noise sources on site in order to achieve the required overall total site noise attenuation. Nevertheless, it is expected that all of the potential BESS equipment suppliers, using measures such as thermal cycling and fan speed controls or attenuation, will be able to include sufficient and adequate noise control to achieve the Project's target noise levels at all receivers during the combined operation of all Project stages.

It is further noted that the BESS units would most likely reach their operational peak during the mid-morning period (6am – 8am) and evening period (5pm – 7pm), with a reduced operation during the midday and night periods. As such, it is not expected that there will be a significant crossover of when the BESS will be at its peak of operation and when night period noise enhancing conditions (i.e. temperature inversions) are expected to be present.

It has been predicted that noise from the Project would be quieter than that of the Cooranbong Entrance Site in NCA 1 (Gradwells Road) and hence noise from the Project would not be the dominant noise source, limiting the possibility of a cumulative noise impact.

In regards to cumulative noise impacts with the EPS, noise from the Project is expected to be predominately masked by existing EPS noise. In instances where the Project is predicted to be the louder noise source, the cumulative impact may increase noise levels by up to 3 dB(A). The cumulative noise level of all three stages of the Project and EPS may reach up to 44 dB(A), 2 dB(A) above the night noise limit under noise-enhancing conditions. As per the applicable guidelines, this exceedance would be negligible in nature and would not be discernible by the average listener, and therefore would not warrant receiver-based treatments or controls. Additionally, as previously stated, the likelihood of the Project undergoing full load while also requiring full thermal performance at the same time as night-time noise enhancing conditions taking place is very low and would be highly infrequent in nature.

Mitigation and Management

Construction works

The range of noise exceedances as a result of construction would be manageable through the use of standard mitigation measures of the Interim Construction Noise Guideline (Department of Environment and Climate Change [DECC], 2009) and Construction Noise and Vibration Guideline (RMS, 2016). These measures would be applied where reasonable and feasible to address the predicted impacts. As no vibration impacts have been predicted, no vibration mitigation is required.

Operation

The achievement of compliance with the noise limits from the combined operation of all Project stages will be incorporated as a performance expectation of the supply, installation, operation and maintenance contracts between Origin and the supplier(s). Origin would undertake a review of noise impacts of the ultimately chosen technology and layout for the need to implement site-specific noise controls or attenuation treatments to assure that the Project fully complies with the PNTL at all receivers at all times under all licensable meteorological conditions. The Project would also implement a Noise Management Program (NMP). The NMP would include that noise measurement and modelling investigation be undertaken during commissioning and operation of initial stages, with the specific purpose of quantifying any noise reduction that may be necessary for subsequent stages or to be retro-fitted if necessary.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential construction and operation related noise impacts for the Eraring BESS in accordance with the scope of services set out in the contract between Jacobs and Origin Energy (Origin). That scope of services, as described in this report, was developed with Origin.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Origin and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from Origin (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the Project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Origin, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and Origin. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Project Background

Origin Eraring Energy Pty Limited (Origin) owns and operates the Eraring Power Station (EPS), the largest power station in Australia having a capacity of 2,880 megawatts (MW). EPS is scheduled to be among 14 gigawatts (GW) of coal-fired generation plants to be retired within the next few decades (AEMO, 2020). The retirement of the EPS will support Origin's carbon emission reduction goals. As such, Origin is now progressing an application to provide energy storage and key network services that would facilitate long term emissions reduction in the National Electricity Market (NEM) while supporting the delivery of secure and reliable electricity for consumers and businesses.

Origin is seeking regulatory and environmental planning approval for the construction and operation of a grid-scale Battery Energy Storage System (BESS) with a discharge capacity of 700 MW and storage capacity of 2,800 megawatt hours (MWh) on existing Origin landholding associated with the EPS (the Project).

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP) and subject to Part 4, Division 4.7 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). As such, the Project requires the preparation of an EIS in accordance with Secretary's Environmental Assessment Requirements (SEARs) and the approval of the Independent Planning Commission under circumstances described in SRD SEPP or the NSW Minister for Planning and Public Spaces.

1.2 Purpose of this Report

This Noise Impact Assessment (NIA) has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project on 19th April 2021 by the Planning Secretary of the NSW Department of Planning, Industry and Environment (DPIE).

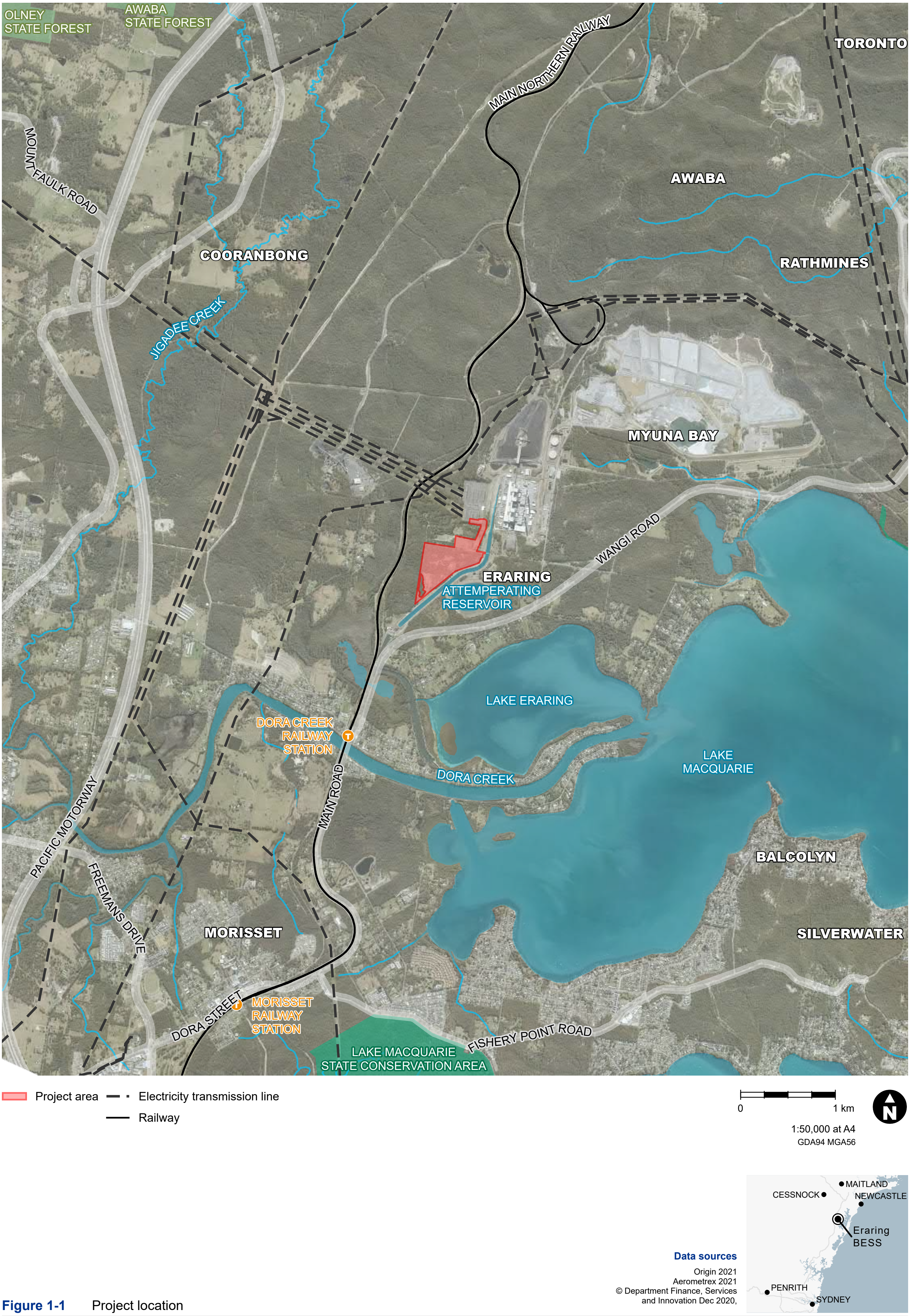
The SEARs relevant to the NIA are summarised in **Table 1.1**, along with a reference to where these requirements have been addressed.

Table 1.1: Secretary's Environmental Assessment Requirements – Noise

Requirement of SEARs	Where addressed
Noise – including an assessment of the:	
construction noise impacts of the development in accordance with the Interim Construction Noise Guideline (ICNG),	**Section 5.1** and **Section 6.1**
operational noise impacts in accordance with the NSW Noise Policy for Industry (2017),	**Section 5.2** and **Section 6.2**
cumulative noise impacts (considering other developments in the area), and	**Section 6.4**
a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria;	**Appendix E**

1.3 Project location

The Project will be situated on land zoned SP2 Infrastructure for electricity generating purposes and within an area previously disturbed by power station activities. No re-zonings or land acquisitions are required. The Project is located within, Lots 10 and 11 DP 1050120, Rocky Point Road Eraring, within the Lake Macquarie City Council (LMCC) LGA, as illustrated in **Figure 1-1**.



Data sources

Origin 2021
Aerometrex 2021
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Figure 1-1 Project location

The surrounding land consists of residential developments and low-density residential properties. The closest commercial centre and population centre nearby is Charlestown (29.1 km north east), and the closest residential suburbs are Eraring (south and east) and Dora Creek (1.2 km south). In between, the centres of Toronto and Morisset are located approximately 8 km northeast and 4km southwest respectively. The closest sensitive receiver is 600 m west of the Project on Gradwells Road and south on Border Street.

The Great Northern Railway (also known as the Main North Line) alignment runs along the border of Dora Creek and Eraring suburbs, 200 m west of the Project. The M1 Pacific Motorway also runs in a north-south direction 3 km west of the Project.

The Project area is surrounded by the following features with the Origin landholding:

- EPS operations area, elevated TransGrid switchyard, coal yards and extensive EPS buffer lands to the north;
- Elevated attemperation reservoir to the east;
- EPS inlet canal to the south and east; and
- Mature vegetation within E2 environmental protection zoned land along a ridge line to the west.

The nearest private receptors to the Project area are located as follows:

- Residential dwellings approximately 600 m to the west on Gradwells Road beyond the Great Northern Railway;
- Dora Creek township approximately 1.5 km to the south;
- Properties on Border Street, Eraring approximately 600 m to the south which are screened by the EPS inlet canal and attemperation reservoir and beyond Wangi Road; and
- Dwellings to the north of Project area located over 4 km away beyond the EPS and mining operations.

1.4 Report Structure

The report structure is as follows:

- **Section 2: Project Description -** describes the Project setting, details and potential noise related risks.
- **Section 3: Existing Environment -** outlines key features of the existing environment including surrounding receivers and background noise levels.
- **Section 4: Policy Setting and Criteria -** establishes suitable assessment criteria.
- **Section 5: Noise emissions -** estimates noise related emissions during the construction and operation of the Project.
- **Section 6: Assessment of Impacts -** predicts the potential for noise related impacts at the identified surrounding receivers.
- **Section 7: Mitigation and Management -** evaluates the significance of these predictions and recommends mitigation and management measures.

2. Project Description

2.1 Overview

Origin is seeking regulatory and environmental planning approval for the construction and operation of a grid-scale BESS with a discharge capacity of 700 MW and storage capacity of 2,800 MWh at the Project area. The Eraring BESS would be among the largest battery projects in NSW and Australia in terms of peak power output and discharge duration. The Project would provide energy storage and key network services that would facilitate long term emissions reduction in the NEM while supporting the delivery of secure and reliable electricity for consumers and businesses.

The Project would be situated within the Origin landholding associated with the EPS located on the western shore of Lake Macquarie. The EPS is approximately 40 km south of Newcastle and approximately 120 km north of Sydney in NSW. The total area of the Origin's landholding is approximately 1,200 hectares (ha), including EPS operational areas, Eraring Ash Dam and surrounding buffer lands consisting of bushland and grassland interspersed with roads and water management and electricity transmission infrastructure.

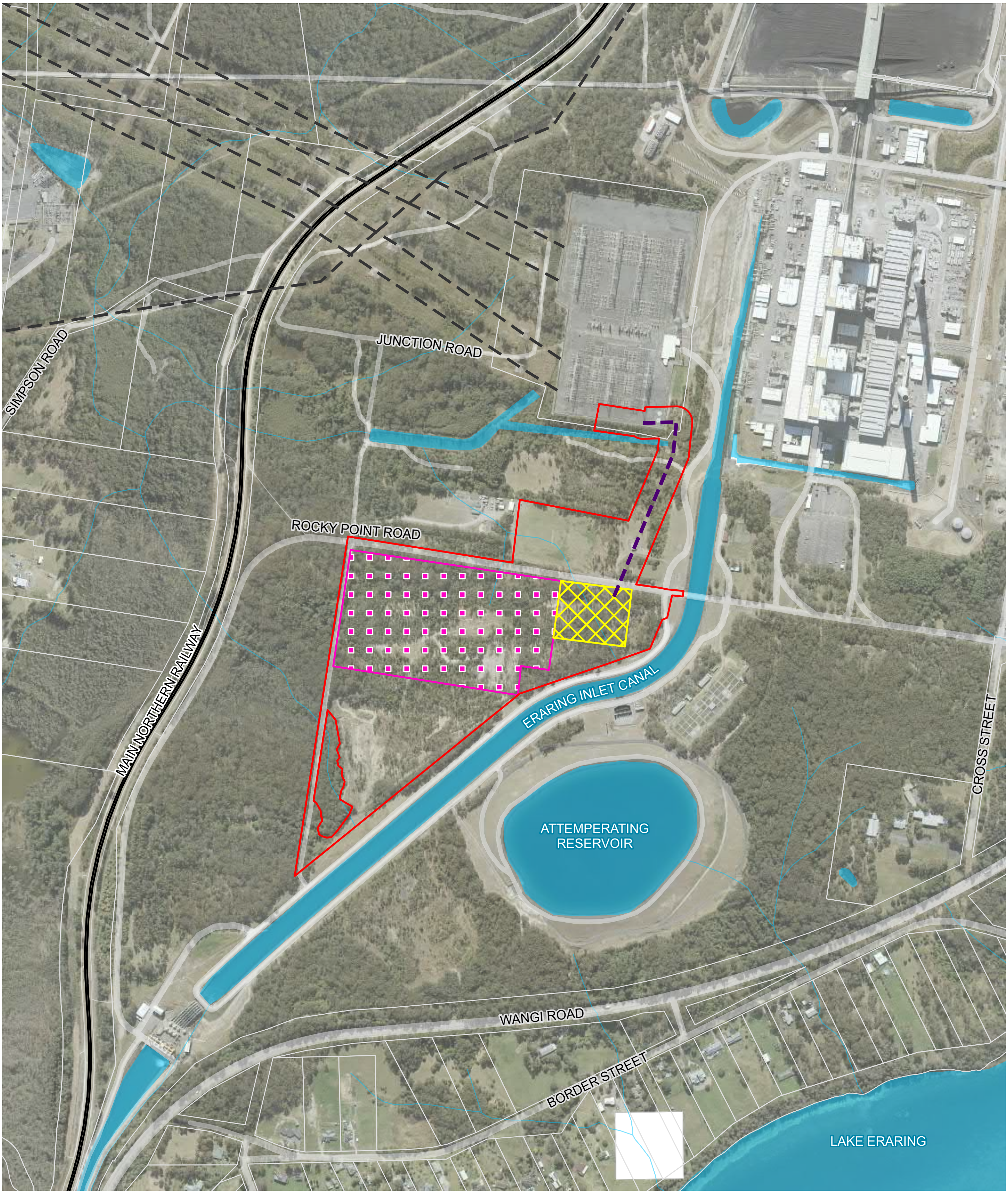
The Project would include the construction and operation of:

- BESS compounds housing rows of enclosures housing lithium-ion type batteries and associated power conversion systems with discharge capacity of up to 700 MW and storage capacity of 2800 MWh able to dispatch over variable durations from four hours to beyond eight hours;
- A BESS substation housing high voltage (HV) and medium voltage (MV) transformers and associated infrastructure;
- Approximately 400 m of overhead 330 kilovolt (kV) transmission line connecting the BESS substation to the existing 330 kV TransGrid switchyard; and
- Ancillary infrastructure and facilities including safety protection systems and site ancillary facilities such as laydown areas and site offices.

A full description of the Project is included in Section 3 of the EIS.

The BESS will be capable of providing energy, Frequency Control Ancillary Services (FCAS), System Restart Ancillary Services (SRAS), as well as fast frequency response and synthetic inertia - security services currently under consideration in the NEM.

The Project maximum disturbance area is approximately 25 hectares (ha) in size with permanent infrastructure likely to cover half this area. Construction may require temporary compounds or laydown areas outside the permanent footprint but within the Project area and would be located in existing vacant areas of the Project area as illustrated in **Figure 2-1.**



Project area
Proposed 330kV transmission connection
Battery Energy Storage System
Substation
Electricity transmission line
Railway
Cadastre

0 300 m
1:10,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
Aerometrex 2021,
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Figure 2-1 Project overview

Date: 10/22/2021 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\11_EIS\IS365800_GIS_EIS_r3v2.aprx
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2.2 Battery system

The BESS technology provider is not yet confirmed; however, the batteries are likely to consist of modular lithium-ion type racks, housed within battery enclosures containing protection, control and heating, ventilation and air conditioning.

Other infrastructure within the BESS compound will include:

- PCS comprising of inverters and battery transformers;
- HV reticulation including ring main unit (RMU), cables and switchboards; and
- Switch rooms and control rooms.

The PCS will be four-quadrant bidirectional type, with capability for both charge/ discharge in leading and lagging reactive power scenarios. The PCS will also have grid forming capability to allow islanded operation and SRAS where required.

2.3 Network connection

The Project would take advantage of the close proximity to the existing TransGrid owned 330 kV switchyard which has sufficient spare capacity for the size of the proposed BESS. The Project's connection will be electrically separate to that of EPS, so it can be operated independently of the EPS.

The following components are required to connect the BESS to the NEM:

- 33/330 kV transformers in a bunded transformer area;
- Overhead steel structure lattice towers complete with insulators and conductor(s) spanning the distance between the Project area and the existing TransGrid 330 kV switchyard;
- Associated protection and control systems.

Connection works into the TransGrid switchyard is targeting existing vacant connection bays but allowance is made for bench extension and installation of additional infrastructure.

2.4 Construction works

The construction methodology for the Project will be developed in more detail during the preparation of the detailed design. However, it is expected to involve:

- Installation and maintenance of environmental controls including drainage and sediment controls;
- Upgraded construction access track from existing internal access road to battery location;
- Vegetation clearing;
- Cut and fill to level areas and establish a hardstand pad and construction laydown areas;
- Structural works – slabs to support battery modules, power conversion systems and transformer structures;
- Delivery, installation and electrical fit-out of battery modules, power conversion systems and transformers;
- Installation of 330 kV overhead cabling from the battery transformers to the TransGrid switchyard;
- Testing and commissioning activities; and
- Removal of construction equipment and rehabilitation of construction areas.

2.5 Construction workforce

The Project will involve the recruitment and training of a construction workforce and ongoing operations and maintenance roles. The Project will also provide localised upskilling and training in the region in relation to the deployment of batteries. Major contractors will be asked to demonstrate their commitment to using a regional workforce and creating Indigenous and equal opportunity employment.

2.6 Construction program

The Project's modular design provides significant deployment flexibility with the capacity to stage the 700 MW to meet market needs. The Project is proposed to be commissioned in three stages with the sizing and layout of each stage subject to detailed design. The construction of the first stage of the BESS is expected to begin in 2022 (subject to approval) and have a duration of 18 months, with commercial operations possible by 2023. The indicative timeline for subsequent stages of the Project include:

- Stage 2 construction commencing 2023 and operations commencing 2025; and
- Stage 3 construction commencing 2026 and operations commencing 2027.

2.7 Operation

Operation will be 24 hours/365 days per week and will respond to market demand, fluctuating from discharge at full capacity for up to four hours or partial capacity for a longer duration. Maintenance activities will be ongoing (landscaping, asset protection zones, water management infrastructure, access tracks and inspection, testing and replacement of components). Operation life is expected to be between 20 to 30 years. Component replacements and/or upgraded may extend this timeframe.

2.8 Decommissioning

Following the end of economic life, above ground components would be removed and, where possible, re-purposed. Land rehabilitation will be undertaken where necessary to achieve acceptable conditions as far as reasonably practicable.

2.9 Primary Noise and Vibration Related Risks

Noise and vibration-related impacts can arise when levels from industry or construction activities result in unacceptable levels at surrounding sensitive receivers. Noise has the potential to be generated during both the construction and operational phases of the Project, with vibration-generating plant and equipment also intended to be used during construction. The key construction and operational activities with the potential to generate noise and vibration during the Project include:

- Earthworks and site establishment works during construction;
- Installation and construction of the BESS components; and
- Operation of BESS (noise only).

3. Existing Environment

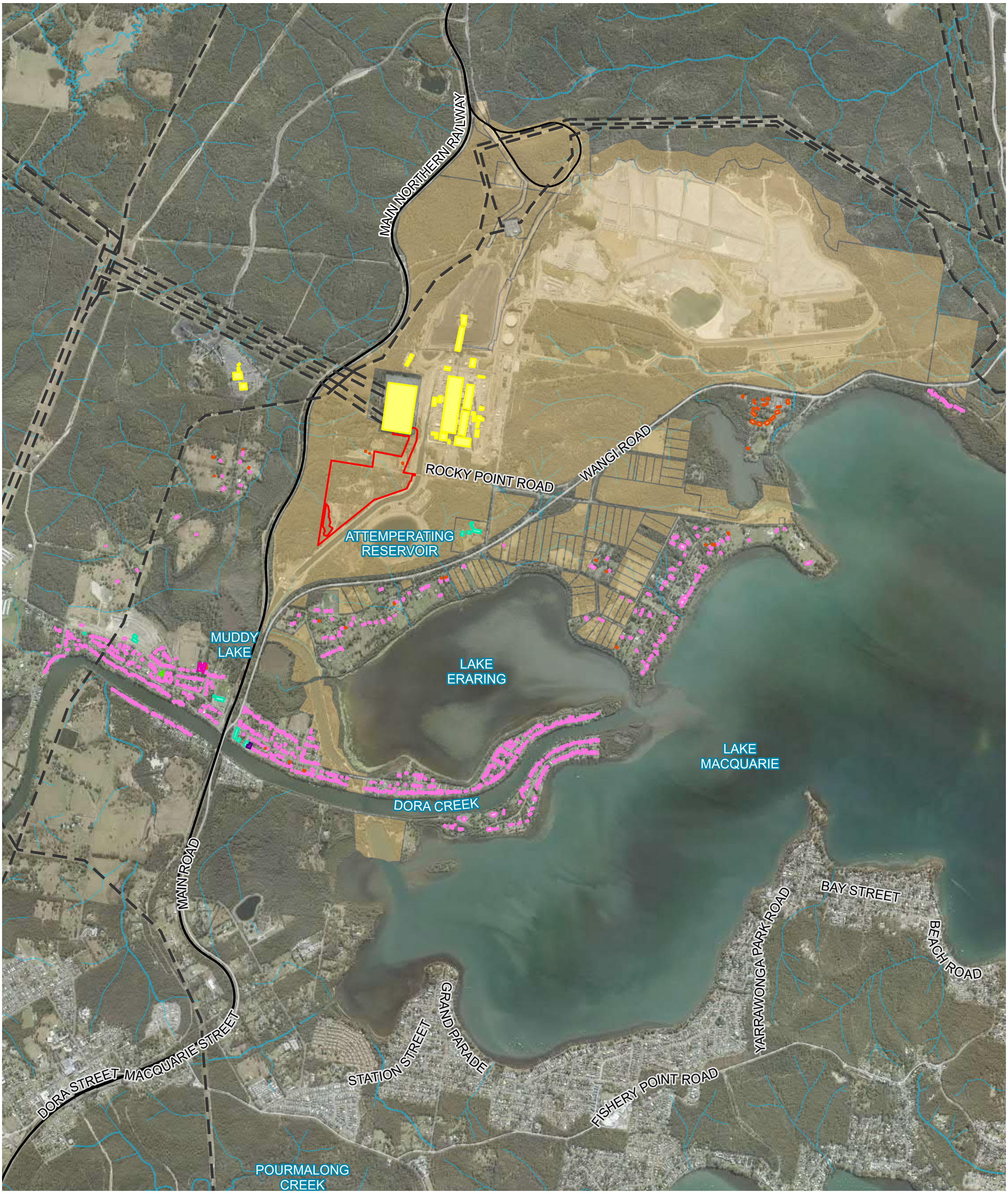
3.1 Surrounding Land Uses

The Project Site is located entirely within the current boundary of the EPS, currently zoned SP2 Infrastructure (Electricity Generating Works) under the *Lake Macquarie Local Environmental Plan 2014*. Historically, the land in the vicinity of the project has been utilised for power generation and coal mining with these uses commencing in the immediate area in the early 1980's.

Land use surrounding the Project Site is described as follows:

- To the north is the EPS, zoned as SP2 Infrastructure (Electricity Generating Works);
  - Land zoned as SP2 – Infrastructure is generally reserved for infrastructure land that is unlikely to be used for a different purpose in the future, including power stations, landfill and waste disposal and sewage treatment plants;
- To the west is land zoned predominately as E2 – Environmental Conservation and RU2 – Rural Landscape along Gradwells Road, Dora Creek;
  - Land zoned as E2 – Environmental Conservation is intended to protect land that has high conservation values which are outside of national parks and reserves;
  - Land zoned as RU2 – Rural Landscape is intended for primary industry and a range of compatible activities,;
- To the east and southeast is also zoned predominately as E2 – Environmental Conservation, with land along Border Street zoned as RU4 – Primary Production Small Lots and the land along Point Piper Road zoned as E4 – Environmental Living; and
  - Land zoned as RU4 – Primary Production Small Lots is land zoned for small scale and emerging commercial agricultural and primary industry production, which can operate on smaller rural holdings;
  - Land zoned as E4 – Environmental Living is intended for land with special environmental and scenic values, which accommodates low impact residential development. Generally the zone is applicable for rural areas which still has some conservation values;
- To the south is land predominately zoned as R2 – Low Density Residential and RE1 – Public Recreation associated with the Dora Creek township.
  - Land zoned as R2 – Low Density Residential is intended for areas which are primarily used for low density, detached dwelling housings, generally away from major transport nodes or larger activity centres; and
  - Land zoned as RE1 – Public Recreation is intended for a wide range of public recreational uses, such as parks, open spaces, recreational facilities and community facilities.

The surrounding land uses and receivers are detailed in **Figure 3-1**.



Project area
Origin owned land

Building usage
- Commercial
- Educational
- Industrial
- Medical
- Place of Worship
- Residential
- Unused or Unoccupied

Electricity transmission line
Railway

0 800 m
1:40,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
Aerometrex 2021,
© Department Finance, Services and Innovation Dec 2020

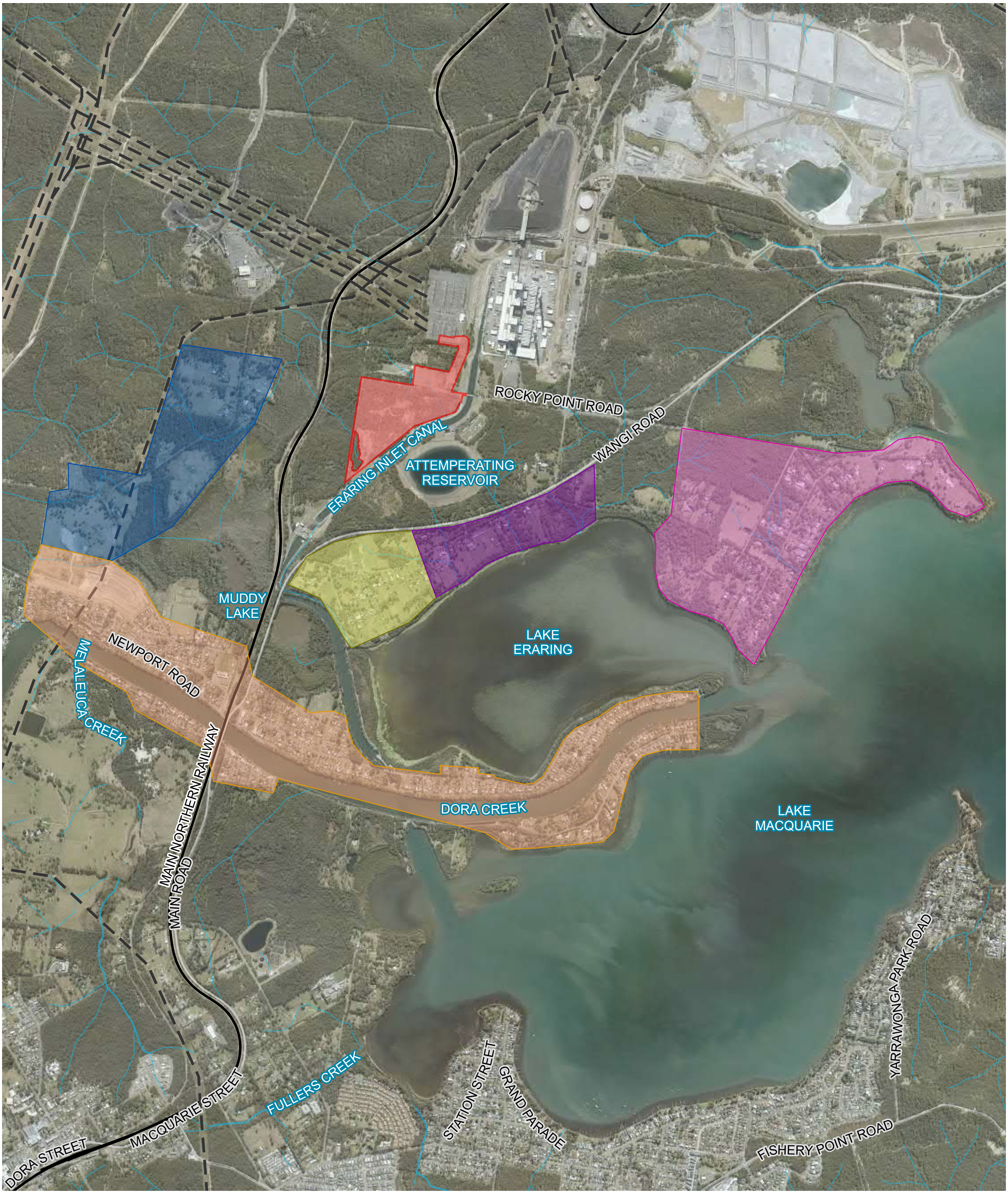
Figure 3-1 Surrounding Land Usage

3.2 Noise Catchment Areas

Based on a desktop study of sensitive receivers, land use and noise influencing factors surrounding the Project site, five Noise Catchment Areas (NCAs) have been established to assess potential noise impacts. In addition to the land use, other factors such as the predominate noise sources were also used to determine the NCAs. **Table 3.1** below details each NCA, and the extent of the NCAs are displayed in **Figure 3-2**.

Table 3.1: Noise Catchment Area Summary

Noise Catchment Area	Location	Approximate Distance of Nearest Sensitive Receiver from Project Site	Predominate Land Use (Zoning)	Predominate Background Noise Feature
NCA 1	Gradwells Road, Dora Creek	650 m	▪ RU2 – Rural Landscape ▪ E2 – Environmental Conservation	Environmental noise, industrial noise, residential noise, rail noise
NCA 2	Dora Street and surrounds, Dora Creek	1,500 m	▪ R2 – Low Density Residential ▪ RE1 – Public Recreation	Traffic noise, residential noise, rail noise
NCA 3	Western Border Street, Eraring	850 m	▪ RU4 – Primary Production Small Lots	Environmental noise, traffic noise, residential noise
NCA 4	Eastern Border Street, Eraring	650 m	▪ RU4 – Primary Production Small Lots ▪ E4 – Environmental Living	Heavy traffic noise, environmental noise, residential noise
NCA 5	Point Piper Road and surrounds, Eraring	1,500 m	▪ E4 – Environmental Living ▪ E2 – Environmental Conservation	Environmental noise, residential noise



Project area

Noise catchment areas
- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 5

Electricity transmission line

Railway

0 800 m

1:32,000 at A4

GDA94 MGA56

Data sources

Origin 2021,
Aerometrex 2021,

Figure 3-2 Noise Catchment Areas

3.3 Background Noise

3.3.1 Background Noise Levels

Background noise monitoring was performed over a two-week period in June 2021. A monitoring location was selected to represent each of the NCAs with the exception of NCA 5, where the land use and noise environment surrounding NM3 was considered representative. A summary of the monitored background noise levels is provided in **Table 3.2**. Graphs of the monitored noise levels are detailed in **Appendix A**. These noise monitoring locations were displayed in **Figure 3-3**.

It should be noted that noise from the Eraring Power Station has been included in background noise as the project will be operated under a separate EPL to the power station itself. Further justification of the inclusion of power station noise, with reference to *NPfI* Fact Sheet A1 include:

- The EPS has been operating continuously and consistently through day, evening and night-time periods for a period in excess of 10 years (40 years), and is considered a normal part of the acoustic environment (noting the EPS site has been central to power generation and coal mining for same period, 40 years);
- Analysis of background noise data, as described in more detail below, indicates the operation of the EPS is a notable and normal existing contributor to the acoustic environment (particularly at night); and
- The EPL does not contain noise criteria and the operation of the EPS adopts industry standard and fit for purpose noise management for a coal fired power station of its age which at the time of approval relied on site selection and establishment and maintenance of buffers to sensitive receptors including acquisition where necessary to avoid significant noise impacts. Importantly EPS operates without any adverse noise impacts, and Origin have advised that they have received fewer than 3 noise complaints in the past 5 years

Table 3.2: Background Noise Levels

Monitor ID	NCA	Monitoring Location	Monitoring Duration	Measurement	Measured Noise Level – dB(A)		
					Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
NM1	NCA 1	232 Gradwells Road, Dora Creek	7 June – 21 June 2021	L_{Aeq} (equivalent noise level)	46	45	45
				Rating Background Level (Background L_{A90})	41	39	38
NM2	NCA 2	Adjacent to 102M Dora Street, Dora Creek		L_{Aeq} (equivalent noise level)	49	47	44
				Rating Background Level (Background L_{A90})	40	40	38
NM3	NCA 3	8 Border Street, Eraring		L_{Aeq} (equivalent noise level)	50	48	45
				Rating Background Level	43	39	37

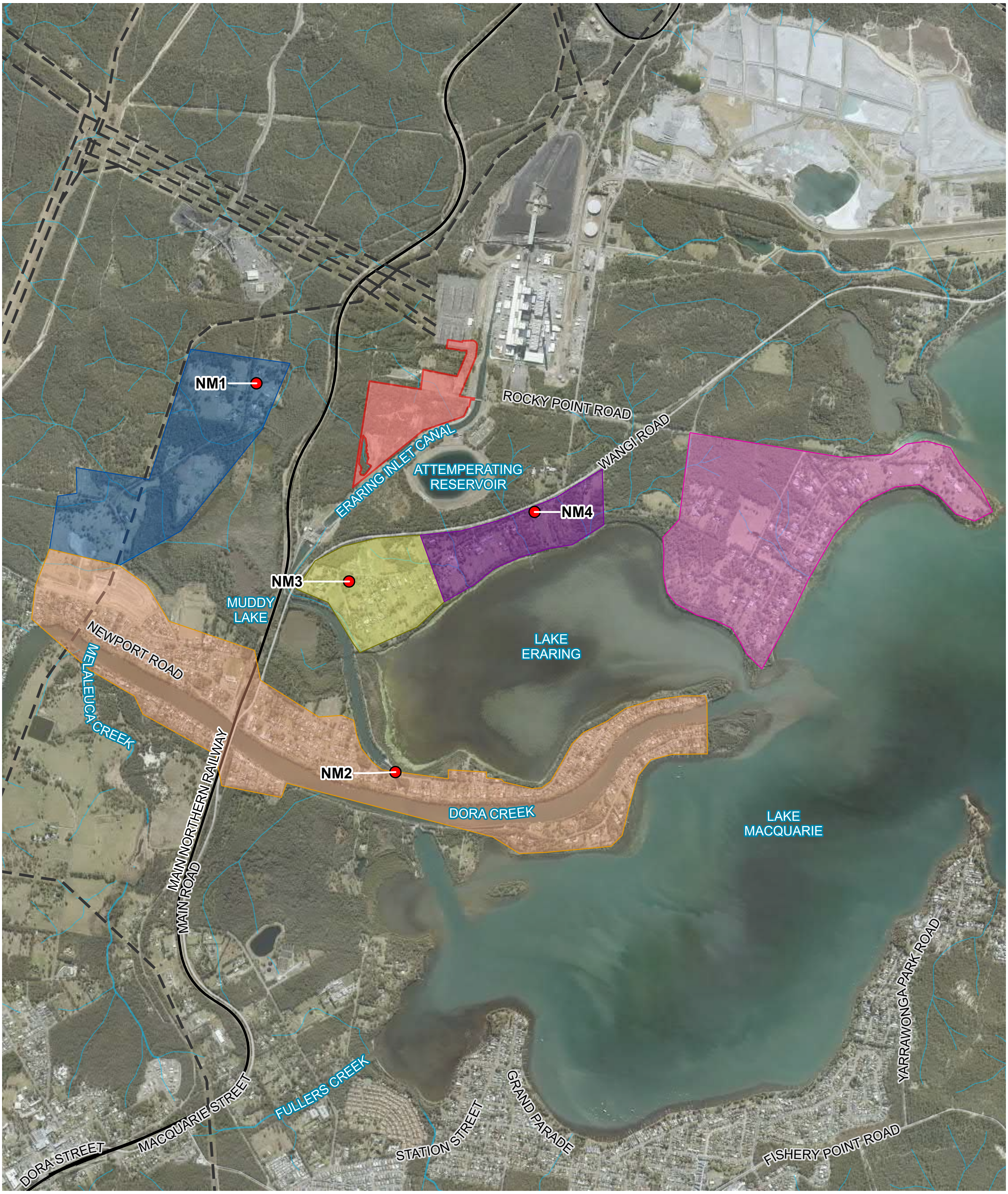
Monitor ID	NCA	Monitoring Location	Monitoring Duration	Measurement	Measured Noise Level – dB(A)		
					Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
				(Background L_{A90})			
NM4	NCA 4	124 Border Street, Eraring		L_{Aeq} (equivalent noise level)	59	55	53
				Rating Background Level (Background L_{A90})	48	41	37
N/A*	NCA 5	N/A*	N/A*	Rating Background Level (Background L_{A90})	35	30	30

** Note: RBLs were based on the NPI's 'minimum assumed RBLs'. See paragraphs below.*

During the noise monitoring for the project, monitoring at NCA 5 was not performed to minimise disruption to the local community as an initial desktop study showed no material risk of noise impact. NCA 5 was adopted post-monitoring in order for the assessment to consider noise impacts in every direction from the project where noise sensitive receivers were present.

Due to NCA 5's greater distance from noise sources such as Wangi Road and the Eraring Power Station, in addition to featuring lower density residential housing, the noise environment is almost certainly different from the other NCAs, and in turn would also likely have lower RBLs than the NCAs.

As such, the 'minimum assumed RBLs' as presented in Table 2.1 of the NPI (35 dB(A) during the Day and 30 dB(A) during the Evening and Nighttime periods) were conservatively adopted at NCA 5 for the assessment.



Project area

Background noise measurement locations

Noise catchment areas

- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 5

Electricity transmission line

Railway

0 800 m

1:32,000 at A4

GDA94 MGA56

Data sources

Origin 2021,
Aerometrex 2021,
© Department Finance, Services and Innovation Dec 2020

Figure 3-3 Background Noise Measurement Locations

Date: 10/22/2021 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\12_Noise\IS365800_GIS_Noise_r1v4.aprx
Created by : KD | QA by : SR

3.3.2 Background Noise Sources

In order to gain an understanding of the sources of background noise, handheld attended noise monitoring was undertaken at each noise monitoring location midway through the monitoring period. These noise sources are detailed in **Table 3.3**.

Table 3.3 Noise sources detected during attended monitoring

Monitoring Location	**NM1**	**NM2**	**NM3**	**NM4**
Date and Time	14 June 2021 9:20am	14 June 2021 9:30am	14 June 2021 10am	14 June 2021 10:50am
Recorded $L_{Aeq,15min}$ Noise Level	52 dB(A)	55 dB(A)	53 dB(A)	60 dB(A)
Recorded $L_{A90,15min}$ Noise Level	48 dB(A)	49 dB(A)	48 dB(A)	51 dB(A)
Day Noise Sources, SEL	▪ Bird Calls – 50 to 55 dB(A) ▪ Distant Traffic – 50 dB(A) ▪ Industrial Hum (source unidentified) – 48 dB(A) ▪ Passing Train – 48 to 50 dB(A) ▪ Overhead Light Plane – 66 dB(A) ▪ Passing Car – 60 dB(A)	▪ Traffic on Wangi Road – 50 dB(A) ▪ Local Traffic – 60 dB(A) ▪ Bird Calls – 55 to 60 dB(A) ▪ 4WD on Local Road – 68 dB(A) ▪ Pedestrian Chatter – 55 dB(A)	▪ Traffic on Wangi Road – 56 dB(A) ▪ Local Traffic – 62 dB(A) ▪ Passing 4WD – 71 dB(A) ▪ Quiet Period – 47 dB(A)	▪ Traffic on Wangi Road – 60 dB(A) ▪ Distant Traffic (No Traffic Passing on Wangi Road) – 54 dB(A) ▪ Passing Motorbike – 80 dB(A) ▪ Passing 4WD – 80 dB(A)

3.4 Vibration Sensitive Receivers

Whilst most receivers and surrounding structures are sensitive to vibration impacts, some receivers such as medical centres, precision industry and heritage structures are more typically susceptible and are subject to more stringent criteria. The nearest medical centre to the Project Site, Southlakes Medical Group, is located approximately 2km south of the Project site. No precision industry has been identified in the vicinity of the Project.

A single medical centre has been identified in the vicinity of the Project, the South Maitland Railway System, located approximately 1.3km from the site. No precision industry was identified within a 4 km radius of the Project. Two local heritage items have been identified in the vicinity of the Project:

- The Great Northern Railway, approximately 200m west of the Project, and
- Eraring Power Station, in which the Project is located. The power station itself is approximately 320m northeast of the Project.

At these distances, no vibration impacts from the Project Site are predicted.

4. Policy Setting and Criteria

4.1 Construction Noise

4.1.1 Noise Management Levels

The "Interim Construction Noise Guideline" (ICNG) (Department of Environment and Climate Change [DECC], 2009) provides guidance for assessing noise from construction activities in NSW. It establishes noise management levels (NMLs) for recommended standard construction hours and for outside of the recommended standard hours. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the applicable noise management level. **Table 4.1** lists ICNG guidance for establishing construction NMLs at residential receivers.

Table 4.1: ICNG guidance for establishing construction NMLs at residential receivers

Time of day	Management level $L_{Aeq(15min)}$	How to apply
Recommended standard hours (**SH**): Monday to Friday 7am to 6pm Saturday 8am to 1pm 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: 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.

Considering the adopted RBLs presented in **Table 4.1**, the NMLs for the identified surrounding residential receivers are presented in **Table 4.2**.

Table 4.2: Construction noise management levels (residential receivers)

NCA	**NML $L_{eq\ 15\ min}$ dB(A)**			
	Day (during standard hours) 7am – 6pm Weekdays, 8am – 1pm Saturdays	**Day (outside standard hours)** 7am – 8am & 1pm – 6pm Saturdays 8am – 6pm Sundays and Public Holidays	**Evening** 6pm-10pm Weekdays 6pm – 10pm Saturdays	**Night** 10pm-7am Weekdays, 10pm – 8am Saturdays 6pm – 7am Sundays and Public Holidays
NCA 1	51	46	44	43
NCA 2	50	45	45	43
NCA 3	53	48	44	42
NCA 4	58	53	46	42
NCA 5	45	40	35	35

The ICNG also provides construction NMLs for non-residential land uses. These are presented in Table 4.3.

Table 4.3: ICNG NMLs for non-residential receivers

Non-residential receiver type	**Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)**
Commercial	External Noise Level – 70 dB(A)
Industrial	External Noise Level – 75 dB(A)
Educational facilities	Internal Noise Level – 45 dB(A)
Hospital / Medical	Internal Noise Level – 45 dB(A)
Place of Worship	Internal Noise Level – 45 dB(A)
Passive Recreation	External Noise Level – 60 dB(A)
Active Recreation	External Noise Level – 65 dB(A)

It should be noted that the NSW EPA is developing a new construction noise guideline, the *Construction Noise Guideline*, which is currently in-draft. When released, the *Construction Noise Guideline* will replace the ICNG.

4.1.2 Sleep Disturbance

For premises where night construction (and operations) occurs, the potential for noise levels to lead to sleep disturbance should be considered. Section 4.3 of the ICNG discusses the method for assessing and managing sleep disturbance. This guidance references further information in the *NSW Road Noise Policy* (RNP) (NSW EPA, 2013) that discusses criteria for the assessment of sleep disturbance.

Where noise levels from a construction (or industrial) source at a residential receptor at night exceeds the following, a maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 40 dB(A) or the RBL + 5 dB(A), whichever is greater, and/or

- L_{AFMax} 52 dB(A) or the RBL +15 dB(A), whichever is greater.

Based on this guidance, **Table 4.4** presents sleep disturbance screening criterion for the noise catchment areas surrounding the Project.

Table 4.4: Sleep disturbance criterion

Noise Catchment Area	$L_{eq\ 15\ min}$ dB(A)	L_{AFMax} dB(A)
NCA 1	43	53
NCA 2	43	53
NCA 3	42	52
NCA 4	42	52
NCA 5	40	52

4.1.3 Annoying Noise Characteristics

Equipment that has the potential to produce a tonal noise, an impulsive noise or any other type of noise defined by the ICNG as ‘particularly annoying’, the noise level for that particular equipment will receive a + 5 dB(A) penalty.

As per guidance from the NPI, the penalty for intermittent noise (e.g., the hammers, packers and compactors) would only be applied during night periods. The penalty for tonal noise (e.g., roadsaws and grinders) will apply for all periods.

4.2 Operation Noise

4.2.1 Overview

Operational noise criteria for the Project were determined in accordance with the NSW EPA’s NPI which seeks to regulate noise impact from ‘industrial activity’ pertaining to noise from fixed industry and mechanical plant rather than from road, rail or construction sources. To achieve this, the NPI applies two separate noise criteria:

- Limiting the intrusiveness of the Project’s noise against the prevailing background noise; and
- Achieving suitable acoustic amenity for the surrounding land uses from industry.

The more stringent of these is used to define the operational noise criteria for a Project.

4.2.2 Intrusiveness Noise Levels

A noise source will be deemed to be non-intrusive if the monitored $L_{Aeq\ (period)}$ noise level of the development does not exceed the RBL by more than 5 dB(A). **Table 4.5** presents the noise intrusiveness criteria for the noise catchment areas, based on their RBLs (see **Table 3.2**). Intrusiveness noise levels are not used directly as regulatory criterion. They are used in combination with the amenity noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options and subsequently determine achievable noise requirements.

Table 4.5: NPI intrusiveness noise levels

Receiver Group	Time of Day	L_{90} (RBL) dB(A)	Allowance	Noise intrusiveness criteria dB(A)
NCA 1	Day (7 am to 6 pm)	41	+5 dB(A)	46
	Evening (6 pm to 10 pm)	39		44

Receiver Group	Time of Day	L_{90} (RBL) dB(A)	Allowance	Noise intrusiveness criteria dB(A)
	Night (10 pm to 7 am)	38		43
NCA 2	Day (7 am to 6 pm)	40		45
	Evening (6 pm to 10 pm)	40		45
	Night (10 pm to 7 am)	38		43
NCA 3	Day (7 am to 6 pm)	43		48
	Evening (6 pm to 10 pm)	39		44
	Night (10 pm to 7 am)	37		42
NCA 4	Day (7 am to 6 pm)	48		53
	Evening (6 pm to 10 pm)	41		46
	Night (10 pm to 7 am)	37		42
NCA 5	Day (7 am to 6 pm)	35		40
	Evening (6 pm to 10 pm)	30		35
	Night (10 pm to 7 am)	30		35

4.2.3 Amenity Noise Levels

As per the NPI (2017), the recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the Project amenity noise level represents the objective for noise from a single industrial development at a receiver location. Project amenity noise levels ensure that industrial noise levels remain within the recommended amenity noise levels for an area.

Amenity noise levels are not used directly as regulatory criterion. They are used in combination with the Project intrusiveness noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options, and subsequently determine achievable noise requirements.

Amenity noise levels for residential receivers are defined based on three amenity noise areas: urban, suburban and rural. These are defined based on a number of factors detailed in Table 2.3 of the NPI. The table has been duplicated in **Table 4.6** below.

Table 4.6 Determining which of the residential receiver categories applies. (Table 2.3 of the NPI)

Receiver Category	Typical planning zoning – standard instrument*	Typical existing background noise levels	Description
Rural Residential	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime RBL <40 dB(A) Evening RBL <35 dB(A) Night RBL <30 dB(A)	**Rural** – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered

Receiver Category	Typical planning zoning – standard instrument*	Typical existing background noise levels	Description
Suburban Residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime RBL <45 dB(A) Evening RBL <40 dB(A) Night RBL <35 dB(A)	**Suburban –** an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban Residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime RBL >45 dB(A) Evening RBL >40 dB(A) Night RBL >35 dB(A)	**Urban –** an area with an acoustical environment that: ▪ is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources ▪ has through-traffic with characteristically heavy and continuous traffic flows during peak periods ▪ is near commercial districts or industrial districts ▪ has any combination of the above

4.2.3.1 NCA 1 Amenity Classification

In reference to **Table 4.6**, properties in NCA 1 are predominately zoned as Rural Landscape, which ostensibly corresponds to the Rural Residential amenity area. However, the acoustic environment of the NCA is atypical for that of a rural landscape. The RBLs at NCA 1 (46 dB(A) Day, 39 dB(A) Evening and 38 dB(A) Night) are above the 'Typical existing background noise levels' for the 'Rural Residential amenity area, with the night RBL being more in line with the Urban Residential amenity area.

NCA 1 receives noise from a number of noise sources. In addition to sources such as natural (animal) and residential noise, other noise sources in the area exist. One source is rail noise from the Great Northern Railway line, located approximately 350m east of the noise monitoring location.

Additionally, the Cooranbong Entry Site of the Mandalong coal mine, located 420m north of the NCA was also identified as a noise source. Monitoring detailed in *Centennial Mandalong 2020 Annual Review* (Centennial Mandalong, 2021), performed on the northern border of NCA 1 (approximately 230m northwest of monitoring location) found noise levels from the Cooranbong Site Entrance ranged from $L_{Aeq,15min}$ 29 – 36 dB(A) and up to 46 dB(A) depending on the weather conditions.

Finally, noise from the Eraring Power Station (1.4km northeast of the monitoring location) was also a contributing source of measured noise levels. Monitoring in *Centennial Mandalong 2020 Annual Review* (Centennial Mandalong, 2021) also identified noise from Eraring Power Station of $L_{Aeq,15min}$ 36 dB(A) at the same location (noting that NCA 1's noise monitoring location was closer to EPS than the Centennial Mandalong Annual Review monitoring location). During the noise monitoring performed for this project, noise from the EPS was identified by an Origin staff member at the NCA 1 monitoring location.

Noise monitored at NCA 1 (and NCA 3) has been further analysed to determine the industrial noise at the monitoring location. This is detailed in **Section 4.2.3.6**.

4.2.3.2 NCA 2 Amenity Classification

In reference to **Table 4.6**, NCA 2 is predominately comprised of properties zoned as Low Density Housing, in line with the Suburban Rural amenity area. Additionally, the RBLs for NCA (40 dB(A) Day, 40 dB(A) Evening and 38 dB(A) Night) generally agree with the 'Typical existing background noise levels' for the Suburban Residential Amenity Area (with the night RBLs being 3 dB(A) over the typical night background noise levels). During noise monitoring, background noise was found to be predominantly controlled by local traffic, as well as from through traffic along Wangi Road and railway noise from the railway corridor running through the NCA. Residential noise was also a contributing source of measured noise levels. Due to these factors, the Suburban Residential amenity area was found to be appropriate for this location.

4.2.3.3 NCA 3 Amenity Classification

In reference to **Table 4.6**, NCA 4's properties are predominantly zoned as Primary Production Small Lots, which is ostensibly associated with the Rural Residential amenity area. However, the acoustic environment of the NCA is atypical for that of a Rural Residential amenity area. The RBLs of NCA 3 (43 dB(A) Day, 39 dB(A) Evening and 37 dB(A) Night). This is above the 'Typical existing background noise levels' for the 'Rural Residential amenity area, with the night RBL being more in agreement with the Urban Residential amenity area.

In addition to expected noise sources (residential noise, local traffic), noise from the typically continuous and heavy through-traffic along Wangi Road is also prominent at the location. Additionally, the Eraring Power Station Inlet Canal Pumps are relatively close, being located at approximately 200m from the nearest receiver.

Noise monitored at NCA 3 (and NCA 1) has been further analysed to determine the industrial noise at the monitoring location. This is detailed in **Section 4.2.3.6**.

4.2.3.4 NCA 4 Amenity Classification

In reference to **Table 4.6**, NCA 4's properties are predominately zoned as Primary Production Small Lots, which is typically associated with the Rural Residential amenity area. However, the acoustic environment of the NCA is atypical for that of a rural landscape.

RBLs measured at NCA 4 (48 dB(A) Day, 41 dB(A) Evening and 37dB(A) Night), are 6 – 8 dB(A) above the 'Typical background noise levels' and more closely agree with the 'Typical background noise levels' of an Urban Residential amenity area.

Additionally, the background noise is primarily driven by the through traffic along Wangi Road. This traffic noise from the road exists near continuously during day and evening periods, and while it isn't continuous during the night period it still remains a prominent contributor to noise levels. Noise recordings undertaken during unattended noise monitoring also identified instances where industrial noise was audible within the NCA, however this was less prominent than those at NCA 1 and NCA 3 due to the dominance of the traffic noise. This is in line with one of the characteristics of the Urban Residential amenity criteria, in particular that the NCA '*has through-traffic with characteristically heavy and continuous traffic flows during peak periods*' (refer **Table 4.6**).

Due to the RBLs of NCA 4 being consistent with the 'Typical background noise levels' of an Urban Residential amenity area, and since the source of noise i through traffic, NCA 4 has been classified as an Urban Residential amenity area.

4.2.3.5 NCA 5 Amenity Classification

In reference to **Table 4.6**, as properties are predominately zoned as Environmental Living, the zoning of the NCA matches the Rural Residential amenity area. Additionally, a desktop study of the area shows a sparse distribution of properties, in line with the description of the Rural Residential amenity area. As such, NCA 5 has been classified as a Rural Residential amenity area.

4.2.3.6 Analysis of Industrial Noise in NCA 1 and NCA 3

In order to confirm the appropriate amenity area classification for NCA 1 and NCA 3, further detailed post-processing of raw measured background noise data has been undertaken. Specifically, the raw data has been analysed to isolate and identify the contribution of existing industrial noise sources in the area to the measured background noise levels.

The results of the above data analysis indicates that the sources of industrial noise at NCA 1 are a combination of noise from the Eraring Power Station (EPS) (approx. 1.4km away from the noise logger), as well as the Centennial Coal Mine Entrance (420m away).

In comparison, L_{A90} noise levels at the Border Street (NCA 3) noise logging location are dominated by the nearby EPS Inlet Plant (330m away). Additionally, traffic along Wangi Road, which runs along the top of a ridge between the NCA 3 receiver and the EPS Inlet Plant, provides a loud and semi-constant noise source, which increases the background noise. However, the acoustic data analysis process included frequency filtering, which was specifically devised to exclude the influence of traffic noise from the results so that the reported industrial noise levels at NCA 3 are comprised mostly of noise from Eraring Power Station.

The justification of the Urban Residential amenity area for NCA 1 and NCA 3 based on the presence of industrial noise can be demonstrated through the following data analysis on the background data:

1. The measured background noise data and the associated audio sound recordings were reviewed to identify time periods when industrial noise was clearly audible and was obviously the dominant source of noise in the environment at the time. These data samples were then used to identify and isolate additional time periods throughout the monitoring period during which the industrial noise sources were the most audible noise sources
2. After identification of the time periods when industrial noise was dominant, the isolated sections of the audio recordings were passed through a digital signal filter to eliminate frequencies greater than 800Hz (since based on Jacobs' experience, frequencies less than 800Hz are typical of industrial noise). The purpose of this frequency range was also to specifically filter out traffic noise, which is notably prominent NCA 3.

The results of this analysis are provided in **Table 4.7**. As displayed in the table, when isolated from the overall ambient noise environment and filtered to reduce the influence of extraneous noise sources, noise from industrial noise sources ranges from 40 – 41 dB(A) L_{eq} and 36 dB(A) 10^{th} percentile L_{A90}.

Table 4.7 Additional data analysis results - isolated industrial noise levels compared to overall noise levels

	Parameter	NCA 1	NCA 3
Industrial Noise Isolated (all time periods)	L_{Aeq}	43	41
	10^{th} percentile L_{A90} (filtered & isolated)	38	37[1]
Industrial Noise Isolated and Frequency Filtered (all time periods)	L_{Aeq}	41	40
	10^{th} percentile L_{A90} (filtered & isolated)	**36**	**36**[1]
Overall (Day Period)	L_{Aeq}	46	50
	RBL (10^{th} percentile L_{A90})	41	43
Overall (Evening Period)	L_{Aeq}	45	48

	Parameter	NCA 1	NCA 3
	RBL (10th percentile L_{A90})	39	39
Overall (Night Period)	L_{Aeq}	45	45
	RBL (10th percentile L_{A90})	38	37

Note 1: The data analysis procedure was considered to be effective at removing most extraneous noise sources, however due to the proximity of Wangi Road the frequency filtered and isolated 10th percentile L_{A90} noise levels at NCA-3 may contain a small residual influence of road traffic noise

Through the analysis in 'Step 1' as detailed above, it was found that the industrial noise created a 'floor' for background noise, which held the prevailing background noise of the area to between 35 and 40 dB(A).

As shown in **Table 4.7**, the data analysis indicates that the 10th percentile L_{A90} noise levels solely due to industrial noise at NCA 1 and NCA 3 was found to be approximately 36 dB(A) consistently throughout all measurement periods. In comparison, the overall RBL (which consists of the combination of all ambient environmental noise sources) ranged between 38 to 41 dB(A) at NCA 1 and between 37 and 43 dB(A) at NCA 3. Indeed the overall Night RBL at NCA 1 and NCA 3 was only 1 to 2 dB(A) higher than the industrial-only noise levels. In terms of relative sound energy composition, this means that the RBL during the Night time period consists of approximately 80% industrial noise.

Similarly, during the Evening the RBL at NCA 1 and NCA 3 was only 3 dB(A) higher than the industrial-only noise levels. This means that the RBL during the Evening is made up of approximately 50% industrial noise.

During the Day, the RBL is approximately 5 to 7 dB(A) above the industrial-only noise levels, which means that the RBL during the Day is composed of approximately 20% to 30% industrial noise.

Furthermore, the data clearly shows that the L_{A90} background noise levels never drops below the industrial-only noise level which is consistently maintained at approximately 36 dB(A). It is important to note that the dominant industrial noise sources in the area that control the background noise environment (EPS, Cooranbong Site Entrance and the Inlet Plant) are 24-hour noise sources, and both produce constant noise emissions throughout the Day, Evening and Night time periods. The data therefore shows that the floor of the background noise environment at NCA 1 and NCA 3 is controlled during all time periods by the constant industrial noise from the Eraring Power Station and the Centennial Coal Mine

The key factors from the data analysis results and site observations relevant to the classifications of receiver areas NCA 1 and NCA 3 are:

- The RBL during the Night time period is >35 dB(A)
- The component of the Night RBL that is comprised solely of industrial noise is >35 dB(A)
- The background noise of the acoustical environment is dominated by constant industrial noise during all time periods
- NCA 1 is affected by noise from a major rail line, while NCA 3 is affected by a road that carries characteristically heavy and continuous flows during peak periods

Based on the above observations, along with the information presented in **Section 4.2.3.1** and **Section 4.2.3.3**, both NCA 1 and NCA 3 are consistent with the descriptors of the 'Urban residential' receiver category.

It is noted that the RBL measured at NCA 1 and NCA 2 during the Evening and the Day time periods were not greater than 40 dB(A) and 45 dB(A) respectively, however this does not preclude these receiver areas from the classification of 'Urban residential' receiver category as NPI Table 2.3 refers to these RBL as "Typical existing background noise levels". NPI Table 2.3 does not specifically require that classification of receiver areas be strictly assessed based on these "Typical" RBL values necessarily being exceeded during background noise measurements.

It is also noted that the descriptions of the 'Suburban residential' and 'Rural' receiver categories are entirely inappropriate for the receivers in NCA 1 and NCA 2. Specifically, the following descriptions are readily identified as being inappropriate:

> ***"Rural**: an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels."*
>
> ...
>
> ***"Suburban** – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity."*

The data analysis and site observations described above have clearly demonstrated that neither of the above descriptions from NPI Table 2.3 are applicable to the receivers in NCA 1 or NCA 3.

In regard to the "Typical existing background noise levels" nominated in NPI Table 2.3, the variation in RBL during the different time periods is due to diurnal fluctuations in the combination of all noise sources such as industrial sources, traffic, residential noise and natural noise. In areas where the RBL is controlled by constant 24-hour industrial noise sources, it is typical that the industrial noise would determine the floor of the $L_{A90(15\ minute)}$ during all time periods, but the RBLs during the Day and Evening time periods may or may not exceed the Typical RBLs for the Urban amenity classification. Consequently in areas where the Night RBL is controlled by 24-hour industrial noise sources, it is considered that the RBL during the night time period is the critical factor regarding the classification of the receivers' amenity category.

Since the acoustical environment of an area is dominated by industrial noise, the industrial noise sources are constant 24-hour operations, and the industrial noise controls the floor of the background noise levels during all time periods, it is considered reasonable to classify a receiver amenity area as 'Urban Residential' based solely on the RBL during the Night period.

In summary, the classification of the Urban Residential amenity area receiver category for NCA 1 and NCA 3 is considered to have justification consistent with the NPI since:

1. The measured night time RBL is higher than the Urban amenity classification for the night time period,
2. The existing background noise environment is dominated by industrial noise during the night time period,
3. The 10th percentile L_{A90} due to industrial noise alone is higher than the Urban amenity classification during the night time period
4. The proposed noise emissions during under-load operations of the BESS would be consistent during the Day, Evening and Night time periods
5. The noise assessment criterion is lower during the Night than the Day or Evening time periods
6. (Based on 4. and 5. above) The Night time period is the deciding time period for the purpose of achieving and assessing compliance
7. For a proposed 24-hour noise source, since the receiver area conforms to the requirements of an Urban Amenity Area classification for the night time period, it should be recognised that the RBL during the Day and Evening periods are of lesser relevance. Therefore it is considered that the Night time period is the appropriate time period relevant to the proposal.

4.2.3.7 Summary of Amenity Area Classification

Table 4.8 presents a summary of the adopted noise amenity area for each NCA. The table also displays the recommended amenity noise levels tied to the amenity noise areas, and the resulting Project amenity noise level (recommended amenity noise level minus 5 dB, plus 3 dB to convert from a period level to a 15-minute noise level).

Table 4.8: NPI amenity noise criteria, residential receivers

Noise Catchment Area	Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	Project amenity $L_{eq\ 15\text{-minute}}$ Noise Level dB(A)
NCA 1	Urban Residential	Day (7 am to 6 pm)	60	58
		Evening (6 pm to 10 pm)	50	48
		Night (10 pm to 7 am)	45	43
NCA 2	Suburban Residential	Day (7 am to 6 pm)	55	53
		Evening (6 pm to 10 pm)	45	43
		Night (10 pm to 7 am)	40	38
NCA 3	Urban Residential	Day (7 am to 6 pm)	60	58
		Evening (6 pm to 10 pm)	50	48
		Night (10 pm to 7 am)	45	43
NCA 4	Urban Residential	Day (7 am to 6 pm)	60	58
		Evening (6 pm to 10 pm)	50	48
		Night (10 pm to 7 am)	45	43
NCA 5	Rural Residential	Day (7 am to 6 pm)	50	48
		Evening (6 pm to 10 pm)	45	43
		Night (10 pm to 7 am)	40	38

The NPI also provides amenity noise levels for non-residential receivers. **Table 4.9** presents these levels for non-residential land usage.

Table 4.9: NPI amenity noise criteria, non-residential receivers

Receiver type	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	Project amenity $L_{eq\ 15\ minute}$ Noise Level dB(A)
Commercial	When in use	65	63
Industrial	When in use	70	68
Educational / Childcare	Noisiest 1-hour period when in use	35 (internal), 45 (external)	33 (internal), 43 (external)
Hospital / Medical	Noisiest 1-hour period	35 (internal), 50 (external)	33 (internal), 48 (external)
Place of Worship	When in use	40 (internal), 50 (external)	38 (internal), 48 (external)
Passive Recreation	When in use	50	48
Active Recreation	When in use	55	53

4.2.4 Project operational noise criteria

The NPI recommends that the more stringent values between intrusiveness and amenity noise level criteria be applied for an operational noise assessment. Considering the intrusive and amenity criteria outlined in **Section 4.2.2** and **Section 4.2.3**, **Table 4.10** presents the PNTL adopted for the various NCAs related to the Project and this assessment.

Table 4.10: Project operational noise criteria

Receiver type	Time of day	Recommended L_{Aeq} Noise Level dB(A)
NCA 1	Day (7 am to 6 pm)	46
	Evening (6 pm to 10 pm)	44
	Night (10 pm to 7 am)	43
NCA 2	Day (7 am to 6 pm)	45
	Evening (6 pm to 10 pm)	43
	Night (10 pm to 7 am)	38
NCA 3	Day (7 am to 6 pm)	48
	Evening (6 pm to 10 pm)	44
	Night (10 pm to 7 am)	42
NCA 4	Day (7 am to 6 pm)	53
	Evening (6 pm to 10 pm)	46
	Night (10 pm to 7 am)	42
NCA 5	Day (7 am to 6 pm)	40
	Evening (6 pm to 10 pm)	35

Receiver type	Time of day	Recommended L_{Aeq} Noise Level dB(A)
	Night (10 pm to 7 am)	35

4.2.5 Sleep Disturbance

The NPI (2017) also derives its guidance for the sleep disturbance screening criteria from the RNP (NSW EPA, 2011), and as such the criteria adopted for the construction phase (refer to **Table 4.4**) is also applicable for the operations phase.

4.2.6 Annoying Noise Characteristics

'Annoying' noise characteristics associated with the operation of industrial facilities are addressed in Fact Sheet C of the NPI. Where an 'annoying' noise characteristic is identified, a correction will be applied to the noise levels to account for it. For this assessment, the two most likely 'annoying' noise characteristics are tonality and low frequency noise.

Where a tonal noise is predicted to be generated from a noise source, a one-third octave analysis should be performed using the methodology detailed in *ISO 1996-2:2007 Annex D: Objective Method for Assessing the Audibility of Tones in Noise*. Where the level of one-third octave band exceeds the level of the adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz;
- 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz; or
- 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz

Then a correction of 5 dB should be applied to the noise source.

Low Frequency Noise is accounted for using a two-step assessment of the A-weighted and C-weighted noise levels. A correction for low frequency noise will be applied where:

- The C-weighted noise contribution is 15 dB greater than the A-weighted noise source contribution at a noise receiver, and
- Any of the third octave noise levels presented in Table C2 of Fact Sheet C of the NPI are exceeded at the noise receiver.

Where the C-weighted noise level at a receiver is 15 dB above the A-weighted noise level **AND** any of the third octave noise levels exceed those levels in Table C2 of Fact Sheet C, then:

  - If the exceedance of the third octave noise levels is less than or equal to 5 dB, a correction of 2 dB is applied during the evening and night periods, and
  - If exceedance of the third octave noise levels is greater than 5 dB, a correction of 5 dB is applied during the evening and night periods.

4.3 Vibration

4.3.1 Overview

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

4.3.2 Human comfort

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

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

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

Preferred and maximum values of human exposure for continuous and impulsive vibrations are listed in Table 4.11 (DECC, 2006), for relevant receivers to this Project. As per DECC, daytime is between 7 am and 10 pm, and night is between 10 pm and 7 am.

Table 4.11: Preferred and maximum weighted Root Mean Square (RMS) values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis[2]	x and y axis[2]	z-axis	x and y axis
Continuous vibration					
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Impulsive vibration					
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14

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

[2] z-axis refers to vertical vibration, while the x and y axes refer to horizontal vibration.

Intermittent vibration is assessed differently using vibration dose values (VDV). Preferred and maximum VDVs for different types of receivers have been reproduced in **Table 4.12** for relative receivers in this assessment.

Table 4.12: Preferred and maximum VDVs for intermittent vibration ($m/s^{-1.75}$), (DECC, 2006)

Location	Day time (7 am to 10 pm)		Night-time (10 pm to 7 am)	
	Preferred VDV	Maximum VDV	Preferred VDV	Maximum VDV
Residences	0.20	0.40	0.13	0.26

4.3.3 Buildings and structures

Section J4.4.3 of *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives* provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration* [BS7385-2:1993] and are presented in **Table 4.13**.

Table 4.13: Transient vibration guideline values for cosmetic damage

Type of building	**Peak particle velocity (ppv) mm/s**		
	4 to 15 Hz	**15 to 40 Hz**	**40 Hz and above**
Reinforced or framed structures industrial and heavy commercial buildings	50		
Un-reinforced or light-framed structures residential or light commercial type buildings	15 to 20	20 to 50	50

Guidance for more sensitive structures is presented in the German standard, *DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures* (DIN 4150-3: 2016). Vibration velocities not exceeding 3 mm/s at 1 to 10 Hz are recommended in this standard.

4.3.4 Construction Noise and Vibration Guideline

Section 7 of the CNVG provides guidance for safe working distances to achieve human comfort (*Assessing Vibration: a technical guideline*, (DECC, 2006) and cosmetic building damage (BS7385-2:1993) criteria for a range of different plant and equipment. These safe working distances are relevant for some plant and equipment that may be used during construction of the Project, and so this guidance (presented below in **Table 4.14**) was considered.

Table 4.14: Recommended safe setback distances

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

5. Technical Inputs

5.1 Construction Noise Emissions

5.1.1 Construction Phasing and Plant

Construction of each Project Stage would be undertaken in four key 'phases', distinct from the 'stages' in which the Project will be operated. The four key construction phases are as follows:

- Site establishment;
- Cut and fill to battery compound and transformer yard and establishment of pad;
- Structural works to support battery enclosures, inverters, transformers, building and transformer compounds and transmission structures; and
- Delivery, installation and electrical fit-out of components.

A fifth Project phase is also assessed in the NIA related to the use of an air track drill for establishment of transmission structure footings within the transmission line easement only. This fifth phase would be undertaken only during works associated with the first Project stage to be constructed and over short duration.

Sound power levels were estimated for each phase of construction for the Project. Sound power levels for each construction phase were determined by developing an inventory of noise producing equipment and the estimated numbers of equipment based on the works taking place and estimating the sound power levels of each piece of equipment using sound power levels presented in national and international standards and guidelines, as well as from a Jacobs measurement database.

The indicative construction phases for the Project works are presented in Table 5.1.

Table 5.1: Construction Phase Sound Power Levels

Phase	Works	Location	Equipment	Number of Equipment	Individual Equipment SWL (dB(A))	Phase SWL (dB(A))
1	Site Establishment	BESS Platform	Truck (medium rigid)	2	106	113
			Road truck	2	111	
			Scissor lift	1	98	
			Light vehicles	4	94	
			Franna crane	1	98	
2	Cut and fill to battery compound and transformer yard and establishment of pad	BESS Platform	Franna crane	1	98	123
			Excavator (tracked) 35t	2	110	
			Grader	1	113	
			Vibratory roller	1	109	
			Concrete truck	2	109	
			Dump truck	2	113	
			Water cart	1	107	
			Concrete pump	1	109	
			Concrete vibrator	1	113	

Phase	Works	Location	Equipment	Number of Equipment	Individual Equipment SWL (dB(A))	Phase SWL (dB(A))
			Generator	1	103	
			Light vehicles	8	97	
			Front loader	2	115	
			Backhoe	2	114	
			Asphalt truck and sprayer	1	103	
3	Structural works to support battery enclosures, inverters, transformers, building and transformer compounds and transmission structures	BESS Platform	Mobile crane	1	113	118
			Concrete vibrator	1	113	
			Concrete pump	1	109	
			Welding equipment	1	105	
			Excavator (tracked) 35t	1	110	
			Generator	1	103	
4	Delivery, installation and electrical fit-out of components	BESS Platform	Rigid trucks	2	106	118
			Mobile crane	2	116	
			Compressor	1	109	
			Welding equipment	1	105	
			Generator	1	103	
5	Transmission structure footings	Transmission line corridor	Air track drill*	1	126	126

** - Noise source is considered to feature annoying characteristics and has been applied with a 5 dB(A) penalty. The noise source has also had a time correction applied, noting that it would operate on a sporadic basis over the construction phase.*

5.1.2 Construction Timing

For this assessment, it has been assumed that construction works will only take place during standard construction hours, between the hours of 7am and 6pm on weekdays and 8am to 1pm on Saturdays.

5.2 Operation Noise Emissions

5.2.1 Operational Plant and Equipment

Three representative noise sources were identified for the operation of the Project. These sources, the number of each and the layouts of the sources across the Project site have been determined based on a number of data sources and inputs provided to Origin by prospective suppliers. The range of sound power levels and unit numbers have been detailed in **Table 5.2**. The noise levels of the units assume the units will be operating at their peak load (i.e., at their highest noise producing capability).

Table 5.2: BESS Sound Power Levels

Noise Source	Number of Units	Sound Power Level (dB(A))
Battery Enclosures	1044 - 2130	71 dB(A) – 82.6 dB(A)
Transformers / Inverters	170 - 355	67.5 dB(A) – 90 dB(A)

Noise Source	Number of Units	Sound Power Level (dB(A))
Grid Transformers	3	92 dB(A)

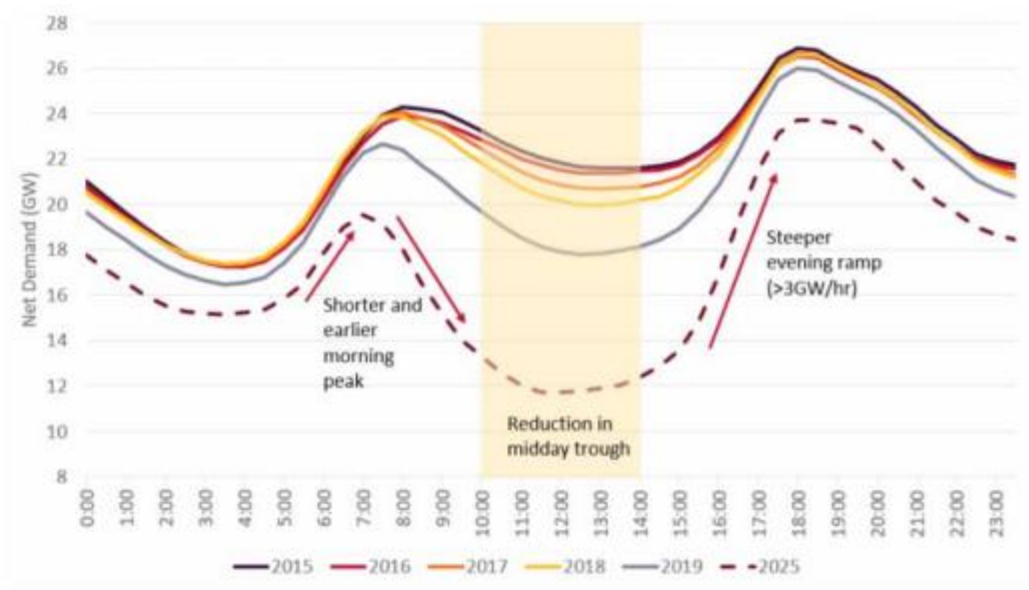
5.2.2 Operational Timing

The Project noise assessment has been prepared in a scenario to operate continuously, with the same noise levels and number of units operational over a 24-hour period. The likelihood of continuous 24hr operation is remote in consideration of the daily electricity demand and charge/discharge cycles of the BESS.

General operation will be characterised by the requirement to store excess solar generation via charging the battery from early to mid-morning through to mid to late afternoon dependant on the season. Similarly, the battery will be generally required to discharge at energy demand peaks usually occurring early morning and late afternoon to early evening in Winter and predominantly mid-afternoon to mid evening in Summer.

Due to this, coincidence of peak or high load operation during night-time noise enhancing conditions (i.e., temperature inversions at night with wind up to 2 m/s) is not expected to be the base case for operation of the Project. Due to this, while the operation of the project at full load under these conditions is required through the assessment process, the market and thermal characteristics of the BESS equipment make this circumstance extremely unlikely to occur, assuring a level of conservatism in the analysis.

These operational expectations are supported by the depiction below from the *AEMO Renewable Integration Study: Stage 1 Report* (AEMO, 2020) defining the likely dispatch periods described.



Source: AEMO, *Renewable Integration Study: Stage 1 report*, 2020, p. 58.

5.3 Construction Vibration Emissions

5.3.1 Construction Staging and Plant

Vibration producing equipment have been identified from the construction staging. The vibration producing equipment along with the associated setback distances have been detailed in **Table 5.3**.

Table 5.3: Construction Phase Vibration Setbacks

Phase	Works	Equipment	Cosmetic damage (Ref: BS7385-2: 1993)	Human response (Ref: DECC, 2006)	Heritage Structure Impact (Ref: DIN 4150-3, 2016)
2	Cut and fill to battery compound and transformer yard and establishment of pad	Vibratory roller	25m	100m	45m
5	Transmission structure footings	Air track drill	15m	50m	27m

5.3.2 Construction Timing

For this assessment, it has been assumed that construction works will take place during standard construction hours, with no works taking place out of work hours.

5.4 Model Setup

Noise from the operation of the Project was modelled using the SoundPLAN 8.0 acoustic modelling software. Within the noise modelling software, the CONCAWE noise propagation calculation was applied for dB(A) noise calculations. The CONCAWE calculation was selected due to its reliability in assessing industrial noise impacts. CONCAWE considers noise propagation and attenuation by:

- Geometrical spreading;
- Atmospheric absorption;
- Ground effects;
- Meteorological conditions conducive of the propagation of noise;
- Barriers; and
- Topography and distance between the source and receptor.

A number of inputs were used to create the model. These are detailed in **Table 5.4**.

Table 5.4: Noise Model Input Details

Model Input	Details
Topography	Terrain data were derived from a combination of the NSW Land Property Information (LPI) 10 m resolution bare earth Digital Elevation Model (DEM) and a DEM provided by Origin Energy.
Buildings	Footprints for receptor and other buildings in the area surrounding works was determined from aerial photography. Heights and floor numbers were ascertained from Google Street view, or otherwise, assuming a building height of 3 m per floor plus 2 m for the roof.
Ground Absorption	Heavily Forested Area: 1.00 Rural Area/Grassland: 1.00 Urban Area: 0.50 Industrial Area: 0.00 Water: 0.00
Noise Sources	Construction and Operational SWLs were set as outlined in Section 5.1.1 and Section 5.2.1, respectively.
Meteorology	Meteorological conditions were set out as outlined in Table 5.5.

5.4.1 Meteorological Conditions

An assessment of local meteorology was undertaken and has been displayed in **Appendix B**. As the assessment confirmed the presence of both wind speeds between 0.5 and 3 m/s and temperature inversions above the 30% threshold detailed in the NPI, both, 'standard' and 'noise-enhancing' case meteorological conditions were considered for the assessment. The specific meteorological conditions applied are detailed in **Table 5.5**.

Table 5.5: Meteorological Parameters used in the Assessment

<table>
<tr><th>Atmospheric Condition</th><th>Definition</th><th>Air Temperature (degrees centigrade)</th><th>Humidity (%)</th><th>Wind Velocity (m/s)</th><th>Wind Direction (°)</th><th>Barometric Pressure (millibars)</th><th>Atmosphere Stability Class</th></tr>
<tr><td>Standard</td><td>Stability categories A-D with wind speed up to 0.5 m/s at 10m AGL</td><td rowspan="3">20*</td><td rowspan="3">70*</td><td>0</td><td>Source to Receiver</td><td rowspan="3">1013.3*</td><td>D</td></tr>
<tr><td>Noise Enhancing Day</td><td>Stability categories A-D with light wind (up to 3 m/s at 10m AGL)</td><td>3</td><td>Source to Receiver</td><td>D</td></tr>
<tr><td>Noise Enhancing Night</td><td>Stability categories A-D with light wind (up to 3 m/s at 10m AGL) and/or stability category F with winds up to 2 m/s at 10m AGL</td><td>2</td><td>Source to Receiver</td><td>F</td></tr>
</table>

** - Standard Modelling Parameter.*

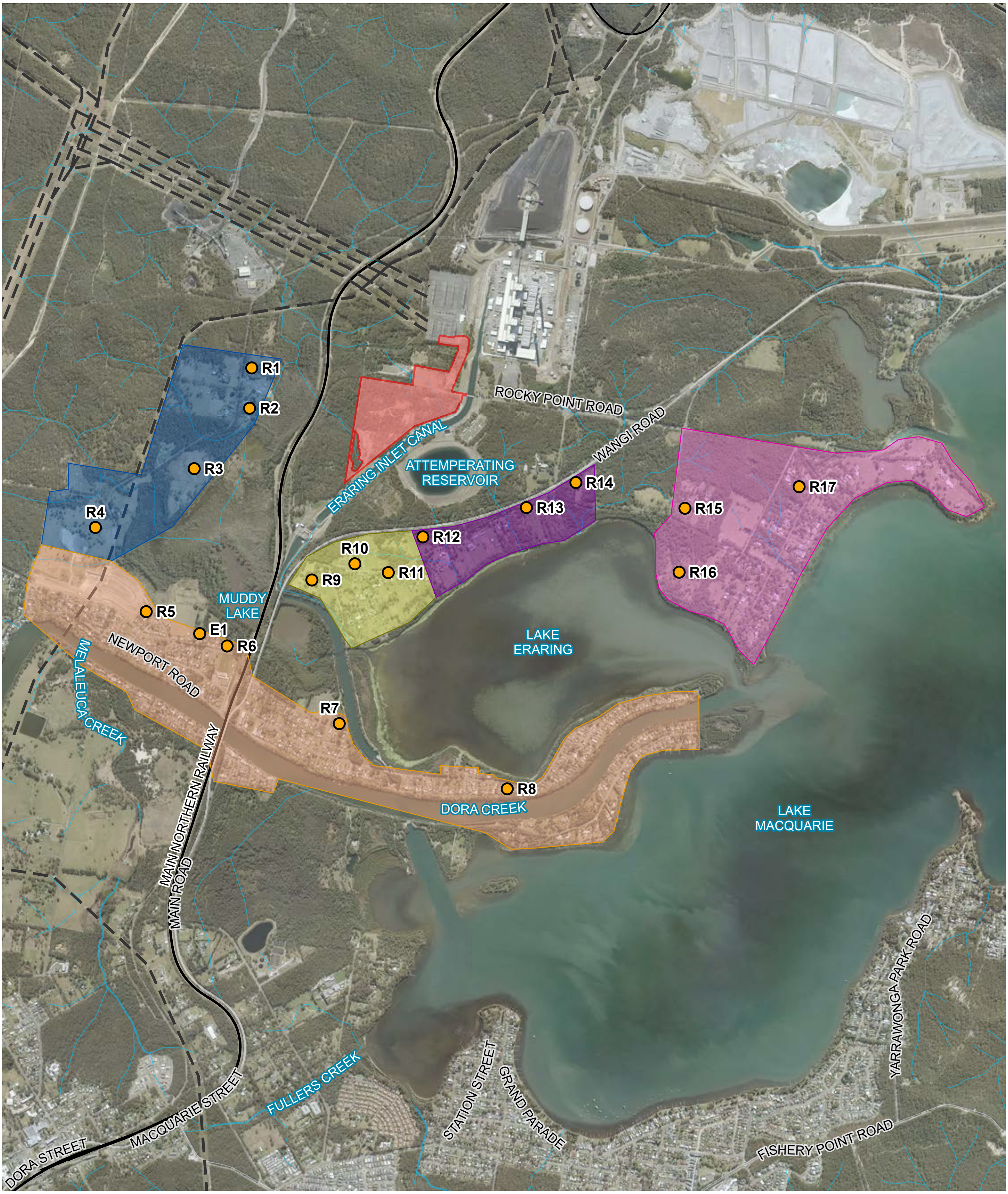
5.5 Noise Prediction Locations

In order to understand the potential noise impacts at receivers around the Project, a number of receivers within each NCA have been selected as locations where noise predictions have been modelled. These receivers were selected with the intention of covering the extents of each NCA nearest to the project location, and were verified with further modelling to confirm that each were the most noise affected in their NCA. Through this selection of receivers, compliance with noise limits at all representative receivers within an NCA should in turn represent full compliance of that NCA. These are detailed in **Table 5.6**.

Table 5.6: Receivers used to Predict Noise Impacts

Receiver	Address	Type of Receiver	Noise Catchment Area
R1	242 Gradwells Road, Dora Creek	Residential	NCA 1
R2	214 Gradwells Road, Dora Creek	Residential	
R3	170 Gradwells Road, Dora Creek	Residential	
R4	95 Gradwells Road, Dora Creek	Residential	
R5	10 Greenway Street, Dora Creek	Residential	NCA 2
R6	9 Coorumbung Road, Dora Creek	Residential	
R7	38 Douglass Street, Dora Creek	Residential	
R8	172 Dora Street, Dora Creek	Residential	
R9	8 Awaba Road, Eraring	Residential	NCA 3
R10	21 Border Street, Eraring*	Residential	
R11	32 Border Street, Eraring	Residential	
R12	63 Border Street, Eraring	Residential	NCA 4
R13	124 Border Street, Eraring	Residential	
R14	140 Point Piper Road, Eraring	Residential	
R15	70 Point Piper Road, Eraring	Residential	NCA 5
R16	41 MacLeay Street, Eraring	Residential	
R17	6 Payten Street, Eraring	Residential	
E1	Dora Creek Public School	Educational	NCA 2

** Note: Both adjacent receivers (19 Border Street and 23 Border Street) receive equal noise levels to 21 Border Street. Regarding the sections below, the predictions at receiver R10 should also be considered to be valid at 19 Border Street and 23 Border Street.*



Project area
Receptor locations

Noise catchment areas
- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 5

Electricity transmission line
Railway

0 800 m
1:32,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
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Figure 5-2 Noise Prediction Locations

6. Assessment of Impacts

6.1 Construction Impacts

6.1.1 Construction Noise Impacts

Estimated noise levels at the nearest receivers were predicted from the anticipated noise levels generated during each construction phase of the Project. **Table 6.1** presents the predicted noise impact at the nearest residential receiver of each NCA during each construction phase.

The assessment approach adopted considered a "worst-case" scenario which assumed all plant and equipment for each activity was operated concurrently while positioned within their work location (as defined in **Table 5.1**) at a location closest to each respective prediction location. This was considered to be a conservative approach and while this may provide for the determination of conservative noise levels, actual construction noise levels should be lower than predicted in this assessment.

As **Table 6.1** shows noise levels were predicted to exceed the standard hours NMLs of residential receivers in NCA 1, NCA 2 and NCA 3 during Phase 2, as well as the standard hours NMLs of residential receivers in NCA 1,, NCA 2, NCA 3 and NCA 5 during Phase 5.

The construction phase predicted to result in the highest noise levels at the nearest sensitive receivers is Phase 5 (i.e., Transmission Structures footings establishment). These works would result in noise levels in exceedance of the standard hours NMLs by up to 3 dB(A) at R1, R2, R6, R15 and R16, 2 dB(A) at R11, and 1 dB(A) at R10. It is however noted that these works are transient in nature and would only occur during the construction of Stage 1 of the Project, not being repeated during the construction of the additional Stages.

Noise contour maps for each of the assessed construction phases are displayed in **Appendix C**.

Table 6.1: Noise Impact from Construction Phases

Receiver	NCA	Standard Hours Construction Noise Criteria (dB(A))	Predicted Noise Performance									
			Construction Phase 1		Construction Phase 2		Construction Phase 3		Construction Phase 4		Construction Phase 5	
			Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)
R1	NCA 1	51	41	-	52	1 dB(A)	47	-	46	-	54	3 dB(A)
R2			42	-	53	2 dB(A)	48	-	47	-	54	3 dB(A)
R3			39	-	49	-	44	-	44	-	50	-
R4			32	-	42	-	37	-	37	-	43	-
R5	NCA 2	50	35	-	45	-	40	-	40	-	47	-
R6[1]			41	-	51	1 dB(A)	46	-	46	-	53	3 dB(A)
R7[2]			33	-	44	-	39	-	38	-	46	-
R8			37	-	47	-	42	-	42	-	48	-
R9		53	45	-	55	2 dB(A)	50	-	50	-	52	-

Receiver	NCA	Standard Hours Construction Noise Criteria (dB(A))	Predicted Noise Performance									
			Construction Phase 1		Construction Phase 2		Construction Phase 3		Construction Phase 4		Construction Phase 5	
			Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)	Predicted Noise Level – dB(A)	Exceedance of Noise Criteria – dB(A)
R10	NCA 3		45	-	55	2 dB(A)	50	-	50	-	54	1 dB(A)
R11			43	-	53	-	48	-	48	-	55	2 dB(A)
R12	NCA 4	58	34	-	45	-	40	-	39	-	48	-
R13			40	-	51	-	46	-	45	-	55	-
R14			29	-	39	-	34	-	34	-	40	-
R15	NCA 5	45	34	-	45	-	40	-	39	-	48	3 dB(A)
R16			35	-	45	-	40	-	40	-	48	3 dB(A)
R17			29	-	40	-	35	-	34	-	43	-
E1	NCA 2	55	39	-	49	-	44	-	44	-	50	-

Note 1: Noise prediction taken at the nearby 23 Coorumbong Road as this receiver experienced greater construction noise levels
Note 2: Noise prediction taken at the nearby 23 Awaba Road as this receiver experienced greater construction noise levels

6.1.2 Sleep Disturbance

Potential impacts on sleep disturbance have not been assessed because construction works will not be undertaken outside of standard hours.

6.2 Operation Noise

The predicted noise impacts resulting from the operation of the Project at residential receivers are detailed in **Table 6.2**. The 'standard' and 'noise-enhancing' meteorological conditions were adopted for the assessment (refer to **Section 5.4.1**), and the Project has been assumed to operate continuously over a 24-hour period.

As discussed in **Section 5.2.2**, the BESS units would most likely reach their operational peak during the mid-morning period (6am – 8am) and evening period (5pm – 7pm), with a reduced operation during the midday and night periods. Due to this, the potential crossover of noise enhancing conditions (i.e., night time temperature inversion events with wind up to 2 m/s) and the BESS operating at peak load will be limited, that is the frequency of occurrence when these two conditions may coincide would be rare and the durations of such events would be short.

Noise contours displaying the spatial distribution of noise from the operation of the Project are displayed in **Appendix D**. As displayed in the appendix, the highest levels of noise from the project are restricted to the EPS property, which residual noise reaching the nearby receivers.

As shown in **Table 6.2**, no exceedances of the PNTL have been predicted during any of the three Stages of the Project's operation. It should be noted however that at R10 during the operation of Stages 1, 2 and 3 simultaneously, noise levels reach but do not exceed the PNTL noise at the receiver. The noise levels and forms of noise associated with the project remains consistent with those historically produced by the EPS itself.

Table 6.2 Operational Noise Impact

Receiver	Noise Catchment Areas	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))						Noise Criteria (PNTL)	Compliant with Noise Criteria?					
		Stage 1		Stages 1 and 2		Stages 1 and 2 and 3			Stage 1		Stage1 and 2		Stages 1 and 2 and 3	
		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions
R1	NCA 1	31	36	34	39	36	40	Day – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R2		31	36	34	39	36	41	Day – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R3		26	31	29	35	31	37	Day – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R4		18	24	21	27	23	29	Day – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R5	NCA 2	20	26	24	30	26	32	Day – 45 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes

Receiver	Noise Catchment Areas	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))						Noise Criteria (PNTL)	Compliant with Noise Criteria?					
		Stage 1		Stages 1 and 2		Stages 1 and 2 and 3			Stage 1		Stage1 and 2		Stages 1 and 2 and 3	
		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions
								Night – 38 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R6		22	28	26	32	29	35	Day – 45 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 38 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R7		17	23	22	28	24	30	Day – 45 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 38 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R8		18	24	23	29	26	32	Day – 45 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 38 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R9	NCA 3	30	35	34	39	36	41	Day – 48 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 42 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R10		30	36	34	39	37	42	Day – 48 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes

Receiver	Noise Catchment Areas	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))						Noise Criteria (PNTL)	Compliant with Noise Criteria?					
		Stage 1		Stages 1 and 2		Stages 1 and 2 and 3			Stage 1		Stage1 and 2		Stages 1 and 2 and 3	
		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 42 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R11		29	34	33	38	35	40	Day – 48 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 44 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 42 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R12	NCA 4	20	26	24	29	26	31	Day – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 42 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R13		20	26	24	29	25	31	Day – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 42 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R14		13	18	18	23	20	26	Day – 53 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 46 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 42 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes

Receiver	Noise Catchment Areas	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))						Noise Criteria (PNTL)	Compliant with Noise Criteria?					
		Stage 1		Stages 1 and 2		Stages 1 and 2 and 3			Stage 1		Stage1 and 2		Stages 1 and 2 and 3	
		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions
R15	NCA 5	21	26	24	30	26	31	Day – 40 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 35 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 35 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R16		22	28	25	31	25	31	Day – 40 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 35 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 35 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
R17		16	22	18	24	20	26	Day – 40 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Evening – 35 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Night – 35 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
								Sleep Disturbance – 52 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes
E1	NCA 2	21	27	25	30	27	33	When Operating – 43 dB(A)	Yes	Yes	Yes	Yes	Yes	Yes

6.3 'Annoying' Noise Characteristics

The following sections detail the applicability of the NPI's penalties for 'annoying' noise characteristics (such as low frequency noise and tonal noise). For the Project's proposed transformers, sound emission data in 1/3 octave frequency bands have been estimated from noise measurements of similar transformers (ref. *Heatherton Terminal Station Noise Emissions Report* (Vipac, 2014)). Noise emission data for the Project's batteries has been obtained from manufacturer's specifications which provides 1/3 octave noise levels in and above the 100 Hz frequency band. The batteries' dominant onboard noise sources are the cooling fans, and due to the physical sizes of the types of fans used to cool the batteries the noise emissions at frequencies below 100 Hz are expected to be negligible.

6.3.1 Low Frequency Noise

As per the Fact Sheet C of the NPI, and as described in the NPI, in order to account for potential low frequency noise impacts, a correction may be applied to noise levels based on a two-step assessment process. This is to determine if a positive adjustment (i.e., a penalty) of two dB or five dB should be applied to the predicted A-weighted noise levels during the evening and night periods.

The first step is to analyse the difference between the C-weighted and A-weighted noise levels predicted at the assessed receivers. If the difference between the C-weighted and A-weighted noise levels is greater than 15 dB, the second step of the assessment will be undertaken. The second assessment step involves comparing the predicted low frequency noise spectrum against a standard reference threshold spectrum, which is given in NPI Table 2.

6.3.1.1 Low-frequency assessment Step 1: difference between C-weighted and A-weighted noise levels

The predicted C-weighted noise levels under noise-enhancing conditions were predicted in SoundPLAN and were compared to the predicted A-weighted levels under noise-enhancing conditions, to assess the worst-case scenario of potentially received low-frequency noise levels. The comparison of the difference in C and A weighted noise levels, and whether each exceeds the NPI criterion is detailed below in **Table 6.3**.

Table 6.3: Predicted Operational Noise Levels (C and A weighted)

Noise Sensitive Receiver	Difference between C and A weighted predicted noise levels $L_{eq,15min}$ dB		
	Noise-Enhancing conditions	Is the difference dB(C) - dB(A) greater than 15 dB?	Requires assessment at the octave band level to determine the level of adjustment due to LFN?
NCA 1 Nearest Residential Receiver (R2)	48 dB(C) – 41 dB(A) = 7 dB	No	No
NCA 2 Nearest Residential Receiver (R6)	43 dB(C) – 35 dB(A) = 8 dB	No	No
NCA 3 Nearest Residential Receiver (R10)	49 dB(C) – 42 dB(A) = 7 dB	No	No
NCA 4 Nearest Residential Receiver (R12)	43 dB(C) – 31 dB(A) = 12 dB	No	No
NCA 5 Nearest Residential Receiver (R15)	40 dB(C) – 31 dB(A) = 9 dB	No	No

As shown in **Table 6.3**, the difference between C and A weighted noise levels do not exceed the 15 dB criteria at each nearest receiver. As such, no low frequency penalty is applicable to Project noise levels and the NPI does not require additional detailed assessment of low-frequency noise impacts. Nonetheless an assessment of the predicted low frequency noise in 1/3 octave bands against the NPI Table C2 criterion has been undertaken and is presented in Section 6.3.1.2.

6.3.1.2 Low-frequency assessment Step 2: comparison of low-frequency spectrum against NPT Table C2

Although the low-frequency noise assessment Step 1 indicates that Step 2 is not required, the Step 2 assessment has been undertaken as shown below.

The predicted 1/3 octave low frequency noise contributions at each of the nearest receivers are compared to the criterion presented in Table C2 of the NPI in **Table 6.4**.

Table 6.4: Predicted Low Frequency Noise Contribution, 1/3 Octave frequency bands, dB(Z)

Noise Sensitive Receiver	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz
NPI Table C2 Threshold Levels	89	86	77	69	61	54	50	50	48	48	46	44
NCA 1 Nearest Residential Receiver (R2)	-	-	-	20.6	15.6	12.6	18.6	33.6	33.6	41.6	37.8	37.2
NCA 2 Nearest Residential Receiver (R6)	-	-	-	15.7	10.7	7.7	13.7	28.7	28.7	36.5	32.7	32.0
NCA 3 Nearest Residential Receiver (R10)	-	-	-	21.3	16.3	13.3	19.3	34.3	34.3	42.1	38.3	37.8
NCA 4 Nearest Residential Receiver (R12)	-	-	-	23.8	18.8	15.8	21.8	36.8	36.8	36.4	31.8	30.3
NCA 5 Nearest Residential Receiver (R15)	-	-	-	16.6	11.6	8.6	14.6	29.6	29.6	33.6	29.6	28.8

As shown in Table 6.4, based on the provided and the estimated low frequency noise data for the transformers and the batteries, the predicted noise level spectra at the receivers do not exceed the NPI Table C2 Threshold Levels.

6.3.2 Tonal Noise

As per the Fact Sheet C of the NPI, tonality is assessed based on a 1/3 octave band analysis using the *Objective method for assessing the audibility of tones in noise – simplified method* (ISO1996.2-2007 – Annex D). The NPI details that a 5 dB(A) penalty should be applied when the level of a one-third octave band exceeds the level of the adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz
- 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz
- 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.

Table 6.5 details the comparison of the 1/3 octave band sound pressure levels at each of the nearest receivers within each NCA to the above assessment criterion. As displayed in the table, no exceedances of the above criterion have been identified, and hence no tonal penalty is applicable to the received noise levels.

Table 6.5 Tonal Noise Assessment

Measurement	1/3 Octave Band Frequencies (dB(Z))																										
	25Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1k Hz	1.25k Hz	1.6k Hz	2k Hz	2.5k Hz	3.15k Hz	4k Hz	5k Hz	6.3k Hz	8k Hz	10k Hz
Nearest Receiver in NCA 1 (R2)																											
Sound Pressure Level	20.6	15.6	12.6	18.6	33.6	33.6	41.6	37.8	37.2	35.4	41.8	29.9	31.0	37.4	34.5	32.5	26.7	30.6	25.9	23.6	19.4	20.1	13.6	2.0	-14.0	-38.0	-72.4
Level above Left Neighbour	N/A	-5.0	-3.0	6.0	15.0	0.0	8.0	-3.8	-0.6	-1.8	6.4	-11.9	1.1	6.3	-2.9	-2.0	-5.9	4.0	-4.8	-2.3	-4.2	0.7	-6.4	-11.6	-16.0	-24.0	-34.4
Level above Right Neighbour	5.0	3.0	-6.0	-15.0	0.0	-8.0	3.8	0.6	1.8	-6.4	11.9	-1.1	-6.3	2.9	2.0	5.9	-4.0	4.8	2.3	4.2	-0.7	6.4	11.6	16.0	24.0	34.4	N/A
Penalty Triggered?	N/A	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	N/A
Nearest Receiver in NCA 2 (R6)																											
Sound Pressure Level	15.7	10.7	7.7	13.7	28.7	28.7	36.5	32.7	32.0	31.8	37.9	25.6	26.7	32.5	29.0	24.5	18.0	21.1	14.3	10.4	3.7	0.4	-12.2	-33.4	-64.4	-112.0	-
Level above Left Neighbour	N/A	-5.0	-3.0	6.0	15.0	0.0	7.8	-3.8	-0.6	-0.2	6.1	-12.3	1.1	5.8	-3.5	-4.5	-6.6	3.2	-6.9	-3.9	-6.7	-3.3	-12.5	-21.2	-31.0	-47.6	N/A
Level above Right Neighbour	5.0	3.0	-6.0	-15.0	0.0	-7.8	3.8	0.6	0.2	-6.1	12.3	-1.1	-5.8	3.5	4.5	6.6	-3.2	6.9	3.9	6.7	3.3	12.5	21.2	31.0	47.6	N/A	N/A
Penalty Triggered?	N/A	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	N/A	N/A
Nearest Receiver in NCA 3 (R10)																											
Sound Pressure Level	21.3	16.3	13.3	19.3	34.3	34.3	42.1	38.3	37.8	37.1	43.5	31.6	32.4	38.6	35.7	32.7	26.7	30.6	25.2	22.8	18.2	18.4	11.2	-1.7	-19.6	-46.8	-86.1

Measurement	1/3 Octave Band Frequencies (dB(Z))																									
	25Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1k Hz	1.25k Hz	1.6k Hz	2k Hz	2.5k Hz	3.15k Hz	4k Hz	5k Hz	6.3k Hz	8k Hz	10k Hz
Level above Left Neighbour	N/A	-5.0	-3.0	6.0	15.0	0.0	7.8	-3.8	-0.6	-0.7	6.4	-11.9	0.8	6.2	-2.8	-3.0	-6.0	3.9	-5.4	-2.5	-4.5	0.2	-7.2	-12.9	-17.9	-27.1	-39.3
Level above Right Neighbour	5.0	3.0	-6.0	-15.0	0.0	-7.8	3.8	0.6	0.7	-6.4	11.9	-0.8	-6.2	2.8	3.0	6.0	-3.9	5.4	2.5	4.5	-0.2	7.2	12.9	17.9	27.1	39.3	N/A
Penalty Triggered?	N/A	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	N/A
Nearest Receiver in NCA 4 (R12)																											
Sound Pressure Level	23.8	18.8	15.8	21.8	36.8	36.8	36.4	31.8	30.3	29.4	35.0	22.2	21.4	27.3	23.1	18.9	12.1	15.2	9.3	7.0	2.9	3.5	-2.6	-13.8	-29.1	-52.1	-84.9
Level above Left Neighbour	N/A	-5.0	-3.0	6.0	15.0	0.0	-0.4	-4.6	-1.4	-0.9	5.6	-12.8	-0.9	5.9	-4.2	-4.2	-6.8	3.1	-5.9	-2.3	-4.1	0.6	-6.2	-11.2	-15.3	-23.0	-32.8
Level above Right Neighbour	5.0	3.0	-6.0	-15.0	0.0	0.4	4.6	1.4	0.9	-5.6	12.8	0.9	-5.9	4.2	4.2	6.8	-3.1	5.9	2.3	4.1	-0.6	6.2	11.2	15.3	23.0	32.8	N/A
Penalty Triggered?	N/A	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	N/A
Nearest Receiver in NCA 5 (R15)																											
Sound Pressure Level	16.6	11.6	8.6	14.6	29.6	29.6	33.6	29.6	28.8	27.4	33.5	21.1	23.3	29.0	25.4	21.6	14.9	17.9	10.8	6.6	-0.6	-4.9	-18.6	-41.6	-75.5	-	-
Level above Left Neighbour	N/A	-5.0	-3.0	6.0	15.0	0.0	4.0	-4.0	-0.8	-1.3	6.0	-12.4	2.3	5.6	-3.5	-3.8	-6.7	3.0	-7.1	-4.2	-7.2	-4.3	-13.7	-23.0	-33.9	N/A	N/A
Level above Right Neighbour	5.0	3.0	-6.0	-15.0	0.0	-4.0	4.0	0.8	1.3	-6.0	12.4	-2.3	-5.6	3.5	3.8	6.7	-3.0	7.1	4.2	7.2	4.3	13.7	23.0	33.9	N/A	N/A	N/A
Penalty Triggered?	N/A	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	N/A	N/A	N/A

6.4 Cumulative Noise

6.4.1 Myuna Colliery

Centennial operates the Myuna Colliery at Wangi Wangi, approximately 5km east northeast from the Project site. The colliery features surface operations for an underground coal mine, supplying coal to EPS.

The *Myuna Colliery Modification report for modification to project approval MP 10_0080* (EMM, 2020) details the predicted noise impacts associated with regular operation of the facility along with the (no longer proceeding) proposed modifications on site activities (additional truck movements, and coal mixing activities). The assessment predicted noise levels of 35 dB(A) at Eucalypt Close, west of the facility. Noting that Eucalypt Close is approximately 2km northeast of NCA 4, the nearest NCA to the facility, it has been deemed unlikely for cumulative noise impacts between the Myuna Colliery and the Project. Additionally, as the noise predictions were for the regular operation of the colliery with additional activities, it is almost certain that noise from the Myuna Colliery is less than those predicted.

6.4.2 Mandalong Mine Cooranbong Site Entrance

In addition to the Myuna Colliery, Centennial additionally operates the Cooranbong Site Entrance to the Mandalong Mine. The site entrance is located 1km northwest of the Project site and like the Myuna Bay Colliery features surface operations to support underground coal mining operations.

Appendix 5 of the *Centennial Mandalong 2020 Annual Review* (Centennial Mandalong, 2021) features noise monitoring to determine compliance with the Cooranbong Site Entrance's EPL noise limits. One set of noise monitoring performed for the review determined that the site entrance produces noise levels of 36 dB(A) at the measurement location at the intersection of Gradwells Road and Simpson Road (approximately 400m directly south of the site entrance). Another set of monitoring performed under noise enhancing conditions (night, stability class F and wind up to 2.6 m/s) determined that noise from the Cooranbong Site Entrance was 46 dB(A).

While reported to have been withdrawn from the application process, the *Northern Coal Logistics Project: Modification report for modification to development consent SSD-5145* (EMM, 2020) featured a noise assessment of the existing Cooranbong Site Entrance, which noted that under noise enhancing conditions noise levels could be up to 46 dB(A) during noise enhancing conditions, in line with the measurements above. The report also noted that this noise was above the Coorangbong Site Entrances' PNTLs during the day, night and evening periods (40 dB(A), 40 dB(A) and 38 dB(A), respectively). This indicates that the residencies in NCA 1 are already experiencing noise impacts from a nearby industrial operation.

Due to the measured noise levels, it has been deemed unlikely that noise from the site entrance could pose a cumulative risk outside of NCA 1. Therefore, a Cooranbong Site Entrance noise levels of 36 dB(A) under standard meteorological conditions and 46 dB(A) under noise enhancing meteorological conditions has been conservatively adopted at each receiver in NCA 1 when determining the cumulative noise impact. The potential cumulative noise impacts resulting from the Project and the Cooranbong Site Entrance operations are detailed in **Table 6.6**.

As displayed in the table, under standard meteorological conditions in Stage 1, predicted noise from the Project is lower than that of the Cooranbong Site Entrance and would not be the dominant contributor of noise in the NCA. This is also predicted to be the case at R3 and R4 during all stages under standard conditions.

Under noise enhancing conditions, cumulative noise levels would be dominated by the noise of the Cooranbong Site Entrance, and under these circumstances the Project would not be the most audible noise source in NCA 1.

Table 6.6 Cumulative Noise Impact under the Supplier A Configuration with Mandalong Mine Cooranbong Site Entrance

Receiver	Noise Catchment Areas	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))						Contribution from Mandalong Mine Cooranbong Site Entrance (L_{Aeq} dB(A))		Highest Predicted Cumulative Noise Level at Residential Receiver (L_{Aeq} dB(A))					
		Stage 1		Stages 1 and 2		Stages 1 and 2 and 3				Stage 1		Stages 1 and 2		Stages 1 and 2 and 3	
		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions
R1	NCA 1	31	36	34	39	36	40	36	46	37	46	38	47	39	47
R2		31	36	34	39	36	41			37	46	38	47	39	47
R3		26	31	29	35	31	37			36	46	37	46	37	47
R4		18	24	21	27	23	29			36	46	36	46	36	46

6.4.3 Eraring Power Station

During discussion with Origin Energy, it was confirmed that both the EPS and EPS water inlet were at full operation during monitoring for the duration of background noise monitoring. Following the performance of monitoring, noise generated from the entire EPS operation was isolated from the background noise. This isolated noise has been detailed in **Table 6.7**. A more in-depth isolation was performed at NCA 1 and NCA 3 (see **Section 4.2.3.6**), and the results of this in depth isolation were adopted at the two NCAs.

Table 6.7 Measured EPS Noise Levels

Noise Measurement Location	Maximum Recorded Level (dB(A))	Minimum Recorded Level (dB(A))	Average Recorded Level (dB(A))	Adopted EPS Contribution (dB(A))
Gradwells Road	N/A			40 (at NCA 1)
Dora Street	33	30	31	31 (at NCA 2)
8 Border Street	N/A			40 (at NCA 3)
124 Border Street	37	31	35	35 (at NCA 4 & 5)

The levels have been adopted as the EPS noise contribution when considering cumulative noise impacts with the Project. In the case of NCA 5, the EPS noise adopted for NCA 4 has been conservatively adopted based on the fact that NCA 4 sits between the straight-line measurement from both the power station and water inlet.

The cumulative noise impact of the operation of the Project and the EPS are detailed in **Table 6.8**. Generally, with the exception of the receivers most affected by the Project in NCA 1 and NCA 3, noise levels from the Project are less than the noise levels of EPS. In these instances, the primary contribution of noise is from EPS instead of the Project.

At other receivers where noise levels from the Project are louder than noise levels from the EPS, the cumulative noise levels may be up to 3 dB(A) greater than those of the Project alone. During Stage 3, the cumulative noise level under noise enhancing conditions may exceed the night PNTL by up to 2 dB(A) but would remain at or below the recommended amenity level for all receivers except R2, R9 and R10, where noise would only be negligibly (1dB(A)) above the recommended amenity level.

The EPS has been scheduled to cease operation no later than 2032, and hence would no longer pose a cumulative noise risk after that time.

Table 6.8 Cumulative Noise Impact with EPS

Receiver	Noise Catchment Areas	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))						Contribution from EPS (L_{Aeq} dB(A))	Highest Predicted Cumulative Noise Level at Residential Receiver (L_{Aeq} dB(A))					
		Stage 1		Stages 1 and 2		Stages 1 and 2 and 3			Stage 1		Stages 1 and 2		Stages 1 and 2 and 3	
		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions		Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions	Standard Conditions	Noise Enhancing Conditions
R1	NCA 1	31	36	34	39	36	40	40	41	41	41	43	41	43
R2		31	36	34	39	36	41		41	41	41	43	41	44
R3		26	31	29	35	31	37		36	36	36	38	36	39
R4		18	24	21	27	23	29		35	35	35	36	35	36
R5	NCA 2	20	26	24	30	26	32	31	31	32	32	34	32	35
R6		22	28	26	32	29	35		32	33	32	35	33	36
R7		17	23	22	28	24	30		31	32	32	33	32	34
R8		18	24	23	29	26	32		31	32	32	33	32	35
R9	NCA 3	30	35	34	39	36	41	40	40	41	41	43	41	44
R10		30	36	34	39	37	42		40	41	41	43	42	44
R11		29	34	33	38	35	40		40	41	41	42	41	43
R12	NCA 4	20	26	24	29	26	31	35	35	36	35	36	36	36
R13		20	26	24	29	25	31		35	36	35	36	35	36
R14		13	18	18	23	20	26		35	35	35	35	35	36
R15	NCA 5	21	26	24	30	26	31	35	35	36	35	36	36	36
R16		22	28	25	31	25	31		35	36	35	36	35	36
R17		16	22	18	24	20	26		35	35	35	35	35	36
E1	NCA 2	21	27	25	30	27	33	31	31	32	32	34	32	35

6.4.4 Construction of Additional BESS stages

During the construction of Stage 2 of the Project, noise from both the construction phases and the operation of the BESS would occur concurrently. Likewise, this would also occur during the operation of Stage 2 of the Project and construction of Stage 3.

It should be noted that unlike phases 1 – 4, phase 5 will only take place during the construction of Stage 1 of the project and hence there is no potential cumulative risk. Additionally, this cumulative assumption is conservative in nature, as the majority of earthworks and structural works would likewise be performed during the construction of Stage 1.

As displayed in **Table 6.9** and **Table 6.10**, the operation of Stage 1 of the Project would generally increase noise levels during Phase 1 of construction by 1 dB(A) and would otherwise not have an impact on construction noise levels during phases 2 to 5. Noise from the operation of Stage 2 would generally increase noise levels during construction Phase 1 by 2 dB(A) and noise levels during construction phases 3 and 4 by 1 dB(A).

It should be noted that both construction noise and operational noise are assessed independently from one another and hence there is no noise criteria for the cumulative noise impact of construction and operation noise together.

Table 6.9 Cumulative Noise Impact from the Operation of Stage 1 and the Construction of Stage 2 of the Project

Receiver	Noise Catchment Area	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))								
		Operation of Stage 1 of Project (Noise-Enhancing Conditions)	Construction Phase 1	Construction Phase 2	Construction Phase 3	Construction Phase 4	Operation of Stage 1 plus Construction Phase 1	Operation of Stage 1 plus Construction Phase 2	Operation of Stage 1 plus Construction Phase 3	Operation of Stage 1 plus Construction Phase 4
R1	NCA 1	36	41	52	47	46	42	52	47	46
R2		36	42	53	48	47	43	53	48	47
R3		31	39	49	44	44	40	49	44	44
R4		24	32	42	37	37	33	42	37	37
R5	NCA 2	26	35	45	40	40	36	45	40	40
R6		28	41	51	46	46	41	51	46	46
R7		23	33	44	39	38	33	44	39	38
R8		24	37	47	42	42	37	47	42	42
R9	NCA 3	35	45	55	50	50	45	55	50	50
R10		36	45	55	50	50	46	55	50	50
R11		34	43	53	48	48	44	53	48	48
R12	NCA 4	26	34	45	40	39	35	45	40	39
R13		26	40	51	46	45	40	51	46	45
R14		18	29	39	34	34	29	39	34	34
R15	NCA 5	26	34	45	40	39	35	45	40	39
R16		28	35	45	40	40	36	45	40	40
R17		22	29	40	35	34	30	40	35	34
E1	NCA 2	27	39	49	44	44	39	49	44	44

Table 6.10 Cumulative Noise Impact from the Operation of Stage 2 and the Construction of Stage 3 of the Project

Receiver	Noise Catchment Area	Highest Predicted Noise Level at Residential Receiver (L_{Aeq} dB(A))								
		Operation of Stage 2 of Project (Noise-Enhancing Conditions)	Construction Phase 1	Construction Phase 2	Construction Phase 3	Construction Phase 4	Operation of Stage 2 plus Construction Phase 1	Operation of Stage 2 plus Construction Phase 2	Operation of Stage 2 plus Construction Phase 3	Operation of Stage 2 plus Construction Phase 4
R1	NCA 1	39	41	52	47	46	43	52	48	47
R2		39	42	53	48	47	44	53	49	48
R3		35	39	49	44	44	40	49	45	45
R4		27	32	42	37	37	33	42	37	37
R5	NCA 2	30	35	45	40	40	36	45	40	40
R6		32	41	51	46	46	42	51	46	46
R7		28	33	44	39	38	33	44	39	38
R8		29	37	47	42	42	38	47	42	42
R9	NCA 3	39	45	55	50	50	46	55	50	50
R10		39	45	55	50	50	46	55	50	50
R11		38	43	53	48	48	44	53	48	48
R12	NCA 4	29	34	45	40	39	35	45	40	39
R13		29	40	51	46	45	40	51	46	45
R14		23	29	39	34	34	30	39	34	34
R15	NCA 5	30	34	45	40	39	35	45	40	40
R16		31	35	45	40	40	36	45	41	41
R17		24	29	40	35	34	30	40	35	34
E1	NCA 2	30	39	49	44	44	40	49	44	44

6.5 Vibration

As identified in **Section 5.1.1**, vibratory rollers and air track drills, which are considered to be a vibration-generating plant, would be used during construction. The equipment, setback distances and nearest impacted receivers are displayed in **Table 6.11**.

Table 6.11 Predicted Vibration Impact

Equipment	Setback Distance (m)			Nearest Affected Receiver (m)			Vibration Impact?
	Human Comfort	Cosmetic Building Damage	Heritage Structure Impact	Residency	Occupancy	Heritage Item	
Vibratory Roller	100m	25m	45m	700m	300m	200m	No
Air Track Drill	50m	15m	27m				No

As displayed in the table, no vibration impacts at nearest receivers have been predicted as a result of the construction of the Project. Additionally, as the nearest medical facility is 2 km away from the Project site, no impacts to medical facilities due to construction vibration have been predicted.

No equipment used during the operation of the Project has been predicted to produce vibration impacts.

7. Mitigation and Management

7.1 Construction Noise

Construction noise impacts in the range of 3 dB(A) above NMLs have been predicted at residential receivers in the vicinity of the Project during Phase 2 and Phase 5.

In order to reduce construction noise levels, standard mitigation measures from the *Construction Noise and Vibration Guidelines* (RMS, 2016) have been recommended. These are provided in **Table 7.1**.

Noting that the noise levels of the construction works are only 3 dB(A) above the NMLs during certain phases, not all of the listed mitigation measures would need to be adopted. Instead, the measures should be adopted where reasonable and feasible, during the construction phases that have been identified as requiring noise mitigation. As required by the SEARs, a draft construction noise management plan is provided in Appendix D.

Table 7.1: Standard measures, noise during construction.

Measure	Details	Timing
Equipment restrictions	Select low-noise plant and equipment. Ensure equipment mufflers operate in a proper and efficient manner.	Prior to and during construction
Substitute methods	Where possible, use quieter and less vibration emitting construction methods.	During construction
Limit equipment use	Only have necessary equipment on-site and turn off when not in use.	During construction
Limit activity duration	Where possible, concentrate noisy activities at one location and move to another as quickly as possible.	During construction
Site access	Vehicle movements, including deliveries outside standard hours should be minimised and avoided where possible.	During construction
Equipment maintenance	Ensure all plant and equipment is well maintained and where possible, fitted with silencing devices.	Prior to and during construction
Reduce equipment power	Use only the necessary size and powered equipment for tasks.	During construction
Quieter working practices	Implement training to induct staff on noise sensitivities	Prior to and during construction
Reversing alarms	Where possible, consider the application of less intrusive alternatives to reverse beepers such as 'squawker' or 'broadband' alarms.	During construction
Noise barriers	Consider the installation of temporary construction noise barriers or earth mounds for concentrated, noise-intensive activities.	During construction
Enclosures	Where practicable, install enclosures around noisy mobile and stationary equipment as necessary.	During construction
Use and siting of plant	Where possible, avoid simultaneous operation of two or more noisy plant close to receivers. The offset distance between noisy plant and sensitive receivers should be maximised.	During construction

Measure	Details	Timing
Plan work sites and activities to minimise noise	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements.	Prior to and during construction
Monitoring	Complete routine monitoring to evaluate construction noise levels and evaluate whether the mitigation measures in place are adequate or require revision.	During construction

7.2 Operation Noise

As discussed in Section 6.2, no noise criteria exceedances from the Project have been determined to take place during any Stage of operation. However, when the peak operation of BESS occurs in conjunction with the noise-enhancing conditions in the night period, noise levels may reach but not exceed the PNTLs at one location.

As the peak operation of the BESS will predominately take place during the mid-morning and evening period, the potential time periods where the BESS will operate at peak load at highest environmental temperatures (and hence maximum noise production) and where noise enhancing conditions will take place at night will be limited. However, as the risk that these events will coincide still exists, and that final technology selection and layout would be subject to detailed design, measures to mitigate noise impact to avoid exceedances have been detailed below.

7.2.1 Site-Wide Mitigation

It is noted that Project detailed design may result in configuration and layout changes while the technology provider is also yet to be selected. The detailed design of the Project would include further consideration and modelling of the selected BESS component supplier's equipment SPLs and layout to confirm the predictions of the noise impact assessment remain valid.

Adopting currently available battery solutions and known SPLs, and without any mitigation, noise from the operation of the Project is predicted to remain at or below all applicable noise PNTL at all times. The achievement of compliance with the noise limits from the combined operation of all Project stages will be incorporated as a performance expectation of the supply, installation, operation and maintenance contracts between Origin and the supplier(s).

Origin would undertake a review of noise impacts of the ultimately chosen technology and layout for the need to implement site-specific noise controls or attenuation treatments to assure that the Project fully complies with the PNTL at all receivers at all times under all licensable meteorological conditions. The Project would also implement a Noise Management Program which would include that noise measurement and modelling investigation be undertaken during commissioning and operation of initial stages, with the specific purpose of quantifying any noise reduction that may be necessary for subsequent stages or to be retro-fitted if necessary.

Following the determination of appropriate acoustic treatments and/or mitigation measures, the results of the noise surveys and revised modelling should be incorporated into the Project Noise Management Program.

7.2.2 Noise at NCA 3

As displayed in **Appendix D**, while the local topography mostly shields NCA 3 and NCA 4 from noise impacts, at a small section of land east of the EPS pumping station, noise spills through the topography into NCA 3 leading to increased noise levels at those receivers compared to their neighbours. During the detailed design of the Project, risks and opportunities relating to this issue should be explored in addition to the site-wide mitigation in order to possibly assist in reducing noise impacts within NCA 3.

7.3 Construction Vibration

No vibration impacts have been predicted as a result of the construction of the Project. In the event that the proponent seeks to further mitigate vibration impacts, measures for limiting vibration impacts from *Assessing Vibration: a technical guideline*, (DECC, 2006) have been provided in **Table 7.2**.

Table 7.2: Vibration management measures from DECC, 2006

Control measure	Details
Controlling vibration levels from the source	▪ Choosing alternative, lower-impact equipment or methods wherever possible ▪ Scheduling the use of vibration-causing equipment at the least sensitive times of the day (wherever possible) ▪ Locating high vibration sources as far away from sensitive receiver areas as possible ▪ Sequencing operations so that vibration-causing activities do not occur simultaneously. ▪ Keeping equipment well maintained ▪ Do not conduct vibration intensive works within the recommended safe setback distances.
Consultation	Informing nearby receivers about the nature of construction phases and the vibration-generating activities.

8. Conclusion

8.1 Noise

8.1.1 Construction

The construction and preparation of the platform the BESS would be positioned on, as well as the installation of the BESS units themselves will be undertaken in five construction phases. Phases 2 and 5 have been identified as requiring mitigation of noise impacts. Without additional noise mitigation, noise from Phase 5 is predicted to be up to 3 dB(A) above the relevant NMLs at NCA 1, NCA 2 and NCA 5, the two most impacted NCAs, and an exceedance of up to 2 dB(A) above the NML at NCA 3.

Construction noise impacts would be manageable through the use of reasonable and feasible mitigation measures. A number of mitigation measures have been provided in **Section 7.1**.

8.1.2 Operation

Operational noise levels for the full development of the Project are predicted to comply with Project noise trigger levels at all receivers while operating at full load during all time periods and meteorological conditions. The noise levels and forms of noise associated with the Project is also consistent with those historically produced by the EPS itself.

Without the installation of site-specific noise attenuation treatments, during operation of Project Stages 1, 2 and 3, operational noise levels are predicted to reach but not be higher than the PNTL in NCA 3 while under noise enhancing meteorological conditions.

It is expected that, if required, feasible and reasonable noise control attenuation treatments will be readily able to achieve the required level of noise reduction for the entire Project site. The exact types, sizes and acoustic performance of individual noise reduction devices will be determined during the Detailed Design phase, as the design requirements will depend on the battery and other equipment's manufacturer's specifications. Furthermore, depending on the variation in noise emissions of different plant components between different manufacturers' models, more or less noise attenuation may need to be applied to different types of noise sources on site in order to achieve the required overall total site noise attenuation. Nevertheless, it is expected that all of the potential BESS equipment suppliers will be able to include sufficient and adequate noise control in order to achieve the Project's target noise levels at all receivers during the combined operation of all Project Stages. Measures such as thermal cycling and fan speed controls could also be utilised to manage noise.

8.1.3 Cumulative

It was determined that a cumulative operational noise impact may be posed from the operation of the Project, the EPS and the Cooranbong Entrance to the Mandalong Mine.

It has been predicted that noise from the Project would be quieter than that of the Cooranbong Entrance in NCA 1 and hence noise from the Project would not be the dominant noise source, limiting the possibility of a cumulative noise impact.

In regards to cumulative noise impacts with the EPS, at the majority of receivers noise from the Project is expected to be masked by existing EPS noise. In instances where the Project is predicted to be the louder noise source, the cumulative impact may increase noise levels by up to 3 dB(A). The cumulative noise level of the Project and EPS may reach up to 44 dB(A), 2 dB(A) above the night PNTL. As per the NPI, this exceedance would be negligible in nature and would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.

8.2 Vibration

The vibration impact as a result of construction were, at their maximum extent potentially capable of causing human comfort impacts 100m from the Project site, cosmetic damage impacts 25m away from the Project site and damage to heritage items at 45m from the Project site. All vibration sensitive receivers are beyond these setback distances, and hence no vibration impacts resulting from the Project have been predicted.

9. References

Australian Energy Market Operator, (2020). *Renewable Integration Study: Stage 1 report*. AEMO, Melbourne, Australia

British Standards Group, (1993). *Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration*. BS 7385-2:1993. British Standards. London, UK

British Standards Group, (2008). *Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting*. BS 6472-1: 2008. British Standards. London, UK

Centennial Mandalong, (2021). *Mandalong Mine Annual Review*. Centennial Coal Company Pty Ltd, Sydney, NSW

Deutsches Institut für Normung, (2016). *Vibrations in buildings – Part 3: Effects on structures DIN 4150-3*. DIN, Berlin, Germany

EMM, (2020). *Myuna Colliery Modification Report for Modification to Project Approval MP 10_0080*. EMM Consulting, St Leonards, NSW

EMM, (2020). *Northern Coal Logistics Project: Modification report for modification to development consent SSD-5145*. EMM Consulting, St Leonards, NSW

NSW Department of Environment and Climate Change, (2009). *Interim Construction Noise Guideline*. DECC, Sydney South, NSW

NSW Department of Environment and Climate Change, (2011). *NSW Road Noise Policy*. DECC, Sydney South, NSW

NSW Department of Environment and Conservation, (2006). *Assessing Vibration: a technical guideline*. DEC, Sydney, NSW

NSW Environmental Protection Agency, (2017). *Noise Policy for Industry*. NSW EPA, Sydney South, NSW

Roads and Maritime Services, (2016). *Construction Noise and Vibration Guideline*. RMS, North Sydney, NSW

Standards Australia, (2006). *Explosives – Storage and use Part 2: Use of explosives*. AS 2187.2 – 2006. Standards Australia, Sydney, NSW

Vipac Engineers & Scientists, (2014). *Heatherton Terminal Station Noise Emissions Report*. Vipac, Port Melbourne, VIC

Appendix A. Noise Monitoring Graphs

A.1 232 Gradwells Road

A.2 Dora Street

A.3 8 Border Street

A.4 124 Border Street

Appendix B. Local Meteorology Assessment

As per the Noise Policy for Industry (NPI), (NSW EPA, 2017), consideration of local meteorology needs to be accounted for in order to appropriately assess the potential for noise enhancing conditions to take place in the vicinity of the Project. The NPI notes two tests for determining the significance of noise enhancing conditions:

- The existence of light winds up to 3 m/s during all time periods during all stability classes other than E, F and G
- The existence of temperature inversions during the winter night period (6pm – 7am)

Where either of these occur greater than 30% of the time, noise-enhancing conditions need to be considered for modelling. An assessment of local wind speed and temperature inversions is detailed in the sections below.

B.1 Wind Speed

The significance of wind speeds up to 3 m/s was assessed at the 16 wind sectors (i.e. each direction of a 16 point compass) for stability classes A – D. Additionally, the percentage of wind speeds up to 3 m/s for all stability classes was also assessed and displayed in **Table B.1**.

As displayed in the table, when considering only stability classes A – D as per the NPI requirements, no wind sectors would experience winds up to 3 m/s greater than 30% of the time, and hence noise enhancing conditions during the day, evening and nights (outside of temperature inversions) have been considered not significant.

Table B.1 Summary of the significance of wind speeds up to 3 m/s during stability classes A – D

Period	2015	2016	2017	2018	2019	2020
Day	No	No	No	No	No	No
Evening	No	No	No	No	No	No
Night	No	No	No	No	No	No

No = no percentage (%) occurrence of wind speeds up to 3 m/s greater than 30% in any wind sector

Yes = percentage (%) occurrence of wind speeds up to 3 m/s greater than 30% in one or more wind sector

The full breakdown of the percentage occurrence of wind speeds up 3 m/s per wind sector and per time period have been tabulated and detailed in **Section B.1**.

B.2 Temperature Inversions

Sigma Theta values for the same six years collected at Dora Creek meteorology monitoring station was used to determine the presence of Temperature Inversions in the vicinity of the Project. Sigma Theta values were used to develop Stability Classes from the local meteorology, which were then further developed into Pasquill – Gifford Stability Classes. The percentage occurrence of the Stability Class F (representing Temperature Inversions) between 6pm and 7am in winter is displayed in **Table B.2**. As displayed in the table, temperature inversions occurred approximately 50% of the time in each year with the exception of 2020 and 2021 which were outliers with temperature inversion percentages of 27% and 35%, respectively. As all but one year experience temperature inversions more than 30% of the time, night-time temperature inversion noise enhancing conditions have been considered significant.

Table B.2 Winter Night Stability Classes – Dora Creek

Year	Stability Class	Percentage Occurrence during Winter Nights
2015	D	16%
	E	29%
	F	**55%**
2016	D	24%
	E	21%
	F	**54%**
2017	D	16%
	E	26%
	F	**58%**
2018	D	21%
	E	27%
	F	**52%**
2019	D	23%
	E	23%
	F	**54%**
2020	D	33%
	E	40%
	F	27%
2021	D	31%
	E	34%
	F	**35%**

An analysis was performed on the wind speeds found during the winter night temperature inversions. It was found that generally, the maximum wind speed during these events sat slightly below 3 m/s, while the mean wind speed during the temperature inversions sat on approximately 1 m/s. The 95th percentile wind speed was approximately 2 m/s, in line with the modelling requirements of the NPI night-time noise enhancing conditions.

Table B.3 Wind Speeds during Winter Night Temperature Inversion Conditions – Dora Creek

Year	Maximum Wind Speed (m/s)	Mean Wind Speed (m/s)	95th Percentile Wind Speed (m/s)
2015	2.6	0.7	2.0
2016	2.9	1.1	2.1
2017	2.7	1.1	2.0
2018	2.9	1.3	2.2
2019	2.7	1.1	2.3

Year	Maximum Wind Speed (m/s)	Mean Wind Speed (m/s)	95th Percentile Wind Speed (m/s)
2020	2.7	0.9	1.8

B.1 Wind Sector Tables

B.1.1 2015

Table B.4: Dora Creek, 2015, day

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
NNE	4.1	2.7	2.5	0.1	9.4
NE	4.6	5.0	5.6	0.9	16.1
ENE	4.5	6.1	8.0	1.7	20.3
E	4.1	5.3	7.7	2.1	19.2
ESE	4.0	3.7	6.4	1.7	15.8
SE	4.3	3.0	4.5	1.0	12.8
SSE	5.5	2.2	2.2	0.5	10.4
S	6.4	2.7	0.6	0.1	9.8
SSW	7.6	3.0	0.3	0.0	10.9
SW	8.5	4.2	0.9	0.2	13.8
WSW	7.9	3.9	2.1	0.3	14.2
W	9.5	3.5	2.2	0.6	15.8
WNW	9.0	2.4	1.8	0.5	13.7
NW	9.1	1.2	0.7	0.4	11.4
NNW	5.8	1.1	0.4	0.1	7.4
N	4.4	0.8	0.2	0.1	5.5

Table B.5: Dora Creek, 2015, evening

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.1	0.1
NE	0.0	0.0	0.0	1.2	1.2
ENE	0.0	0.0	0.0	2.9	2.9
E	0.0	0.0	0.0	4.5	4.5
ESE	0.0	0.0	0.0	3.7	3.7
SE	0.0	0.0	0.0	2.0	2.0
SSE	0.0	0.0	0.0	0.3	0.3
S	0.0	0.0	0.0	0.3	0.3
SSW	0.0	0.0	0.0	0.3	0.3
SW	0.0	0.0	0.0	0.7	0.7
WSW	0.0	0.0	0.0	1.6	1.6
W	0.0	0.0	0.0	2.2	2.2

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
WNW	0.0	0.0	0.0	2.1	2.1
NW	0.0	0.0	0.0	1.1	1.1
NNW	0.0	0.0	0.0	0.5	0.5
N	0.0	0.0	0.0	0.1	0.1

Table B.6: Dora Creek, 2015, night

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
NNE	0.1	0.1	0.0	0.0	0.2
NE	0.1	0.2	0.0	0.2	0.5
ENE	0.1	0.1	0.1	0.7	0.9
E	0.2	0.2	0.2	1.2	1.7
ESE	0.3	0.2	0.2	1.3	1.9
SE	0.4	0.2	0.2	0.9	1.7
SSE	0.4	0.2	0.1	0.4	1.1
S	0.3	0.2	0.1	0.3	0.9
SSW	0.2	0.2	0.2	0.3	0.9
SW	0.2	0.2	0.1	1.1	1.6
WSW	0.2	0.2	0.1	1.7	2.2
W	0.2	0.1	0.1	2.7	3.1
WNW	0.3	0.0	0.1	2.7	3.1
NW	0.2	0.0	0.1	2.7	3.0
NNW	0.2	0.0	0.0	1.6	1.8
N	0.1	0.1	0.0	0.8	0.9

B.1.2 2016

Table B.7: Dora Creek, 2016, day

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
NNE	2.1	0.9	1.0	0.0	4.1
NE	4.3	4.3	4.1	0.2	12.9
ENE	5.6	6.4	7.2	1.0	20.1
E	5.9	6.3	8.0	1.7	22.0
ESE	5.3	3.9	5.4	1.7	16.2
SE	5.8	2.0	2.3	1.0	11.1
SSE	7.0	1.4	0.5	0.2	9.1
S	8.6	1.3	0.3	0.1	10.3
SSW	8.9	2.5	0.9	0.4	12.7
SW	9.1	3.4	1.3	0.6	14.5
WSW	9.7	2.8	1.1	0.6	14.3

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
W	11.5	2.1	0.6	0.4	14.5
WNW	11.6	1.8	0.5	0.3	14.2
NW	8.9	1.7	0.5	0.3	11.4
NNW	5.1	1.1	0.4	0.2	6.8
N	2.5	0.4	0.1	0.0	3.0

Table B.8: Dora Creek, 2016, evening

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.3	0.3
ENE	0.0	0.0	0.0	1.7	1.7
E	0.0	0.0	0.0	3.4	3.4
ESE	0.0	0.0	0.0	3.6	3.6
SE	0.0	0.0	0.0	2.3	2.3
SSE	0.0	0.0	0.0	0.5	0.5
S	0.0	0.0	0.0	0.2	0.2
SSW	0.0	0.0	0.0	0.9	0.9
SW	0.0	0.0	0.0	2.6	2.6
WSW	0.0	0.0	0.0	3.3	3.3
W	0.0	0.0	0.0	5.3	5.3
WNW	0.0	0.0	0.0	4.0	4.0
NW	0.0	0.0	0.0	3.1	3.1
NNW	0.0	0.0	0.0	0.5	0.5
N	0.0	0.0	0.0	0.0	0.0

Table B.9: Dora Creek, 2016, night

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.0	0.0
NE	0.1	0.0	0.0	0.2	0.3
ENE	0.1	0.0	0.1	0.5	0.7
E	0.1	0.1	0.1	0.8	1.0
ESE	0.1	0.1	0.1	0.8	1.0
SE	0.2	0.2	0.0	0.4	0.8
SSE	0.4	0.2	0.0	0.2	0.8
S	0.6	0.4	0.1	0.1	1.1
SSW	0.6	0.4	0.2	1.4	2.6
SW	0.5	0.5	0.5	2.6	4.2
WSW	0.9	0.6	0.6	4.2	6.2

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
W	1.1	0.8	0.8	6.1	8.7
WNW	1.1	0.8	0.5	6.4	8.8
NW	0.6	0.5	0.5	4.8	6.5
NNW	0.3	0.3	0.2	1.6	2.3
N	0.1	0.1	0.0	0.1	0.3

B.1.3 2017

Table B.10: Dora Creek, 2017, day

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
NNE	2.0	0.0	0.0	0.0	2.0
NE	3.8	0.6	0.0	0.0	4.4
ENE	6.3	5.2	3.1	0.8	15.3
E	7.0	5.7	4.8	1.8	19.2
ESE	5.7	6.3	6.1	2.2	20.2
SE	6.7	2.6	3.0	1.5	13.8
SSE	9.4	2.2	1.4	0.5	13.4
S	13.8	1.7	0.1	0.0	15.6
SSW	13.3	3.4	0.6	0.0	17.3
SW	11.9	4.5	1.3	0.2	17.9
WSW	9.6	3.9	1.4	0.3	15.3
W	9.5	1.7	1.0	0.6	12.9
WNW	9.8	1.2	0.4	0.6	12.0
NW	8.2	1.3	0.2	0.5	10.3
NNW	5.7	1.1	0.1	0.3	7.3
N	3.1	0.5	0.0	0.0	3.7

Table B.11: Dora Creek, 2017, evening

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.1	0.1
NE	0.0	0.0	0.0	0.1	0.1
ENE	0.0	0.0	0.0	1.1	1.1
E	0.0	0.0	0.0	3.6	3.6
ESE	0.0	0.0	0.0	4.5	4.5
SE	0.0	0.0	0.0	3.4	3.4
SSE	0.0	0.0	0.0	0.9	0.9
S	0.0	0.0	0.0	0.0	0.0
SSW	0.0	0.0	0.0	0.6	0.6
SW	0.0	0.0	0.0	1.8	1.8

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
WSW	0.0	0.0	0.0	2.7	2.7
W	0.0	0.0	0.0	7.4	7.4
WNW	0.0	0.0	0.0	7.2	7.2
NW	0.0	0.0	0.0	6.5	6.5
NNW	0.0	0.0	0.0	1.2	1.2
N	0.0	0.0	0.0	0.3	0.3

Table B.12: Dora Creek, 2017, night

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
NNE	0.3	0.0	0.0	0.0	0.3
NE	0.3	0.0	0.0	0.0	0.3
ENE	0.3	0.1	0.0	0.2	0.5
E	0.2	0.1	0.1	0.8	1.2
ESE	0.2	0.2	0.2	1.3	1.9
SE	0.3	0.2	0.3	1.2	2.0
SSE	0.5	0.2	0.2	0.6	1.5
S	1.0	0.3	0.0	0.0	1.4
SSW	1.1	0.6	0.2	0.7	2.6
SW	1.2	0.7	0.3	1.8	4.0
WSW	1.4	0.8	0.4	3.7	6.2
W	1.5	0.8	0.7	9.5	12.5
WNW	1.2	0.9	1.0	10.7	13.8
NW	0.7	0.7	0.9	8.9	11.2
NNW	0.3	0.3	0.3	2.4	3.4
N	0.2	0.1	0.0	0.1	0.4

B.1.4 2018

Table B.13: Dora Creek, 2018, day

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
NNE	2.1	0.2	0.1	0.0	2.4
NE	2.8	0.2	0.1	0.0	3.1
ENE	5.1	3.7	2.1	0.3	11.3
E	6.0	4.6	3.1	1.0	14.7
ESE	5.8	4.9	4.3	1.6	16.6
SE	5.7	2.7	2.8	1.5	12.7
SSE	7.9	2.0	1.9	0.9	12.7
S	10.4	1.4	0.5	0.2	12.5
SSW	12.5	2.0	0.1	0.1	14.7

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
SW	10.7	2.9	0.8	0.1	14.5
WSW	8.4	3.4	1.4	0.3	13.5
W	6.3	2.0	1.8	0.5	10.6
WNW	6.7	1.3	1.3	0.6	9.8
NW	6.8	1.2	0.8	0.4	9.3
NNW	5.8	1.1	0.3	0.3	7.5
N	3.7	0.7	0.1	0.1	4.6

Table B.14: Dora Creek, 2018, evening

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.1	0.1
ENE	0.0	0.0	0.0	1.0	1.0
E	0.0	0.0	0.0	4.2	4.2
ESE	0.0	0.0	0.0	5.5	5.5
SE	0.0	0.0	0.0	5.2	5.2
SSE	0.0	0.0	0.0	2.1	2.1
S	0.0	0.0	0.0	0.5	0.5
SSW	0.0	0.0	0.0	0.5	0.5
SW	0.0	0.0	0.0	1.2	1.2
WSW	0.0	0.0	0.0	1.8	1.8
W	0.0	0.0	0.0	4.7	4.7
WNW	0.0	0.0	0.0	6.1	6.1
NW	0.0	0.0	0.0	5.4	5.4
NNW	0.0	0.0	0.0	2.2	2.2
N	0.0	0.0	0.0	0.1	0.1

Table B.15: Dora Creek, 2018, night

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
NNE	0.2	0.0	0.0	0.1	0.3
NE	0.2	0.0	0.0	0.1	0.2
ENE	0.2	0.0	0.0	0.1	0.3
E	0.2	0.0	0.0	0.2	0.5
ESE	0.2	0.1	0.1	0.5	0.8
SE	0.2	0.2	0.2	0.7	1.2
SSE	0.6	0.2	0.1	0.5	1.5
S	1.1	0.2	0.1	0.2	1.5
SSW	1.5	0.4	0.2	0.4	2.5

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
SW	1.5	0.5	0.4	1.7	4.1
WSW	1.3	0.8	0.6	3.2	5.8
W	1.4	0.8	0.6	8.5	11.3
WNW	1.0	0.8	0.9	12.3	15.0
NW	0.9	0.5	0.8	11.1	13.2
NNW	0.3	0.2	0.5	5.4	6.4
N	0.2	0.0	0.1	0.3	0.6

B.1.5 2019

Table B.16: Dora Creek, 2019, day

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
NNE	3.9	0.2	0.0	0.0	4.1
NE	2.9	0.3	0.0	0.0	3.3
ENE	3.9	3.5	2.6	0.3	10.3
E	4.5	4.2	4.6	1.4	14.7
ESE	4.1	4.5	5.4	1.9	16.0
SE	3.7	2.4	3.0	1.7	10.7
SSE	5.5	1.8	1.0	0.6	8.8
S	7.4	0.9	0.2	0.0	8.5
SSW	10.6	1.7	0.3	0.1	12.7
SW	9.2	3.1	0.8	0.3	13.4
WSW	7.8	3.9	1.3	0.6	13.6
W	6.1	3.2	1.3	0.7	11.3
WNW	7.0	2.4	1.0	1.2	11.6
NW	6.7	2.3	0.7	0.9	10.5
NNW	6.3	1.6	0.5	0.7	9.1
N	4.8	0.9	0.2	0.0	6.0

Table B.17: Dora Creek, 2019, evening

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0
ENE	0.0	0.0	0.0	0.2	0.2
E	0.0	0.0	0.0	1.7	1.7
ESE	0.0	0.0	0.0	3.0	3.0
SE	0.0	0.0	0.0	3.1	3.1
SSE	0.0	0.0	0.0	1.6	1.6
S	0.0	0.0	0.0	0.3	0.3

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
SSW	0.0	0.0	0.0	0.3	0.3
SW	0.0	0.0	0.0	1.3	1.3
WSW	0.0	0.0	0.0	2.9	2.9
W	0.0	0.0	0.0	5.6	5.6
WNW	0.0	0.0	0.0	8.6	8.6
NW	0.0	0.0	0.0	7.1	7.1
NNW	0.0	0.0	0.0	4.0	4.0
N	0.0	0.0	0.0	0.1	0.1

Table B.18: Dora Creek, 2019, night

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
NNE	0.1	0.0	0.0	0.0	0.1
NE	0.2	0.0	0.0	0.0	0.2
ENE	0.2	0.1	0.0	0.0	0.2
E	0.1	0.1	0.0	0.2	0.3
ESE	0.0	0.1	0.1	0.5	0.6
SE	0.1	0.1	0.1	0.6	0.9
SSE	0.3	0.1	0.1	0.5	0.9
S	0.4	0.2	0.0	0.1	0.8
SSW	0.5	0.3	0.0	0.3	1.1
SW	0.5	0.5	0.1	1.4	2.5
WSW	0.5	0.6	0.4	3.0	4.4
W	0.5	0.6	0.5	7.4	9.1
WNW	0.6	0.5	0.8	14.8	16.7
NW	0.5	0.3	0.6	13.7	15.2
NNW	0.3	0.1	0.4	9.0	9.8
N	0.1	0.0	0.0	0.5	0.7

B.1.6 2020

Table B.19: Dora Creek, 2020, day

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
NNE	2.7	0.1	0.0	0.0	2.9
NE	2.6	0.0	0.0	0.0	2.6
ENE	3.9	5.9	4.3	0.3	14.4
E	5.0	6.9	7.0	1.4	20.4
ESE	5.5	8.6	10.1	2.2	26.3
SE	6.0	5.6	7.0	6.9	25.6
SSE	7.6	4.9	4.3	5.7	22.6

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, day				
	A	B	C	D	A-D
S	8.9	3.3	1.3	5.0	18.5
SSW	7.5	2.0	0.3	0.0	9.8
SW	6.3	2.3	0.6	0.0	9.2
WSW	4.5	2.2	0.7	0.0	7.3
W	4.6	1.1	0.9	0.0	6.6
WNW	4.7	1.4	0.6	0.0	6.8
NW	5.5	1.9	0.6	0.0	7.9
NNW	5.2	1.7	0.1	0.0	7.0
N	4.0	0.9	0.1	0.0	5.0

Table B.20: Dora Creek, 2020, evening

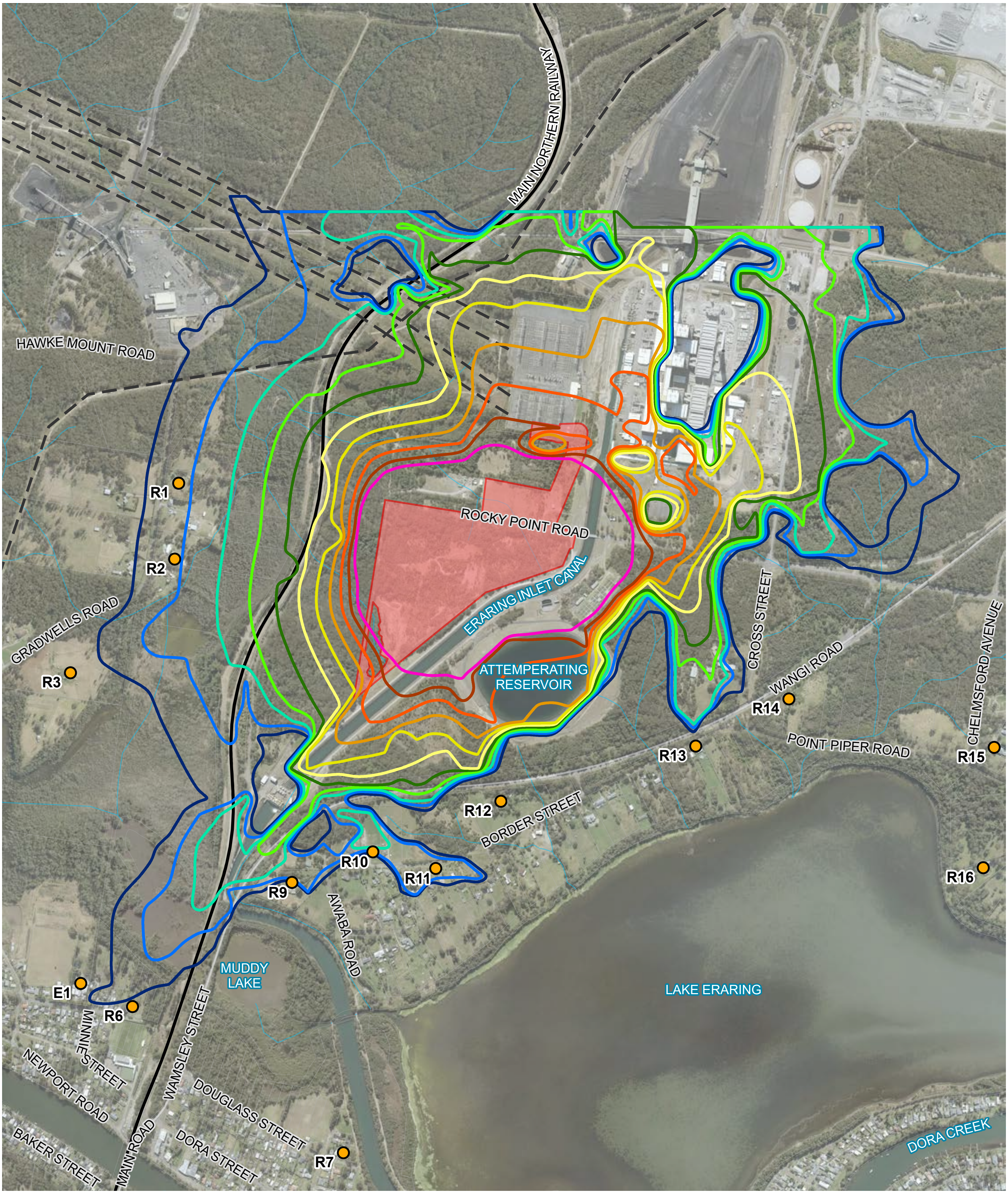
Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, evening				
	A	B	C	D	A-D
NNE	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0
ENE	0.0	0.0	0.0	4.0	4.0
E	0.0	0.0	0.0	10.0	10.0
ESE	0.0	0.0	0.0	13.9	13.9
SE	0.0	0.0	0.0	16.3	16.3
SSE	0.0	0.0	0.0	10.4	10.4
S	0.0	0.0	0.0	5.2	5.2
SSW	0.0	0.0	0.0	0.0	0.0
SW	0.0	0.0	0.0	0.0	0.0
WSW	0.0	0.0	0.0	0.0	0.0
W	0.0	0.0	0.0	0.0	0.0
WNW	0.0	0.0	0.0	0.0	0.0
NW	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.0	0.0	0.0	0.0
N	0.0	0.0	0.0	0.0	0.0

Table B.21: Dora Creek, 2020, night

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
NNE	0.5	0.0	0.0	0.0	0.5
NE	0.5	0.0	0.0	0.0	0.5
ENE	0.3	0.0	0.0	0.2	0.5
E	0.2	0.0	0.0	1.0	1.2
ESE	0.2	0.0	0.0	2.3	2.4
SE	0.9	0.2	0.0	7.3	8.4
SSE	2.1	0.3	0.0	6.5	8.9

Wind sector	Percentage (%) occurrence of wind speeds up to 3 m/s, night				
	A	B	C	D	A-D
S	3.3	0.3	0.2	4.7	8.6
SSW	2.8	0.5	0.5	0.2	4.0
SW	1.7	0.7	0.7	0.9	4.0
WSW	0.3	0.9	0.7	1.2	3.1
W	0.2	0.9	0.5	2.8	4.4
WNW	0.0	0.7	1.2	5.4	7.3
NW	0.2	0.5	1.0	5.1	6.8
NNW	0.3	0.2	0.9	3.3	4.7
N	0.5	0.0	0.0	0.0	0.5

Appendix C. Construction Noise Contours



Project area
Receptor locations

Noise level
40 dB(A)
42 dB(A)
44 dB(A)
46 dB(A)
48 dB(A)
50 dB(A)
52 dB(A)
54 dB(A)
56 dB(A)
58 dB(A)
60 dB(A)

Electricity transmission line
Railway
Cadastre

0 600 m

1:17,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
Aerometrex 2021,
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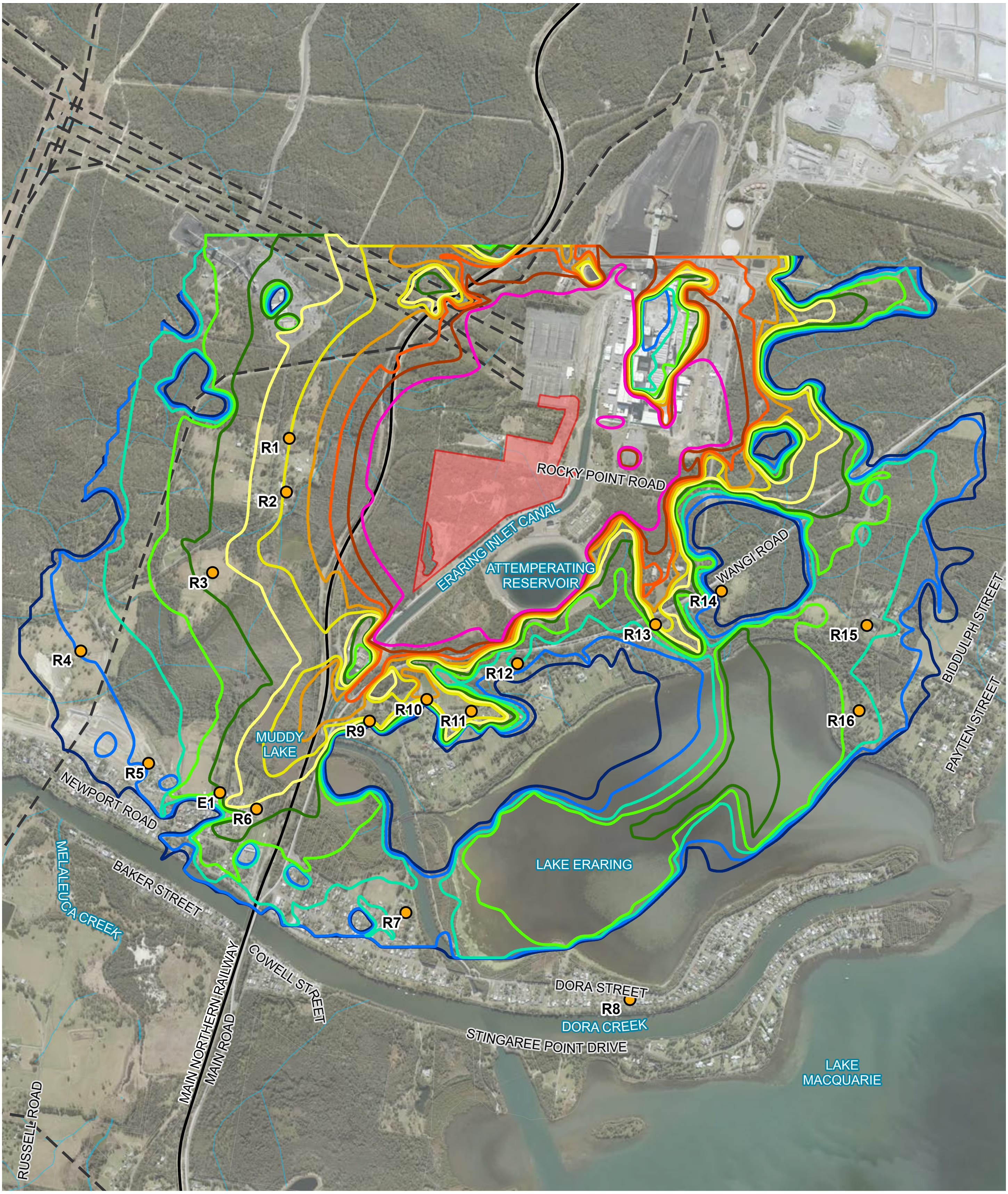
Figure C-1 BESS Construction Phase 1



Project area
Receptor locations

Noise level
40 dB(A)
42 dB(A)
44 dB(A)
46 dB(A)
48 dB(A)
50 dB(A)
52 dB(A)
54 dB(A)
56 dB(A)
58 dB(A)
60 dB(A)

Electricity transmission line
Railway
Cadastre

0 600 m
1:24,000 at A4
GDA94 MGA56

N

Data sources
Origin 2021,
Aerometrex 2021,
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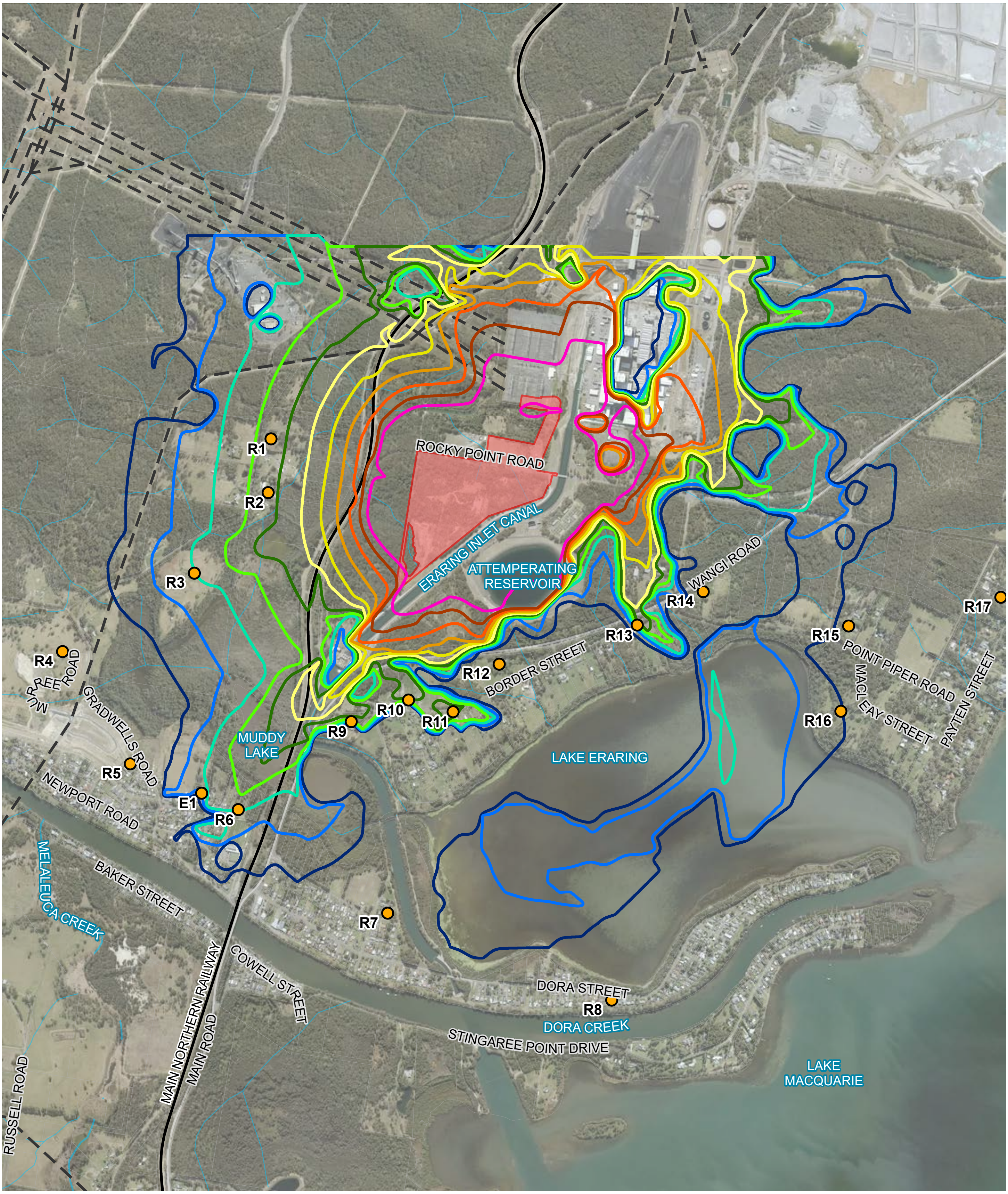
Figure C-2 BESS Construction Phase 2



Project area

Receptor locations

Noise level

40 dB(A)

42 dB(A)

44 dB(A)

46 dB(A)

48 dB(A)

50 dB(A)

52 dB(A)

54 dB(A)

56 dB(A)

58 dB(A)

60 dB(A)

Electricity transmission line

Railway

Cadastre

0 600 m

1:24,000 at A4

GDA94 MGA56

N

Data sources

Origin 2021, Aerometrex 2021, © Department Finance, Services and Innovation Dec 2020

Figure C-3 BESS Construction Phase 3

Date: 23/02/2022 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\12_Noise\IS365800_GIS_Noise_r1v5.aprx
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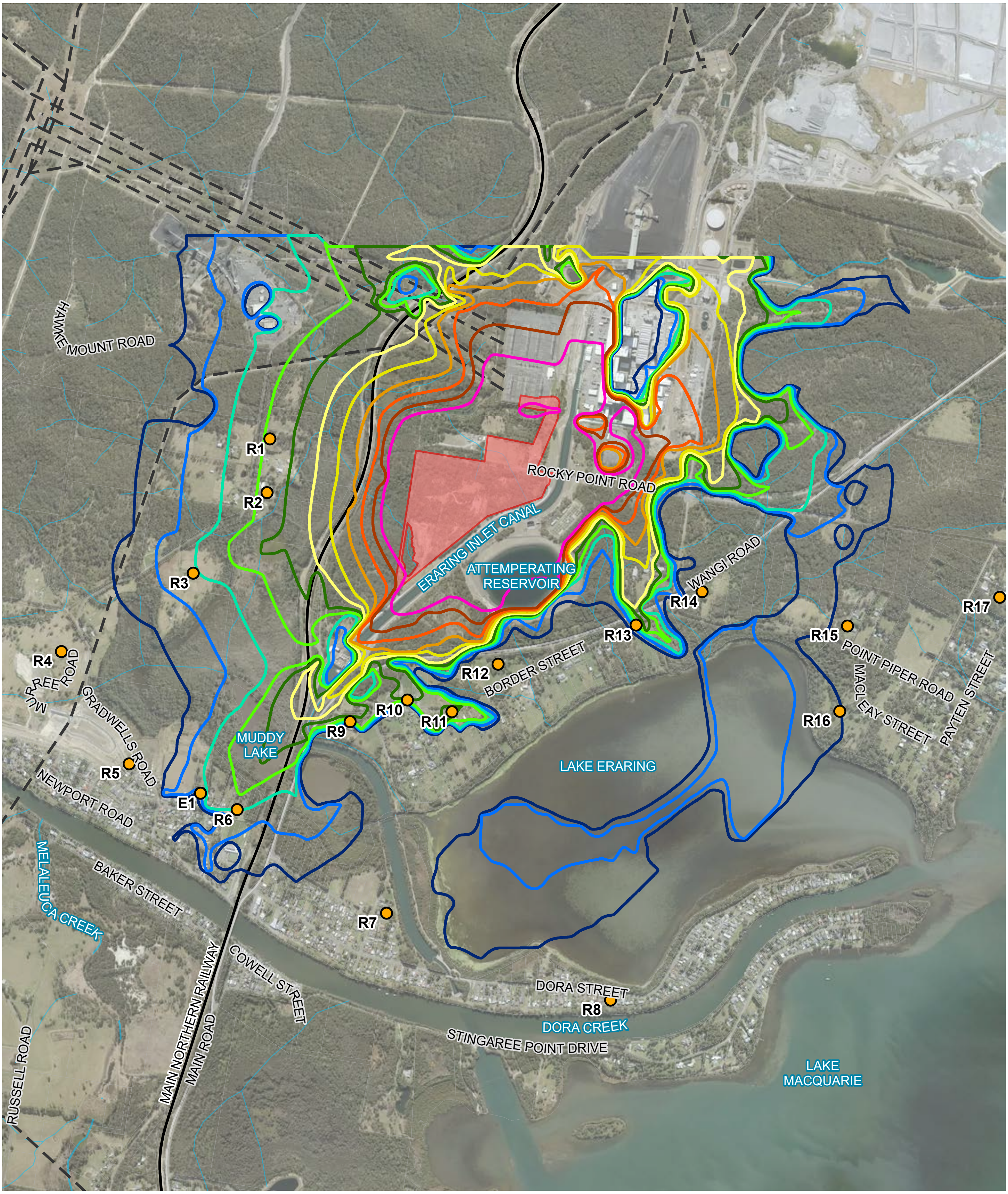

Project area
Receptor locations

Noise level
40 dB(A)
42 dB(A)
44 dB(A)
46 dB(A)
48 dB(A)
50 dB(A)
52 dB(A)
54 dB(A)
56 dB(A)
58 dB(A)
60 dB(A)

Electricity transmission line
Railway
Cadastre

0 600 m
1:24,000 at A4
GDA94 MGA56
N

Data sources
Origin 2021,
Aerometrex 2021,
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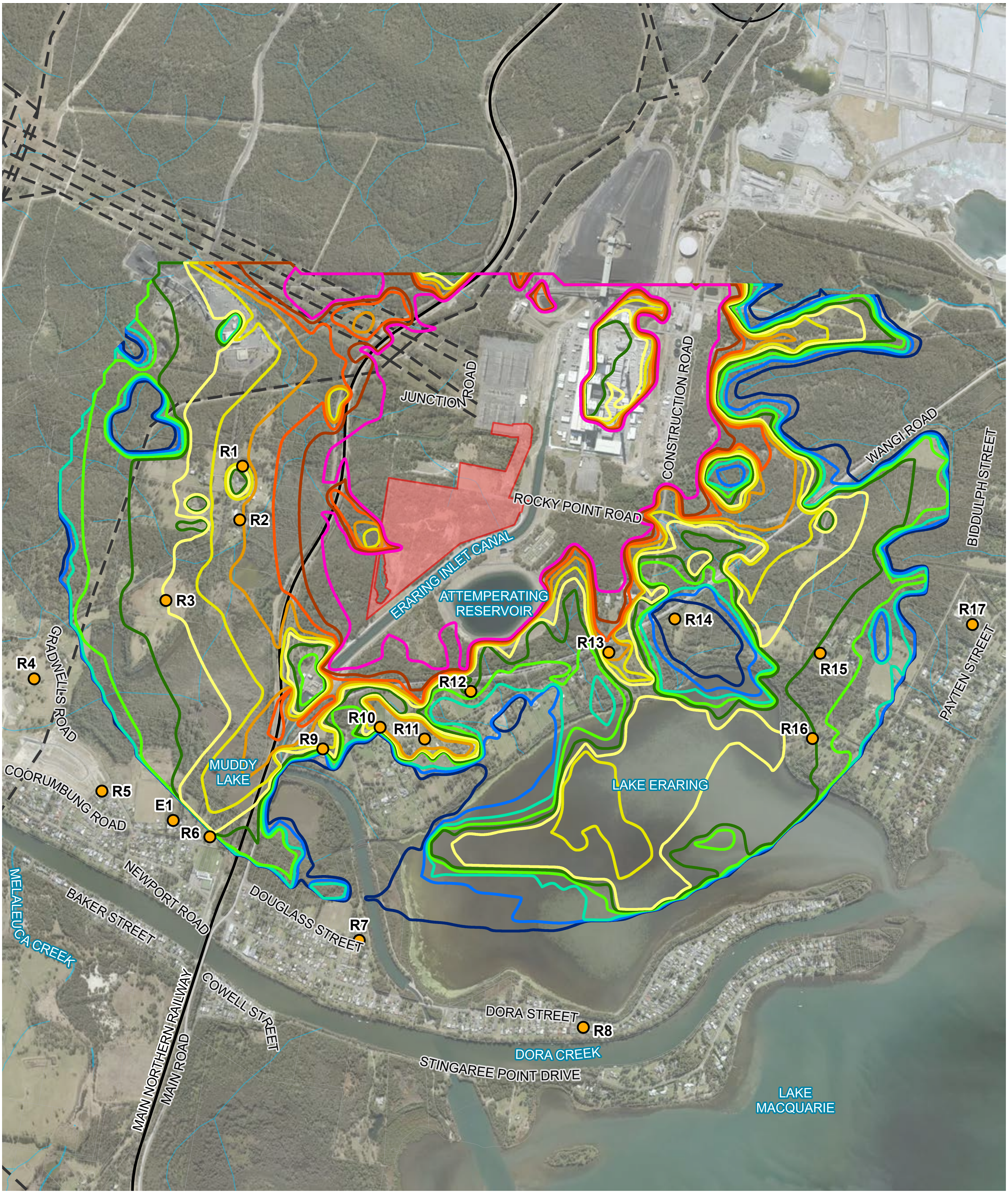
Figure C-4 BESS Construction Phase 4



Project area
Receptor locations

Noise level
40 dB(A)
42 dB(A)
44 dB(A)
46 dB(A)
48 dB(A)
50 dB(A)
52 dB(A)
54 dB(A)
56 dB(A)
58 dB(A)
60 dB(A)

Electricity transmission line
Railway
Cadastre

0 600 m
1:24,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
Aerometrex 2020,
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Figure C-5 BESS Construction Phase 5

Date: 23/02/2022 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\12_Noise\IS365800_GIS_Noise_r1v5.aprx
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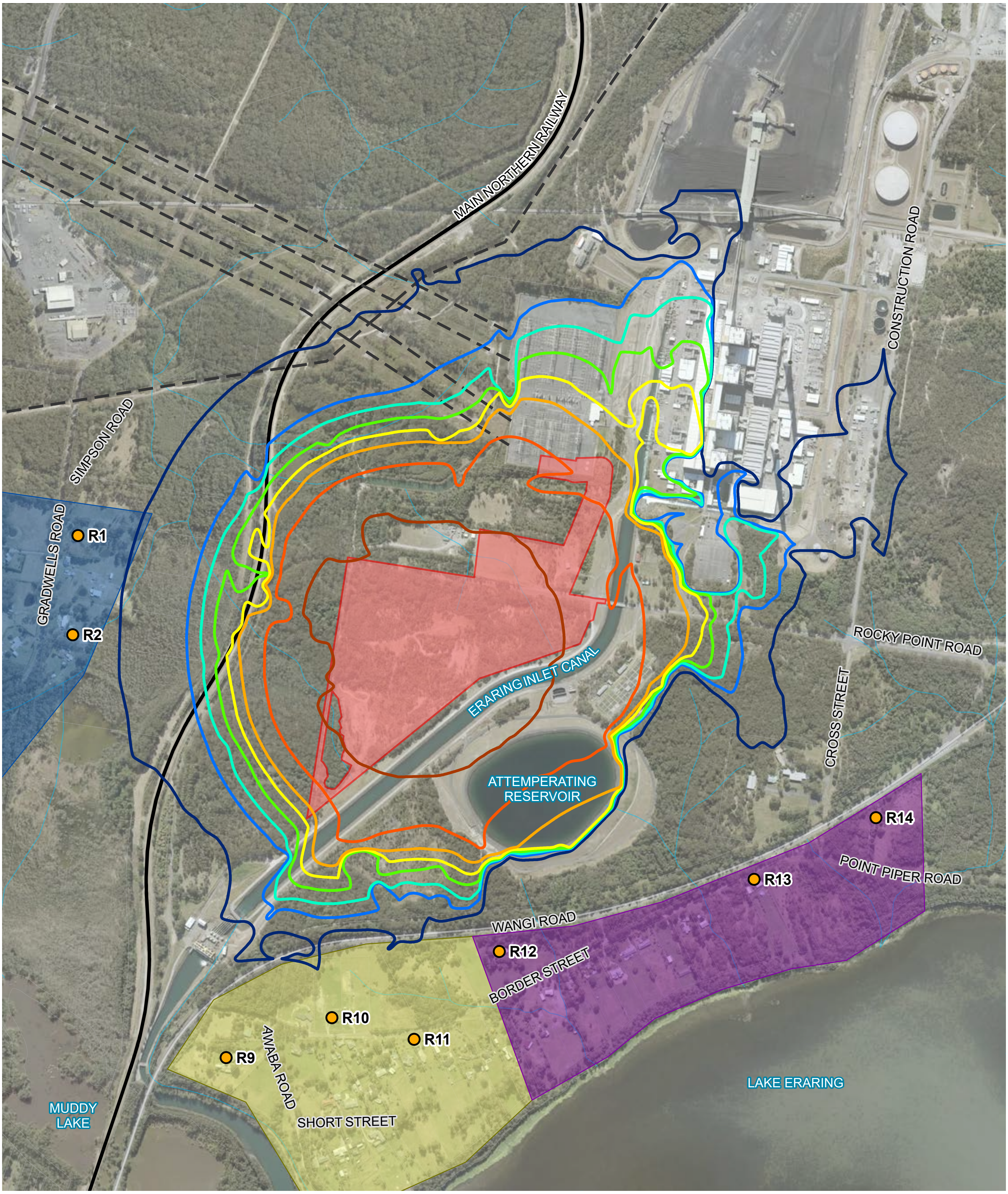
Appendix D. Operation Noise Contours



Project area
Receptor locations

Noise level
- 38 dB(A)
- 42 dB(A)
- 43 dB(A)
- 44 dB(A)
- 45 dB(A)
- 46 dB(A)
- 48 dB(A)
- 53 dB(A)

Noise catchment areas
- NCA 1
- NCA 3
- NCA 4

Electricity transmission line
Railway
Cadastre

0 300 m
1:13,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
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Figure D-1 Candidate BESS Noise Levels, Standard Meteorological Conditions

Date: 23/02/2022 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\12_Noise\IS365800_GIS_Noise_r1v5.aprx
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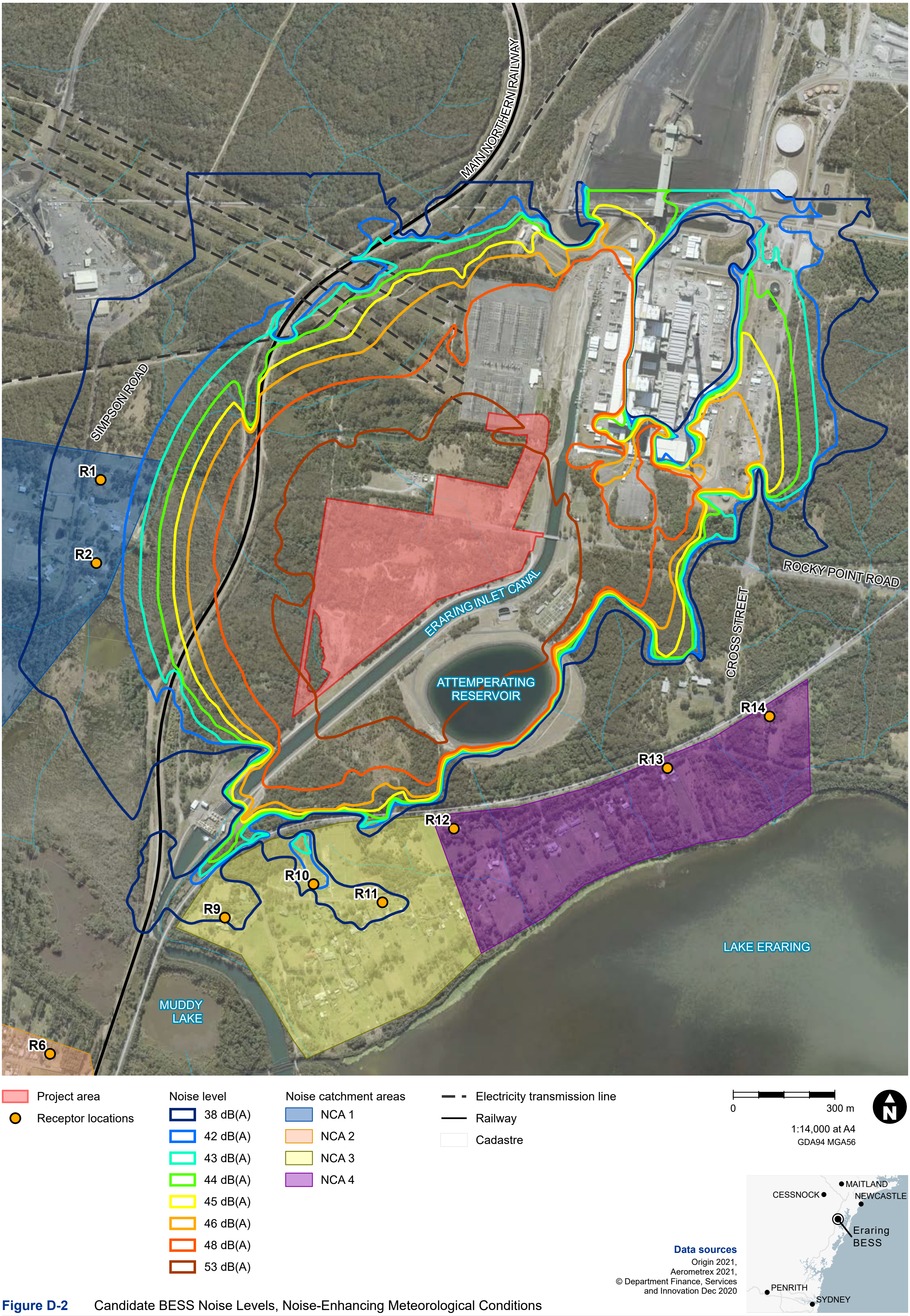

Data sources
Origin 2021,
Aerometrex 2021,
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Figure D-2 Candidate BESS Noise Levels, Noise-Enhancing Meteorological Conditions

Date: 23/02/2022 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\12_Noise\IS365800_GIS_Noise_r1v5.aprx
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Appendix E. Draft Construction Noise and Vibration Management Plan

Eraring Power Station Battery Energy Storage Systems

Draft Construction Noise and Vibration Management Plan

IS365800_NIA_CNVMP | 02

25 February 2022

Origin Energy

Eraring Power Station Battery Energy Storage Systems

Project No: IS365800
Document Title: Draft Construction Noise and Vibration Management Plan
Document No.: IS365800_NIA_CNVMP
Revision: 02
Document Status: Draft
Date: 25 February 2022
Client Name: Origin Energy
Client No: Client Reference
Project Manager: Thomas Muddle
Author: Sean Brennan
File Name: IS365800_EraringBESS_CNVMP_Draft_NIA Appendix E.docx

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01	14/10/2021	Draft for EIS Exhibition	S Brennan	D Davis	D Davis	T Muddle
02	25/02/2022	Revision based on EPA Comments	S Brennan	D Davis	D Davis	T Muddle

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1. Introduction

1.1 Context

This Draft Construction Noise and Vibration Management Plan (CNVMP) has been developed to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the Eraring Battery Energy Storage System Project (Project) on 19th April 2021 by the Planning Secretary of the NSW Department of Planning, Industry and Environment (DPIE). The SEARs specifically refer to the preparation of a draft noise management plan in the event that construction noise impacts were identified. The full noise SEARs are detailed below.

"*Noise – including an assessment of the construction noise impacts of the development in accordance with the Interim Construction Noise Guideline (ICNG), operational noise impacts in accordance with the NSW Noise Policy for Industry (2017), cumulative noise impacts (considering other developments in the area), and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria.*"

The Project would be located within Lots 10 and 11 DP 1050120, Rocky Point Rd Eraring, within the Lake Macquarie City Council (LMCC) Local Government Area (LGA) within the Origin landholding associated with the adjacent to the Eraring Power Station (EPS) as illustrated in Figure 1-1.

1.1.1 Purpose

The purpose of this CNVMP is to provide details on the framework of mitigation and management measures proposed to address potential noise and vibration impact resulting from the construction of the Project. It is not the intention of this CNMP to reproduce assessment methodology and noise impact prediction and this CNVMP should be read in conjunction with the *Eraring Power Station Battery Energy Storage System Noise Impact Assessment Report* (Jacobs, 2021) to the extent necessary.

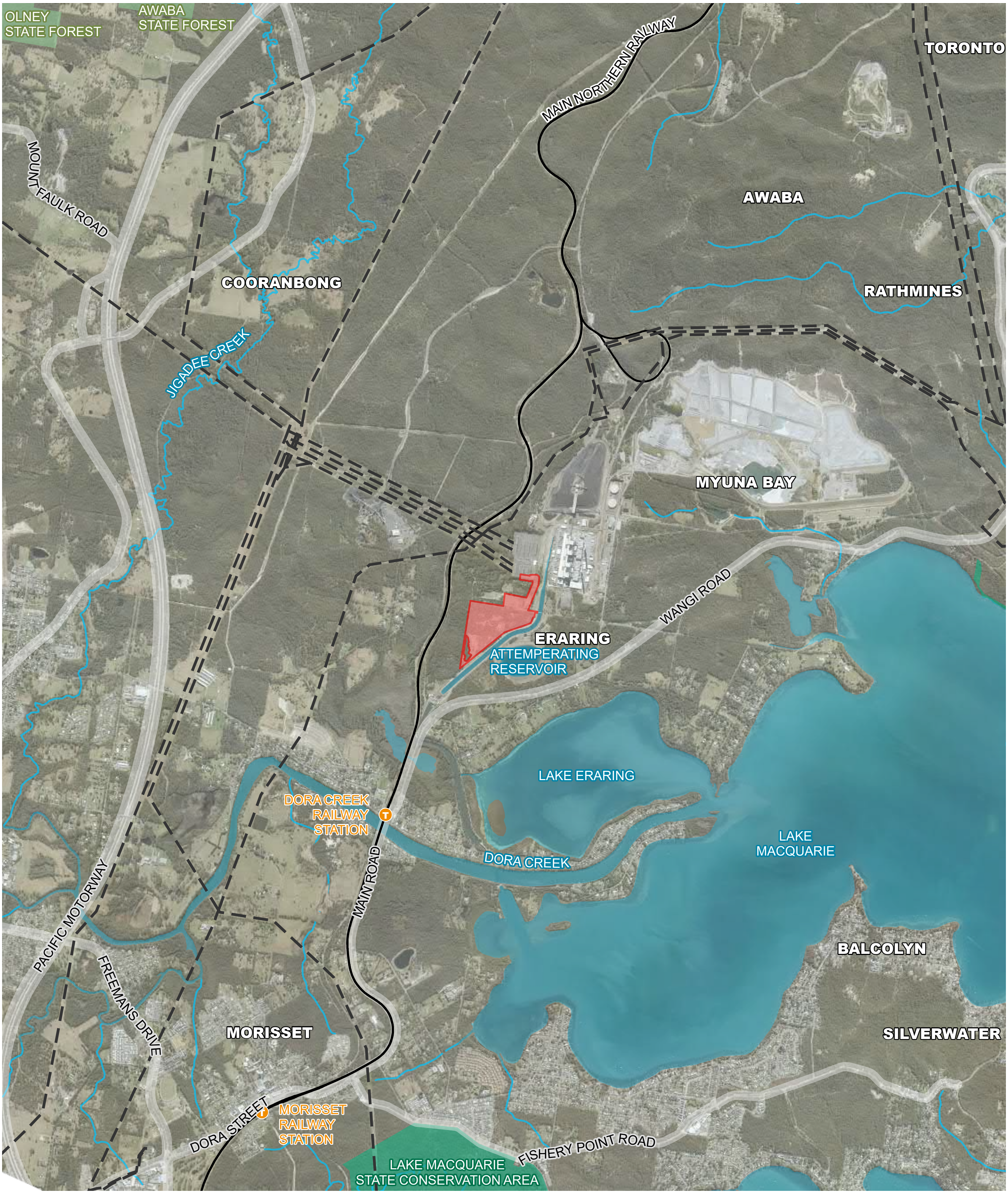
1.1.2 Scope

This CNVMP has been developed to address construction works specifically occurring in relation to the Project under a prospective approval provided by DPIE in order to fulfil the requirements of the SEARs and in accordance with Origin's environmental and social commitments. The scope of the CNVMP will continue to be developed through the incorporation of Conditions of Approval and licence requirements, as well as updated Project information throughout the detailed design process.

1.1.3 Objectives

The CNVMP has been prepared to ensure that all Conditions of Approval (CoAs), management and mitigation measures detailed in the Environmental Impact Statement (EIS)and Response to Submissions reports and all other licence and permit requirements have been adequately described, assigned and scheduled. The documents with requirements that have been addressed include:

- The EIS prepared for the Eraring Battery Energy Storage System (when accepted by DPIE);
- Response to Submissions Report (when accepted by DPIE);
- Conditions of Approval (upon receipt); and
- Environmental Protection Licence (upon receipt).



Project area
Electricity transmission line
Railway

0 1 km
1:50,000 at A4
GDA94 MGA56

Data sources

Origin 2021
Aerometrex 2021
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Figure 1-1 Project location

Date: 10/22/2021 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS365800\Geospatial\Apps\11_EIS\IS365800_GIS_EIS_r3v2.aprx
Created by : KM | QA by : SW

1.1.4 Goals and Targets

The following goals and targets have been established to guide the management of noise and vibration impacts from the construction of the project:

- Compliance with all CoAs, EPL requirements and all other regulatory requirements;
- Consideration of all construction-related noise mitigation measures detailed in the EIS and RtS reports;
- Ensure training and inductions pertaining to noise and vibration management are provided to all staff working on site prior to starting work;
- Assure all noise and vibration impacts are implemented in an efficient manner;
- Avoid noise complaints and manage all community noise concerns in a timely manner; and
- Produce no exceedances of relevant noise and vibration limits.

1.2 Project Background and Description

1.2.1 Project Background

Origin Eraring Energy Pty Limited (Origin) owns and operates the EPS, Australia's largest power stations, having a capacity of 2,880 megawatts (MW). EPS is scheduled to be among 14 gigawatts (GW) of coal-fired generation plants to be retired within the next few decades (AEMO, 2020). The retirement of the EPS will support Origin's carbon emission reduction goals. As such, Origin is now progressing an application to provide energy storage and key network services that would facilitate long term emissions reduction in the National Electricity Market (NEM) while supporting the delivery of secure and reliable electricity for consumers and businesses.

Origin is seeking regulatory and environmental planning approval for the construction and operation of a grid-scale Battery Energy Storage System (BESS) with a discharge capacity of 700 MW and storage capacity of 2,800 megawatt hours (MWh) on existing Origin landholding associated with the EPS (the Project).

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP) and subject to Part 4, Division 4.7 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). As such, the Project requires the preparation of an EIS in accordance with Secretary's Environmental Assessment Requirements (SEARs) and the approval of the Independent Planning Commission under circumstances described in SRD SEPP or the NSW Minister for Planning and Public Spaces.

1.2.2 Project Objectives

The Project has a primary objective of delivering safe and reliable energy storage and to contribute to lowering emissions for electricity supply in NSW. The retirement of the EPS will support Origin's carbon emission reduction goals and will align with the strategic transition away from coal in NSW. The development of the project would provide energy storage and key network services that facilitate long term emissions reduction in the NEM while supporting the delivery of secure and reliable electricity for consumers and businesses.

1.2.3 Project Description

The Project would include the construction and operation of:

- BESS compounds housing rows of enclosures housing lithium-ion type batteries and associated power conversion systems with discharge capacity of up to 700 MW and storage capacity of 2800 MWh able to dispatch over variable durations from four hours to beyond eight hours;
- A BESS substation housing high voltage (HV) and medium voltage (MV) transformers and associated infrastructure;
- Approximately 400 m of overhead 330 kilovolt (kV) transmission line connecting the BESS substation to the existing 330 kV TransGrid switchyard; and

- Ancillary infrastructure and facilities including safety protection systems and site ancillary facilities such as laydown areas and site offices.

A full description of the Project is included in Section 3 of the EIS.

The BESS will be capable of providing energy Frequency Control Ancillary Services (FCAS), System Restart Ancillary Services (SRAS), as well as fast frequency response and synthetic inertia - security services currently under consideration in the NEM.

The Project maximum disturbance area is approximately 25 hectares (ha) in size with permeant infrastructure likely to cover half this area. Construction may require temporary compounds or laydown areas outside the permanent footprint but within the Project area and would be located in existing vacant areas of the Project area as illustrated in **Figure 1-2.**

The Project is proposed to be commissioned in three stages with the sizing and layout of each stage subject to detailed design.

1.2.4 Construction works

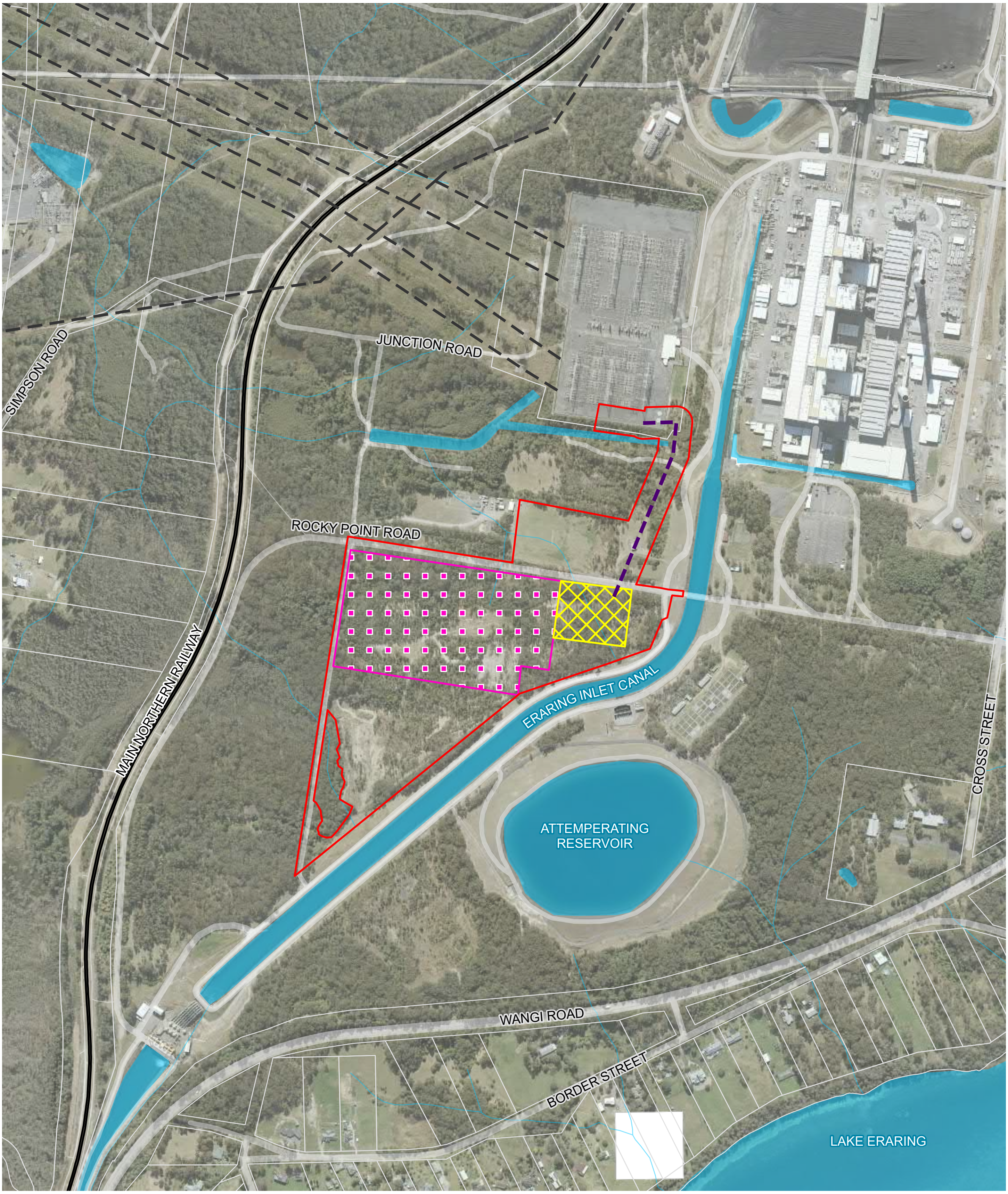
The construction methodology for the Project will be developed in more detail during the preparation of the detailed design however it is expected to involve:

- Installation and maintenance of environmental controls including drainage and sediment controls;
- Upgraded construction access track from existing internal access road to battery location;
- Vegetation clearing;
- Cut and fill to level areas and establish a hardstand pad and construction laydown areas;
- Structural works - slabs to support battery modules, power conversion systems and transformer structures;
- Delivery, installation and electrical fit-out of battery modules, power conversion systems and transformers;
- Installation of 330 kV overhead cabling from the battery transformers to the TransGrid switchyard;
- Minor works to connect the battery to vacant structures in the TransGrid switchyard;
- Testing and commissioning activities; and
- Removal of construction equipment and rehabilitation of construction areas.

Construction of each Project Stage would be undertaken in four key phases as follows:

- Site establishment;
- Cut and fill to battery compound and transformer yard and establishment of pad;
- Structural works to support battery enclosures, inverters, transformers, building and transformer compounds and transmission structures; and
- Delivery, installation and electrical fit-out of components.

A fifth Project phase is also assessed in the NIA related to the use of an air track drill for establishment of transmission structure footings within the transmission line easement only. This fifth phase would be undertaken only during works associated with the first Project stage to be constructed and over short duration.



Project area
Proposed 330kV transmission connection
Battery Energy Storage System
Substation
Electricity transmission line
Railway
Cadastre

0 300 m

1:10,000 at A4

GDA94 MGA56

Data sources

Origin 2021,
Aerometrex 2021,
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Figure 1-2 Project overview

Construction program

The Project's modular design provides significant deployment flexibility with the capacity to stage the 700 MW to meet market needs. The construction of the first stage of the BESS is expected to begin in 2022 (subject to approval) and have a duration of 18 months, with commercial operations possible by 2023. The indicative timeline for subsequent stages of the Project include:

- Stage 2 construction commencing 2023 and operations commencing 2025; and
- Stage 3 construction commencing 2026 and operations commencing 2027.

Construction works would generally be limited to standard construction hours of:

- Monday-Friday 0700-1800;
- Saturday 0800-1300;
- No works on Sunday or public holidays.

Activities outside of the standard construction hours include:

- Work determined to comply with the relevant noise management level;
- The delivery of materials as required by the authorities for safety reasons;
- Commissioning activities where the operation of the Project must align with demands on the grid;
- Emergency situations to prevent the loss of lives and properties and/or to prevent environmental harm; and
- Situations where agreement is reached with affected receivers.

Construction workforce

The Project is anticipated to require the recruitment and training of a construction workforce of up to 128 people during peak construction periods.

2. Existing Environment

As part of the *Eraring Power Station Battery Energy Storage Systems Noise Impact Assessment Report* (Jacobs, 2021), the pre-existing land use around the site was delineated and the nearby noise and vibration sensitive receivers were identified, while background noise monitoring to determine pre-existing noise levels was also performed. The findings of this are detailed below.

2.1 Land use context

The surrounding land consists of rural development and low-density residential properties. The closest commercial centre and population centre nearby is Charlestown (29.1 km north east), and the closest residential suburbs are Eraring (south and east) and Dora Creek (1.2 km south). In between, the centres of Toronto and Morisset are located approximately 8 km northeast and 4km southwest respectively. The closest sensitive receiver is 600 m west of the Project on Gradwells Road and south on Border Street.

The Great Northern Railway alignment runs along the border of Dora Creek and Eraring suburbs, approximately 200 metres (m) west of the Project area.

The Project area is surrounded by the following features with the Origin landholding:

- EPS operations area, elevated TransGrid switchyard, coal yards and extensive EPS buffer lands to the north;
- Elevated attemperating reservoir to the east;
- EPS inlet canal to the south and east; and
- Mature vegetation within E2 environmental protection zoned land along a ridge line to the west.

Land use surrounding the Project Site is described as follows:

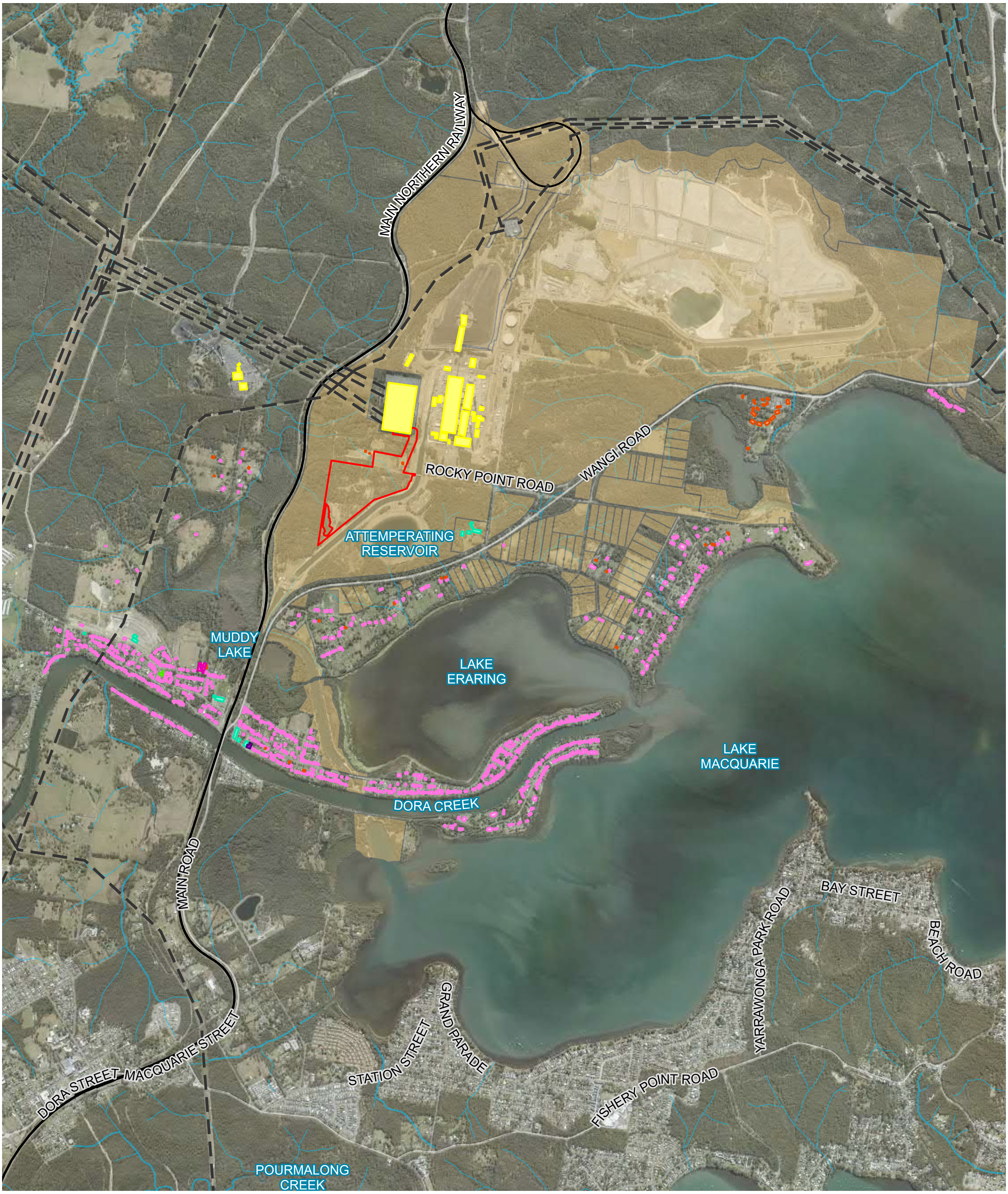
- To the north is the EPS, zoned as SP2 Infrastructure (Electricity Generating Works);
  - Land zoned as SP2 – Infrastructure is generally reserved for infrastructure land that is unlikely to be used for a different purpose in the future, including power stations, landfill and waste disposal and sewage treatment plants;
- To the west is land zoned predominately as E2 – Environmental Conservation and RU2 – Rural Landscape along Gradwells Road, Dora Creek;
  - Land zoned as E2 – Environmental Conservation is intended to protect land that has high conservation values which are outside of national parks and reserves;
  - Land zoned as RU2 – Rural Landscape is intended for primary industry and a range of compatible activities,;
- To the east and southeast is also zoned predominately as E2 – Environmental Conservation, with land along Border Street zoned as RU4 – Primary Production Small Lots and the land along Point Piper Road zoned as E4 – Environmental Living; and
  - Land zoned as RU4 – Primary Production Small Lots is land zoned for small scale and emerging commercial agricultural and primary industry production, which can operate on smaller rural holdings;
  - Land zoned as E4 – Environmental Living is intended for land with special environmental and scenic values, which accommodates low impact residential development. Generally the zone is applicable for rural areas which still has some conservation values;
- To the south is land predominately zoned as R2 – Low Density Residential and RE1 – Public Recreation associated with the Dora Creek township.
  - Land zoned as R2 – Low Density Residential is intended for areas which are primarily used for low density, detached dwelling housings, generally away from major transport nodes or larger activity centres; and

- Land zoned as RE1 – Public Recreation is intended for a wide range of public recreational uses, such as parks, open spaces, recreational facilities and community facilities.

The nearest private receptors to the Project area are located as follows:

- Rural residential dwellings approximately 600 m to the west on Gradwells Road beyond the Great Northern Railway;
- Dora Creek township approximately 1.5 km to the south;
- Properties on Border Street, Eraring approximately 600 m to the south which are screened by the EPS inlet canal and attemperating reservoir and beyond Wangi Road; and
- Dwellings to the north of Project area located over 4 km away beyond the EPS and mining operations.

The surrounding land uses and receivers are detailed in **Figure 2-1**.



Project area
Origin owned land

Building usage
- Commercial
- Educational
- Industrial
- Medical
- Place of Worship
- Residential
- Unused or Unoccupied

Electricity transmission line
Railway

0 800 m
1:40,000 at A4
GDA94 MGA56

Data sources
Origin 2021,
Aerometrex 2021,
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Figure 2-1 Surrounding Land Usage

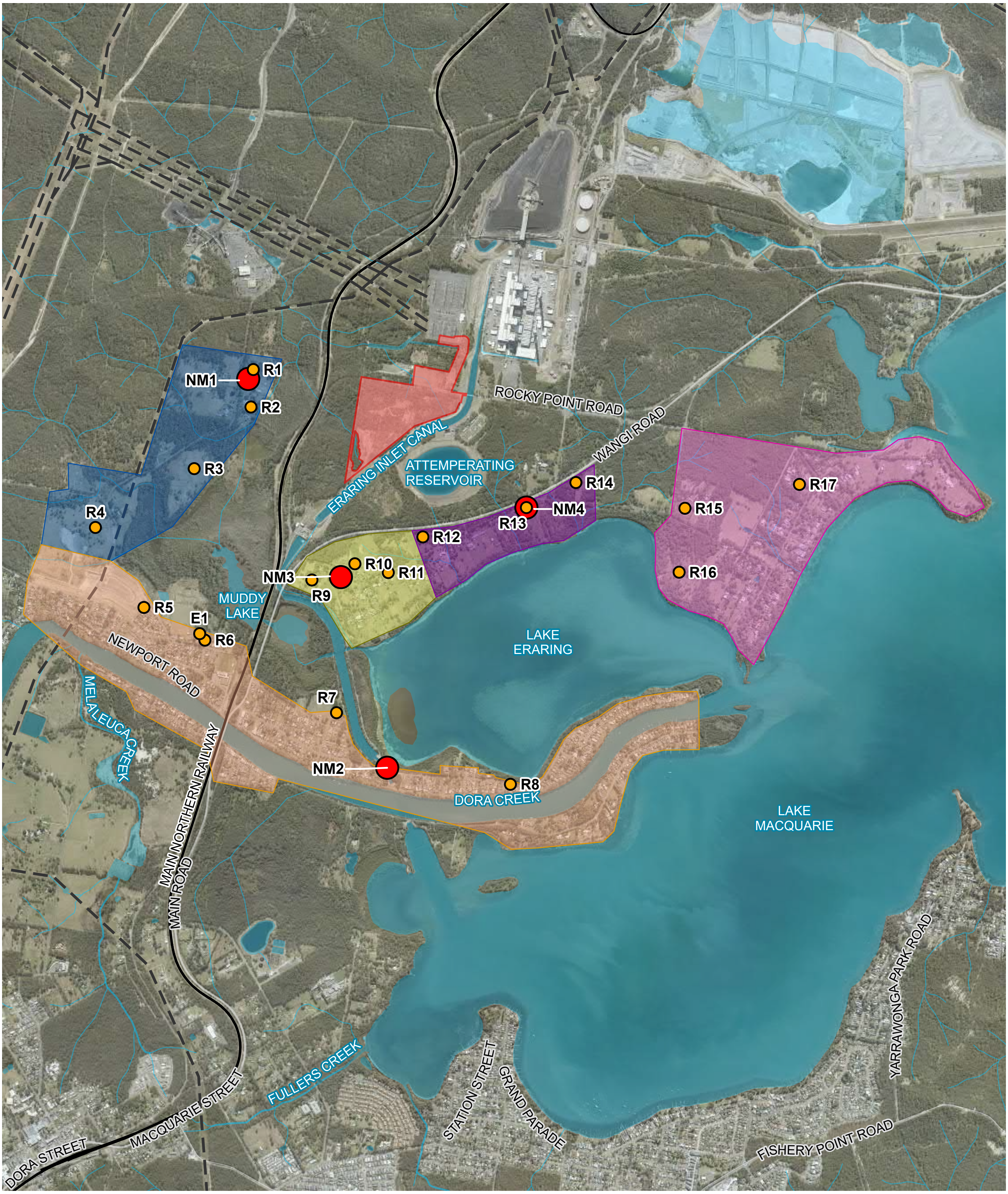
2.2 Existing noise context

Establishing the existing noise context has involved establishing Noise Catchment Areas (NCA), representative sensitive receivers and the capture of background noise data at representative locations within each NCA. These NCAs, representative receivers and monitoring locations are illustrated in **Figure 2-2**.

Based on a desktop study of sensitive receivers, land use and noise influencing factors surrounding the Project site, five NCAs have been established to assess potential noise impacts. In addition to the land use, other factors such as the predominate noise sources were also used to determine the NCAs. **Table 2.1** below details each NCA.

Table 2.1: Noise Catchment Area Summary

Noise Catchment Area	Location	Approximate Distance of Nearest Sensitive Receiver from Project Site	Predominate Land Use (Zoning)	Predominate Background Noise Feature
NCA 1	Gradwells Road, Dora Creek	600 m	▪ RU2 – Rural Landscape ▪ E2 – Environmental Conservation	Environmental noise, industrial noise, residential noise, rail noise
NCA 2	Dora Street and surrounds, Dora Creek	1,500 m	▪ R2 – Low Density Residential ▪ RE1 – Public Recreation	Traffic noise, residential noise, rail noise
NCA 3	Western Border Street, Eraring	600 m	▪ RU4 – Primary Production Small Lots	Environmental noise, traffic noise, residential noise
NCA 4	Eastern Border Street, Eraring	650 m	▪ RU4 – Primary Production Small Lots ▪ E4 – Environmental Living	Heavy traffic noise, environmental noise, residential noise
NCA 5	Point Piper Road and surrounds, Eraring	1,500 m	▪ E4 – Environmental Living ▪ E2 – Environmental Conservation	Environmental noise, residential noise



Project area

Receptor locations

Background noise measurement locations

Noise catchment areas

NCA 1

NCA 2

NCA 3

NCA 4

NCA 5

Electricity transmission line

Railway

0 800 m

1:32,000 at A4

GDA94 MGA56

N

Data sources

Origin 2021,
Aerometrex 2021,
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Figure 2-2 Project noise catchment areas, representative receivers and background noise monitoring locations

In order to understand the potential noise impacts at receivers around the Project, a number of the nearest receivers to the Project within each NCA were selected as locations where modelled noise predictions have been measured. These are detailed in **Table 2.2** and displayed in **Figure 2-2**.

Table 2.2: Receivers used to Predict Noise Impacts

Receiver	Address	Type of Receiver	Noise Catchment Area
R1	242 Gradwells Road, Dora Creek	Residential	NCA 1
R2	214 Gradwells Road, Dora Creek	Residential	
R3	170 Gradwells Road, Dora Creek	Residential	
R4	95 Gradwells Road, Dora Creek	Residential	
R5	10 Greenway Street, Dora Creek	Residential	NCA 2
R6	23 Coorumbung Road, Dora Creek	Residential	
R7	23 Awaba Road, Dora Creek	Residential	
R8	172 Dora Street, Dora Creek	Residential	
R9	8 Awaba Road, Eraring	Residential	NCA 3
R10	21 Border Street, Eraring*	Residential	
R11	32 Border Street, Eraring	Residential	
R12	63 Border Street, Eraring	Residential	NCA 4
R13	124 Border Street, Eraring	Residential	
R14	140 Point Piper Road, Eraring	Residential	
R15	70 Point Piper Road, Eraring	Residential	NCA 5
R16	41 MacLeay Street, Eraring	Residential	
R17	6 Payten Street, Eraing	Residential	
E1	Dora Creek Public School	Educational	NCA 2

Background noise monitoring was performed over a two-week period from 7 June to 21 June 2021. A monitoring location was selected to represent each of the NCAs with the exception of NCA 5, where the land use and noise environment surrounding NM3 was considered representative. A summary of the monitored background noise levels is provided in **Table 2.3**, with the monitoring locations displayed in **Figure 2-2**. Graphs of the monitored noise levels are detailed in Appendix A of the NIA.

Table 2.3: Background Noise Levels

Monitor ID	NCA	Monitoring Location	Monitoring Duration	Measurement	Measured Noise Level – dB(A)		
					Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
NM1	NCA 1	232 Gradwells Road, Dora Creek	7 June – 21 June 2021	L_{Aeq} (equivalent noise level)	46	45	45
				Rating Background Level	41	39	38

Monitor ID	NCA	Monitoring Location	Monitoring Duration	Measurement	Measured Noise Level – dB(A)		
					Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
				(Background L_{A90})			
NM2	NCA 2	Adjacent to 102M Dora Street, Dora Creek		L_{Aeq} (equivalent noise level)	49	47	44
				Rating Background Level (Background L_{A90})	40	40	38
NM3	NCA 3	8 Border Street, Eraring		L_{Aeq} (equivalent noise level)	50	48	45
				Rating Background Level (Background L_{A90})	43	39	37
NM4	NCA 4	124 Border Street, Eraring		L_{Aeq} (equivalent noise level)	59	55	53
				Rating Background Level (Background L_{A90})	48	41	37
N/A*	NCA 5	N/A*	N/A*	Rating Background Level (Background L_{A90})	35	30	30

** Note: RBLs were based on the NPI's 'minimum assumed RBLs'.*

During the noise monitoring for the project, monitoring at NCA 5 was not performed to minimise disruption to the local community as an initial desktop study showed no material risk of noise impact. NCA 5 was adopted post-monitoring as to have noise receiver locations in every direction from the project where noise sensitive receivers were present.

Due to NCA 5's greater distance from noise sources such as Wangi Road and the Eraring Power Station, in addition to featuring lower density residential housing, the noise environment is almost certainly different from the other NCAs, and in turn would also likely have lower RBLs than the NCAs.

As such, the 'minimum assumed RBLs' as presented in Table 2.1 of the NPI (35 dB(A) during the Day and 30 dB(A) during the Evening and Nighttime periods) were conservatively adopted at NCA 5 for the assessment.

In order to gain an understanding of the sources of background noise, handheld attended noise monitoring was undertaken at each noise monitoring location midway through the monitoring period in the morning of 14 June 2021. These noise sources are detailed in **Table 2.4**.

Table 2.4 Noise sources detected during attended monitoring

Monitoring Location	**NM1**	**NM2**	**NM3**	**NM4**
Recorded $L_{Aeq,15min}$ Noise Level	52 dB(A)	55 dB(A)	53 dB(A)	60 dB(A)
Recorded $L_{A90,15min}$ Noise Level	48 dB(A)	49 dB(A)	48 dB(A)	51 dB(A)
Day Noise Sources, SEL	▪ Bid Calls – 50 to 55 dB(A) ▪ Distant Traffic – 50 dB(A) ▪ Industrial Hum (source unidentified) – 48 dB(A) ▪ Passing Train – 48 to 50 dB(A) ▪ Overhead Light Plane – 66 dB(A) ▪ Passing Car – 60 dB(A)	▪ Traffic on Wangi Road – 50 dB(A) ▪ Local Traffic – 60 dB(A) ▪ Bird Calls – 55 to 60 dB(A) ▪ 4WD on Local Road – 68 dB(A) ▪ Pedestrian Chatter – 55 dB(A)	▪ Traffic on Wangi Road – 56 dB(A) ▪ Local Traffic – 62 dB(A) ▪ Passing 4WD – 71 dB(A) ▪ Quiet Period – 47 dB(A)	▪ Traffic on Wangi Road – 60 dB(A) ▪ Distant Traffic (No Traffic Passing on Wangi Road) – 54 dB(A) ▪ Passing Motorbike – 80 dB(A) ▪ Passing 4WD – 80 dB(A)

2.2.1 Vibration sensitive receivers

Whilst most receivers and surrounding structures are sensitive to vibration impacts, some receivers such as medical centres, precision industry and heritage structures are more typically susceptible and are subject to more stringent criteria. The nearest medical centre to the Project Site, Southlakes Medical Group, is located approximately 2 km south of the Project site. No precision industry has been identified in the vicinity of the Project.

A single medical centre has been identified in the vicinity of the Project, the South Maitland Railway System, located approximately 1.3 km from the site. No precision industry was identified within a 4 km radius of the Project.

Two local heritage items have been identified in the vicinity of the Project:

- The Great Northern Railway, approximately 200 m west of the Project; and
- EPS, in which the Project is located. The power station itself is approximately 320 m northeast of the Project.

At these distances, no vibration impacts from the Project site are predicted.

3. Regulatory Requirements

3.1 Relevant Legislation and Guidelines

3.1.1 Legislation

Legislation applicable to the development and implementation of the CNVMP includes:

- EP&A Act as enforced through application of CoA; and
- Protection of the Environment Operations Act as enforced through applicable Environmental Protection Licence.

3.1.2 Guidelines

The main guidelines, standards and policies relevant to this CNVMP include:

- NSW Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009);
- NSW Road Noise Policy (Department of Environment and Climate Change, 2011);
- Roads and Maritime: Construction Noise and Vibration Guideline (RMS, 2016);
- Assessing Vibration: A technical guideline (Department of Environment and Conservation, 2006);
- British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration;
- British Standard BS 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting; and
- German Standard DIN 4150-3:2016 Vibrations in buildings – Part 3: Effects on structures.

3.2 Minister's Conditions of Approval

Following the approval of the project and the development of the Conditions of Approval (CoA), the CoAs relevant to the CNVMP will be listed in this section.

3.3 Other Requirements Relevant to the Development of this Plan

Following the lodgement of the EIS and RtS reports, the finalised environmental requirements will be listed in this section.

3.4 Consultation

This plan is to be provided to the relevant authorities and landholders as required by the received CoAs.

3.5 Cumulative Noise Impacts

No cumulative construction impacts have been predicted to take place during the construction of the project. Where other construction activities in the vicinity of the project are identified, consultation with the proponents will be undertaken to coordinate the works to minimise construction noise impacts in accordance with any relevant CoAs.

4. Noise and Vibration Objectives

4.1 Summary of Objectives

The relevant policies and standards used to determine construction noise and vibration mitigation and management objectives are listed in **Table 4.1**.

Table 4.1 Summary of noise and vibration objectives

Impact	Relevant policy, standard and/or guideline used to establish noise and vibration management levels
Work Hours	Conditions of Approval EPLs
Airborne Noise	Conditions of Approval Interim Construction Noise Guideline
Human Comfort Vibration Impact	Conditions of Approval Assessing Vibration: A technical guideline
Cosmetic Building Damage Vibration Impact	Conditions of Approval BS 7385-2:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives
Heritage Structure Damage Vibration Impact	Conditions of Approval DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures
Buried Services Damage Vibration Impact	Conditions of Approval DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures

4.2 Construction Hours

Construction work has been scheduled to take place only during the Interim Construction Noise Guideline's standard construction hours (i.e. Monday to Friday 7 am to 6 pm as well as Saturday 8 am to 1 pm). Construction hours are nominated as part of the impact assessment process and will be finalised by the determination of the CoAs.

If any works must unavoidably take place outside of the standard hours and where required by CoAs, an Out-of-Hours Work Protocol would be prepared to identify a process for the consideration, management and approval of work which is outside those hours, as well as any hours approved under the CoAs or EPL.

4.3 Airborne Construction Noise Objectives

4.3.1 Noise Management Levels

The ICNG establishes noise management levels (NMLs) for recommended standard construction hours and for outside of the recommended standard hours. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the applicable noise management level. Considering the adopted RBLs presented in **Table 2.3**, the NMLs for the identified surrounding residential receivers are presented in **Table 4.2**.

Table 4.2: Construction noise management levels (residential receivers)

NCA	NML $L_{eq\ 15\ min}$ dB(A)			
	Day (during standard hours) 7am – 6pm Weekdays, 8am – 1pm Saturdays	**Day (outside standard hours)** 7am – 6pm Weekdays 7am – 8am & 1pm – 6pm Saturdays 8am – 6pm Sundays and Public Holidays	**Evening** 6pm-10pm Weekdays 6pm – 10pm Saturdays	**Night** 10pm-7am Weekdays, 10pm – 8am Saturdays 6pm – 7am Sundays and Public Holidays
NCA 1	51	46	44	43
NCA 2	50	45	45	43
NCA 3	53	48	44	42
NCA 4	58	53	46	42
NCA 5	45	40	35	35

The ICNG also provides construction NMLs for non-residential land uses. These are presented in Table 4.3.

Table 4.3: ICNG NMLs for non-residential receivers

Non-residential receiver type	Noise management level, $L_{Aeq(15min)}$ (applies when properties are being used)
Commercial	External Noise Level – 70 dB(A)
Industrial	External Noise Level – 75 dB(A)
Educational facilities	Internal Noise Level – 45 dB(A)
Hospital / Medical	Internal Noise Level – 45 dB(A)
Place of Worship	Internal Noise Level – 45 dB(A)
Passive Recreation	External Noise Level – 60 dB(A)
Active Recreation	External Noise Level – 65 dB(A)

4.3.2 Annoying Noise Characteristics

Equipment that has the potential to produce a tonal noise, an impulsive noise or any other type of noise defined by the ICNG as 'particularly annoying', the noise level for that particular equipment will receive a + 5 dB(A) penalty.

As per guidance from the NPI, the penalty for intermittent noise (e.g., impact piling, hammers, packers and compactors) would only be applied during night periods. The penalty for tonal noise (e.g., roadsaws and grinders) will apply for all periods.

4.4 Construction Vibration Criteria

4.4.1 Human comfort

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

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

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

Assessing Vibration: A technical guideline (DECC, 2006) (AV:ATG) recommends that continuous and impulsive vibration is to be assessed using vibration acceleration (m/s^2) whereas intermittent vibration is to be assessed using vibration dose values (VDV).

The AV:ATG criteria for preferred and maximum values of human exposure for continuous and impulsive vibrations are listed in Table 4.4, for relevant types of receivers.

Table 4.4: Preferred and maximum weighted Root Mean Square (RMS) values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz (DECC, 2006)

Location	**Assessment period**[1]	**Preferred values**		**Maximum values**	
		z-axis[2]	**x and y axis**[2]	**z-axis**	**x and y axis**
Continuous vibration					
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Impulsive vibration					
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14

[1] Day time is 7am to 10pm. Night-time is 10 pm to 7 am (DECC, 2006)

[2] z-axis refers to vertical vibration, while the x and y axes refer to horizontal vibration.

The criteria for intermittent vibration, provided as preferred and maximum VDVs are reproduced in Table 4.5 for relevant types of receivers.

Table 4.5: Preferred and maximum VDVs for intermittent vibration (m/s$^{-1.75}$), (DECC, 2006)

Location	**Day time (7 am to 10 pm)**		**Night-time (10 pm to 7 am)**	
	Preferred VDV	**Maximum VDV**	**Preferred VDV**	**Maximum VDV**
Residences	0.20	0.40	0.13	0.26

4.4.2 Cosmetic Building Damage

Section J4.4.3 of *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives* provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration* [BS7385-2:1993] and are presented in Table 4.6.

Table 4.6: Transient vibration guideline values for cosmetic damage (BS7385-2:1993)

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

4.4.3 Heritage Item Impact

Guidance for more sensitive structures is presented in the German standard, *DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures* (DIN 4150-3: 2016). Vibration velocities not exceeding 3 mm/s at 1 to 10 Hz are recommended in this standard for heritage structures.

4.4.4 Buried Services

DIN 4150-3:2016 also provides guidance for evaluating the effects of short-term vibration on buried services. This guidance has been reproduced below.

Table 4.7 DIN 4150-3: 2016 guidance for evaluating effects of short-term vibration on buried services

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

5. Construction Noise and Vibration Impacts

5.1 Context

As further described in Sections 5 and 6 of the *Eraring Power Station Battery Energy Storage System Noise and Vibration Impact Assessment* (Jacobs, 2021), noise impacts resulting from the construction of the project have been assessed by computer noise modelling, while vibration impacts have been assessed through the use of vibration setback distances consistent with guidance from the RMS *Construction Noise and Vibration Guideline* (CNVG).

The following subsections detail the predicted impacts of the construction phases. It should be noted that the construction scheduling and equipment usage was based on what was accurate during the EIS stage and may be superseded by the time construction activities have been finalised.

5.2 Construction Noise Impact

Noise levels have been predicted at the nearest receivers based on the estimated noise emissions from construction activities during each of the construction Phases. **Table 5.1** presents the predicted noise impact at the representative receivers during each construction phase.

As **Table 5.1** shows, the predicted worst-case noise levels during standard hours are marginally higher than the NMLs at NCA 1, NCA 2 and NCA 3 during construction Phase 2, and also at NCA 1, NCA 2 and NCA 3 during construction Phase 5.

The construction phase predicted to result in the highest noise levels at the nearest sensitive receivers is Phase 5 (i.e., Transmission Structures footings establishment). These works would result in noise levels in exceedance of the standard hours NMLs by up to 3 dB(A) at R1 and R6, 2 dB(A) at R2 and R11 and 1 dB(A) at R10. It is however noted that these works are transient in nature and would only occur during the construction of Stage 1 of the Project, not being repeated during the construction of the additional Stages.

Table 5.1: Estimated Noise Impact from Construction Activities

Receiver	NCA	Standard Hours Construct-ion Noise Criteria (dB(A))	Predicted Noise Performance														
			Phase 1 – Site Establishment			Phase 2 – Cut and fill to battery compound and transformer yard and establishment of pad			Phase 3 – Structural works to support battery enclosures, inverters, transformers, building and transformer compounds and transmission structures			Phase 4 – Delivery, installation and electrical fit-out of components			Phase 5 - Transmission structure footings		
			Overall Phase SWL (dB(A))	Predicted Noise Level(dB(A))	Exceedance of NML	Overall Phase SWL (d(A))	Predicted Noise Level (dB(A))	Exceedance of NML	Overall Phase SWL (dB(A))	Predicted Noise Level (dB(A))	Exceedance of NML	Overall Phase SWL (dB(A))	Predicted Noise Level (dB(A))	Exceedance of NML	Overall Phase SWL (dB(A))	Predicted Noise Level (dB(A))	Exceedance of NML
R1	NCA 1	51	113	41	-	123	52	1 dB(A)	118	47	-	118	46	-	126	54	3 dB(A)
R2				42	-		53	2 dB(A)		48	-		47	-		54	3 dB(A)
R3				39	-		49	-		44	-		44	-		50	-
R4				32	-		42	-		37	-		37	-		43	-
R5	NCA 2	50		35	-		45	-		40	-		40	-		47	-
R6				41	-		51	1 dB(A)		46	-		46	-		53	3 dB(A)
R7				33	-		44	-		39	-		38	-		46	-
R8				37	-		47	-		42	-		42	-		48	-
R9	NCA 3	53		45	-		55	2 dB(A)		50	-		50	-		52	-
R10				45	-		55	2 dB(A)		50	-		50	-		54	1 dB(A)
R11				43	-		53	-		48	-		48	-		55	2 dB(A)
R12	NCA 4	58		34	-		45	-		40	-		39	-		48	-
R13				40	-		51	-		46	-		45	-		55	-

Receiver	NCA	Standard Hours Construct-ion Noise Criteria (dB(A))	Predicted Noise Performance														
			Phase 1 – Site Establishment			Phase 2 – Cut and fill to battery compound and transformer yard and establishment of pad			Phase 3 – Structural works to support battery enclosures, inverters, transformers, building and transformer compounds and transmission structures			Phase 4 – Delivery, installation and electrical fit-out of components			Phase 5 - Transmission structure footings		
			Overall Phase SWL (dB(A))	Predicted Noise Level(dB(A))	Exceedance of NML	Overall Phase SWL (d(A))	Predicted Noise Level (dB(A))	Exceedance of NML	Overall Phase SWL (dB(A))	Predicted Noise Level (dB(A))	Exceedance of NML	Overall Phase SWL (dB(A))	Predicted Noise Level (dB(A))	Exceedance of NML	Overall Phase SWL (dB(A))	Predicted Noise Level (dB(A))	Exceedance of NML
R14				29	-		39	-		34	-		34	-		40	-
R15				34	-		45	-		40	-		39	-		48	3 dB(A)
R16	NCA 5	45		35	-		45	-		40	-		40	-		48	3 dB(A)
R17				29	-		40	-		35	-		34	-		43	-
E1	NCA 2	55		39	-		49	-		44	-		44	-		50	-

5.2.1 Sleep Disturbance

As construction works will not be undertaken outside of standard hours, potential impacts on sleep disturbance have not been assessed.

5.3 Vibration Assessment

As identified in the *Eraring Power Station Battery Energy Storage System Noise and Vibration Impact Assessment* (Jacobs, 2021), some items of plant that are expected to be used to construction such as vibratory rollers and air track drills are considered to be vibration-generating plant. The recommended setback distances for these plant items and the distances to the nearest vibration-sensitive receivers are shown in **Table 5.2**.

Table 5.2 Construction Vibration Impact Assessment

Equipment	Setback Distance (m)			Nearest Affected Receiver (m)				Vibration Impact?
	Human Comfort	Cosmetic Building Damage	Heritage Structure Impact	Medical	Residence	Non-Residential Occupancy	Heritage Item	
Vibratory Roller	100m	25m	45m	2000m	700m	300m	200m	No
Air Track Drill	50m	15m	27m					No

As shown in **Table 5.2**, as all receivers are located at distances farther than the recommended setback distances, no vibration impacts at the nearest receivers are anticipated as a result of construction of the project.

6. Noise and Vibration Control Measures

6.1 Mitigation and Management Measures

Mitigation measures will be implemented to address the impacts predicted in **Section 5**. Mitigation measures will be updated with the following the submission of the EIS and RtS reports, in addition to the determination of CoAs.

Table 6.1 Noise and Vibration Management Measures

ID	Measure/Requirement	When to Implement	Responsibility	Reference	Evidence
NV1	Develop a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria	Design	Contractor, Origin Energy Environmental Officer	SEAR	This Plan
NV2	Incorporate, where reasonable and feasible, the standard mitigation measures from Appendix B of the *Construction Noise and Vibration Guidelines* (RMS, 2016).	Design, Prior to Construction, During Construction	Contractor, Origin Energy Environmental Officer	EIS	Section 6.2
NV3	Incorporate, where reasonable and feasible, the standard mitigation measures from Section 3 of *Assessing Vibration: a technical guideline*, (DECC, 2006).	Design, Prior to Construction, During Construction	Contractor, Origin Energy Environmental Officer	EIS	Section 6.3

6.2 Standard Noise Mitigation Measures

In order to reduce construction noise levels, standard mitigation measures from the *Construction Noise and Vibration Guidelines* (RMS, 2016) (CNVG) have been recommended. These are provided in **Table 6.2**.

Noting that the predicted worst-case noise levels from construction works are only 4 dB(A) above the NMLs during certain phases, not all of the listed mitigation measures would need to be adopted. Instead the measures should be adopted where reasonable and feasible, during the construction phases that have been identified as potentially requiring noise mitigation.

Additionally, as the construction noise modelling was based on a preliminary equipment list, upon the revision of modelling with the finalized equipment data, mitigations will be revised to reflect the updated construction noise levels.

Table 6.2: Standard measures, noise during construction.

Measure	Details	Timing	Responsibility
Time constraints and scheduling	Wherever possible and safe, limit works to standard hours of construction.	During construction	Construction Contractor, Origin Environmental Advisor

Measure	Details	Timing	Responsibility
Equipment restrictions	Select low-noise plant and equipment. Ensure equipment mufflers operate in a proper and efficient manner.	Prior to and during construction	Construction Contractor, Origin Environmental Advisor
Substitute methods	Where possible, use quieter and less vibration emitting construction methods.	During construction	Construction Contractor, Origin Environmental Advisor
Limit equipment use	Only have necessary equipment on-site and turn off when not in use.	During construction	Construction Contractor, Origin Environmental Advisor
Limit activity duration	Where possible, concentrate noisy activities at one location and move to another as quickly as possible.	During construction	Construction Contractor, Origin Environmental Advisor
Site access	Vehicle movements, including deliveries outside standard hours should be minimised and avoided where possible.	During construction	Construction Contractor, Origin Environmental Advisor
Equipment maintenance	Ensure all plant and equipment is well maintained and where possible, fitted with silencing devices.	Prior to and during construction	Construction Contractor, Origin Environmental Advisor
Reduce equipment power	Use only the necessary size and powered equipment for tasks.	During construction	Construction Contractor, Origin Environmental Advisor
Quieter working practices	Implement training to induct staff on noise sensitivities	Prior to and during construction	Construction Contractor, Origin Environmental Advisor
Reversing alarms	Where possible, consider the application of less intrusive alternatives to reverse beepers such as 'squawker' or 'broadband' alarms.	During construction	Construction Contractor, Origin Environmental Advisor
Noise barriers	Consider the installation of temporary construction noise barriers or earth mounds for concentrated, noise-intensive activities.	During construction	Construction Contractor, Origin

Measure	Details	Timing	Responsibility
			Environmental Advisor
Enclosures	Where practicable, install enclosures around noisy mobile and stationary equipment as necessary.	During construction	Construction Contractor, Origin Environmental Advisor
Use and siting of plant	Where possible, avoid simultaneous operation of two or more noisy plant close to receivers. The offset distance between noisy plant and sensitive receivers should be maximised.	During construction	Construction Contractor, Origin Environmental Advisor
Plan work sites and activities to minimise noise	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements.	Prior to and during construction	Construction Contractor, Origin Environmental Advisor
Monitoring	Complete routine monitoring to evaluate construction noise levels and evaluate whether the mitigation measures in place are adequate or require revision.	During construction	Construction Contractor, Origin Environmental Advisor

6.3 Standard Vibration Mitigation Measures

Vibration impacts have not been predicted at any receiver during the construction of the project. However, if vibration impact is a concern, standard management measures from *Assessing Vibration: a technical guideline*, (DECC, 2006) have been provided for general guidance on limiting vibration impacts during construction. These are detailed in **Table 6.3**.

Table 6.3: General vibration management measures (for reference information)

Measure	Details	Timing	Responsibility
Controlling vibration levels from the source	Choosing alternative, lower-impact equipment or methods wherever possible.	During construction	Construction Contractor, Origin Environmental Advisor
	Scheduling the use of vibration-causing equipment at the least sensitive times of the day (wherever possible).	Prior to and during construction	Construction Contractor, Origin Environmental Advisor
	Locating high vibration sources as far away from sensitive receiver areas as possible.	During construction	Construction Contractor, Origin Environmental Advisor

Measure	Details	Timing	Responsibility
	Sequencing operations so that vibration-causing activities do not occur simultaneously.	During construction	Construction Contractor, Origin Environmental Advisor
	Keeping equipment well maintained.	During construction	Construction Contractor, Origin Environmental Advisor
	Do not conduct vibration intensive works within the recommended safe setback distances.	During construction	Construction Contractor, Origin Environmental Advisor
Consultation	Informing nearby receivers about the nature of construction phases and the vibration-generating activities.	During construction	Construction Contractor, Origin Environmental Advisor

6.4 Mitigation and Management of Out of Hours Work

Where works are unavoidably required to take place outside the standard construction hours in accordance with the confirmed CoAs, an Out of Hours Work (OOHW) Protocol will be developed. The OOHW Protocol will be developed in accordance with all relevant CoAs pertaining to the OOHW.

6.5 Construction Noise and Vibration Impact Statements

As detailed in **Section 5.1**, there is a possibility that the works program to be undertaken deviates from the works detailed in the EIS, RtS and CNVMP. Where works are expected to result in a greater noise impact than those predicted in the CNVMP, a CNVIS should be undertaken.

Construction Noise and Vibration Impact Statements (CNVIS) will be employed in order to inform and direct noise and vibration management for high noise and/or vibration impacts that have not been otherwise addressed in this CNVMP. CNVIS will be progressively produced if and when required to assess all noise and vibration risks associated with each relevant construction Phase(s) and to prescribe any appropriate mitigation and management measures to be undertaken.

Each CNVIS would be developed in accordance with the requirements of the received CoAs, and would also contain:

- Detail the scope of works covered by the CNVIS;
- Detail the nearest noise and vibration sensitive receivers;
- Provide justification for any OOHW, if required;
- Provide the noise and vibration objectives and criteria;
- Detail the predicted noise and vibration impacts; and
- Provide appropriate noise and vibration management measures and monitoring requirements.

7. Compliance Management

7.1 Roles and Responsibilities

The overall organisational structure and responsibilities regarding this CNVMP will be developed as part of the associated CEMP.

7.2 Training

All staff and contractors working on the construction of the project will undergo education and training regarding noise and vibration impacts and management. Training would include:

- Toolbox Talks;
- Work Inductions;
- Meetings between contractors and environmental staff; and
- Posters and Educational Items.

Training should detail:

- The contents of this CNVMP;
- Legislation pertaining to noise and vibration impact and management;
- Construction hours;
- Nearby noise sensitive locations;
- Complaints reporting;
- Management measures listed in this CNVMP; and
- Specific responsibilities regarding the mitigation measures.

7.3 Monitoring

Routine inspection would be undertaken by the Origin or construction contractor environmental staff. Details of the inspections will be developed in the CEMP. Noise and vibration monitoring would also be undertaken. The results of monitoring would be compared against the predicted noise impacts and the NMLs. Where monitoring has found noise and vibration impacts to be above the relevant criteria, the following actions may be undertaken in order to reduce impacts:

- Stoppage of work that has been identified as the cause of the criteria exceedance;
- Determine if any non-project noise sources may be causing the criteria exceedance;
- Determine if a particular piece of equipment is the cause of the criteria exceedance, and if any options exist to mitigate or replace the equipment;
- Adopt any other mitigation or management measures where reasonable and feasible to reduce noise;
- Review the work practices undertaken against the CNVMP; and
- Adopt any lessons learnt into future modelling, mitigation actions and training.

7.3.1 Noise Monitoring

Noise monitoring, including the monitoring specifications and parameters, locations of monitoring, and the reporting of monitoring data will be determined in accordance with the confirmed CoAs and EPL. A preliminary noise monitoring program has been established in the subsections below.

7.3.1.1 Attended Noise Monitoring

Attended noise monitoring will be undertaken in the following situations:

- At the commencement of activities where it has been identified that verification monitoring is required, such as confirming that noise levels are consistent with those predicted and to confirm the effectiveness of mitigation;
- In response to a complaint received regarding construction noise (where determined appropriate);
- Where there is a change in methodology that may result in an increase in noise levels;
- As directed by the EPA;
- As required by a CNVIS; and
- Ongoing, case-by-case spot checks for noise intensive plant and equipment will be undertaken throughout construction to ensure compliance with the noise levels.

Locations for noise monitoring will be determined on a case by case basis, in response to complaints and/or the locations of predicted noise impacts. Likewise, the duration and amount of noise monitoring will ultimately be dependent on the scale of the construction activities and extent of expected noise impacts. Noise monitoring will cover a 'representative period' of the construction activity, wherein the plant and equipment operating is consistent with the full range of plant and equipment modelled in the noise assessment (i.e. the monitoring will not be undertaken when key noise producing equipment is not in operation). Where possible, monitoring will be undertaken at the most affected noise sensitive receiver. Noise monitoring locations factors include:

- Proximity of the receiver to the works;
- Noise sensitivity of the receiver;
- Location of previous monitoring;
- Expected duration of the impact;
- Background noise levels; and
- Safety of personnel undertaking the measurements.

7.3.1.2 Out of Hours Protocol Noise Monitoring

Monitoring in accordance with the Out of Hours Protocol will be determined following the confirmation of CoAs.

7.3.1.3 EPL Noise Monitoring

Monitoring in accordance with the Out of Hours Protocol will be determined following the receipt of an EPL.

7.3.1.4 Quality Assurance

All monitoring will be undertaken by suitably trained and competent personnel, who are experienced in undertaking noise measurements.

Noise monitoring equipment used will be at least Class 2 instruments or better and calibrated in accordance with manufacturer specifications and/or relevant Australian Standards. Records of equipment laboratory calibration will be maintained by Origin and the construction contractor throughout the delivery of the Project. The calibration of the monitoring equipment will be checked in the field before and after the noise measurement period.

Noise measurements while winds are greater than 5 m/s at 10 m above ground level or while rainfall is present should be discarded, in line with the monitoring requirements of the *Noise Policy for Industry* (EPA, 2017).

Noise monitoring will be undertaken and recorded in accordance with the relevant noise measurement requirements in the reference standards and documents listed in Section 3.1. All monitoring records will be retained throughout the delivery of the Project by Origin Energy. Noise monitoring records will be completed to record:

- Name of person undertaking the measurement;
- Date and time of measurement, length of measurement and any measurement time intervals;
- Type and model number of monitoring instrumentation;
- Results of field calibration checks;
- Measurement location details and number of measurements at each location;
- Weather conditions during measurements;
- Operation and activities of the noise sources under investigation;
- Estimated contribution of the Project's activities; and
- Noise due to other extraneous and environmental sources (e.g. traffic, aircraft, trains, dogs barking, insects).

7.4 Complaints

The complaint response, recording and management procedure will be detailed in the CEMP.

7.5 Reporting

Reporting requirements and responsibilities will be determined in accordance with the confirmed CoAs and EPL.

8. Review and Improvement

8.1 Continuous Improvement

Continuous improvement of the CNVMP will be carried out through the continued evaluation of mitigation and management measures against environmental policies, objectives and targets and identifying where opportunities exist for improvement.

The continuous improvement process will include:

- Identifying opportunities to improve environmental management measures and performance;
- Identify the causes of any non-compliances with the relevant criteria;
- Develop an effective plan to address any identified non-compliances;
- Determine the effectiveness of applied mitigation measures;
- Document any changes to work procedures undertaken to control non-compliances and/or improve efficiencies; and
- Compare work process results with the relevant objectives and targets.

8.2 Review and Amendment

Where necessary, the CNVMP will be reviewed and where necessary updated. Review and updates are expected to be required at the following times:

- On receipt of approvals to incorporate CoA and EPL requirements;
- As part of detailed design in response to more detailed plant and equipment lists and schedules;
- In the event of any modification of approval; and
- In response to confirmed non-conformance with CoA.

The process to update the CNVMP will be detailed in the CEMP.