APPENDIX K

Noise and vibration assessment

Wellington South Battery Energy Storage System

Noise and Vibration Impact Assessment

Prepared for AMPYR Australia Pty Ltd

October 2022

Wellington South Battery Energy Storage System

Noise and Vibration Impact Assessment

AMPYR Australia Pty Ltd

J210534 RP7

October 2022

Version	Date	Prepared by	Approved by	Comments
V1	10 May 2022	Carl Fokkema	Najah Ishac	
V2	18 May 2022	Carl Fokkema	Najah Ishac	
V3	3 June 2022	Carl Fokkema	Najah Ishac	
V4	21 October 2022	Carl Fokkema	Najah Ishac	

Approved by

Najah Ishac
Director
21 October 2022

Ground floor 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

TABLE OF CONTENTS

1 Introduction 1

1.1 Overview 1

1.2 The project 2

1.3 Project objectives 2

1.4 The applicant 6

1.5 Key terminology 6

1.6 Purpose of this report 6

1.7 Other relevant reports 7

2 Project description 8

2.1 Overview 8

2.2 Physical layout and design 13

2.3 Construction 17

2.4 Operations 20

3 Existing environment 22

3.1 Noise and vibration assessment locations 22

3.2 Background noise 25

4 Assessment criteria 26

4.1 Operational noise 26

4.2 Construction noise 29

4.3 Construction vibration 31

5 Assessment method 37

5.1 Noise modelling 37

5.2 Construction noise 37

5.3 Construction vibration 40

5.4 Operations noise 41

5.5 Road traffic noise 42

6 Impact assessment 44

6.1 Construction noise 44

6.2 Construction vibration 47

6.3 Road traffic noise 47

6.4 Operational noise 47

6.5 Cumulative operational noise impacts 55

7 **Management of impacts** 56

7.1 Construction 56

7.2 Operational noise and vibration 57

8 **Conclusion** 59

References 60

Abbreviations 61

Glossary 62

Tables

Table 1.1	Summary of SEARs for noise and vibration	1
Table 1.2	Key terminology	6
Table 2.1	Key aspects of the project description	8
Table 2.2	Key project features	13
Table 2.3	Typical construction plant and equipment	19
Table 3.1	Noise assessment locations	22
Table 4.1	Project intrusiveness noise levels	26
Table 4.2	Project amenity noise levels	27
Table 4.3	Project noise trigger levels	27
Table 4.4	Sleep disturbance screening criteria at residences	28
Table 4.5	Significance of residual noise impacts	29
Table 4.6	ICNG construction noise management levels for residences	30
Table 4.7	ICNG noise levels at other land uses	31
Table 4.8	Construction noise management levels – all assessment locations	31
Table 4.9	Peak vibration levels and human perception of motion	32
Table 4.10	Examples of types of vibration	32
Table 4.11	Acceptable vibration dose values for intermittent vibration	33
Table 4.12	Transient vibration guide values - minimal risk of cosmetic damage	34
Table 4.13	Road traffic noise assessment criteria for residential land uses	35
Table 4.14	Road traffic relative increase criteria for residential land uses	36
Table 5.1	Typical construction plant and equipment	39
Table 5.2	Recommended safe working distances for vibration intensive plant	40
Table 5.3	Operational noise source sound power levels	41
Table 5.4	Conditions adopted in the model	42
Table 5.5	Road segments considered in noise assessment	43
Table 6.1	Predicted construction noise levels – Phase 1	44
Table 6.2	Road traffic noise calculations, Day (7am to 10pm)	47
Table 6.3	Predicted operational noise levels – adverse meteorological conditions	48

Table 6.4 Predicted cumulative noise levels 55
Table 7.1 Relative effectiveness of various forms of noise control 57

Figures

Figure 1.1 Regional context 4
Figure 1.2 Local context 5
Figure 2.1 Project overview 12
Figure 3.1 Noise assessment locations 24
Figure 4.1 Graph of transient vibration guide values for cosmetic damage 34
Figure 6.1 Construction noise contours, day, 3m/s wind 46
Figure 6.2 Operational noise contours, day, 40%, 3m/s wind 52
Figure 6.3 Operational noise contours, evening, 40%, 3m/s wind 53
Figure 6.4 Operational noise contours, night, 20%, 3°C/100m temperature inversion 54
Figure G.1 Common sources of noise with levels 64

1 Introduction

1.1 Overview

AMPYR Australia Pty Ltd (AMPYR) and Shell Energy Operations Pty Ltd (Shell) propose to develop and operate the Wellington Battery Energy Storage System (the project). This involves the development of a large-scale battery energy storage system (BESS) with a discharge capacity of 500 megawatts (MW) and a storage capacity of 1,000 megawatt hours (MWh). The project also incorporates an on-site substation and connection infrastructure to facilitate transfer of energy to and from the electrical grid, and ancillary infrastructure. The project is described in detail in Chapter 2.

The site proposed to be developed is located within the Dubbo Regional Council local government area (LGA) at 6773 Goolma Road at Wuuluman NSW, approximately 2.2 km north-east of the township of Wellington and 44 km south-east of the township of Dubbo. The project will be developed within privately owned land (Lot 32 DP 622471) and will incorporate either an overhead or underground transmission line and upgrade works to Wellington substation in the adjoining TransGrid owned landholding (Lot 1 DP 1226751). Physical infrastructure associated with the BESS will occupy an area of approximately 13 ha, however during construction, the project will require a disturbance area of approximately 19 ha. The project is shown in its regional and local context in Figure 1.1 and Figure 1.2, respectively.

The project will complement nearby renewable energy generation assets such as the Wellington Solar Farm and the approved Uungula Wind Farm by smoothing out fluctuations in electricity supply from these new intermittent power sources, in addition to providing grid stability services. In operation, the project will be one of the largest battery projects in NSW and will contribute to the overall storage capacity and reliability of the National Electricity Market (NEM). The project also supports state and Commonwealth emission commitments by facilitating renewable energy input into the grid network during periods of low renewable energy generation.

This noise and vibration impact assessment (NVIA) has been prepared by EMM Consulting Pty Limited (EMM) on behalf of AMPYR and addresses the specific requirements provided in the Secretary's Environmental Assessment Requirements (SEARs) issued by the Department of Planning and Environment (DPE) on 1 October 2021 (SSD-27014706), as summarised in Table 1.1. It supports the environmental impact statement (EIS) and associated application for development consent under Part 4, Division 4.7 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The project is classified as state significant development (SSD) under the EP&A Act.

Table 1.1 Summary of SEARs for noise and vibration

Key issue	Requirements
Noise and Vibration	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.

1.2 The project

The project will involve the following components:

- construction and operation of the BESS compound, comprising between 1,400–6,200 pre-assembled battery enclosures housing lithium-ion battery packs and related control equipment, and transformers and inverters with a peak maximum generation capacity of 500 MW/1,000 MWh;
- construction and operation of an on-site BESS substation, comprising two 330 kilovolt (kV) transformer bays, 33/0.440 kV auxiliary transformers, and an auxiliary services building to house supporting equipment and systems;
- connection to the adjoining TransGrid Wellington substation by way of an underground or aboveground;
- upgrade of the TransGrid Wellington Substation, which may include an additional 330 kV switch bay with power transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), switchyard bench extension to the south of the existing bench and relocation of security fencing; and
- ancillary infrastructure to facilitate construction and operation of the project, including improvements to the existing access road and a control and office building.

Construction of the project is expected to commence in 2023. Construction may be undertaken as a single stage, or over two stages. For the staged construction scenario, Stage 1 would likely include 300 MW installed discharge capacity, all civil and enabling works, installation of batteries, one transformer and switchgear and associated structural, mechanical and electrical works, and connection to the substation. Stage 2 would consist of 200 MW, including installation of a second transformer and associated switchgear and batteries. It is anticipated that construction of Stage 2 would commence approximately 6–12 months following completion of Stage 1 works, with each stage (or construction of the project in a single stage) anticipated to occur over a period of 12–18 months. TransGrid has advised that the Wellington Substation upgrade works may incorporate installation of one new 330 kV switch bay and multiple transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), and may be installed in stages to coincide with the staged construction of the BESS should a staged approach be adopted.

Operation of the project is expected to commence from 2024 for a period of approximately 20 years at which point the project be decommissioned. Throughout its operational life, certain components and technologies may be replaced and/or upgraded, however such works are unlikely to be intensive. The BESS would operate 24 hours a day, 7 days a week and be operated remotely.

1.3 Project objectives

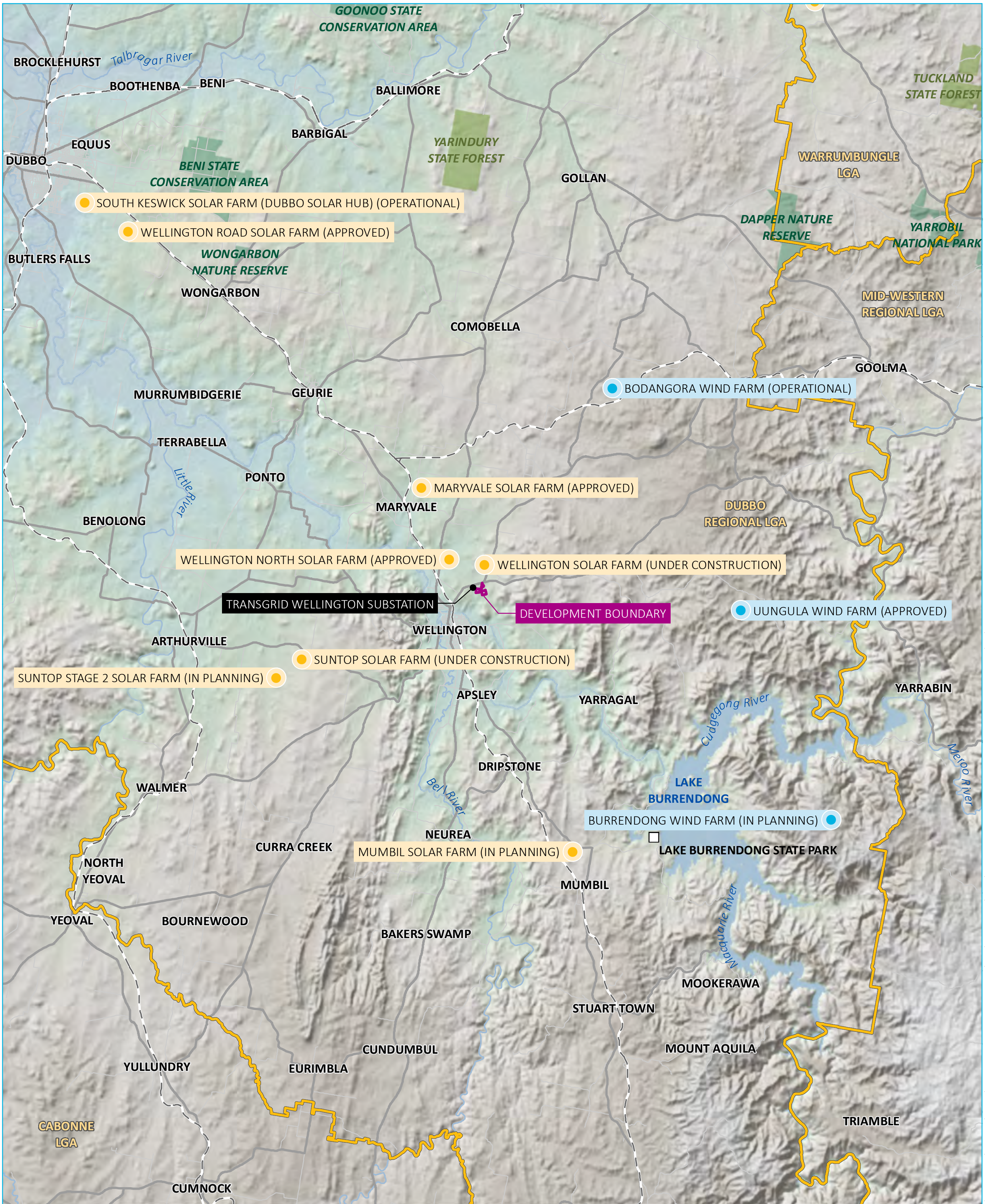
The primary objective of the EIS is to inform the public, government authorities and other stakeholders about the project and the measures that will be implemented to mitigate, manage and/or monitor potential impacts, together with a description of the residual social, economic and environmental impacts.

The project has the following key objectives:

- to support the *NSW Electricity Strategy* (DPIE 2019) and *NSW Electricity Infrastructure Roadmap* (DPIE 2020) by facilitating renewable energy input into the grid network and by contributing to energy storage capacity in NSW;
- to contribute to the overall storage capacity of the NEM and provide greenhouse gas benefits by increasing the surplus of electricity generated from renewable sources that are intermittent (such as solar and wind) and where previously gas-fired generation has supported peak demand;
- to deliver improvements to network reliability by providing back-up power during network disruptions;
- to decrease average prices by smoothing out price differences (ie by arbitraging electricity price differences during peak and off-peak periods); and
- to demonstrate the local application of an emerging technology by an operator with extensive global experience in the technology.

The project will have the following benefits:

- creating around $545 million of initial capital investment into local and regional economies and further benefits to local businesses and the local community during the 30 year operation of the project; and
- generation of up to 100 jobs during construction, the majority of which are likely to be sourced from the Dubbo Regional LGA.



\\emmsvr1\EMM3\2021\J210534 - Wellington BESS\GIS\02_Maps_EIS\EIS001_RegionalLocation_20221020_09.mxd 20/10/2022

Source: EMM (2022); DPIE (2022); DFSI (2017); GA (2011); ASGC (2006)

0 10 20 km

GDA 1994 MGA Zone 55 N

KEY

- Development boundary
- Lake Burrendong State Park
- Rail line
- Major road
- Minor road
- River
- Named waterbody
- Local government area
- NPWS reserve
- State forest

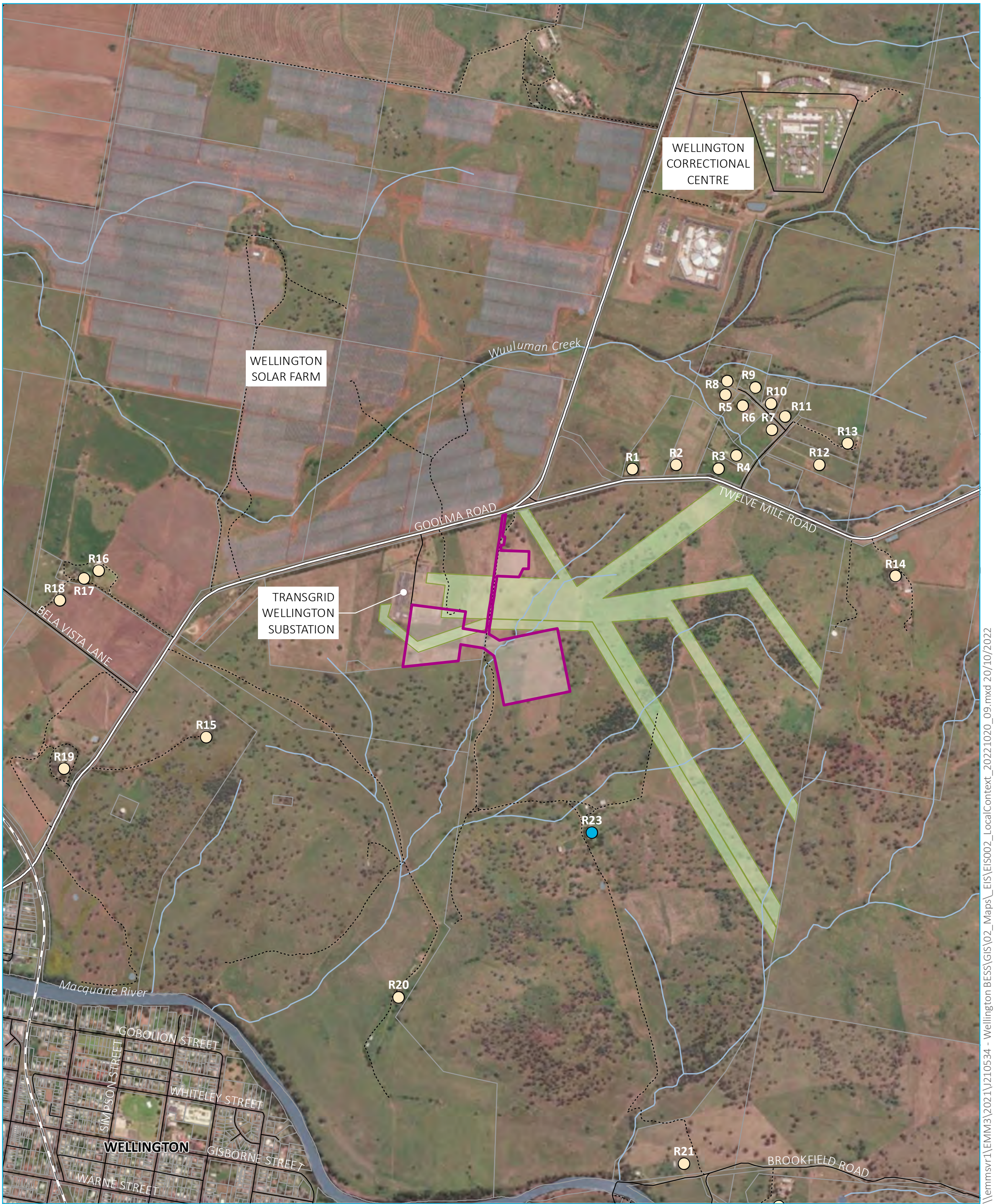
Renewable energy project

- Solar farm
- Wind farm

Regional context

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 1.1

EMM
creating opportunities



Source: EMM (2022); AMPYR (2021); ESRI (2021); DFSI (2017); ICSM (2014)

KEY

Development boundary
Rail line
Major road
Minor road
Vehicular track
Watercourse/drainage line
Waterbody
Cadastral boundary
Freehold easement
Receivers
Non-project residential receivers
Project participating landowner

Local context

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 1.2

EMM creating opportunities

1.4 The applicant

AMPYR is wholly owned by AGP Sustainable Real Assets, an asset management group that finances, develops and operates sustainable real assets with an aim to drive a net zero greenhouse gas emissions future.

AMPYR's team has over 10 years' experience developing renewable energy projects, mostly large-scale on-shore wind and solar but also including battery storage and hydroelectricity. AMPYR is presently developing five battery storage facilities internationally with a combined capacity of up to 1190 MW (AMPYR 2022).

AMPYR has partnered with Shell Energy Operations Pty Ltd (Shell) to deliver the project.

1.5 Key terminology

For the purposes of this NVIA, the following definitions have been adopted and are referred to in Figure 1.1 and Figure 1.2 and throughout the NVIA.

Table 1.2 Key terminology

Terminology	Description
The project	The Wellington Battery Energy Storage System. This refers to all elements, including associated ancillary infrastructure and connection/augmentation works at the TransGrid Wellington Substation, that comprise the project for which approval is sought.
Development boundary	The extent of the project site including permanent infrastructure and temporary construction surface disturbance required to facilitate the construction of the project
TransGrid Wellington Substation	The 330/132kV substation operated by TransGrid and located at 6909 Goolma Road in Wuuluman.
BESS compound	The portion of the project footprint dedicated to containing battery enclosures and ancillary infrastructure such as the control and office building. The compound will be surrounded by security fencing and accessed from the existing driveway via Goolma Road.
BESS substation	The portion of the project footprint dedicated to the on-site substation. The substation will convert electricity between the high voltage transmission network and medium voltage BESS compound.

1.6 Purpose of this report

This NVIA supports the EIS for the proposed battery energy storage system (BESS). It documents the existing noise environment, applicable impact assessment criteria, source of noise and vibration, noise modelling of operational and construction activities including traffic and assessment of predicted impacts relative to criteria.

This NVIA consists of the following sections:

- a description of the local setting and surrounds of the site;
- a description of the existing environment, including existing noise environment;
- a list of plant and equipment adopted for noise modelling of construction and operation of the proposed BESS;
- noise modelling of operational and construction noise emissions including noise enhancing meteorological scenarios;

- assessment of road traffic noise as a result of construction related vehicles on public roads; and
- an overview of compliance, noise mitigation measures and residual impacts where relevant.

The NVIA has been prepared in general accordance with the guidelines specified in:

- NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry;*
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP);
- NSW Department of Environment and Conservation 2006, *Assessing Vibration: a technical guideline;*
- NSW Department of Environment Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- Australian and New Zealand Environment Council 1990, Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration;
- BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2";
- British Standard 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz); and
- German Standard DIN 4150 Part 2 1975.

1.7 Other relevant reports

This NVIA has been prepared with reference to other technical reports that have been prepared in support of the Wellington BESS EIS. The other relevant report referenced in this NVIA is the Traffic Impact Assessment (EMM 2022), appended to the EIS.

2 Project description

2.1 Overview

The project consists of the construction and operation of a major grid-scale battery project immediately south-east of the TransGrid Wellington Substation. The project will use lithium-ion battery technology and will have a peak maximum generation capacity of 500 MW/1000 MWh.

A summary of the key aspects of the project is provided in Table 2.1. A more detailed description for the project is provided in this chapter. The works described in these sections are subject to detailed design.

Table 2.1 Key aspects of the project description

Key aspects	Description
Project area	
Address and legal description	6773 Goolma Road, Wuuluman (battery energy storage system and transmission line) described as Lot 32 DP 622471 and 6909 Goolma Rd, Wuuluman (transmission line and Wellington substation upgrade) described as Lot 1 DP 1226751.
Development boundary/disturbance area	Disturbance area of approximately 19 ha during construction (see Figure 2.1).
Operational footprint	Operational footprint including permanent infrastructure of approximately 13 ha (see Figure 2.1).
Environmental constraints near the project area	The following constraints are present within the site: • nearby sensitive receivers, the closest of which being a resident along Twelve Mile Road, approximately 600 m north-east of the site; • the presence of a tributary to Macquarie River and associated riparian vegetation; • the presence of native vegetation and its associated ecosystem and species values; and • a portion of the site is within a designated bushfire prone area. The project has been designed to avoid these constraints (refer Figure 2.1).
Physical layout and design	
Layout	The proposed BESS will generally comprise the following components: • lithium-ion (Li-ion) batteries inside battery enclosures; • power conversion systems (PCS) incorporating inverters and transformers; • an aboveground or underground transmission line to the TransGrid Wellington substation; • an on-site substation comprising two 330 kilovolt (kV) transformer bays; • cabling and collector units; and • an Asset Protection Zone (APZ). The project layout showing these components is presented in Figure 2.1.

Table 2.1 Key aspects of the project description

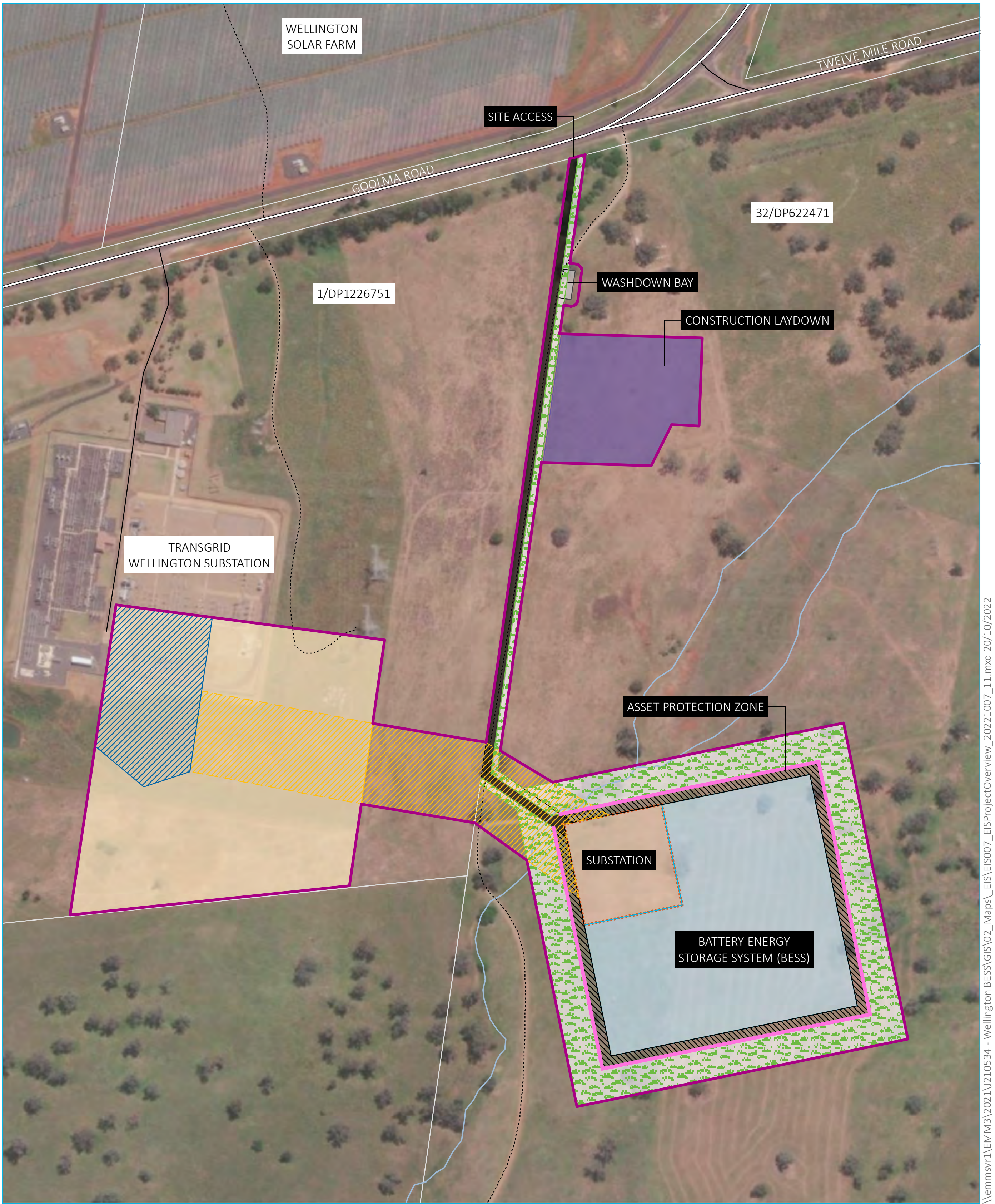
Key aspects	Description
Ancillary infrastructure and upgrades	The project will include the following ancillary components and upgrades: • an upgrade to the existing site access (currently at the intersection of Goolma Road and Twelve Mile Road) to facilitate safer connection to roadway network and to facilitate the entry of larger construction vehicles; • upgrades to existing access tracks within the project boundary; • connection to the switchyard in adjoining TransGrid Wellington substation; • upgrade of the TransGrid Wellington Substation, which may include an additional 330 kV switch bay with power transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), switchyard bench extension to the south of the existing bench and relocation of security fencing; • control and office building and associated parking; • drainage and stormwater management; • ancillary infrastructure including security fencing, lighting and closed-circuit television; and • connection to utilities (telecom, water, etc). The project layout showing ancillary infrastructure and upgrades in Figure 2.1.
Built design, materials and finishes	Project enclosure components and cabinets will be light in colour to assist with heat management and made of steel. The control and office building will be a prefabricated building comprising a lunch room, office and ablutions room. The building will be assembled onsite and built to a height of 5 m tall. The building will be made of Trimclad steel or similar and grey in colour. Upgrade of the Wellington substation will comprise an extension to the existing infrastructure elements on that site.
Design elements subject to change during detailed design	Detailed design for the project has yet to be completed. The following design elements may be amended throughout the detailed design process: • the layout of the BESS units and substation infrastructure; • the transmission line alignment and arrangement (ie either above ground on steel lattice tension structures and poles or underground); • the control and office building (material, finishes); • works at the TransGrid Wellington substation and switchyard to accommodate project connection; and • the location of attenuation features (noise wall/bunds) and fencing.
Plans and figures illustrating the layout and design in plan-view and cross section	An overview of the project layout is provided in Figure 2.1.
Specifications	
Discharge capacity	Up to 500 MW.
Storage capacity	Up to 1,000 MWh or two hours of maximum discharge capacity.
Typical operating cycle	One to two cycles per day.
BESS compound components	Specific component requirements are subject to selection of the potential technology provider. The BESS compound will comprise: • 1,400–6,200 pre-assembled battery enclosures incorporating power conversion systems, thermal management systems, and safety systems; • 150–300 inverters/transformers; and • ancillary infrastructure (eg electrical switchroom, a control and office building, security fencing). Battery enclosures would be 3 m tall.

Table 2.1 Key aspects of the project description

Key aspects	Description
BESS substation components	An on-site substation will comprise: • two 330 kV transformer switch bays; and • 33kV indoor switchgear housed in portable substation containers. The tallest component of the substation would be the tips of bushings, approximately 11 m tall, however the bulk of the unit would be 9 m tall.
Connection infrastructure	An approximate 500 m 330 kV transmission line will extend from the BESS substation. TransGrid has advised that the Wellington Substation upgrade works may incorporate installation of one new 330 kV switch bay and multiple transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), and may be installed in stages to coincide with the staged construction of the BESS should a staged approach be adopted.
Construction	
Capital investment value	$545 million AUD.
Construction activities	Construction of the project would involve: • civil and enabling works; • structural, mechanical and electrical works; • commissioning; and • demobilisation. The project is anticipated to take approximately 12 months to construct. Construction of the project will require an area of approximately 19 ha to facilitate the movement of plant and equipment (disturbance footprint). This area is illustrated in Figure 2.1. The area also incorporates a temporary laydown zone near the site access for the storage of materials and infrastructure prior to installation.
TransGrid connection works	The project will connect to the TransGrid Wellington substation switchyard either via overhead or underground cables extending from the on-site substation. TransGrid has advised that the Wellington Substation upgrade works may incorporate installation of one new 330 kV switch bay and multiple transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), and may be installed in stages to coincide with the staged construction of the BESS should a staged approach be adopted.
Construction workforce	The project will create up to approximately 100 construction employment opportunities, many of which are expected to be sourced from the Dubbo region and other surrounding regional areas.
Construction scheduling	Construction of the project would be undertaken over a minimum of 8 months and up to a maximum of 12–18 months under normal circumstances. There is the potential for the project to be constructed in two stages. Stage 1 (300 MW) would be constructed followed by Stage 2 (200 MW) 6-12 months after the completion of Stage 1. With total construction period for each stage anticipated to be 12–18 months.
Construction hours	Construction of the project would be undertaken in accordance with the recommended standard hours as defined by the *Interim Construction Noise Guideline* (DECC 2009), being: • Monday to Friday: 7.00 am to 6.00 pm; • Saturday: 8.00 am to 1.00 pm; and • no works of Sunday and Public Holidays. Some exceptions may be made for low impact works and extraordinary circumstances.

Table 2.1 Key aspects of the project description

Key aspects	Description
Vehicle movements	The following maximum vehicle movements are predicted (subject to detailed design): • an average of up to 100 passenger vehicles per day (100 in and 100 out) during the construction works phase; • an average of up to 60 heavy vehicles per day (60 in and 60 out) during the construction works phase; and • up to 20 oversize over mass (OSOM) vehicle deliveries during the construction works phase.
Transport	Project components (batteries, enclosures, PCS components and substation components) will be transported to the site from Sydney/Newcastle via the Mitchell Highway and Goolma Road, an approved B-double route. Construction materials sourced from surrounding concrete batching plants and hard rock quarries. Construction labour, equipment and plant would likely be sourced from Dubbo and other surrounding regional centres.
Water demand	Water used directly on site for construction is estimated at 10 mega litres (ML) used predominantly for dust suppression purposes. Water sources will be confirmed during detailed design but are likely to include a combination including from bore water located on the participating landholder's land, municipal water supply (in agreement with the relevant authority) and/or imported water in portable tanks.
Operation	
Operational activities	Operation of the project would involve: • maintenance and cleaning of equipment; • general office activities; and • waste removal.
Operational employment	The project will contribute to the employment of two employees during operation.
Operational life expectancy	The BESS is expected to operate for 20 years. At the end of operational life, this may be extended subject to the replacement of components.
Operational hours	The BESS would operate 24 hours a day, 7 days a week and be operated remotely.
Vehicle movements	Up to 4 trips per day (4 in-bound and 4 out-bound), compromising: • staff vehicles up to 3 per day (3 in-bound and 3 out-bound); and • heavy vehicles up to 1 per day transporting replacement parts and equipment as required. Vehicle movements to and from the project site will occur infrequently during operations, primarily for scheduled maintenance.
Decommissioning	
Decommissioning timing	At the end of the operational life of the BESS. The project will either be replaced and upgraded or rehabilitated with built infrastructure removed from the site.
Decommissioning works	Works undertaken during decommissioning would not exceed intensity associated with construction works and is expected to take up to 8 months.



Source: EMM (2022); AMPYR (2022); ESRI (2022); DFSI (2017); ICSM (2014)

0 100 200 m
GDA 1994 MGA Zone 55
N

KEY

Development boundary

Project components

- Indicative asset protection zone (10 m)
- Indicative transmission connection corridor
- Indicative TransGrid substation upgrade core infrastructure area
- Indicative TransGrid substation upgrade disturbance area
- Battery Energy Storage System (BESS) (battery rows offset at 6 m spacing and setback from substation)
- Substation
- Washdown bay
- Construction laydown
- Indicative landscaping (post construction)
- Access road
- Indicative location of noise bund

Existing environment

- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Cadastral boundary

Project overview

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 2.1

EMM
creating opportunities

2.1.1 Concept design

The project is subject to detailed design. Aspects of the project (including the siting of project elements and construction methodology) are subject to change during detailed design process. This EIS is based on consideration of reasonable worst case environmental impacts to allow flexibility in design and construction methodology.

2.1.2 Project area and location

The project will be developed within privately owned Lot 32 DP 622471 and will incorporate either an overhead or underground transmission line and upgrade works to Wellington substation in the adjoining TransGrid owned landholding (Lot 1 DP 1226751). The Wellington Substation is located approximately 300 m west of the proposed location of the BESS substation.

Lot 32 DP 622471 is proposed to be subdivided from the remainder of the landholding which will continue to use for grazing and agricultural purposes.

The 'project area' referenced throughout this report comprises the development boundary, along with the minor additional impact area associated with proposed site access and road upgrade works as recommended in the traffic impact assessment report (refer Appendix L of the EIS) as shown in Figure 1.2.

2.2 Physical layout and design

2.2.1 The BESS compound

The project team has engaged with the supply chain and conducted a preliminary tender process with technology suppliers and has undertaken a formal technology review initially focused on technical inverter capabilities. Concept designs from numerous suppliers have been relied upon to develop this project description and in some cases, ranges have been provided to allow for different equipment options under consideration. Detailed design of the project will be conducted following contractor selection to allow sufficient flexibility in the selection of technology. This approach will allow the project to maximise potential benefits from the rapid technology advancements currently underway in the BESS industry. Key design features of the BESS are provided in Table 2.2.

Table 2.2 Key project features

Feature	Parameter
Power output	500 MW
Energy storage capacity	1,000 MWh
Transmission voltage	330 kV
Charge and discharge cycle	365 days per year and 1–2 cycles per day
Design life	20 years (subject to component replacement and life extension)

The BESS compound is proposed to be developed within a footprint immediately south-east of the TransGrid Wellington substation and shown in Figure 2.1.

The project will comprise up to 1,400 to 6,200 battery enclosures. The exact number of enclosures required will be subject to the technology provider selected. The largest enclosure type would be 2.5 x 2.5 x 3 m (length x width x height).

Battery enclosures will be arranged in rows and comprise:

- racks of lithium-ion type batteries;
- a battery management system to protect cells from harmful excesses of voltage, temperature, and current;
- an energy management system which is responsible for system power flow control; and
- a thermal management system which controls all functions related to the heating, ventilation, and air-conditioning of the enclosure system.

Battery enclosures will be integrated with a power conversion system (PCS). A PCS will contain equipment such as inverters and transformers and will function to convert the power flow between battery and grid. The PCS will also house the required control and monitoring components such as voltage sensing units and thermal management of power electronics components.

The BESS compound will be supported by ancillary infrastructure, including:

- electrical switchrooms;
- a control and office building and associated parking for operational staff and visitors;
- connection to utilities (telecom, water, etc);
- drainage and stormwater management;
- lighting;
- closed-circuit television cameras (CCTV); and
- security fencing.

A single-storey control and office building would be established during construction and kept for the duration of operation to allow for remote operation and facility management.

Battery units would be up to 3 m in height and arranged in rows across the BESS compound area. Batteries will be arranged in groups and mounted on concrete footings or potentially compacted gravel.

The compound will be surrounded by security fencing and accessed from the existing driveway via Goolma Road.

2.2.2 BESS substation

A substation will be established within the site to convert electricity between the high voltage transmission network and medium voltage BESS compound. The substation would be within an indicative footprint of approximately 100 m x 100 m and established on a concrete pad. The substation would be separated from BESS compound infrastructure by security fencing and an asset protection zone. The BESS substation will comprise up to two 330 kilovolt (kV) transformer bays. Transformer bays will be bunded and subject to separation distances in accordance with manufacturer requirements. The BESS substation will also include:

- an auxiliary services building to accommodate secondary protection systems, AC/DC distribution equipment, fire detection systems, a supervisory control and data acquisition (SCADA) system, system dispatch control, CCTV, and intrusion detection;
- 33/0.440 kV auxiliary transformers;

- high voltage connections between switchgear; and
- other ancillary components including security fencing, lightning protection, lighting poles, security poles and cabling.

The BESS substation will connect to BESS infrastructure by way of underground 33 kV cables.

2.2.3 Network connection

The project will connect to the adjoining TransGrid Wellington Substation by way of a 330 kV cable. The following infrastructure is required to connect the battery to the grid:

- medium voltage electrical reticulation to allow the delivery of electricity from the point of connection;
- 33/330kV transformer(s);
- an overhead or underground tie-in to the TransGrid Wellington substation; and
- protective equipment and connection infrastructure at the switchyard within the TransGrid Wellington substation.

The transmission line would extend approximately 500 m from the BESS substation and if overhead, will be strung on two 330 kV double circuit steel lattice tension structures with 330 kV steel pole terminal structures. The transmission line will require the establishment of an easement up to 60 m wide.

i TransGrid switchyard works

The project is proposing to connect into the existing, neighbouring TransGrid switchyard. The required upgrade works on the TransGrid site are subject to detailed design, but are expected to require the connection of overhead or underground conductors and an additional 330 kV switch bay with power transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), and may be installed in stages to coincide with the staged construction of the BESS should a staged approach be adopted. The work will include:

- switchyard bench extension to the south of the existing bench;
- relocation of security fencing;
- may include construction of new 330 kV gantry columns and beams, three phase busbar supports, single phase busbar supports, three phase disconnectors, three phase circuit breaker, single phase current transformers, single phase voltage transformers, single phase surge arresters; and
- overhead or underground cables as required for the new 330 kV switch bay.

2.2.4 Control and office building

A control and office building will be established within the BESS compound. The building will be established during construction and maintained throughout the project's operational life. The control and office building will be a prefabricated building comprising a lunch room, office and ablutions room and involve the following equipment:

- a power plant controller which will be used to dispatch the BESS in accordance with instructions received from the supervisory control and data acquisition (SCADA) system;
- a remote terminal unit which will marshal all digital and analogue signals originating within the BESS equipment for communication via the SCADA system;

- high resolution power monitoring equipment which will monitor the output voltages, currents, power and reactive power of the BESS;
- AC and DC auxiliary power distribution boards;
- 330/33 kV transformer protection systems;
- 330 kV protection necessary for the 330 kV cabling, overheads, switchgear and busbars;
- 33 kV protection of the cabling between the 330/33 kV transformers and the 33kV switchgear substation buildings;
- ventilation and air conditioning systems; and
- fire detection and fire suppressant systems.

The building will be assembled onsite and built to a height of 5 m tall. The building will be built of Trimclad steel or similar and grey in colour.

2.2.5 Utilities and services

Power and telecoms will be established as part of the construction of the transmission line system. Auxiliary power shall be sourced from 33/0.440 kV station auxiliary transformers. The main AC distribution board shall be housed in the control and office building. Each of the 33 kV switchgear rooms will house their associated AC distribution boards.

Protection and control systems will be supplied by duplicate DC auxiliary supplies and associated station batteries. The main DC distribution boards will be housed in the control and office building and each of the 33 kV switchgear rooms will house their associated DC distribution boards.

Water source(s) will be confirmed during detailed design but may involve municipal water supply, local bore water supply and/or imported water.

Sewerage will be managed via a septic tank system and involve routine pump out.

2.2.6 Access and internal road network

Plant, equipment, and materials will be transported to the main construction area via a new access off Goolma Road and realignment an existing internal access road into the site. This road will be improved to facilitate the access and egress of larger trucks during construction. Improvements would include gravel coverage, widening to 8 metres and additional drainage as required. The road will be maintained during operation to allow for the access and egress of maintenance and operational vehicles to batteries and control and office building.

2.2.7 Design elements subject to change during detailed design

Flexibility is required in the siting of certain components of the project (in particular batteries and cabling) in order to:

- minimise the need for cut and fill;
- avoid sensitive areas of biodiversity; and
- accommodate changes in technologies and/or plant depending on availability.

Notwithstanding these potential changes to design, the project will continue to be entirely within the development boundary (Figure 2.1).

2.3 Construction

2.3.1 Construction activities

Key construction activities that will be undertaken as a part of the proposed BESS will comprise:

- installation and maintenance of environmental controls including drainage and sediment controls;
- mobilisation and establishment of temporary construction facilities and temporary laydown area;
- improvements to existing access and internal track;
- vegetation clearing to accommodate BESS compound infrastructure, the transmission line easement and asset protection zones;
- cut, fill, and compaction activities to desired design levels;
- installation of drainage including a consideration of diverting the tributary waterway beneath a section of the project access way;
- construction of concrete pads to support batteries, PCSs, and substation;
- delivery and installation of battery modules and enclosures, power conversion systems, cabling, and transformers;
- installation of tower structures including foundation piles;
- installation of overhead or underground cabling from the BESS substation to the TransGrid substation switchyard;
- relocation of existing security fencing around the TransGrid substation switchyard;
- switchyard bench extensions to the south of the existing bench of the TransGrid substation switchyard;
- construction of new 330 kV gantry columns and beams, three phase busbar supports, single phase busbar supports, three phase disconnectors, three phase circuit breaker, single phase current transformers, single phase voltage transformers, single phase surge arresters;
- installation of overhead cables as required for the new 330 kV switch bay;
- connection works to connect to the TransGrid substation;
- landscaping;
- testing and commissioning; and
- removal of construction equipment and rehabilitation of disturbance areas.

2.3.2 Construction program

Construction is expected to commence in May 2023 (subject to approvals and market conditions). The project will be constructed and commissioned in line with battery supply availability, labour and equipment availability and increasing demand in the network. This may occur in a single stage over a period of 12–18 months. Alternatively, it is considered likely that it may occur over two stages as follows:

- Stage 1 – commencement of construction May 2023 and operations May 2024; and
- Stage 2 – commencement of construction November 2024 and operation November 2025.

Construction of the project, or each stage of it, would be undertaken in four phases, as follows:

- enabling works (ie site establishment) – approximately 2–4 months;
- construction works (civil works, structural works, and electrical works) – approximately 5–8 months;
- commissioning – approximately 4–5 months; and
- demobilisation – approximately 1 month.

For the staged construction scenario, Stage 1 would likely include 300 MW installed discharge capacity, all civil and enabling works, installation of batteries, one transformer and switchgear and associated structural, mechanical and electrical works, and connection to the substation. Stage 2 would consist of 200 MW, including installation of a second transformer and associated switchgear and batteries.

TransGrid has advised that the Wellington Substation upgrade works may incorporate installation of one new 330 kV switch bay and multiple transformers (which would be installed as an alternative to the transformer bays being located on the BESS site), and may be installed in stages to coincide with the staged construction of the BESS should a staged approach be adopted.

2.3.3 Construction hours

Construction hours for the project will be consistent with the *Interim Construction Noise Guideline* (DECC 2009) recommended standard construction hours for normal construction, namely:

- Monday to Friday: 7.00 am to 6.00 pm;
- Saturday: 8.00 am to 1.00 pm; and
- no works of Sunday and public holidays.

Certain activities may be required outside of the standard construction hours. These activities potentially include:

- delivery of plant and equipment for safety reasons (eg oversize overmass vehicles);
- commissioning and testing activities that must align with demands on the grid; and
- situations where agreement is reached with nearby affected receivers and local council.

2.3.4 Construction workforce

The construction phase of the project is expected to generate up to 100 construction personnel, the majority of which are expected to be generated in the Dubbo/Wellington region. Preference will be made for contractors utilising a regional workforce.

2.3.5 Plant and equipment

The typical plant and equipment required for construction will include items listed in Table 2.3.

The majority of the plant and equipment will be delivered to site on rigid and semi-trailer low-loaders. Construction materials will be delivered on rigid concrete agitators, truck and dog, and semi-trailer dump trucks.

Table 2.3 Typical construction plant and equipment

Construction phase	Plant type
Enabling works	• Front end loaders • Dump trucks • Road trucks • Water trucks • Excavators • Graders • Compactors and rollers • Light vehicles • Scissor lifts • Franna cranes
Construction and commissioning works	• Front end loaders • Dump trucks • Road trucks • Water trucks • Concrete trucks and pumps • Excavators • Graders • Compactors and rollers • Scrapers • Backhoe • Concrete saws and grinders • Light vehicles • Scissor lifts • Franna cranes • Mobile cranes • Generators • Welding equipment • Compressors
Commissioning	N/A
Demobilisation	• Road trucks • Water trucks • Concrete saws and grinders • Excavators • Franna cranes • Backhoes • Compactors and rollers

2.3.6 Construction materials

Construction materials would be sourced locally where practicable. The following indicative volumes of materials are likely to be required for the construction of the project:

- approximately 220 tonnes (t) of structural steel;
- approximately 5,000 cubic metres (m^3) of concrete;
- cabling (quantity and mass subject to detailed design);
- prefabricated enclosures and buildings; and
- sand (for cable bedding), gravel, and bitumen (quantities subject to detailed design).

Approximately 10 ML of water will be required during construction and sourced either from bore water located on the participating landholder's land, municipal water supply (in agreement with the relevant authority) and/or imported water in portable tanks.

2.3.7 Construction traffic

The following peak construction vehicle movements are anticipated:

- up to 100 passenger vehicles per day (100 in and 100 out) during the construction works phase;
- up to 60 heavy vehicles per day (60 in and 60 out) during the construction works phase; and
- up to 20 oversize overmass (OSOM) vehicles during the entire construction works phase.

Average daily heavy vehicle movements would be significantly lower as delivery of enclosures is anticipated to occur in batches.

Passenger vehicles are expected to arrive at the site prior commencement of construction shifts. Construction vehicles are anticipated to be primarily via regional centres including Dubbo/Wellington (60%) and Gulgong (40%) and are anticipated to travel to the site via the Mitchell Highway and Goolma Road (west) and Goolma Road (east), respectively.

Heavy vehicle movements, particularly those associated with the delivery of materials and equipment will generally be evenly spread throughout construction hours. Most heavy vehicles are anticipated to be via Sydney/Newcastle and surrounding regional centres (60%). Some heavy vehicles will also originate from Dubbo, Orange, and Parkes (40%). Vehicles travelling from Sydney and Newcastle are anticipated to travel to site via the Castlereagh Highway and Goolma Road (east), an approved B-double route. Other vehicles are anticipated to access the site via the Mitchell Highway and Goolma Road (west).

OSOM vehicle movements will occur outside of standard construction hours and are anticipated to be wholly via Sydney/Newcastle and are anticipated to travel to site via the Castlereagh Highway and Goolma Road (east) route.

2.4 Operations

The BESS would operate 24 hours a day, 7 days a week and be operated remotely. The BESS is expected to undergo one to two full cycles of charging and discharging per day.

Regular maintenance activities will be required throughout the project’s operational life. This maintenance may potentially include the replacement of BESS components. Light vehicles will access the site throughout the operations phase for maintenance activities. Heavy vehicles may also occasionally access the site to replace larger components as necessary.

Over the operational life of the project components may be upgraded. These works, if required, would not be intensive and are likely to be significantly lower than the construction works assessed in this EIS. Upgrade works may also provide additional generation capacity without increasing the disturbance area associated with the project.

The operation of the project is expected to commence from 2024 for a period of approximately 20 years. Once the project reaches the end of its investment and operational life, the project infrastructure will be decommissioned and the project site area returned to its pre-existing land use, namely suitable for grazing of sheep and cattle, or another land use as agreed by the project owner and the landholder at that time.

The project would contribute to the employment of up to two employees during operation.

3 Existing environment

The site surrounds accommodate a variety of rural and agricultural, whilst the TransGrid switchyard is located to the west of the proposed development site. Ambient noise levels would be control by natural elements and limited human activity including traffic and other activities.

3.1 Noise and vibration assessment locations

The nearest representative noise sensitive locations to the proposed BESS have been identified for the purpose of assessing potential noise and vibration impacts. Details are provided in Table 3.1 and their locations are shown in Figure 3.1. Note that R23 is a project related residence and comprises a homestead and cottage. They are referred to in this report as assessment locations.

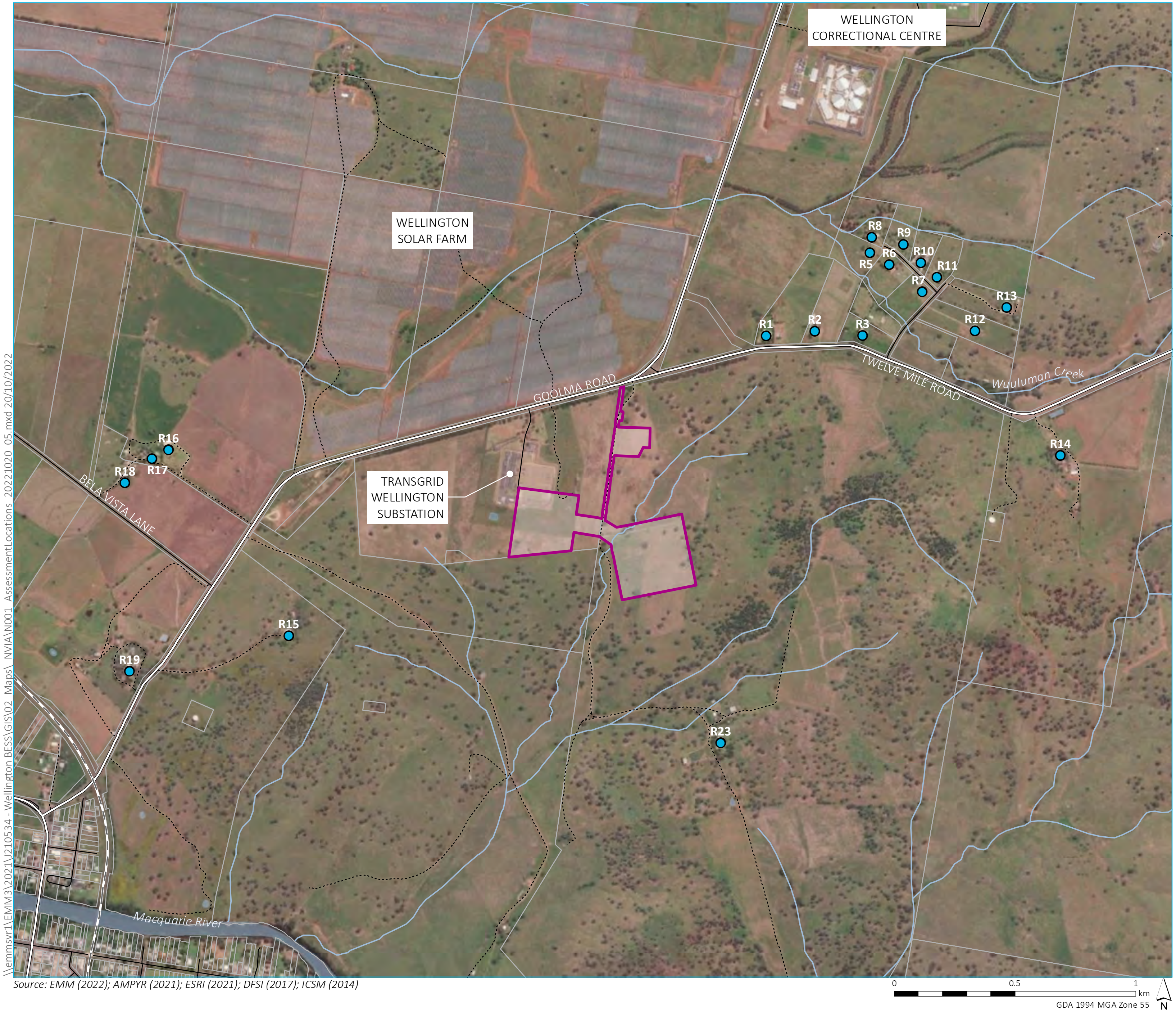
Table 3.1 Noise assessment locations

ID	Classification	Easting	Northing	Distance to site (m)
R1	Residential	685376	6400020	569
R2	Residential	685577	6400039	766
R3	Residential	685775	6400022	954
R4	Residential	685856	6400083	1,047
R5	Residential	685806	6400364	1,105
R6	Residential	685886	6400314	1,153
R7	Residential	686022	6400202	1,239
R8	Residential	685814	6400428	1,144
R9	Residential	685945	6400399	1,243
R10	Residential	686017	6400322	1,277
R11	Residential	686083	6400263	1,317
R12	Residential	686241	6400040	1,414
R13	Residential	686372	6400138	1,562
R14	Residential	686594	6399526	1,624
R15	Residential	683401	6398779	1,133
R16	Residential	682904	6399549	1,517
R17	Residential	682836	6399514	1,579
R18	Residential	682724	6399412	1681
R19	Residential	682743	6398633	1,792
R20	Residential	684293	6397576	1,492
R21	Residential	685614	6396806	2,288

Table 3.1 Noise assessment locations

ID	Classification	Easting	Northing	Distance to site (m)
R22	Residential	686052	6396610	2,615
R23 (project)	*Residential*	*685188*	*6398338*	*699*

Note: GDA 94 MGA Zone 55.



KEY

- Development boundary
- Noise assessment location
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary

\\emmsvr1\EMM3\2021\J210534 - Wellington BESS\GIS\02_Maps_NVIA\N001_AssessmentLocations_20221020_05.mxd 20/10/2022

Source: EMM (2022); AMPYR (2021); ESRI (2021); DFSI (2017); ICSM (2014)

Noise assessment locations

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 3.1

EMM creating opportunities

3.2 Background noise

In terms of the existing noise environment, EMM took the approach of utilising the minimum background noise thresholds of the NSW Noise Policy for Industry (NPfI) on the basis that the area land use is largely rural with limited traffic and industry. The only potential noise sources that may affect the background noise levels in the area is distant traffic on the Mitchell Highway, Goolma Road, noise from existing Wellington substation, Wellington Solar Farm and future noise from the Wellington North Solar Farm.

A review of *'Wellington Solar Farm. Construction & Operational Noise & Vibration Assessment'* prepared by Renzo Tonin & Associates (Tonin 2017) and '*Wellington North Solar Plant. Construction & Operational Noise & Vibration Assessment*' prepared by Renzo Tonin & Associates (Tonin 2018) confirmed measured background noise levels typically below the minimum thresholds of the NPfI.

Accordingly, this assessment has adopted the minimum thresholds outlined within the NPfI for the project, specifically:

- day 35 dB;
- evening 30 dB; and
- night 30 dB.

4 Assessment criteria

This chapter presents the construction and operational noise assessment criteria established for the project and in accordance with the Noise Policy for Industry (NPfI), NSW Road Noise Policy (RNP), and the Interim Construction Noise Guidelines (ICNG).

4.1 Operational noise

4.1.1 Noise Policy for Industry

Operational noise associated with the project will principally be from fixed plant and equipment including battery cubicles, inverters, LV/HV transformers and HV transformers.

Noise from development in NSW is regulated by the local council, Department of Planning and Environment (DPE) and/or the EPA, and sites generally have a licence and/or development consent conditions stipulating noise limits. These limits are typically derived from project specific trigger or operational noise levels predicted at assessment locations. They are based on EPA guidelines (eg NPfI) or noise levels that can be achieved by a specific site following the application of all feasible and reasonable noise mitigation.

The objectives of noise trigger levels established in accordance with the NPfI are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location.

To ensure these objectives are met, the EPA provides project specific noise trigger levels, namely intrusiveness and amenity.

i Intrusiveness noise levels

The NPfI intrusiveness noise triggers require that $L_{Aeq,15min}$ noise levels (energy average noise level over a 15 minute period) from the project do not exceed the rated background level (RBL) by more than 5 dB during the relevant operational periods. The intrusiveness noise levels are only applicable at residential assessment locations.

Table 4.1 presents the intrusiveness noise levels determined for the project based on the adopted RBLs. Where assessment locations have been grouped together in the following tables, it is expected that the ambient noise environment at these assessment locations is similar.

Table 4.1 Project intrusiveness noise levels

Residential assessment location	Assessment period[1]	Adopted RBL, dBA	Project intrusiveness noise level (RBL + 5 dB), $L_{Aeq,15min}$, dB
All residential assessment locations[2]	Day	35	40
	Evening	30	35
	Night	30	35

Notes: 1. Day: 7.00 am to 6.00 pm Monday to Saturday; 8.00 am to 6.00 pm Sundays and public holidays; evening: 6.00 pm to 10.00 pm; night: remaining periods.

2. Excluding R23 – project related residence comprising homestead and cottage.

ii Amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial noise and exclude road or rail traffic noise. Where the measured existing industrial noise approaches recommended amenity noise levels, it needs to be demonstrated that noise levels from new developments will not contribute to existing industrial noise such that amenity noise levels are exceeded.

To ensure that industrial noise levels ('existing' plus the 'new' project) remain within the recommended amenity noise levels for an area, the project amenity noise level for a new industrial development is the recommended amenity noise level (outlined in Table 2.2 of the NPfI) minus 5 dB. It is noted that this approach is based on a receiver being impacted by multiple industrial sites (or noise sources).

Residential areas potentially affected by the project's operational noise are located to the north, east, south and west of the project. The project amenity noise levels for the identified assessment locations are presented in Table 4.2 based on a rural noise amenity area. The NPfI defines rural as 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.

Table 4.2 Project amenity noise levels

Assessment location	Time period[1]	Indicative area	Project amenity noise level[2] dB, $L_{Aeq,period}$
All residential assessment locations[3]	Day	Rural	50 (55-5)
	Evening		40 (45-5)
	Night		35 (40-5)

Source: NPfI (EPA 2017)

1. Day: 7.00 am to 6.00 pm Monday to Saturday; 8.00 am to 6.00 pm Sundays and public holidays; evening: 6.00 pm to 10.00 pm; night: 10.00 pm to 7.00 am Monday to Saturday; 10.00 pm to 8.00 am Sundays and public holidays.
2. Project amenity noise level is Amenity noise level (Table 2.2 of NPfI) -5 dB in accordance with NPfI Section 2.4.2.
3. Excluding R23 – project related residence comprising homestead and cottage.

iii Project noise trigger level

The project noise trigger level (PNTL) is the lower of the calculated intrusiveness or amenity noise levels. Taking account of the measured background noise levels, project intrusive noise levels and project amenity levels for residential assessment locations, a summary of the PNTLs for the assessment of noise from the project operations is presented in Table 4.3.

Table 4.3 Project noise trigger levels

Assessment location	Assessment period[1]	Intrusiveness noise level, $L_{Aeq,15min}$, dB	Amenity noise level[2], $L_{Aeq,15min}$, dB	PNTL[3], $L_{Aeq,15min}$, dB
R1 – R22	Day	40	53	40
	Evening	35	43	35
	Night	35	38	35

Notes: 1. Day: 7.00 am to 6.00 pm Monday to Saturday; 8.00 am to 6.00 pm Sundays and public holidays; evening: 6.00 pm to 10.00 pm; 6.00 am to 7.00 am Monday to Saturday, 6.00 am to 8.00 am Sundays and public holidays; night: remaining periods.
2. Project amenity LAeq,15min noise level is the recommended amenity noise level $L_{Aeq,period}$ +3 dB as per the NPfI.
3. PNTL is the lower of the calculated intrusiveness or amenity noise levels.

iv Sleep disturbance

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where operation or construction night-time noise levels at a residential location exceed screening levels of:

- $L_{Aeq,15\ minute}$ 40 dB or the prevailing RBL plus 5 dB (whichever is the greater); and/or
- L_{Amax} 52 dB or the prevailing RBL plus 15 dB (whichever is the greater).

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon numerous studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current (2011) level of understanding, it is not possible to establish absolute noise level criteria that will correlate to an acceptable level of sleep disturbance.

Additional information is outlined in *WHO* [World Health Organization] *Night Noise Guidelines for Europe* (WHO 2009) and the *Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep* (Basner and McGuire 2018). Further guidance is also provided in the NSW RNP with reference to enHealth "as a rule for planning for short-term or transient noise events, for good sleep over 8 hours the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dB(A) L_{Amax} more than 10 or 15 times per night". It is commonly accepted by acoustic practitioners and regulatory bodies (ie EPA) that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 55 dB calculated at the facade of a residence is unlikely to impact sleep according to the RNP.

If noise levels over the screening criteria are identified, then additional analysis will consider factors such as:

- how often the events will occur;
- the time the events will occur;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current scientific literature available regarding the impact of maximum noise level events at night.

Table 4.4 provides the noise level event screening criteria for the residential assessment locations.

Table 4.4 Sleep disturbance screening criteria at residences

Assessment location	Adopted night RBL, dB	Night-time maximum noise level event screening criteria, dB	
		$L_{Aeq,15\ minute}$	L_{Amax}
R1–R22	30	40	52

4.1.2 Mitigating noise

Where noise levels above the PNTLs are predicted, all feasible and reasonable mitigation are to be considered for the project to reduce noise levels towards the PNTLs, before any residual impacts are determined and addressed.

The significance of the residual noise impacts is generally based around the human perception to changes in noise levels as explained in the glossary of the acoustic terms. For example, a change in noise level of 1 to 2 dB is typically indiscernible to the human ear. The characterisation of a residual noise impact of 0 to 2 dB above the PNTL is therefore considered negligible. The NPfI characterisation of residual noise impact is outlined further in Table 4.5.

Table 4.5 Significance of residual noise impacts

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of the residual noise level is:
≤2 dB	Not applicable	Negligible
≥3 but ≤5 dB	• Less than recommended amenity noise level; or • Greater than recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from development is ≤1 dB.	Marginal
≥ 3 but ≤5 dB	Greater than recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is >1 dB.	Moderate
>5 dB	Less than or equal to recommended amenity noise level.	Moderate
>5 dB	Greater than recommended amenity noise level.	Significant

Source: NPfI (EPA, 2017).

4.2 Construction noise

The *Interim Construction Noise Guideline* (ICNG) (DECC 2009) has been jointly developed by NSW Government agencies, including the NSW Environment Protection Authority (EPA) and Department of Planning (DoP) (now DPE). The objectives of the guideline relevant to the planning process are to promote a clear understanding of ways to identify and minimise noise from construction and to identify 'feasible' and 'reasonable' work practices. The guideline recommends standard construction hours where noise from construction activities is audible at residential premises (ie assessment locations), as follows:

- Monday to Friday 7.00 am to 6.00 pm;
- Saturday 8.00 am to 1.00 pm; and
- no construction work is to take place on Sundays or public holidays.

The ICNG acknowledges that works outside standard hours may be necessary, however, justification should be provided to the relevant authorities.

The ICNG provides two methodologies to assess construction noise emissions, quantitative and qualitative. The first is a quantitative approach, which is suited to major construction projects with typical durations of more than three weeks. This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG recommended noise levels.

The second is a qualitative approach, which is a simplified assessment process that relies more on noise management strategies. This method is suited to short-term infrastructure and maintenance projects of no more than three weeks.

This assessment has adopted a quantitative approach. The qualitative aspects of the assessment include identification of assessment locations, description of works involved including predicted noise levels and proposed management measures that include a complaints handling procedure.

4.2.1 Construction noise management levels - residents

Table 4.6 provides ICNG noise management levels (NML) which apply to residential assessment locations.

Table 4.6 ICNG construction noise management levels for residences

Time of day	NML $L_{Aeq,15min}$	Application
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm, Saturday 8.00 am to 1.00 pm, no work on Sundays or public holidays	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{eq(15\text{-}min)}$ 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 dBA	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: 1. 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); and 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise-affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise-affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

4.2.2 Construction noise management levels – other noise sensitive land uses

Table 4.7 summarises the ICNG recommendations and provides NML for other land uses.

Table 4.7 ICNG noise levels at other land uses

Land use	Management level, $L_{Aeq,15\ minute}$
Industrial premises	External noise level 75 dB (when in use)
Offices, retail outlets	External noise level 70 dB (when in use)
Hotels[1]	External noise level 65 dB (7.00 am to 10.00 pm) 60 dB (10.00 pm to 7.00 am)
Classrooms at schools and other educational institutions	Internal noise level 45 dB (when in use)
Hospital wards and operating theatres	Internal noise level 45 dB (when in use)
Places of worship	Internal noise level 45 dB (when in use)
Active recreation areas	External noise level 65 dB (when in use)
Passive recreation areas	External noise level 60 dB (when in use)

Source: ICNG (DECC 2009).

1. NML based on AS2017 recommend maximum internal noise level and the premise that windows and doors for such development would typically remain closed, providing 20 dB of outdoor to indoor construction noise level reduction.

4.2.3 Project specific construction noise management levels

The project construction NMLs for recommended standard and out of hour periods are presented in Table 4.8 for all assessment locations.

Table 4.8 Construction noise management levels – all assessment locations

Assessment location	Period	Adopted RBL[1]	NML $L_{Aeq,15min}$, dB
R1 – R22	Day (standard ICNG hours)	35	45

Note: 1. The RBLs adopted from Section 3.2.

4.3 Construction vibration

4.3.1 Human perception of vibration

Humans can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not in itself be disturbing or annoying. An individual’s response to that perception, and whether the vibration is “normal” or “abnormal”, depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as “normal” in a car, bus or train is considerably higher than what is perceived as “normal” in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2 1999. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in Table 4.9.

Table 4.9 suggests that people will just be able to feel floor vibration at levels of approximately 0.15 millimetres per second (mm/s) and that the motion becomes "noticeable" at a level of approximately 1 mm/s.

Table 4.9 Peak vibration levels and human perception of motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hertz (Hz) to 80 Hz.

4.3.2 Assessing vibration – a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC 2006) (the guideline) is based on BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1–80 Hz).

The guideline presents preferred and maximum vibration values for the use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended that the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 4.10.

Table 4.10 Examples of types of vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: activities that create up to three distinct vibration events in an assessment period, eg occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZEC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

Continuous vibration associated with compaction of road base for new site access road and hard stand areas is most relevant to the construction of the BESS.

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time. Intermittent vibration is representative of heavy vehicle pass-bys and construction activities such as impact hammering, rolling or general excavation work.

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted rms (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz.

To calculate VDV the following formula is used (refer to Section 2.4.1 of the guideline):

$$VDV = \left[\int_0^T a^4(t) dt \right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV for intermittent vibration are reproduced in Table 4.11.

Table 4.11 Acceptable vibration dose values for intermittent vibration

Location	Daytime		Night-time	
	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

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

These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline recommends that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

4.3.3 Structural vibration

i Australian Standard AS 2187.2 – 2006

In terms of the most recent relevant vibration damage criteria, Australian Standard AS 2187.2 – 2006 *Explosives –* Storage *and Use – Use of Explosives* recommends that the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* be used as they are “applicable to Australian conditions”.

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

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to manage minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4.12 and graphically in Figure 4.1.

Table 4.12 Transient vibration guide values - minimal risk of cosmetic damage

Line[1]	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings.	50 mm/s	50 mm/s
2	Unreinforced or light framed structures. Residential or light commercial type buildings.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Notes: Refers to the "Line" in Figure 4.1.

The standard notes that the guide values in Table 4.12 relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 4.12 may need to be reduced by up to 50%.

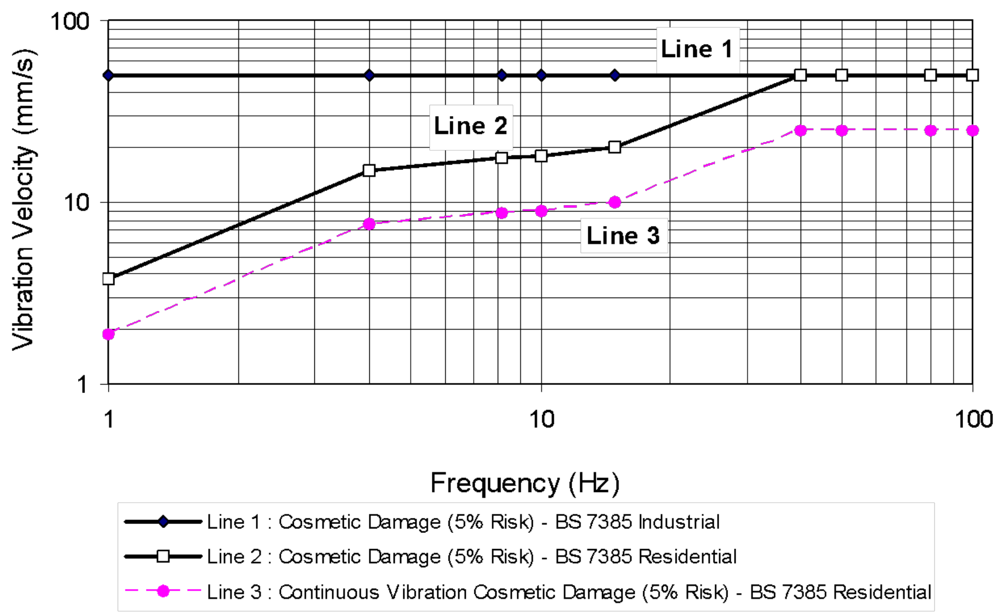


Figure 4.1 Graph of transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz (as shown in Figure 4.1).

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 4.12 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 4.12.

It is noteworthy that in addition to the guide values nominated in Table 4.12 the standard states that:

> Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.

4.3.4 Road traffic noise

Construction and operational traffic require consideration for potential noise impacts. The principle guidance to assess the impact of road traffic noise on assessment locations is in the *NSW Road Noise Policy* (RNP) (EPA 2011). Table 4.13 presents the road noise assessment criteria for residential land uses (ie assessment locations), reproduced from Table 3 of the RNP for road categories relevant to construction and use of the project. Under the definitions of the NSW RNP, Goolma will be a sub-arterial road.

Table 4.13 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria – dBA	
		Day (7.00 am to 10.00 pm)	Night (10.00 pm to 7.00 am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{eq,15hr}$ 60 (external)	$L_{eq,9hr}$ 55 (external)

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to an increase of up to 2 dB.

In addition to meeting the assessment criteria in Table 4.13 any significant increase in total traffic noise at the relevant residential assessment locations must be considered. Residential assessment locations experiencing increases in total traffic noise levels above those presented in Table 4.14 should be considered for mitigation.

Table 4.14 Road traffic relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase – dBA	
		Day (7.00 am to 10.00 pm)	Night (10.00 pm to 7.00 am)
Freeway/arterial/ sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{eq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{eq(9\text{-}hr)}$+ 12 dB (external)

Appendix B of the RNP, states that noise levels shall be rounded to the nearest integer, whilst difference between two noise levels are to be rounded to a single decimal place.

5 Assessment method

5.1 Noise modelling

This section presents the methods and base parameters used to model construction noise and vibration and operational emissions from the proposed BESS.

Operational and construction noise levels were predicted using a computer-generated model using Bruel & Kjaer Predictor proprietary modelling software with the ENM link algorithm.

The model calculates total noise levels at assessment locations from concurrent operation of multiple noise sources. It considers factors that influence noise propagation such as the lateral and vertical location of plant, source-to-receptor distances, ground effects, atmospheric absorption, topography of the site and surrounding area and applicable meteorological conditions.

The model was populated with 3-D topography of the project and surrounding area, extending out past nearest assessment locations. Plant and equipment representing the range of proposed construction and operation scenarios was placed at locations which would represent worst case noise levels throughout the construction and operational scenarios.

5.2 Construction noise

5.2.1 Times

Construction of the BESS would be during daytime hours only and has an envisaged duration of up to 12 to 18 months. Key stages in construction of the site will include:

- bulk earthworks, filling, compaction and drainage;
- trenching and boring of foundations for battery modules, inverters, transformers (possible location in TransGrid Wellington Substation considered) and transmission line towers or trenching subject to design;
- modular battery, inverter, transformer and transmission line installation and commissioning; and
- control building, switch room, operations and maintenance building and substation construction.

5.2.2 Equipment sound power levels

The construction noise impact assessment has adopted sound power levels from the EMM noise database and Department of Environment, Food and Rural Affairs (DEFRA) for plant and equipment items used for similar works. Plant and equipment items, sound power levels and quantities adopted in the noise modelling are summarised in Table 5.1.

Construction for the project will involve the installation of battery modules and associated infrastructure. Site preparation will be the starting phase of the construction works. The need for heavy civil works such as grading/levelling and compaction will be required and is subject to further detailed design.

Site establishment works and preparation for construction may include:

- the establishment of a temporary construction site compound in a fenced-off area within the development footprint including:
  - a site office;
  - containers for storage;
  - parking areas; and
  - temporary laydown areas;
- construction of access tracks and installation of boundary fencing;
- site survey to confirm infrastructure positioning and placement;
- bulk earthworks to establish platform and pad levels for battery modules, inverters, transformers and substation; and
- geotechnical investigations to confirm the ground condition.

Upon completion of the site establishment and pre-construction activities described above, construction will typically be as follows:

- trenching, driven or screw piles for slabs;
- install mounting bases;
- installation of battery modules, inverters and transformers;
- installation of medium voltage and high voltage cables;
- complete substation augmentation;
- establishment of the BESS compound; and
- test and commission project infrastructure.

The assumed list of plant and equipment for each construction scenario provided in Table 5.1 are considered to be representative of a worst-case period of construction in an active works area. However, due to the practicalities of constructing a project of this nature, the plant and equipment quantities may vary from time-to-time to cater for the requirements of the project's construction. For completeness the potential for construction within the TransGrid Wellington Substation to accommodate the transformers has been considered.

If the actual fleet of plant and equipment required varies significantly from that assumed within Table 5.1, a risk assessment of the proposed works will be undertaken to determine the likelihood of noise impacts on surrounding residential assessment locations. Appropriate management and mitigation measures will be used, where required. As described in Section 7, the Construction Environmental Management Plan (CEMP) will include the risk assessment protocol and detail the management and mitigation measures to be implemented during construction consistent with the best practice requirements.

Table 5.1 Typical construction plant and equipment

Description	Equipment	Quantity	Item $L_{Aeq,15min}$	Overall $L_{Aeq,15min}$
Phase 1 – Site establishment	Dozer	2	110	120
	Grader	1	104	
	Excavator	2	107	
	Roller	1	116	
	Bobcat	2	103	
	Front End Loader	1	107	
	Road truck (deliveries)	2	106	
	Concrete truck	2	106	
	Drilling Rig SM 14	1	106	
	Light vehicle	4	76	
Phase 2 – Delivery of BESS infrastructure	Road truck (deliveries)	2	106	114
	Light vehicle	4	76	
	Crane	2	106	
	Forklift	2	106	
	Hand tools	2	80	
Phase 3 – Installation of BESS Infrastructure	Road truck (deliveries)	2	106	113
	Light vehicle	4	76	
	Crane	2	106	
	Hand tools	2	80	

Notes: 1. Standard hours: Monday to Friday 7.00 am to 6.00 pm, Saturday 7.00 am to 1.00 pm and no construction work on Sundays or public holidays.

2. Plant and equipment items have been assumed to operate continuously in any 15-minute period unless otherwise specified.

5.2.3 Noise predictions

i Single point predictions

To assess a potential worst-case construction scenario, the assessment has considered the identified plant and equipment in Table 5.1 operating continuously over a 15 minute period. Construction noise levels were predicted to the assessment locations listed in Table 3.1 and identified in Figure 3.1.

ii Noise contours

Further to the above approach and acknowledging other residential areas to the north, east, south and west of the site, noise contours have been generated for the day construction activities to evaluate noise exposure surrounding the site.

5.2.4 Noise enhancing meteorology

Construction is proposed to occur during day hours only with modelling of construction noise considering default noise enhancing weather conditions of 3 m/s wind.

5.3 Construction vibration

5.3.1 Mobile plant and equipment

Safe working distances for typical items of vibration intensive plant are listed in Table 5.2. The safe working distances are quoted for both "Cosmetic Damage" (refer British Standard BS 7385) and "Human Comfort" (refer British Standard BS 6472-1).

Table 5.2 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
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 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	N/A
Vibratory Rollers	<50 kN (Typically 1–2 tonnes)	5 m	15 to 20 m
	<100 kN (Typically 2–4 tonnes)	6 m	20 m
	<200 kN (Typically 4–6 tonnes)	12 m	40 m
	<300 kN (Typically 7–13 tonnes)	15 m	100 m
	>300 kN (Typically 13–18 tonnes)	20 m	100 m
	>300 kN (>18 tonnes)	25 m	100 m

Source: From Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007 – based on residential building.

Safe work distances relate to continuous vibration. For most construction activity, vibration emissions are intermittent in nature. The safe working distances are therefore conservative.

The safe working distances presented in Table 5.2 are indicative and will vary depending on the item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

The safe working distances have been used to assess the potential for contraction vibration impacts based on proposed construction activities.

5.4 Operations noise

5.4.1 Design drawings

The acoustic assessment has been based on preliminary layout drawing (Figure 2.1). In addition, the noise model has considered the proposed acoustic barriers (4 m in height) to the north, east, south and west of the BESS footprint area maintaining an access opening to the north-west.

5.4.2 Plant and equipment

Noise impact from the general operation of the project was considered at assessment locations outlined in Section 3.1 from BESS.

As part of the detailed design process, the final locations for potential noise-generating infrastructure, in particular the substation and BESS facilities, will consider the distance between this type of infrastructure and nearby non-project related residences, so as to minimise operational noise impacts, where practicable.

Noise sources considered during the operational phase of the project include battery cubicles, power conversion systems (PCS) and high voltage transformers. Envisaged operational noise sources are presented in Table 5.3. Based on manufacturer data and assuming constant operation of the LV/HV transformers and HV transformers, Table 5.3 also incorporates the reduced total sound power levels under varying utilisation levels and cooling system operation of the battery cubicles and inverters.

Table 5.3 Operational noise source sound power levels

Noise source	L_{Aeq} sound power level per unit, dB[1]	Total sound power level, dB
Battery Cubicles/PCS /Inverters (x268) [2]	94	118
LV-MV transformers (4.9 MVA x268) [3]	76	100
MV-HV transformers (325 MVA x2) [4,5]	94	101
Total at 100% utilisation		**118**
Total at 80% utilisation		**116**
Total at 60% utilisation		**113**
Total at 40% utilisation		**109**
Total at 20% utilisation		**106**

Notes: 1. The combined noise levels will be subject to final quantity, configuration and layout of equipment as well as any noise attenuating measures.

2. Combined battery/inverter system 1/3 octave band levels reviewed from supplier information and confirmed not tonal.

3. Standard limit for LV-MV transformer with no tonal penalty.

4. Based on reduced limit AS60076.10 specifications with 5dB tonal penalty to MV-HV transformer only.

5. Potential for HV transformers to be located within the south-east portion of the TransGrid Wellington Substation.

Only on rare occasions (<2%) during high heat load and electricity network demand would a utilisation above 40% occur for the BESS operation – this would also only occur during daytime operation due to the linkage to high heat load. A worst-case discharge cycle during the evening would be a continuous period of around 1.5 hours (full discharging or charging cycles to nameplate capacity are extremely rare), whilst charging is typically conducted during the day in an opportunistic manner when electricity prices are low.

Advice from the applicant has confirmed that batteries would only have 1–2 discharge and charge cycles per day, and based on review of climatic conditions of the Wellington area and equipment operational requirements, would typically operate at the following utilisations:

- day 20–40%;
- evening 20–40%; and
- night 20%.

The operation of the BESS does not result in L_{Amax} noise level events, hence this assessment has considered potential sleep disturbance impacts against the L_{Aeq} 40dB level during night hours.

5.4.3 Noise predictions

i Single point predictions

To assess potential operational noise, the assessment has considered the identified plant and equipment in Table 5.3 operating continuously over a 15 minute period. Operational noise levels were predicted to the assessment locations listed in Table 3.1 and identified in Figure 3.1.

ii Noise contours

Further to the above approach and acknowledging adjacent industrial land uses and other residential areas to the north, east and west of the site, noise contours have been generated for the day (Figure 6.2), evening (Figure 6.3) and night (Figure 6.4) operational activities to determine the potential extent of noise exposure.

5.4.4 Noise enhancing meteorology

Noise modelling was conducted using Bruel & Kjaer Predictor proprietary modelling software with the ENM link algorithm.

A summary of modelling conditions for which noise predictions have been provided are shown in Table 5.4 in accordance with default noise enhancing conditions as recommended in the NPfI.

Table 5.4 Conditions adopted in the model

Period	Meteorological condition	Temperature	Relative humidity
Day	3 m/s wind	20°C	60%
Evening	3 m/s wind	10°C	90%
Night	Temp Inversion 3°C/100 m and 2 m/s wind	10°C	90%

5.5 Road traffic noise

The US EPA Federal Highways (FHWA) methods were considered in the assessment of road traffic noise. Where traffic flows are relatively low (<200 vehicles per hour) the FHWA procedures is adopted as it is more sensitive to low traffic volumes. A summary of the road sections and assessment methodology is provided in Table 5.5.

Table 5.5 Road segments considered in noise assessment

ID	Road segment/name	ADT	Assessment methodology
1	Goolma Road (east)	2247	FHWA
2	Goolma Road (west)	2247	FHWA

Note: 1. FHWA adopted to traffic assessment due to low traffic volumes.

Road traffic movements associated with construction and operation of the BESS have been referenced from the Traffic Impact Assessment (EMM 2022) and adapted to suit RNP assessment requirements (Section 4.3.4).

Road traffic noise levels from the project have been assessed by calculating existing and existing plus project traffic at representative residential assessment locations using FHWA method. The following assumptions have been adopted:

- speed limit for Goolma Road (east) 100 km/h (as signposted);
- speed limit for Goolma Road (west) 100 km/h (as signposted);
- there are no buildings or other intervening objects that will act like a noise barrier between the road and the noise assessment point (ie we are assessing the locations directly exposed to the road);
- vehicle breakdown of:
  - 60% HV from east;
  - 40% HV from west; and
  - 50% LV from east and west;
- a facade reflection has been added to predicted noise levels as appropriate.

Operational traffic associated with the proposal would typically be restricted to occasional maintenance vehicles only with expected maximum of five medium/light vehicles a day. Accordingly, operational traffic from the site is not a concern or assessed further in this report. Assessment of construction traffic is provided in Section 6.5.

6 Impact assessment

6.1 Construction noise

6.1.1 Single point predictions

In accordance with procedures outlined in Section 5.2, prediction of construction noise levels is provided in Table 6.3 for normal day periods under noise enhancing 3 m/s wind conditions for the potential worst impact Phase 1 construction works (Table 5.1). The construction noise level presented for each assessment location represents the energy-average noise level over a 15 minute period and assumes all plant operating concurrently.

The proponent will manage construction noise levels through construction noise management methods detailed in a construction noise management plan as discussed further in Section 7. Construction is to be during standard hours of 7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm Saturday.

Table 6.1 Predicted construction noise levels – Phase 1

Assessment location	Classification	Period	Predicted construction noise level, dB $L_{Aeq,15min}$	Compliance
R1	Residential	Standard hours	51	+6
R2	Residential	Standard hours	46	+1
R3	Residential	Standard hours	46	+1
R4	Residential	Standard hours	45	yes
R5	Residential	Standard hours	45	yes
R6	Residential	Standard hours	45	+1
R7	Residential	Standard hours	46	+1
R8	Industrial	Standard hours	44	yes
R9	Residential	Standard hours	44	yes
R10	Residential	Standard hours	45	+1
R11	Residential	Standard hours	46	+1
R12	Residential	Standard hours	46	+1
R13	Residential	Standard hours	46	+2
R14	Residential	Standard hours	42	yes
R15	Residential	Standard hours	47	+2
R16	Residential	Standard hours	45	+1
R17	Industrial	Standard hours	45	yes
R18	Residential	Standard hours	43	yes
R19	Residential	Standard hours	42	yes

Table 6.1 Predicted construction noise levels – Phase 1

Assessment location	Classification	Period	Predicted construction noise level, dB $L_{Aeq,15min}$	Compliance
R20	Residential	Standard hours	45	yes
R21	Residential	Standard hours	39	yes
R22	Residential	Standard hours	38	yes
R23	*Residential*	*Standard hours*	53	*n/a*

Note: Excluding R23 – project related residence.

The results of the modelling demonstrate predictions of negligible (1-2dB) exceedance for the majority of the assessment locations. A potential exceedance of 6dB is predicted for R1 during Phase 1 works. Compliance with the ICNG NML's is anticipated for the lower noise Phase 2 and Phase 3 works at all assessment locations.

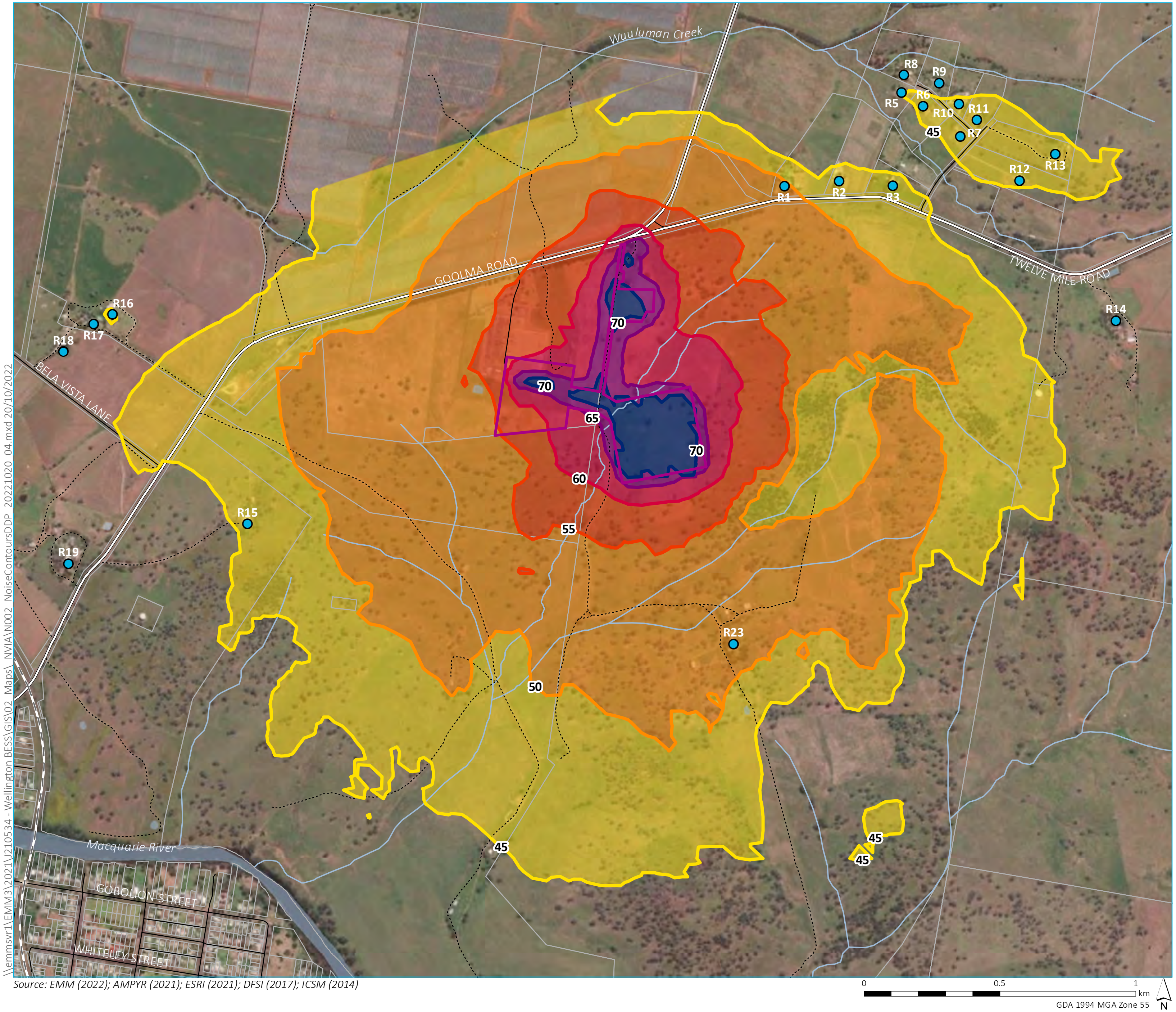
Noise modelling also considered the potential construction activities within the TransGrid Wellington Substation to accommodate an alternate location for the BESS transformers. The results of the modelling confirmed no additional adverse impacts.

Section 6.3 has identified further noise mitigation for R1 in the form of treatment to the dwelling through a negotiated agreement. It is recommended that the treatment to the dwelling contained in the agreement be implemented during the early stages of Phase 1 construction in order to further mitigate construction noise impacts.

Where works outside of standard hours are unavoidable, noise should be managed in accordance with the noise limits of the ICNG. Works outside of standard hours would typically require approval from the relevant regulatory authority and be justified with specialist acoustic assessment of the proposed works to be undertaken.

6.1.2 Noise contours

Predicted $L_{Aeq,15minute}$ noise contours representing the worst-case noise level footprint from the Phase 1 project construction is provided in Figure 6.1. The figure represents the predicted construction noise levels under noise enhancing conditions.



KEY

- Development boundary
- Noise assessment location
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary

Noise contour - construction - day

- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- 60 - 65 dBA
- 65 - 70 dBA
- > 70 dBA

Construction noise contours, day, 3 m/s wind

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 6.1

creating opportunities

Source: EMM (2022); AMPYR (2021); ESRI (2021); DFSI (2017); ICSM (2014)

\\emmsvr1\EMM3\2021\J210534 - Wellington BESS\GIS\02_Maps_NVIA\N002_NoiseContoursDDP_20221020_04.mxd 20/10/2022

6.2 Construction vibration

In relation to human comfort response, the safe working distances in Table 5.2 relate to continuous vibration and apply to residential assessment locations. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, as discussed in BS 6472-1.

The nearest residences (R1 and *R23*) are located approximately 570 m and 700 m respectively to the closest proposed construction activities. These assessment locations are beyond the safe working distances for structural damage and subject to size of vibratory roller required, likely below the levels for human response (Table 2.7). Vibration impacts from construction at residential assessment locations are considered unlikely.

The safe working distances for cosmetic damage should be monitored throughout the construction process. Based on the safe working distances guide in Table 5.2, if construction is within 25 m of sensitive structures, then work practices should be reviewed so that the safe working distance in Table 5.2 are followed.

If safe working distances need to be encroached, real time vibration monitoring with audible and visual alarms should be installed at vibration sensitive structures so actual vibration levels can be monitored and managed appropriately in real-time.

6.3 Road traffic noise

Road traffic noise level predictions for peak generation construction traffic are provided in Table 6.2. Traffic volumes were provided by AMPYR to represent the peak generation of light (LV) and heavy vehicles (HV) associated with the construction of the BESS facility. Construction would be restricted to standard daytime hours only.

Table 6.2 Road traffic noise calculations, Day (7am to 10pm)

ID	Approximate distance from nearest carriageway	Road segments	Existing movements			Existing plus project movements			Noise level increase due to the Project, $L_{Aeq,15hour}$
			Total	%HV	Calculated level, $L_{Aeq,15hour}$	Total	%HV	Predicted level, $L_{Aeq,15hour}$	
1	110 m	Goolma Road (east)	1910	18	62.6	2058	19	63.1	0.5
2	72 m	Goolma Road (west)	1910	18	64.4	2046	19	64.8	0.4

Assessment of day ($L_{Aeq,15hour}$) construction traffic predictions confirm compliance with the <2 dB increase criterion of the RNP for construction vehicles associated with the BESS.

6.4 Operational noise

6.4.1 Single point predictions

In accordance with procedures outlined in Section 5.4.3, prediction of single point operational noise levels is provided in Table 6.3, for day, evening and night periods. The levels presented for each assessment location represents the energy-average noise level over a 15 minute period and assumes all plant operating concurrently under adverse meteorological conditions (Table 5.4).

Preliminary noise modelling of the BESS operational noise levels identified the potential for exceedances at a number of residential assessment locations. To mitigate the noise impacts, four and six metre high noise barriers were considered, with the provision of a six metre noise barrier only providing a marginal improvement above the four meter noise barrier (1dB or less). Accordingly, the assessment has assumed the provision of four metre noise barriers (wall, retaining wall and mound, or acoustic mound) surrounding the BESS facility to the north, east, south and west, retaining a site access to the north-west of the BESS.

Table 6.3 Predicted operational noise levels – adverse meteorological conditions

Assessment location	Classification	Period	PNTL, dB	Predicted noise level, dB $L_{Aeq,15min}$	Satisfies NPfI Y/N (dB)
R1	Residential	Day	40	39	Y
		Evening	35	**40**	N *
		Night	35	31	Y
R2	Residential	Day	40	29	Y
		Evening	35	30	Y
		Night	35	23	Y
R3	Residential	Day	40	28	Y
		Evening	35	29	Y
		Night	35	22	Y
R4	Residential	Day	40	28	Y
		Evening	35	29	Y
		Night	35	21	Y
R5	Residential	Day	40	29	Y
		Evening	35	31	Y
		Night	35	21	Y
R6	Residential	Day	40	31	Y
		Evening	35	32	Y
		Night	35	22	Y
R7	Residential	Day	40	30	Y
		Evening	35	32	Y
		Night	35	21	Y
R8	Residential	Day	40	31	Y
		Evening	35	31	Y
		Night	35	22	Y

Table 6.3 Predicted operational noise levels – adverse meteorological conditions

Assessment location	Classification	Period	PNTL, dB	Predicted noise level, dB $L_{Aeq,15min}$	Satisfies NPfI Y/N (dB)
R9	Residential	Day	40	30	Y
		Evening	35	32	Y
		Night	35	22	Y
R10	Residential	Day	40	30	Y
		Evening	35	32	Y
		Night	35	22	Y
R11	Residential	Day	40	31	Y
		Evening	35	33	Y
		Night	35	22	Y
R12	Residential	Day	40	31	Y
		Evening	35	32	Y
		Night	35	21	Y
R13	Residential	Day	40	32	Y
		Evening	35	33	Y
		Night	35	25	Y
R14	Residential	Day	40	19	Y
		Evening	35	20	Y
		Night	35	14	Y
R15	Residential	Day	40	34	Y
		Evening	35	**36**	N (+1)
		Night	35	30	Y
R16	Residential	Day	40	31	Y
		Evening	35	33	Y
		Night	35	27	Y
R17	Residential	Day	40	31	Y
		Evening	35	32	Y
		Night	35	27	Y

Table 6.3 Predicted operational noise levels – adverse meteorological conditions

Assessment location	Classification	Period	PNTL, dB	Predicted noise level, dB $L_{Aeq,15min}$	Satisfies NPfI Y/N (dB)
R18	Residential	Day	40	29	Y
		Evening	35	31	Y
		Night	35	26	Y
R19	Residential	Day	40	29	Y
		Evening	35	31	Y
		Night	35	22	Y
R20	Residential	Day	40	32	Y
		Evening	35	34	Y
		Night	35	26	Y
R21	Residential	Day	40	23	Y
		Evening	35	25	Y
		Night	35	17	Y
R22	Residential	Day	40	23	Y
		Evening	35	25	Y
		Night	35	17	Y
R23	*Residential*	*Day*	*n/a*	*39*	*n/a*
		Evening	*n/a*	*40*	*n/a*
		Night	*n/a*	*32*	*n/a*

Notes: Noise mitigation options are discussed in Section 7.

Day/evening/night – 40%/40%/20% capacity utilisation as per design and climatic conditions.

R23 included project landholder, comprises homestead and cottage and no specified noise limits to be applied.

Noise modelling has demonstrated the NPfI noise limits are satisfied at all assessment locations during day and night operations with 40% and 20% utilisation of the Wellington BESS with the implementation of the noise mitigation proposed. Noise modelling has indicated the potential for a 5dB exceedance at R1 and a negligible 1 dB exceedance at R15. R1 and R15 are unique assessment locations that are located on higher elevations relative to the site and effectively 'over look' the BESS.

To address the residual noise exceedance at R1 negotiations have commenced between the applicant and landholder for treatment to the dwelling (upgraded glazing and where necessary alternative ventilation) to ensure equivalent internal noise levels are achieved (-10 dB or more) below the relevant external PNTL. The agreed works will be documented in a negotiated agreement.

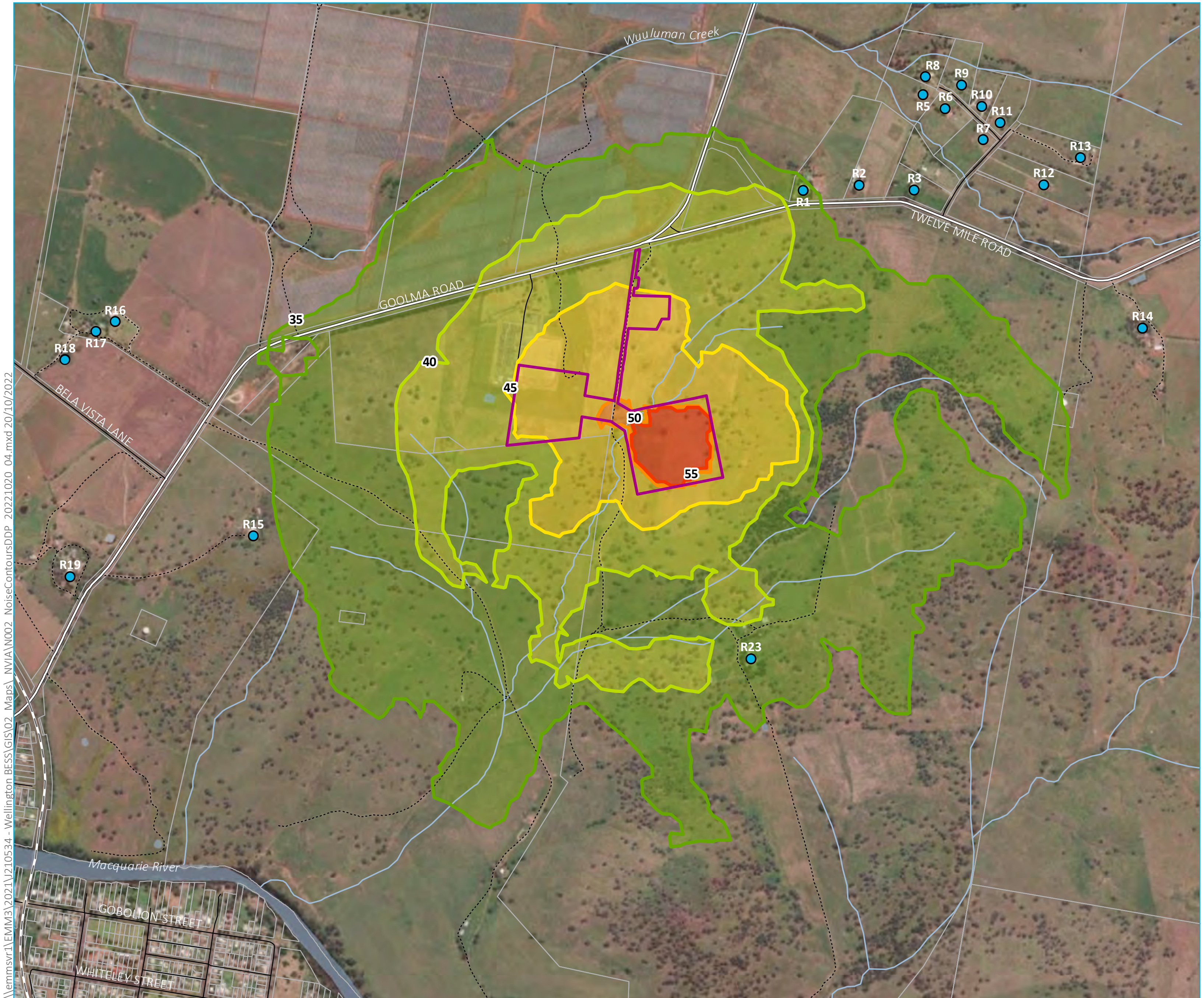
In terms of R15 and its relative height to the BESS, the proposed four metre acoustic barrier to the west of the BESS, and prediction of exceedance of 1dB, all feasible and reasonable mitigation measures have been exhausted and no further mitigation of the residual negligible exceedance is proposed. This is consistent with the approach and requirements of the NPfI. Full compliance is predicted under 20% operational utilisation of the facility.

The operation of the BESS does not result exceed the sleep disturbance screening level of L_{Aeq} 40 dB during night hours.

Noise modelling also considered the operation of the BESS transformers within the TransGrid Wellington Substation. The results of the modelling confirmed no additional adverse impacts to any assessment locations.

6.4.2 Contours

Predicted $L_{Aeq,15min}$ noise contours representing day, evening and night operations are provided in Figure 6.2, Figure 6.3 and Figure 6.4 respectively. The figures represent the predicted operational noise levels during noise enhancing conditions (Table 5.4) for day, evening and night under the stated BESS utilisations.



\\emmsvr1\EMM3\2021\J210534 - Wellington BESS\GIS\02_Maps_NVIA\N002_NoiseContoursDDP_20221020_04.mxd 20/10/2022

Source: EMM (2022); AMPYR (2021); ESRI (2021); DFSI (2017); ICSM (2014)

0 0.5 1 km

GDA 1994 MGA Zone 55

N

KEY

- Development boundary
- Noise assessment location
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary

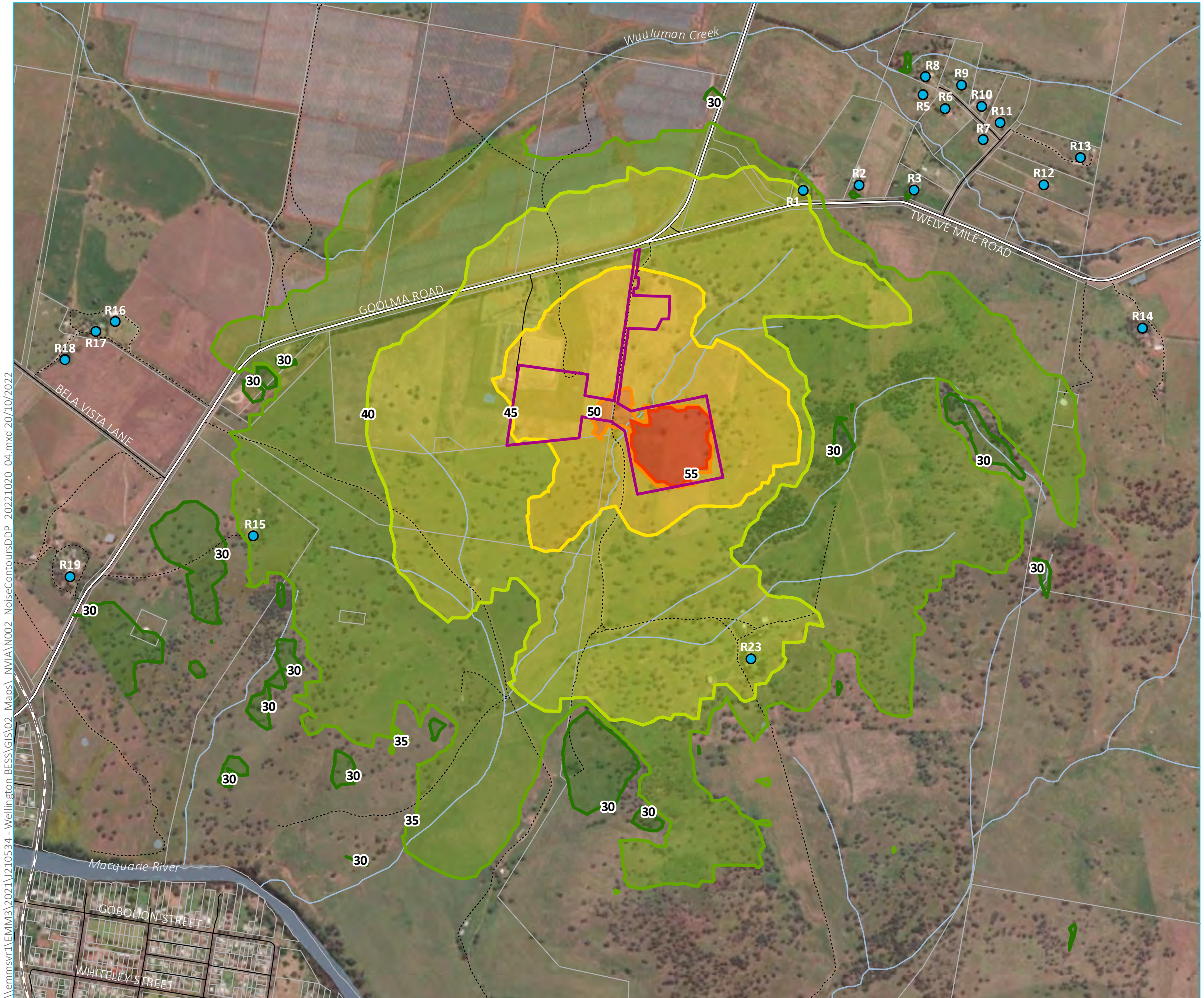
Noise contour - operation - day

- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- > 55 dBA

Operational noise contours, day, 40%, 3 m/s wind

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 6.2

EMM creating opportunities



KEY

- Development boundary
- Noise assessment location
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary

Noise contour - operation - evening

- 30 - 35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- > 55 dBA

\\emmsvr1\EMM3\2021\J210534 - Wellington BESS\GIS\02_Maps_NVIA\N002_NoiseContoursDDP_20221020_04.mxd 20/10/2022

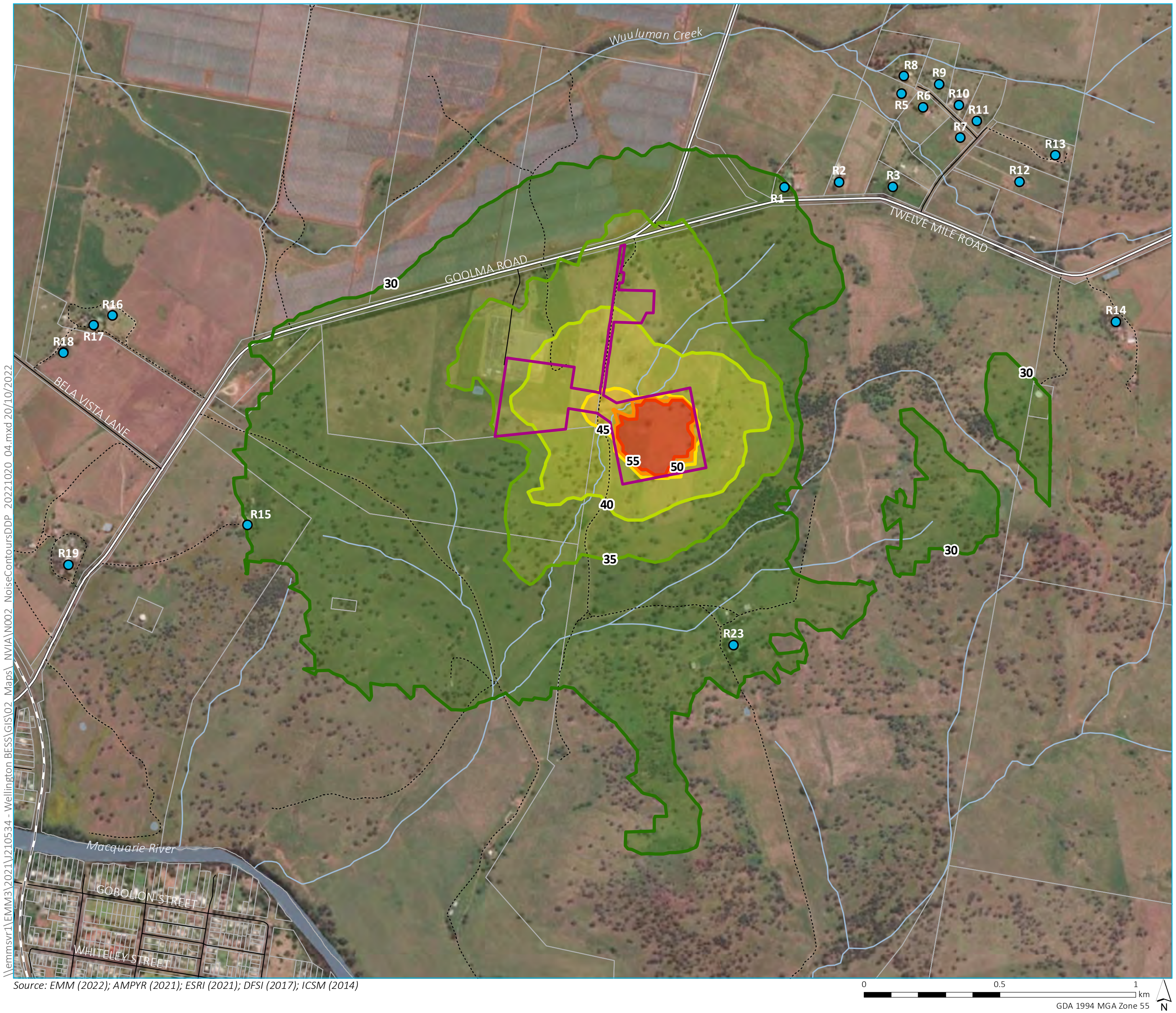
Source: EMM (2022); AMPYR (2021); ESRI (2021); DFSI (2017); ICSM (2014)

0 0.5 1 km
GDA 1994 MGA Zone 55
N

Operational noise contours,
evening, 40%, 3 m/s wind

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 6.3

EMM
creating opportunities



Source: EMM (2022); AMPYR (2021); ESRI (2021); DFSI (2017); ICSM (2014)

Operational noise contours, night, 20%, 3°C/100 m temperature inversion

Wellington Battery Energy Storage System
Noise and vibration impact assessment
Figure 6.4

EMM creating opportunities

6.5 Cumulative operational noise impacts

The potential for cumulative noise impacts associated with the operation of the proposed Wellington BESS facility and the approved and constructed Wellington Solar Farm to the north needs to be considered. The key assessment locations for the BESS facility with the potential to experience cumulative noise impacts are identified as R1-R4, R15 and R16.

EMM reviewed '*Wellington Solar Farm. Construction & Operational Noise & Vibration Assessment*' prepared by Renzo Tonin & Associates (Tonin 2017) and '*Wellington North Solar Plant. Construction & Operational Noise & Vibration Assessment*' prepared by Renzo Tonin & Associates (Tonin 2018) to determine the operational noise level contributions from the solar farm and upgraded substation in order to consider the cumulative noise levels with the BESS operation. A summary of the individual and cumulative noise levels and noise goals is provided in Table 6.4.

Table 6.4 Predicted cumulative noise levels

Assessment location	Period	Amenity noise goal*, dB	Predicted noise level, dB $L_{Aeq,15min}$			Satisfies Amenity Level Y/N (dB)
			BESS	Wellington Solar Farm and Substation	BESS, Wellington Solar Farm and Substation	
R1 (R7[1] R14[2])	Day	55	39	37	41	Y
	Evening	45	40	37	42	Y
	Night	40	31	37	38	Y
R15 (R10[1] R12[2])	Day	55	34	34	37	Y
	Evening	45	36	34	38	Y
	Night	40	30	34	35	Y
R16 (R8[1] R13[2])	Day	55	31	34	36	Y
	Evening	45	33	34	37	Y
	Night	40	27	34	35	Y

Note: () reference location in Tonin[1] and Tonin[2].
* Amenity noise goal for all sources (BESS and Solar Farm/Substation upgrade).

No cumulative noise impacts are anticipated as a result of the operational noise associated with the project.

7 Management of impacts

7.1 Construction

7.1.1 General

The EPA's NSW ICNG requires that construction noise levels are assessed against NMLs.

Construction is expected to commence in 2023. Construction noise levels above NMLs have been predicted for residential assessment locations and it is not uncommon for construction projects to exceed NMLs. For this reason, they are not considered as noise criteria, but as a trigger for all feasible and reasonable noise mitigation and management to be considered, once exceeded.

There is limited opportunity due to proximity of residential assessment locations, extent of site and local topography to provide significant noise mitigation. Management measures that could be implemented on site are provided in the following sections. It is noted that the predicted noise exceedances for construction activities are negligible 1–2 dB at a number of residential assessment locations, and 6 dB at R1.

It is noted that the predicted exceedances are under adverse conditions for the Phase 1 highest noise level works and represents a worst-case noise impact assessment. Phase 2 and Phase 3 works are anticipated to comply with the NML's.

7.1.2 Work practices

Feasible and reasonable mitigation measures to reduce construction noise levels will be reviewed and implemented subject to imposed Conditions of Approval.

Work practice methods may include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- develop routes for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoid the use of equipment that generates impulsive noise; and
- notify residents prior to the commencement of intensive works.

7.1.3 Plant and equipment

Additional measures for plant and equipment may include:

- where possible, choose quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- operate plant and equipment in the quietest and most efficient manner; and
- regularly inspect and maintain plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.

7.1.4 Quantifying noise reductions

Approximate noise reductions provided by some of these measures are provided in Table 7.1.

Table 7.1 Relative effectiveness of various forms of noise control

Noise control	Nominal noise reduction possible, in total A-weighted sound pressure level, dB
Increase source to receiver distance[1]	Approximately 6 db for each doubling of distance.
Reduce equipment operating times or turn off idling machinery[2]	Approximately 3 db per halving of operating time.
Operating training on quiet operation[2]	Up to 3 to 5 db.
Screening (eg noise barrier)[1]	Normally 5 db to 10 db, maximum 15 db.
Enclosure (eg shed/building)[1]	Normally 15 db to 25 db, maximum 50 db.
Silencing (eg exhaust mufflers) [1]	Normally 5 db to 10 db, maximum 20 db.

Notes: 1. Sourced from AS2436-2010.

2. Based on EMM's measurement experience at construction and mining sites.

7.2 Operational noise and vibration

The assessment has demonstrated that the operational noise based on the assumptions adopted and under adverse weather conditions are compliant with the project noise trigger levels for all reference assessment locations during day and night assessment periods. The potential for a negligible 1 dB exceedance is identified for R15 during the evening, whilst a moderate exceedance of 5 dB is predicted for R1 in the absence of additional noise mitigation options.

To address the residual noise exceedance at R1, negotiations have commenced between the applicant and the landholder for treatment to the dwelling (upgraded glazing and where necessary alternative ventilation) to ensure equivalent internal noise levels are achieved (-10dB or more) below the relevant external PNTL and will be documented in the form of a negotiated agreement.

During the detailed design phase of the project all plant and equipment will be reviewed to ensure noise levels predicted in this NVIA can be achieved through:

- selection of plant and equipment;
- site layout and orientation of equipment;
- provision of acoustic barrier (wall/retaining wall and batter or earth mounds) four metres in height to the north, east, south and west with site access provision provided in north-west corner;
- utilisation and operational procedures consistent with the assumptions in this NVIA; or
- a combination of the above measures.

An EMP will be prepared to manage environmental impacts during the operational phase of the project. For operations, the EMP will address noise management and mitigation options (where required) prior to commencement of operations.

The EMP will describe how operational noise levels will be managed. The EMP would address noise mitigation and management to reduce operational noise levels at the potentially most affected assessment location based on the findings of this assessment as a minimum.

The EMP will outline a procedure to:

- measure operational noise levels at early stages during commissioning or within 3 months of operation to validate the predicted operational noise levels; and
- re-evaluate the predicted operational noise levels at assessment locations, and where required review noise management, mitigation measures and site management to reduce levels where required. This may include (but is not limited to):
  - equipment noise controls;
  - provision of additional or amended acoustic barriers;
  - at receiver noise treatment;
  - negotiated agreement; and
  - measuring operational noise levels at assessment locations, especially during the evening and night-time period, if relevant, and implementing further noise management and mitigation measures where an exceedance of approved noise levels is identified.

With effective implementation of plant and equipment selection, acoustic barriers and battery utilisation strategies, operational noise can be managed to meet requirements for all sensitive assessment locations.

8 Conclusion

This NVIA has been prepared to support an EIS for the Wellington BESS at Wellington, NSW. It has documented the methods and results, the initiatives built into the project design to avoid and minimise associated impacts, and the mitigation and management measures recommended to address any residual impacts not able to be feasibly and reasonably avoided.

Construction noise levels from the project are predicted to exceed noise management levels (NMLs) at a number of assessment locations by a negligible level (1–2 dB). An exceedance of 6 dB above NML at R1 closest to the site is predicted in the absence of specific additional mitigation. Noise monitoring during construction will be considered to determine if actual construction noise levels are above NMLs. Subject to the measured level of exceedance, availability of feasible and reasonable noise mitigation and management measures will be determined. This is discussed further in Section 7.1.

The potential for vibration impacts on residents and vibration sensitive structures near construction has been assessed. The nearest residence to construction activity is assessment location R1 which is approximately 570 m away from closest construction activities. This assessment location is outside of the safe working distances of likely plant, required to maintain acceptable human response and structural vibration levels. Vibration impacts from construction at residential assessment locations are therefore highly unlikely.

With the effective management and incorporation of mitigation and management measures listed in Section 7.1, construction noise and vibration emissions from the project can be managed to minimise impacts.

Operational noise has been assessed under adverse weather conditions and considering the actual operational utilisation of the BESS. Noise mitigation measures have been included in the modelling following the outcome of preliminary noise modelling indicating noise exceedances. Following the implementation of all feasible and reasonable mitigation options, the modelling has demonstrated noise compliance can be achieved for all assessment locations during day and night NPfI assessment periods. During the evening assessment period the potential for a moderate exceedance of 5dB was predicted for R1 whilst a negligible 1 dB exceedance was identified for R15. All feasible and reasonable mitigation has been considered for R15, and considering the predicted level is negligible (1 dB) over the PNTL, not further mitigation is proposed.

To address the residual noise exceedance at R1 negotiations have commenced between the applicant and the landholder for treatment to the dwelling (upgraded glazing and where necessary alternative ventilation) to ensure equivalent internal noise levels are achieved (-10 dB or more) below the relevant external PNTL and will be documented in the form of a negotiated agreement.

The potential for road traffic noise impacts on public roads due to project traffic has been assessed in accordance with the NSW Road Noise Policy (RNP) for peak site traffic movements during the construction period. The assessment has confirmed that road traffic associated with the construction of the facility will not increase existing road traffic noise levels by more than 2 dB in accordance with the RNP.

With the effective management and incorporation of mitigation measures listed in Section 7 in place, noise and vibration emissions from the project can be designed to satisfy relevant guidelines, standards and policies.

References

AMPYR 2022, *About us*, viewed 10 January 2022, www.ampyrenergy.com/about-us

Australian and New Zealand Environment Council 1990, Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration

Australian Standard AS 1055 - 1997 - *Acoustics - Description and Measurement of Environmental Noise*.

Australian Standard AS 2107 - 2016 - *Acoustics - Description and Measurement of Environmental Noise*

Australian Standard AS 2187.2 - 2006 "*Explosives* - Storage *and Use - Use of Explosives*"

BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2*"

BS 6472 – 2008 *"Evaluation of human exposure to vibration in buildings (1-80Hz)"*

Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*

EMM 2022, Traffic Impact Assessment, EMM Consulting

Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep (Basner and McGuire 2018)

German Standard DIN 4150 Part 2 1999

NSW Environment Protection Authority (EPA) 2017, *Noise Policy for Industry*

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

NSW Department of Environment Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG)

NSW Department of Environment and Conservation 2006, *Assessing Vibration: a technical guideline*

Tonin 2017, 'Wellington Solar Farm. Construction & Operational Noise & Vibration Assessment' prepared by Renzo Tonin & Associates dated 24 November 2017 (Report No. TJ643-01F01 Report (r5).docx for NGH Environmental

Tonin 2018, 'Wellington North Solar Plant. Construction & Operational Noise & Vibration Assessment' prepared by Renzo Tonin & Associates dated 10 August 2018 (Report No. TJ917-01F01 Report (r7).docx for NGH Environmental

WHO [World Health Organization] *Night Noise Guidelines for Europe* (WHO 2009)

Abbreviations

Abbreviation	Term
ARL	Acoustic Research Laboratories
CEMP	Construction Environmental Management Plan
DEFRA	Department of Environment, Food and Rural Affairs (United Kingdom)
EMM	EMM Consulting Pty Limited
EMP	Environmental Management Plan
FHWA	US EPA Federal Highways
HV	heavy vehicle
LGAs	local government areas
LV	light vehicle
MW	megawatts
NATA	National Association of Testing Authorities
NL	Noise level
NML	Noise management level
NVIA	Noise and vibration impact assessment
OOH	out of hours
PPV	peak particle velocity
RBL	rating background level
TNRP	Traffic Noise Reduction Policy
VDV	vibration dose value

Glossary

Project and technical terms

Term	Meaning
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{A90} statistical noise levels.
Amenity noise level	The amenity noise levels relate to the overall level of industrial noise subject to land zoning or use
A-weighting	There are several different weightings utilised for describing noise, the most common being the 'A-weighting'. This attempts to closely approximate the frequency response of the human ear.
Day period	Monday–Saturday: 7.00 am to 6.00 pm, on Sundays and public holidays: 8.00 am to 6.00 pm.
dB	Noise is measured in units called decibels (dB).
DPIE	NSW Department of Planning, Industry and Environment
EA	Environmental assessment
EMM	EMM Consulting Pty Limited
EP&A Act	NSW *Environmental and Planning Assessment Act 1979* (NSW)
EPA	NSW Environment Protection Authority (formerly the Department of Environment, Climate Change and Water).
Evening period	Monday–Saturday: 6.00 pm to 10.00 pm, on Sundays and public holidays
ICNG	Interim Construction Noise Guideline
Intrusive noise level	The intrusive noise level refers to noise that intrudes above the background level by more than 5 dB.
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The A-weighted noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The A-weighted noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The A-weighted energy average noise level. This is the equivalent continuous sound pressure level over a given period. The $L_{Aeq(15\text{-}minute)}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
L_{Amax}	The maximum A-weighted sound pressure level received during a measurement interval.
Night period	Monday–Saturday: 10.00 pm to 7.00 am, on Sundays and public holidays: 10.00 pm to 8.00 am.
NMP	Noise management plan
PNTL	The project noise trigger levels (PNTLs) are targets for a particular industrial noise source or industry. The PNTLs are the lower of either the project intrusive noise level or project amenity noise level.
POEO Act	NSW *Protection of the Environment Operations Act 1997* (NSW)

Project and technical terms

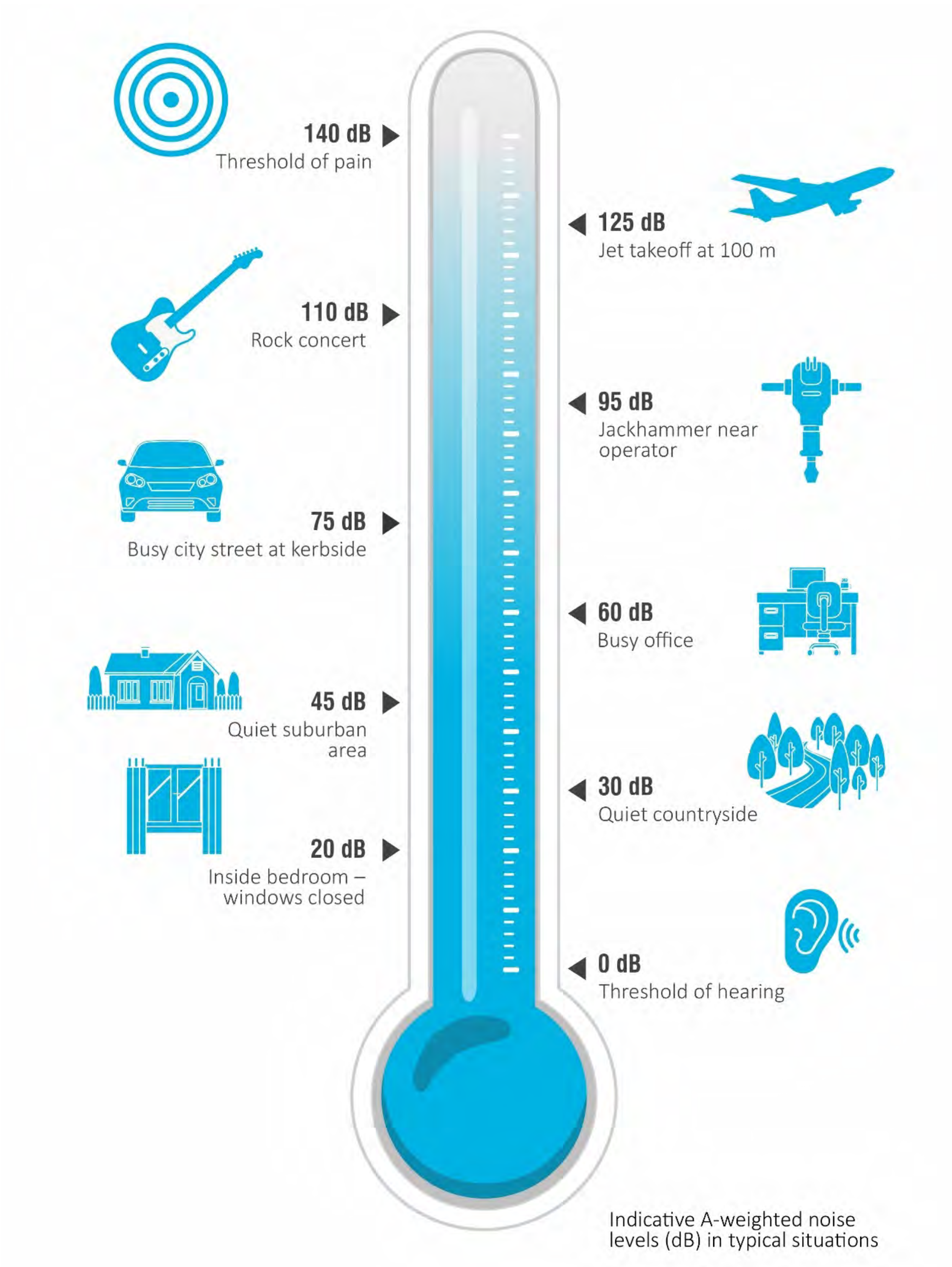
Term	Meaning
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
RNP	Road Noise Policy
Sound power level (L_w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.

Common noise levels

The table below gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels encountered on a daily basis are provided in the figure below.

Perceived change in noise

Change in sound level (dB)	Perceived change in noise
3	Just perceptible
5	Noticeable difference
10	Twice (or half) as loud
15	Large change
20	Four times as loud (or quarter) as loud



Source: Road Noise Policy (DECCW 2011)

Figure G.1 Common sources of noise with levels

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9
109 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1
T 604 999 8297

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au