Liddell Battery and Bayswater Ancillary Works Project

Appendix J - Noise and Vibration Assessment

Liddell Battery and Bayswater Ancillary Works Project

Noise and vibration assessment

| Final

February 2021

AGL Macquarie Pty Ltd

Contents

Glossary and abbreviations

Abbreviation	Definition
ACHAR	Aboriginal Cultural Heritage Assessment Report
AGLM	AGL Macquarie Pty Limited
BAW	Bayswater Ancillary Works
BESS	Battery Energy Storage System
CNVG	Construction Noise and Vibration Guideline
dB	Decibel
dB(A)	A-weighted decibels
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment Climate Change and Water
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
Estimator tool	Former NSW Roads and Maritime Services Construction and Maintenance Noise Estimator Tool
Hz	Hertz
HIAB	Crane truck
ICNG	Interim Construction Noise Guideline
kN	Kilonewton
kV	Kilovolt
L_{Aeq}	Sound level in decibels equivalent to the total A-weighted sound energy
LGA	Local government area
mm/s	Millimetres per second
MW	Megawatt
m/s^2	Metre per second squared
NEM	National Energy Market
NML	Noise management level
NPI	Noise Policy for Industry
NSW	New South Wales
NVA	Noise and Vibration Assessment
OOH	Out-of-hours (outside recommended standard hours)
ppv	Peak particle velocity
RBLs	Rated background level
RMS	Roads and Maritime Services (now referred to as Transport for NSW)
SEARs	Secretary's Environmental Assessment Requirements
SEPP SRD	*State Environmental Planning Policy (State and Regional Development) 2011*
SPL	Sound pressure level
SSD	State Significant Development
SWL	Sound power level
TfNSW	Transport for NSW
VDV	Vibration does values
V	Volt
WOAOW	Bayswater Water and Other Associated Operational Works project

Executive Summary

Background

AGL Macquarie Pty Limited (**AGLM**) owns and operates the Bayswater and Liddell power stations, Hunter Valley Gas Turbines and associated ancillary infrastructure. Liddell power station (**Liddell**) is approaching its end of life and is scheduled for closure in 2023. Bayswater power station (**Bayswater**) would continue to be operated through to 2035 to support the transition of the National Electricity Market (**NEM**) toward net-zero emissions and then is intended to be retired.

Jacobs, on behalf of AGLM is currently developing an Environmental Impact Statement (**EIS**) for the assessment of the Liddell Battery and Bayswater Ancillary Works Project (**the Project**) to facilitate the efficient, safe and reliable continuation of electricity generating works, in accordance with Division 4.7 of the *Environmental Planning and Assessment Act 1979* (**EP&A Act**). The Project is located within the Bayswater and Liddell power stations and surrounding buffer lands on the New England Highway within the Local Government Areas (**LGA**) of Muswellbrook and Singleton.

The features of the Project include:

- **The Battery**: A grid connected Battery Energy Storage System (**Battery**) with capacity of up to 500 megawatt (**MW**) and 2 gigawatt hours (**GWh**)
- **Decoupling works**: Alternative network connection arrangements for the Liddell 33 kilovolt (**kV**) switching station that provides electricity to infrastructure required for the ongoing operation of Bayswater and associated ancillary infrastructure and potential third-party industrial energy users
- **Bayswater Ancillary Works** (**BAW**): Works associated with Bayswater which may include upgrades to ancillary infrastructure such as pumps, pipelines, conveyor systems, roads and assets to enable maintenance, repairs, replacement or expansion
- **Consolidated consents:** A modern consolidated consent for the continued operation of Bayswater through the voluntary surrender and consolidation into this application of various existing development approvals required for the ongoing operation of AGLM assets.

This document presents the results of the Noise and Vibration Impact Assessment undertaken as part of the EIS requirements.

Key features of the existing environment

Aerial imagery was reviewed to identify sensitive receivers and other characteristics of the existing environment around the Project. Nearby heritage structures that may be sensitive to construction vibration were identified by reviewing the Aboriginal Cultural Heritage Assessment Report and the Aboriginal Archaeological Report prepared for the Project. Existing background noise conditions around the identified nearby noise-sensitive receivers were established using recent background noise monitoring data collected for AGLM.

Estimation of emissions

Construction staging and operational noise emissions information provided by AGLM were used to develop emissions inventories for the Project as well as for the Bayswater Water and Other Associated Works (**WOAOW**) project. A cumulative noise assessment was completed as there is some uncertainty around the scheduling of construction programs for both projects, and an overlap may be likely. The construction stage from the WOAOW project with the highest sound power level (**SWLs**) and probable highest noise footprint was assessed together with each Project construction stage to determine conservative worst-case cumulative noise levels at sensitive receivers. Reference SWLs from various standards and guidelines were used to estimate overall SWLs from different phases of construction. These inventories were cross-referenced against recommended safe setback guidance for avoiding vibration-related building cosmetic structural and human health impacts to identify vibration-generating plant/equipment identified to be used.

Assessment of impacts

Noise impacts during construction and operation were quantitatively evaluated by using the Roads and Maritime Services (**RMS -** now Transport for NSW **(TfNSW)**) Construction and Maintenance Noise Estimator Tool (**Estimator tool**). Cumulative noise predictions at surrounding sensitive receivers were compared against criteria developed using guidance from the Interim Construction Noise Guideline (**ICNG**) (DECCW, 2009) and Assessing Vibration: a technical guideline (DEC, 2006), as well as other relevant standards to evaluate the potential for impacts.

The Estimator tool was used to predict resulting noise levels at all residential and non-residential receivers from construction and operation activities. Using this approach, the assessment found that noise levels would comply with relevant noise criteria established for the Project.

The assessment indicated additional noise mitigation measures would not be required at nearby sensitive receivers, during the construction of the Project or during battery operation.

Noise impacts from construction traffic was also assessed using the Estimator tool. It was predicted that cumulative additional road traffic from construction would not increase noise levels by more than 2 decibels (**dB(A**)) above existing average daily traffic noise, complying with the Construction Noise and Vibration Guideline (**CNVG)** (RMS, 2016)**.**

Given the distance of construction works from nearby sensitive receivers, it was determined that vibration impacts would be unlikely.

Important note about your report

The purpose of this report and the associated services performed by Jacobs is to quantify the potential acoustic impacts from construction of the Project in accordance with the scope of services set out in the contract between Jacobs and AGLM. That scope of services, as described in this report, was developed with AGLM.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by AGLM 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 AGLM (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 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 AGLM, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and AGLM. 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

AGL Macquarie Pty Limited (**AGLM**) own and operates the Bayswater power stations (**Bayswater**) and Liddell power stations (**Liddel**l), the Hunter Valley Gas Turbines and associated ancillary infrastructure systems that operate to produce around 23,000 gigawatt hours (**GWh**) annually, or approximately 35 per cent (**%**) of New South Wales (**NSW**) electricity supply.

AGLM is seeking approval for the Liddell Battery and Bayswater Ancillary Works Project (**the Project**). As a State significant development (**SSD**) under the *State Environmental Planning Policy (State and Regional Development) 2011* (**SEPP SRD**) the Project is subject to Part 4, Division 4.7 of the *Environmental Planning and Assessment Act 1979* (**EP&A Act**) which requires the preparation of EIS in accordance with Secretary's Environmental Assessment Requirements (**SEARs**).

This Noise and Vibration Assessment (**NVA**) has been developed in support of the Environmental Impact Statement (**EIS**) for the Project.

1.2 Purpose of this report

This NVA has been prepared in accordance with the SEARs issued for the Project on 29 September 2020 by the Planning Secretary of the NSW Department of Planning, Industry and Environment (**DPIE**).

The SEARs relevant to the NVA are summarised in **Table 1-1**, along with a reference to where these requirements have been addressed.

Table 1-1: SEARs– Noise and vibration

Requirement of SEARs No. SSD 8889679	Where addressed
An assessment of the likely construction noise impacts of the Project under the Interim Construction Noise Guideline (DECCW, 2009)	**Section 4.1** and **Section 6.1**
An assessment of the likely operational noise impacts of the Project under the NSW Noise Policy for Industry (EPA, 2017)	**Section 4.2** and **Section 6.4**
An assessment of the likely road noise impacts of the Project under the NSW Road Noise Policy (EPA, 2011)	**Section 6.2**
An assessment of the likely vibration amenity and structural impacts of the Project under Assessing Vibration: *A Technical Guideline* (DEC. 2006) and *German Standard DIN 4150-3 Structural Vibration – effects of vibration on structures*	**Section 4.3** and **Section 6.6**

1.3 Project location

Liddell and Bayswater are located approximately 15 kilometres (**km**) south-east of Muswellbrook, 25 km north-west of Singleton and approximately 165 km north-west of Sydney (refer to **Figure 1-1**). The total area of the AGLM landholding is approximately 10,000 hectares (**ha**), including the Ravensworth rehabilitation area, Lake Liddell and surrounding buffer lands.

The Liddell Battery (**the Battery**) and Decoupling components would generally be undertaken in close proximity to Liddell and are targeting the use of previously disturbed operational lands no longer required for Liddell operations. The Bayswater Ancillary Works (**BAW**) would occur throughout the AGLM landholding and is located in close proximity to existing infrastructure where prior disturbance has typically occurred.

The Project is located within an area dominated by mining and power generation. The landscape local to Liddell and Bayswater is heavily influenced by industrial activity. Local land use is dominated by large-scale infrastructure associated with Bayswater and Liddell and open cut mining activities at Ravensworth Mine

Complex, Mount Arthur Coal, Hunter Valley Operations, Liddell Coal Mine and the former Drayton Mine. Agricultural clearing for the purposes of grazing is also present within and surrounding the AGLM landholding.

There are limited sensitive receivers or social infrastructure in the locality of the Project. This assessment includes three Project areas (the Battery, BAW and the Bayswater Water and Other Associated Works (**WOAOW**) project), and each Project area consists of several construction zones. As such, the nearest sensitive receiver to one Project may not be the nearest to the others.

The nearest sensitive receiver to the Battery site is Lake Liddell Recreation Area, approximately 2 km north of the Battery and Decoupling areas.

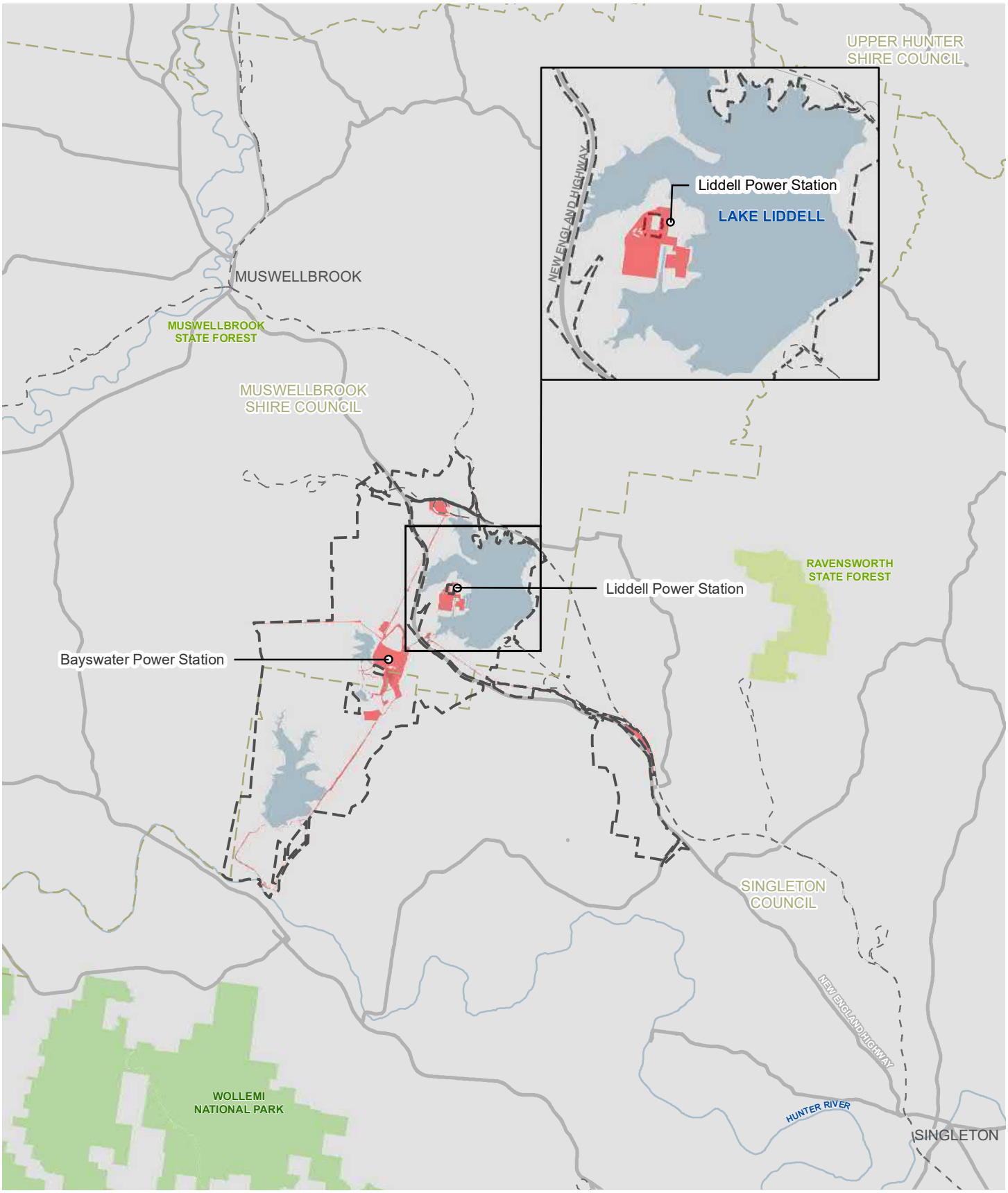
The nearest sensitive receiver to BAW footprint is 2799 Jerrys Plain Rd, Jerrys Plain, approximately 700 metres (**m**) south of the Project, where only certain minor construction works are proposed.

The nearest sensitive receiver to the WOAOW project is the industrial JV Howick Facility, located approximately 2 km south of the ash dam works component of that project.

The closest residential township areas are the Antiene subdivision, which is located approximately 4 km north of the Battery and Decoupling Project components and Jerrys Plains located approximately 1.5 km to the south east of the BAW footprint.

The New England Highway runs between Liddell and Bayswater, with access from the highway provided by means of a dedicated road interchange designed to service the power stations. The Northern Railway Line runs to the east of the AGLM landholding.

The majority of the AGLM landholding has been previously disturbed during the construction and operation of Liddell and Bayswater.



Legend

- Project area
- AGL owned land
- LGA boundary
- Railway
- Road
- Waterway
- Waterbody
- State forest
- National park

0 5 10 km

1:200,000 at A4

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Data sources

Jacobs 2020
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AGL 2019
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Figure 1-1 Project location

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1.4 Report structure

The report structure is as follows:

- **Section 2: Project Description -** describes the Project setting, details and potential noise and vibration-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 and vibration-related emissions during the construction of the Project
- **Section 6: Assessment of Impacts** - predicts the potential for noise and vibration-related impacts at the identified surrounding receivers
- **Section 7: Mitigation and Management** - evaluates the significance of these predictions and recommend mitigation and management measures.

2. Project description

2.1 Project overview

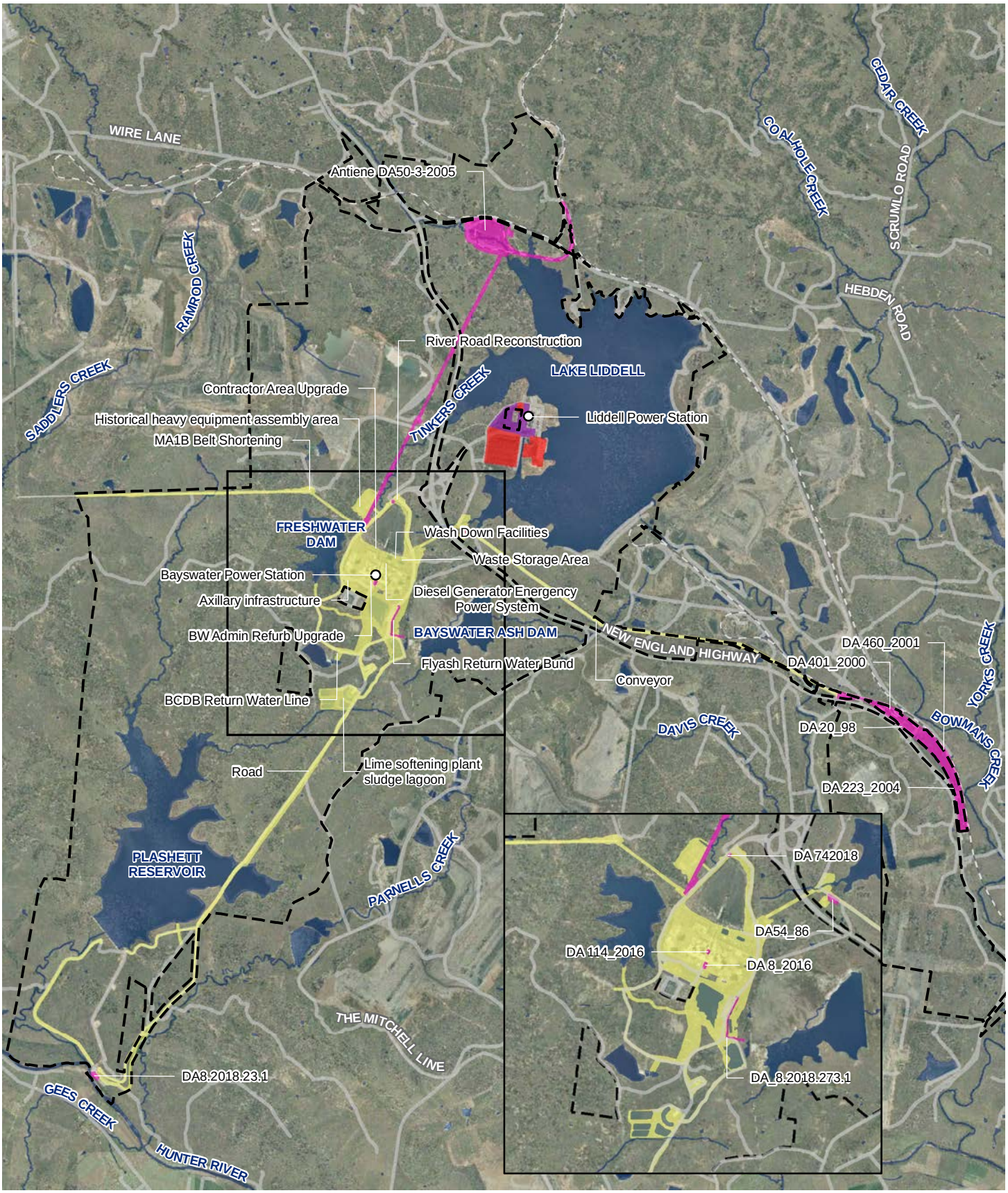
AGLM are progressing plans to facilitate the efficient, safe and reliable continuation of electricity generating works from the Bayswater and Liddell site. The Project would consist of the following:

- **The Battery**: A grid connected Battery Energy Storage System with capacity of up to 500 megawatt (**MW**) and 2 GWh
- **Decoupling works**: Alternative network connection arrangements for the Liddell 33 kV switching station that provides electricity to infrastructure required for the ongoing operation of Bayswater and associated ancillary infrastructure and potential third-party industrial energy users
- **Bayswater Ancillary Works (BAW**): Works associated with Bayswater which may include upgrades to ancillary infrastructure such as pumps, pipelines, conveyor systems, roads and assets to enable maintenance, repairs, replacement or expansion
- **Consolidated consents:** A modern consolidated consent for the continued operation of Bayswater through the voluntary surrender and consolidation into this application of various existing development approvals required for the ongoing operation of AGLM assets.

Construction works associated with the Battery and Decoupling would be likely to involve:

- Installation and maintenance of environmental controls including temporary and permanent water management infrastructure
- Establishment of a new access from Liddell access road
- Establishment of a hardstand pad and construction laydown areas
- Cut and fill to battery compound, transformer compounds, footings and construction laydown area
- Trenching and installation of cable from the Battery to 330 kV/33 kV transformer compounds
- Structural works to support battery enclosures, inverters, transformers, buildings and transformer compounds
- Delivery, installation and electrical fit-out of the Battery
- Delivery installation and fit out of transformers and ancillary equipment for decoupling works
- Testing and commissioning activities
- Removal of construction equipment and rehabilitation of construction areas.

The key components of the Project are shown on **Figure 2-1**. A detailed description of the Project and each component is provided in Chapter 2 of the EIS.



Legend

Project area:

- Bayswater Ancillary Works
- Battery energy storage system
- Decoupling area
- Consolidated consent
- AGL owned land

- Railway
- Road
- Waterway
- Waterbody

0 2 4km

1:90,000 at A4

Data sources

Jacobs 2021
AGL 2020
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Imagery:
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GDA94 MGA56

Figure 2-1 Project overview

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2.2 Construction program

The development of the Battery may be staged to respond to market demand. AGLM anticipates the construction occurring over multiple stages. These stages could potentially be:

- Stage 1 consisting of 150 MW and 150 MWh targeting construction commencement in 2021
- Stage 2 consisting of 150 MW and 150 MWh targeting construction commencement in 2023
- Stage 3 consisting of 200 MW and up to 1700 MWh with storage capacity being added in response to the needs of the NEM.

The construction of each Battery stage is anticipated to take up to 12 months consisting of the civil works component, mechanical and structural component, electrical works and testing and commissioning. Stage 3 may be further divided into smaller stages subject to market demand and be delivered on a progressive basis. The Decoupling works are proposed to be undertaken prior to 2024 to facilitate the planned closure and decommissioning of Liddell. Decoupling works are anticipated to take up to 12 months.

The BAW may be undertaken at any time up to the planned retirement of Bayswater. For assessment purposes, a reasonable worst-case conservative assumption has been made that several BAW components could occur at one time and coincide with the worst-case traffic generation for the Battery, Decoupling and ongoing and currently anticipated works outside of the Project.

2.3 Noise sensitive receivers

This assessment includes three Project areas (the Battery, BAW and WOAOW), and each Project area consists of several construction zones. As such, the nearest sensitive receiver to one Project may not be the nearest to the others.

The nearest sensitive receiver to the Liddell Battery site is Lake Liddell Recreation Area (R16), approximately 2 km north of the Battery and Decoupling areas, on the north side of Lake Liddell. The nearest residential receiver is the Lake Liddell Recreation Area's owner's residence on Hebden Rd (R12), located approximately 2.5 km north of the Battery and Decoupling areas.

The nearest sensitive receiver to the BAW site is 2799 Jerrys Plain Rd, Jerrys Plain (R15), approximately 700 m south of the Project, where only environmental improvement works, and maintenance works have been proposed as part of the construction program.

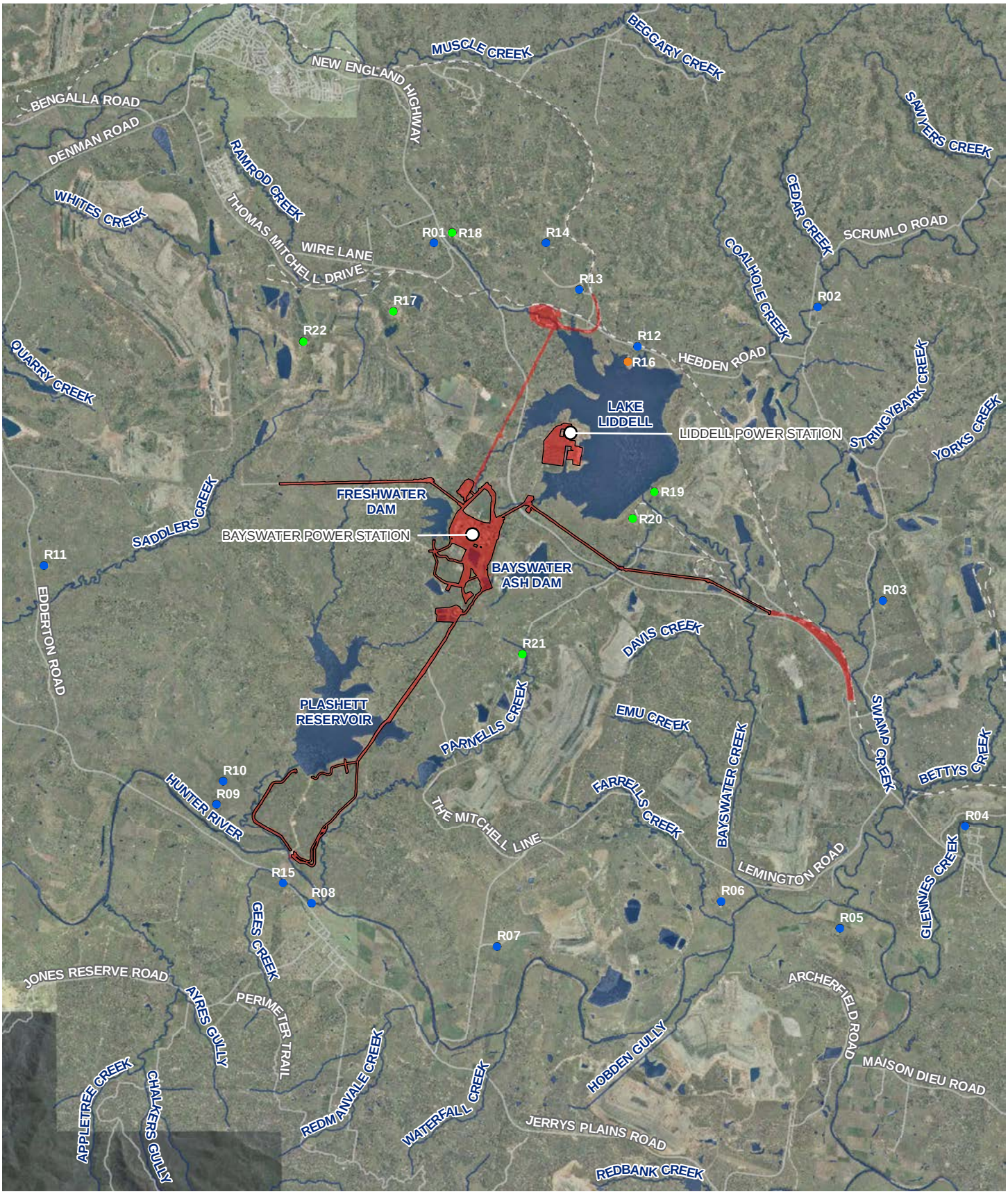
The nearest sensitive receiver to the WOAOW project is the industrial JV Howick Facility, located approximately 2 km south of the ash dam works component of that project.

Including these receivers, there were a total of 15 residential receivers identified for this assessment. Seven noise sensitive, non-residential receivers have also been identified for this assessment – one passive recreation area (Lake Liddell Recreation Area) on the northern side of Lake Liddell, and six industrial receivers surrounding the Project. **Table 2-1** details the closest noise sensitive receivers identified, and **Figure 2-2** presents the locations of these sensitive receivers relative to the Project.

Table 2-1: Noise sensitive receivers

Receiver	Receiver type	Address/Location
R01	Residential	1 Hassall Rd, Muswellbrook
R02	Residential	135B Scrumlo Rd, Hebden
R03	Residential	Hebden Rd, Ravensworth (southwest of the Project)
R04	Residential	24 Dawson St, Camberwell
R05	Residential	Archerfield Rd, Warkworth (south-southwest of the Project)
R06	Residential	Off Lemington Rd, Ravensworth (south of the Project)
R07	Residential	1561 Lemington Rd, Lemington
R08	Residential	2718 Jerrys Plains Rd, Jerrys Plains

Receiver	Receiver type	Address/Location
R09	Residential	388 Jerrys Plains Rd, Jerrys Plains
R10	Residential	388B Jerrys Plains Rd, Jerrys Plains (Edderton Rd)
R11	Residential	1020 Edderton Rd, Jerrys Plains
R12	Residential	Lake Liddell Recreation Area owner's residence (north of the Project)
R13	Residential	60 Antiene Railway Station Rd, Muswellbrook
R14	Residential	240 Antiene Right of Way, Muswellbrook
R15	Residential	2799 Jerrys Plains Road, Jerrys Plains
R16	Passive Recreational	Lake Liddell Recreation Area
R17	Industrial	Industrial/mining facility northwest of the Project
R18	Industrial	Hunter Valley Concrete – 8440 New England Hwy
R19	Industrial	Liddell Coal Operations – southeast of the Project
R20	Industrial	Liddell Coal Operations – southeast of the Project
R21	Industrial	Hunter Valley Operations – JV Howick – south of the Project
R22	Industrial	Bengalla Mining operations - west of the Project



Legend

- Development site
- Project area

Sensitive Receivers

- Industrial
- Passive Recreation
- Residential

- Railway
- Road
- Waterway
- Waterbody

0 2 4km

1:140,000 at A4

N

Data sources

Jacobs 2021
AGL 2020
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Figure 2 - 2 Noise sensitive receivers around the Project

2.4 Primary noise and vibration-related risks

Noise and vibration-related impacts can arise when industrial or construction activities result in increased noise levels at surrounding sensitive receivers. The construction and operation phases of the Project have potential to generate noise and vibration which may impact surrounding sensitive receivers. The key activities with the potential to generate noise and vibration during the Project include:

- Concrete works, associated with concrete saws, pneumatic hammers and concrete vibrators
- Structural works associated with air track drills and bulldozers
- Platforming and road works associated with vibratory rollers, pavement profilers and concrete vibrators.

Noise and vibration risks may also arise during Project operations. The operation of the Battery and transformers has also been considered in this assessment, which is consistent with the requirement of the SEARs.

3. Existing Environment

3.1 Surrounding land uses

The land use surrounding the Project is generally rural, with sparsely populated residential properties, mining infrastructure and industrial facilities. Existing development neighbouring Bayswater includes the Drayton and Liddell coal mines, as well as Liddell and the Main Northern Railway Line. The New England Highway runs parallel to Bayswater, with access from the highway provided by means of a dedicated road interchange designed to service the power stations. Agricultural land (for grazing) also exists within and around the AGLM landholding.

Whilst all receivers and surrounding structures are sensitive to vibration impacts, heritage and precision industries are typically more susceptible and are subject to more stringent criteria. A review of the Aboriginal Cultural Heritage Assessment Report prepared for the Project identified that there are several Aboriginal heritage items near the Project. These items were identified as scatterings and artefacts, which are not vibration sensitive.

3.2 Background noise levels

For this assessment, background noise levels have been adopted from measurements undertaken by Jacobs in the area in June 2018, for the Bayswater Turbine Upgrade Project for AGLM (AGL, 2018). These measured levels are considered indicative representations of the Rating Background noise Levels (**RBLs**) in the surrounding area and are considered more accurate than adopting estimations from relative legislative guidelines.

In the June 2018 Jacobs monitoring assessment, long term unattended monitoring was undertaken at two locations. The first of these monitoring-locations was close to R13, in the Antiene development area. At the time of monitoring, it was noted that the dominant noise source was road traffic on the New England Highway, with Bayswater noted as inaudible. The RBLs measured at this location have been adopted for the northern receivers of this assessment (R01 to R03 and R12 to R14).

The second noise monitoring location was on an eastern peninsula of the Plashett Reservoir. At the time of monitoring, it was noted that distant heavy vehicles on New England Highway as well as birds were the main noise sources. Bayswater operations were inaudible. The RBLs measured at this location have been adopted for the southern receivers of this assessment (R04 to R11 and R15). The RBLs for the southern receivers are noted as being conservative, given they have been measured to be less than 30 dB(A). The NSW Environmental Protection Agency's (**EPA**) Noise Policy for Industry (**NPI**) (EPA, 2017) provides minimum assumed RBLs which are to be applied where measured RBLs are below 35 dB(A) for daytime periods, and 30 dB(A) during evening and night-time periods. **Table 3-1** presents the measured RBLs for this assessment for each receiver. For sensitive receivers R01 to R03 and R12 to R14, the measured RBLs have been adopted for this assessment. For sensitive receivers R04 to R11 and R15 the measured RBLs fall below the NPIs minimum value (presented in brackets). Therefore, the NPIs minimum RBL values have been applied for this assessment.

Table 3-1: Adopted rated background levels

Receiver	Measured noise level (2018) (L_{A90} dB(A))		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
R01	37	36	36
R02	37	36	36
R03	37	36	36
R04	23 (35)	26 (30)	28 (30)
R05	23 (35)	26 (30)	28 (30)
R06	23 (35)	26 (30)	28 (30)
R07	23 (35)	26 (30)	28 (30)

Receiver	Measured noise level (2018) (L_{A90} dB(A))		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
R08	23 (35)	26 (30)	28 (30)
R09	23 (35)	26 (30)	28 (30)
R10	23 (35)	26 (30)	28 (30)
R11	23 (35)	26 (30)	28 (30)
R12	37	36	36
R13	37	36	36
R14	37	36	36
R15	23 (35)	26 (30)	28 (30)

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**) according to the hours in which construction may take place. Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the noise management levels. **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 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)

Receiver	NML $L_{eq\ 15\ min}$ dB(A)			
	Day (during standard hours)	Day (outside standard hours)	Evening	Night
R01	47	42	41	41
R02	47	42	41	41
R03	47	42	41	41
R04	45	40	35	35
R05	45	40	35	35
R06	45	40	35	35
R07	45	40	35	35
R08	45	40	35	35
R09	45	40	35	35
R10	45	40	35	35
R11	45	28	31	33
R12	47	42	41	41
R13	47	42	41	41
R14	47	42	41	41
R15	45	28	31	33

The ICNG also provides construction NMLs for non-residential land uses. **Table 4-3** presents the NML for passive recreation areas and industrial facilities.

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)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level – 60 dB(A)
Industrial	External noise level – 75 dB(A)

4.1.2 Construction traffic noise impacts

Road traffic noise impacts due to the construction and operation of the Project were assessed against the following guidance from the application notes of the EPA's "NSW Road Noise Policy" (**RNP**) (2011):

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

4.1.3 Sleep disturbance

For premises where night construction and operations occur, the potential for noise levels to lead to sleep disturbance should be considered. Where noise levels from an industrial source at a residential receptor at night exceeds the following, a maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 40dB(A) or the RBL + 5dB(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 northern (R01 to R03 and R012 to R14) and southern (R04 to R11 and R15) residential receivers.

Table 4-4: Sleep disturbance criterion – construction and operational noise

Receiver group	NML $L_{eq\ 15\ min}$ dB(A)
Northern	41
Southern	40

4.2 Operational Noise

4.2.1 Overview

Operational noise criteria for the Project are 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 levels: one aimed at limiting the intrusiveness of the Project's noise against the prevailing level of background noise, and the other focused on 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 northern and southern receivers, based on their RBLs (see **Table 4-1**). Intrusiveness noise levels are not used directly as regulatory limits. 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. As per the NPI, minimum intrusiveness RBLs apply where measured RBLs are less than 35 dB(A) during standard hours, and less than 30 dB(A) during the evening and night. The measured RBLs representing the southern sensitive receivers fall below this threshold. Therefore, the NPI minimum intrusiveness RBLs have been applied for the southern receivers.

Table 4-5: NPI intrusiveness noise levels

Receiver Group	Time of Day	L_{90} (RBL) dB (A)	Allowance	Noise intrusiveness criteria dB(A)
Northern residential receivers	Day (7am to 6pm)	37	+5 dB(A)	42
	Evening (6pm to 10pm)	36		41
	Night (10pm to 7am)	36		41
Southern residential receivers	Day (7am to 6pm)	35		40
	Evening (6pm to 10pm)	30		35
	Night (10pm to 7am)	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 limits. 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.

Table 4-6 presents the recommended amenity noise levels as per the NPI, and the Project amenity noise level (recommended amenity noise level minus 5). **Table 4-6** also presents the amenity noise level for passive recreation areas, which represents Lake Liddell Recreation Area, and surrounding industrial receivers as specified in the NPI.

Table 4-6: NPI amenity noise criteria, residential receivers

Receiver type	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	Project amenity $L_{eq\ 15\text{-}minute}$ Noise Level dB(A)
Residential receivers (rural)	Day (7am to 6pm)	50	45
	Evening (6pm to 10pm)	45	40
	Night (10pm to 7am)	40	35
Passive recreation	When in use	50	45
Industrial	When in use	70	65

4.2.4 Project operational noise criteria

The NPI recommends that the more stringent values between intrusiveness and amenity noise levels 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 4-7** presents the operational noise criteria for this assessment.

Table 4-7: Project operational noise criteria

Receiver type	Time of day	Recommended L_{Aeq} Noise Level dB(A)
Northern residential receivers	Day (7am to pm)	42
	Evening (6pm to 10pm)	40
	Night (10pm to 7am)	35
Southern residential receivers	Day (7am to 6pm)	40
	Evening (6pm to 10pm)	35
	Night (10pm to 7am)	35
Passive recreational area	When in use	45
Industrial	When in use	65

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 criteria levels, 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, 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 4-8** (DECC, 2006), for relevant sensitive receivers to this project. As per DECC, daytime is between 7am and 10pm, and night is between 10pm and 7am.

Table 4-8: Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (metre per second squared (m/s^2) 1-80 hertz (Hz)

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x and y axis	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

Intermittent vibration is assessed differently using vibration does values (**VDV**). Preferred and maximum VDVs for different types of receivers have been reproduced in **Table 4-9** for relative sensitive receivers in this assessment.

Table 4-9: Preferred and maximum VDVs for intermittent vibration (ms-1.75), (DECC, 2006)

Location	Day time (7am to 10pm)		Night-time (10pm to 7am)	
	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 4-10**.

Table 4-10: Transient vibration guideline values for cosmetic damage

Type of building	Peak particle velocity (ppv) Millimetres per second (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 "Construction Noise and Vibration Guideline" (**CNVG**), (RMS, 2016) 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 distance have been presented in **Table 4-11**.

Table 4-11: Recommended safe setback distances

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

5. Noise emissions

5.1 Construction noise emissions

5.1.1 Construction staging and plant

Overall **SWLs** were predicted for each phase of construction for the Project and for the WOAOW project (see **Section 5.1.2**). Each construction stage for the Project is assumed to operate at independent times from other stages, and operations within construction compounds are assumed to be active throughout all construction stages. Construction stages were determined based on sequencing and proposed staging for the construction of the Project. The overall SWLs were estimated with reference to individual plant and equipment levels presented in national and international standards and guidelines, as well as from a Jacobs measurement database.

The construction stages for the Battery and Decoupling works would be carried out around the Liddell Battery site as presented in **Figure 2-1**.

Environmental improvement works and maintenance works associated with BAW would extend south, to the east of Plashett Reservoir and towards the Hunter River. High pressure pipeline works would also extend south, only to the east of Plashett Reservoir.

Table 5-1 presents the construction stages, plant and equipment and relative SWLs used for this assessment.

Table 5-1: Noise emissions during construction

Work Program	Construction Stage	Plant/Equipment	No. of plant/equipment	Total SWL dB(A)
Battery Works	1. Site establishment	Truck (medium	2	106
		Road truck	2	111
		Scissor lift	1	98
		Light vehicles	4	94
		Franna crane	1	98
	2. Demolition and deconstruction of existing equipment as required	Excavator (tracked)	1	110
		Excavator (tracked)	1	116
		Bulldozer D9	1	116
		Franna crane 20t	1	98
		Concrete saw	1	118
		Vacuum truck	1	109
		Front end loader	1	112
		Dump truck	2	111
		Generator	1	103
	3. Establishment of hardstand pad and construction laydown areas	Franna crane	1	98
		Pneumatic hammer	1	116
		Excavator (tracked)	1	110
		Grader	1	113
		Vibratory roller	1	109
		Concrete truck	1	109
		Dump truck	2	113

Work Program	Construction Stage	Plant/Equipment	No. of plant/equipment	Total SWL dB(A)
		Water cart	1	107
		Concrete pump	1	109
		Concrete vibrator	1	113
		Generator	1	103
		Light vehicles	8	97
	4. Cut and fill to battery compound	Excavator (tracked)	2	113
		Dump truck	2	113
		Front loader	2	115
		Backhoe	2	114
		Concrete truck	2	112
		Concrete saw	1	118
		Concrete pump	1	109
		Asphalt truck and	1	103
		Generator	1	103
	5. Structural works to support battery enclosures, inverters, transformers, building and transformer compounds	Mobile crane	1	113
		Concrete vibrator	1	113
		Concrete pump	1	109
		Welding equipment	1	105
		Excavator (tracked)	1	110
		Generator	1	103
		Air track drill	1	124
	6. Delivery, installation and electrical fit-out of the battery	Rigid trucks	2	106
		Mobile crane	2	116
		Compressor	1	109
		Welding equipment	1	105
		Generator	1	103
Decoupling Works	1. Installation of cable from the battery to 330/33 kV transformer compounds	Backhoe	1	110
		Franna crane	1	98
		Excavator (tracked)	1	110
		Concrete truck	1	109
		Truck compressor	1	75
		Vibratory roller	1	109
		Road truck	1	108
	2. Delivery installation and fit out of transformers and ancillary equipment for decoupling works	Rigid trucks	2	106
		Mobile crane	1	113
		Compressor	1	109
		Welding equipment	1	105
		Generator	1	103
		Road truck	3	113

Work Program	Construction Stage	Plant/Equipment	No. of plant/equipment	Total SWL dB(A)
	3. Finishing Works	Mobile crane	1	113
		Excavator (tracked)	1	110
		Light vehicles	8	97
		Scissor lift	1	98
Bayswater Ancillary Works	1. MA1B conveyor shortening	Excavator (tracked)	2	113
		Concrete pump	1	102
		Concrete truck	1	109
		Compressor	1	109
		Mobile crane	1	113
		Backhoe	1	110
		Welding equipment	1	105
		Vibratory roller	1	109
		Road truck	2	111
		Dump truck	1	110
	2. Environmental improvements	Franna crane	1	98
		Bobcat	1	98
		Excavator (12t)	1	101
	3. Brine concentrator return water pipeline	Franna crane	1	98
		Welding equipment	1	105
		Bobcat	1	98
		Light vehicles	8	97
	4. Chemical storage tanks upgrade	Mobile crane	1	113
		Excavator	1	110
		Hand tools	2	91
		Bobcat	1	88
	5. Ancillary infrastructure upgrade	Excavator (tracked)	2	113
		Concrete pump	1	102
		Concrete truck	1	109
		Compressor	1	109
		Mobile crane	1	113
		Backhoe	1	110
		Welding equipment	1	105
		Vibratory roller	1	109
		Road truck	2	111
		Dump truck	1	110
	6. Waste storage area formalisation	Excavator (tracked)	2	113
		Concrete pump	1	102
		Concrete truck	1	109
		Compressor	1	109

Work Program	Construction Stage	Plant/Equipment	No. of plant/equipment	Total SWL dB(A)
		Mobile crane	1	113
		Backhoe	1	110
		Welding equipment	1	105
		Vibratory roller	1	109
		Road truck	2	111
		Dump truck	1	110
	7. Cultural heritage storage area	Excavator (tracked)	2	113
		Concrete pump	1	102
		Concrete truck	1	109
		Compressor	1	109
		Mobile crane	1	113
		Welding equipment	1	105
		Vibratory roller	1	109
		Road truck	2	111
	8. Contractor area formalisation	Excavator (tracked)	2	113
		Concrete pump	1	102
		Concrete truck	1	109
		Compressor	1	109
		Mobile crane	1	113
		Backhoe	1	110
		Welding equipment	1	105
		Vibratory roller	1	109
		Road truck	2	111
		Dump truck	1	110
	9. Admin building and social club refurb	Hand tools	1	98
		Flatbed trucks	1	103
		Welding equipment	1	105
		Bobcat	1	98
	10. River Road refurbishment	Excavator	2	113
		Daymaker	2	101
		Pavement profiler	1	117
		Dump truck	2	113
		Front end loader	1	112
		Pavement laying	1	114
		Asphalt truck and	1	106
		Smooth drum roller	1	107
		Water cart	1	107
		Road truck	2	111
		Compactor	1	106

Work Program	Construction Stage	Plant/Equipment	No. of plant/equipment	Total SWL dB(A)
		Backhoe	1	111
		Scraper 651	1	110
	11. Emergency power systems upgrade	Mobile crane	1	113
		Hand tools	2	101
		Welding equipment	1	105
		Bobcat	1	98
Bayswater Ancillary works - Maintenance	1. High pressure pipeline works	Franna crane	1	98
		Bobcat	1	98
		Excavator (12t)	1	101
		Hand tools	1	98
	2. General ongoing maintenance	Hand tools	2	101
		Light vehicles	4	94
		Mini excavator 2t	1	93
		Flatbed truck	1	103
Construction compounds	Continuous operation of construction compounds throughout all construction stages	Flatbed trucks	2	106
		Light vehicles	10	98
		Franna cranes	1	101
		Generator	1	103

5.1.2 Construction staging and plant – Bayswater WOAOW

As the WOAOW project construction programme may operate concurrently with the Project construction program, SWLs from the WOAOW project were also included for this assessment. For modelling purposes, the highest noise emitting construction stage of the WOAOW project was modelled concurrently with each construction stage in **Table 5-1**, and a worst case conservative cumulative noise level was determined at each noise sensitive receiver. The WOAOW project stage with the highest SWL is the ash dam augmentation works and will be undertaken within a large area south of Lake Liddell. This stage of works, along with other WOAOW project stages are presented in **Figure 5-1**. Considering the location of all work stages and the relative SWLs of each stage, the ash dam augmentation works was considered to be the representative worst-case stage to assess cumulative impacts with the Project.

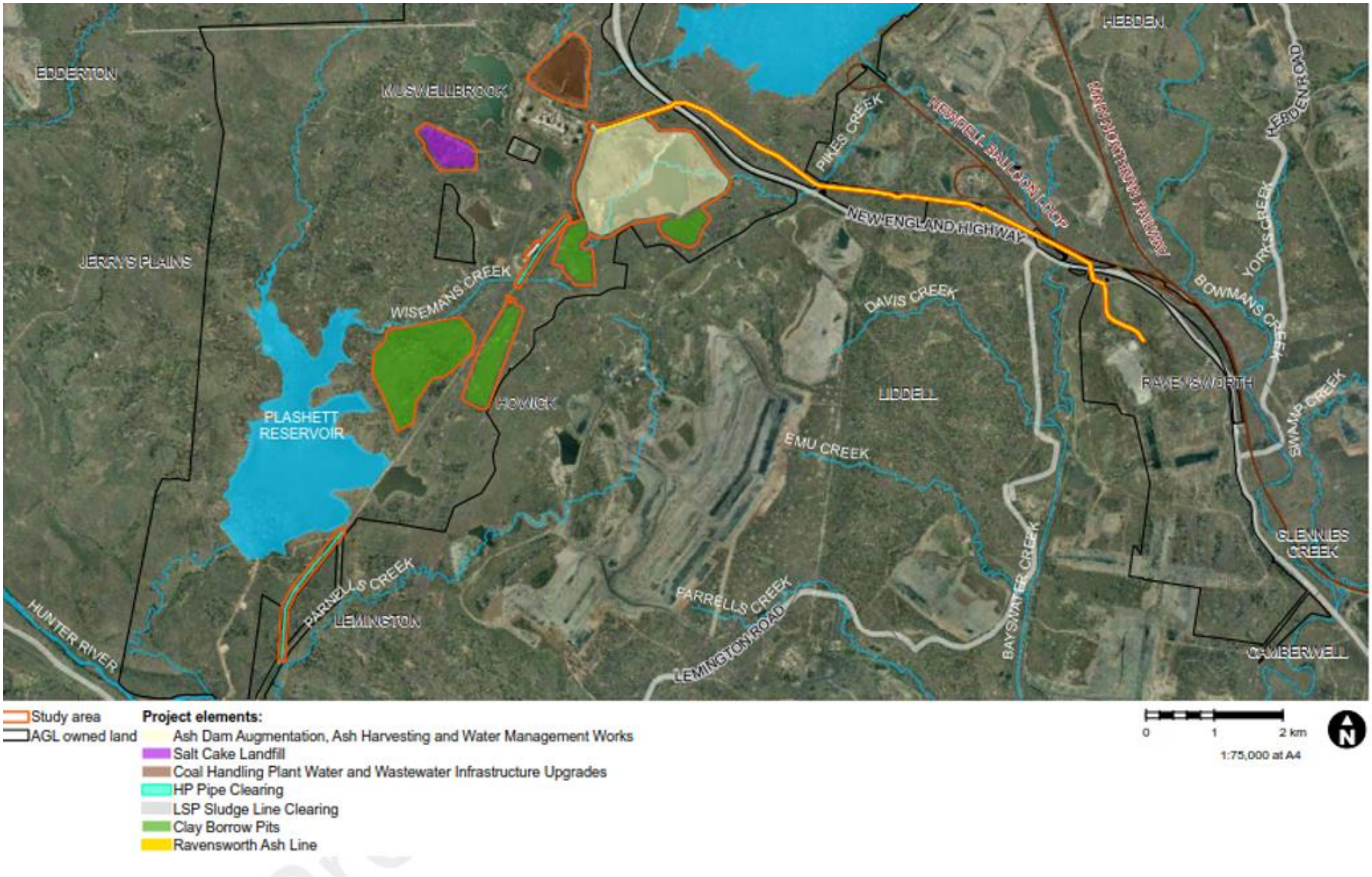

Figure 5-1: WOAOW project elements

The construction stages, plant and equipment and relative SWLs for ash dam augmentation works for the WOAOW project is presented in **Table 5-2**.

Table 5-2: Highest total SWL construction stage during WOAOW project

Construction Stage	Plant/Equipment	No. of plant/equipment	Total Sound Power Level (SWL) dB(A)
1. Ash dam augmentation	Dozer	2	119
	Crane	2	113
	Excavator	2	113
	Excavator mounted breaker	1	112
	Cement truck	1	109
	Truck and dog	4	111
	HIAB	2	108
	Dump truck	2	113
	Lighting towers	2	83
	Water cart	1	107
	Compactor	1	106
	Generator	2	106
	Grader	2	113

5.1.3 Vibration-generating plant and equipment

From the plant and equipment expected to be used during construction, the following have potential for vibration impacts at nearby sensitive receivers.

- Vibratory roller
- Compactor
- Pneumatic hammer.

5.1.4 Construction timings

For this assessment, it has been assumed that construction works will take place during standard hours, evening and night-time as a conservative approach.

5.1.5 Project traffic

The Project would result in additional traffic movements, which could result in additional vehicle-related noise emissions.

During construction, the predicted peak additional traffic flow is as follows:

- Up to around 200 additional light vehicle movements per day
- Approximately 140 additional heavy vehicle movements per day.

No additional operational vehicle movements are considered likely, and so this was not considered further in the assessment.

The WOAOW project would also result in additional traffic movements. The predicted peak additional traffic flow is as follows:

- Up to around 180 additional light vehicle movements per day
- Approximately 150 additional heavy vehicle movements per day.

The predicted peak additional traffic from both projects has been assessed concurrently to determine the cumulative additional vehicle-related noise emissions.

5.2 Operational noise emissions

Once construction is complete, operational noise from the facility will be from the functioning battery and six transformers. Additionally, periodical maintenance activities would result in some operational noise. **Table 5-3** presents the operational noise levels used in this assessment.

Table 5-3: Noise emissions during operations

Operation	Plant/equipment	No. of plant/ equipment	SWL dB(A)
Battery and Decoupling Maintenance	Hand tools	2	101
	Light vehicles	4	94
	Mini excavator 2t	1	93
	Flatbed truck	1	103
Battery Operation	Battery	1	88
	30/330 kV Transformer	6	98

5.3 Noise Assessment Calculator

The RMS Noise Estimator tool (2017) (**Estimator tool**) was used to predict noise levels at each sensitive receiver from construction and operational activities. This Estimator tool uses distance attenuation based on first principles and accounts for basic screening effects using user-specified corrections.

For this assessment, the land use area selected within the tool was 'undeveloped green fields (rural areas with isolated dwellings)', which also represents a semi-industrial, rural representative noise environment with negligible screening between the noise inducing construction activities and sensitive receivers, and stationary operating equipment during battery and transformer operation. Each individual plant and their SWL was entered, as well as the distance between the site and each noise sensitive receiver. Based on these inputs, the Estimator tool provides a predicted total sound pressure level **(SPL)** $L_{Aeq(15\text{-}min)}$ at each sensitive receiver, as well as the total SPL from operations.

6. Assessment of impacts

6.1 Construction noise

Noise levels at sensitive receivers were predicted from cumulative noise generated during each construction stage of the Project combined with ash dam augmentation works from the WOAOW project. Noise levels were not predicted to exceed standard hours, evening hours or night-time NMLs in any stage. **Table 6-1** presents the predicted cumulative noise impact at each noise sensitive residential receiver during each construction stage and **Table 6-2** presents the predicted cumulative noise impact at each non-residential receiver during each construction stage.

As **Table 6-1** shows, noise levels at all residential receivers are predicted to comply with day, evening and night NMLs during each construction stage. Noise levels would be perceived as negligible at all residential receivers during each construction stage.

Section 7 presents the standard mitigation measures recommended as per the RMS CNVG (2017).

As **Table 6-2** shows, noise levels are not predicted to exceed NMLs at any non-residential sensitive receiver. Non-residential receivers R16, R20 and R21 are predicted to encounter noise levels above 20 dB(A) during certain construction stages. However, noise levels still fall well below NMLs.

The construction stage which is predicted to result in the highest noise levels at sensitive receivers is River Road refurbishments, assuming ash dam augmentation works for the WOAOW project is concurrently operating.

Table 6-1: Cumulative construction noise levels at residential sensitive receivers

Receiver		**R01**	**R02**	**R03**	**R04**	**R05**	**R05**	**R07**	**R08**	**R09**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**
Day (standard hours) NML		47	47	47	33	33	33	33	33	33	33	33	47	47	47	33
Day (outside standard hours (NML)		42	42	42	28	28	28	28	28	28	28	28	42	42	42	28
Evening NML		41	41	41	31	31	31	31	31	31	31	31	41	41	41	31
Night NML		41	41	41	33	33	33	33	33	33	33	33	41	41	41	33
Main Works	**Construction Stage**	Predicted noise level $L_{Aeq\ (15\ mins)}$ at receiver														
Battery Works	Site Establishment	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Demolition and deconstruction of existing equipment	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Establishment of hardstand pad and construction laydown areas	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Cut and fill to battery compound	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Structural works to support battery enclosures, inverters, transformers, building and transformer compounds	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Delivery, installation and electrical fit-out of the battery	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Decoupling Works	Trenching and installation of cable from the battery to 330/33 kV transformer compounds	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Delivery installation and fit out of transformers and ancillary equipment for decoupling works	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Finishing works	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Bayswater Ancillary Works	MA1B conveyor shortening	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Environmental improvements	<20	<20	<20	<20	<20	<20	<20	**22**	**23**	**22**	<20	<20	<20	<20	**27**
	Brine concentrator return water pipeline	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Chemical storage tanks upgrade	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Ancillary infrastructure upgrade	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Waste storage area formalisation	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Cultural heritage storage area	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Contractor area formalisation	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Admin building and social club refurb	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	River Road Refurbishment	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Emergency power systems upgrade	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	High pressure pipeline works	<20	<20	<20	<20	<20	<20	<20	**<20**	**<20**	**<20**	<20	<20	<20	<20	**<20**
	Ongoing maintenance	<20	<20	<20	<20	<20	<20	<20	23	25	23	<20	<20	<20	<20	28

Table 6-2: Cumulative construction noise levels at non-residential sensitive receivers

Receiver		R16	R17	R18	R19	R20	R21	R22
Day (standard hours) NML		**60**	**75**	**75**	**75**	**75**	**75**	**75**
Main Works	**Construction Stage**	**Predicted noise level $L_{Aeq\ (15\ mins)}$ at receiver**						
Battery Works	Site Establishment	26	<20	<20	<20	32	34	<20
	Demolition and deconstruction of existing equipment	31	<20	<20	<20	34	34	<20
	Establishment of hardstand pad and construction laydown areas	30	<20	<20	<20	34	34	<20
	Cut and fill to battery compound	31	<20	<20	<20	34	34	<20
	Structural works to support battery enclosures, inverters, transformers, building and transformer compounds	33	<20	<20	<20	36	34	<20
	Delivery, installation and electrical fit-out of the battery	27	<20	<20	<20	33	34	<20
Decoupling Works	Trenching and installation of cable from the battery to 330/33 kV transformer compounds	26	<20	<20	<20	33	34	<20
	Delivery installation and fit out of transformers and ancillary equipment for decoupling works	24	<20	<20	<20	32	34	<20
	Finishing works	<20	<20	<20	<20	30	34	<20
Bayswater Ancillary Works	MA1B conveyor shortening	<20	<20	<20	<20	34	35	<20
	Environmental improvements	<20	<20	<20	<20	33	35	<20
	Brine concentrator return water pipeline	<20	<20	<20	<20	33	34	<20
	Chemical storage tanks upgrade	<20	<20	<20	<20	33	34	<20
	Ancillary infrastructure upgrade	<20	<20	<20	<20	34	35	<20
	Waste storage area formalisation	<20	<20	<20	<20	34	35	<20
	Cultural heritage storage area	<20	<20	<20	<20	34	35	<20
	Contractor area formalisation	<20	<20	<20	<20	34	35	<20
	Admin building and social club refurb	<20	<20	<20	<20	32	34	<20
	River Road Refurbishment	<20	<20	<20	<20	42	40	<20
	Emergency power systems upgrade	<20	<20	<20	<20	33	34	<20
	High pressure pipeline works	<20	<20	<20	<20	33	35	<20
	Ongoing maintenance	<20	<20	<20	<20	<20	<20	<20

6.2 Noise resulting from construction traffic

Existing traffic volumes on New England Highway were obtained from the nearest Transport for NSW (**TfNSW**) permanent count station (ID 6154) located to the north of the project, 1.64 km south of Muscle Creek Road, Muswellbrook. **Table 6-3** presents the average daily traffic count from traffic ID station 6154, between January 2015 and December 2020.

Table 6-3: Average daily vehicle movements TfNSW permanent count station 6154

Vehicle type	Day		Night	
	Northbound	Southbound	Northbound	Southbound
Light	3127	2932	508	758
Heavy	735	753	238	228

During construction of the Project and the concurrent WOAOW project, the combined peak number of light vehicle movements is expected to be 380 per day, and along with 290 heavy vehicle movements per day.

Considering this worst-case estimate of construction vehicle movements per day, using the Estimator tool, it was determined that noise from road traffic would increase by around 0.4 dB(A) during standard hours and by 0.8 dB(A) during night-time works. Therefore, it was predicted that the 2 dB(A) criterion would not be exceeded. Day ($L_{AEq\ 15\text{-}hour}$) and night time ($L_{AEq\ 9\text{-}hour}$) values of 64.7 dB(A) and 63.3 dB(A) were predicted. Although these values exceed the respective 60 and 55 dB(A) from the RNP, since the relative increase was less than 2 dB(A) it was concluded that noise generated from additional traffic during the construction of the Project (including concurrent traffic from the WOAOW project) did not present an issue.

6.3 Sleep Disturbance – Construction

The construction sleep disturbance criteria of 41 dB(A) for the northern residential sensitive receiver group and 40 dB(A) for the southern residential sensitive receiver group is not predicted to be exceeded during any construction stage.

6.4 Operational Noise

Table 6-4 presents the predicted noise levels at residential receivers from the operation of the Battery. This is assuming that construction work for the WOAOW project would be completed before operation activities at the Battery commence.

Table 6-4: Operational noise levels at residential receivers

Receiver	R01	R02	R03	R04	R05	R05	R07	R08	R09	R10	R11	R12	R13	R14	R15
Day (7am-6pm)	**47**	**47**	**47**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**47**	**47**	**47**	**33**
Eve (6pm-10pm)	**41**	**41**	**41**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**31**	**41**	**41**	**41**	**31**
Night (10pm-7am)	**41**	**41**	**41**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**41**	**41**	**41**	**33**
Operation	**Predicted noise level $L_{Aeq\ (15\ mins)}$ at receiver**														
Maintenance	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Battery and 33/330kV transformers operation	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20

Table 6-5 Operational noise levels at non-residential receivers

Receiver	R16	R17	R18	R19	R20	R21	R22
Day (7am-6pm)	**45**	**65**	**65**	**65**	**65**	**65**	**65**
Operation	**Predicted noise level $L_{Aeq\ (15\ mins)}$ at receiver**						
Maintenance	<20	<20	<20	<20	<20	<20	<20
Battery and 33/330kV transformers operation	<20	<20	<20	<20	<20	<20	<20

As presented in **Table 6-4**, there are negligible noise levels predicted at all residential sensitive receivers during proposed operations. Similarly, there are negligible noise levels predicted at all non-residential sensitive receivers during operations as shown in **Table 6-5**.

6.4.1 Meteorological Effects

Certain meteorological conditions can enhance the propagation of noise and their influence is required to be accounted for where they are found to be a feature of the locality. Given the negligible cumulative noise levels predicted from the Project and the WOAOW project, it is unlikely that meteorological conditions will have a significant impact on noise propagation during the construction period and operation of the plant.

6.4.2 Corrections for annoying noise characteristics

The NPI provides corrections where operational noise characteristics are considered 'annoying'. Specifically, if noise carries a tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause a greater annoyance than other noise at the same noise level. To determine whether an annoyance correction is to be applied, a detailed analysis on the sound characteristics of the noise source is required. It is recommended that once a contractor has been confirmed for the transformer, the sound characteristics of the transformer be checked for potential tonality content.

However, given the negligible noise levels predicted during operation of transformers, it may be unlikely that annoying noise characteristics would have an impact on the result of this noise assessment.

6.5 Sleep disturbance – Operational

The sleep disturbance criteria of 41 dB(A) for the northern residential sensitive receiver group and 40 dB(A) for the southern residential sensitive receiver group is not predicted to be exceeded during the operation of the Battery and transformers.

6.6 Vibration

As identified in **Section 5.1.2**, a vibratory roller, compactor and pneumatic hammer would be used during construction, which are considered to be a vibration-generating item of plant. Considering the distances of the nearest sensitive receivers to the construction site is greater than the recommended safe setback distances, it was concluded that vibration impacts would be unlikely.

Archaeological surveys carried out in November 2020 by Jacobs (Liddell Battery and Bayswater Ancillary Works Project - Aboriginal Cultural Heritage Assessment Report) found 13 new sites, along with a previously known large number of sites around the Project area. These sites predominantly consist of isolated items and artefact scatters, and the types of features identified are not susceptible to damage from vibration and are considered not likely to be impacted by any vibration.

7. Mitigation and Management

Consistent with the requirements of the SEARs, this section presents measures to be included in the Project noise management plan. Standard techniques for controlling noise impacts during construction are presented in the ICNG. Controls relevant to the Project have been reproduced below in **Table 7-1**, and should be applied as appropriate.

Table 7-1: Standard measures, noise during construction

Measure	Details	Timing
Time constraints and scheduling	▪ Wherever possible and safe, limit works to standard hours of construction. ▪ Where possible, perform noisy work prior to 11pm. ▪ Limit the completion of out of hours works over consecutive nights.	During construction
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 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
Plan work sites and activities to minimise noise and vibration	• Plan traffic flow, parking and loading/unloading areas to minimise reversing movements.	Prior to and during construction
Minimise disturbance arising from delivery of goods to construction sites	Delivery and loading / unloading of materials should occur as far as possible from sensitive receivers. Select site access points and roads as far as possible from sensitive receivers.	During construction
Monitoring	Complete routine monitoring during construction to evaluate construction noise levels and evaluate whether the mitigation measures in place are adequate or require revision.	During construction

Assessing Vibration: a technical guideline, (DECC, 2006) provides general guidance for limiting vibration impacts during construction. Relevant recommendations have been reproduced in **Table 7-2** and should be considered as appropriate.

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. Avoid the use of vibration intensive plant within the nominated human comfort distances.
Consultation	Informing nearby receivers about the nature of construction stages and the vibration-generating activities.

8. Conclusion

This NVA assessment has been completed to evaluate potential noise and vibration impacts associated with the Project, and the cumulative noise levels from this Project and the WOAOW project. A cumulative assessment has been undertaken as there is uncertainty of construction programmes for both projects, and it may be likely that there is an overlap of schedules.

Noise from construction, construction traffic and operation activities were quantitively assessed using the Estimator tool. Noise levels were evaluated by comparing noise level predictions at surrounding sensitive receivers against criteria developed using measured background noise levels and guidance from the ICNG.

The Estimator tool predicted that noise levels at all residential receivers would comply with NMLs during standard hours, evening and night time construction works for each construction stage. It was also predicted that noise levels at all non-residential receivers would comply with standard hourly construction works for each construction stage. It is therefore concluded that no additional mitigation measures would be required for this Project.

Noise levels from combined additional traffic generated from the Project and the WOAOW project were determined using the Estimator tool. It was determined that cumulative additional traffic noise from construction would be within the criterion of 2.0 dB(A).

Noise levels were not predicted to exceed the sleep disturbance criterion for construction, during any construction phase. Similarly, noise levels were not predicted to exceed the sleep disturbance criteria during the continuous operation of the Battery and transformers once construction is complete.

The operational noise assessment indicated that no additional mitigation measures were required at any surrounding noise sensitive receivers.

Vibration impacts are predicted to be negligible during construction, with vibration levels falling within the setback criteria of 20 m and noise sensitive receivers.

9. References

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