Appendix O

Environmental Noise and vibration assessment

Kentbruck green power hub

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KENTBRUCK GREEN POWER HUB
ENVIRONMENTAL NOISE & VIBRATION ASSESSMENT

Rp 001 R04 20200682 | 16 July 2024

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Project: **Kentbruck Green Power Hub**
Environmental Noise & Vibration Assessment

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GLOSSARY OF ABBREVATIONS

Term	Abbreviation
Construction environmental management plan	CEMP
Environment Effects Statement	EES
Environment Protection Act 2017	EP Act
Environment Protection Authority Victoria	EPA
EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*	Noise Protocol
Environment Protection Regulations 2021	EP Regulations
Environment Reference Standard	ERS
General environmental duty	GED
Kentbruck Green Power Hub	The Project
Marshall Day Acoustics Pty Ltd	MDA
Mineral Resources (Sustainable Development) Act 1990	MRSD Act
NSW Department of Environment and Conservation	NSW DEC
NSW Roads and Maritime Service	NSW RMS
Neoen Australia Pty Ltd	The proponent
Noise management plan	NMP
Planning and Environment Act 1987	PE Act
Road Management Act 2004	RM Act
Victoria Planning Provisions	VPP

EXECUTIVE SUMMARY

This report provides an assessment of the potential noise and vibration levels associated with the construction, operation and decommissioning of the Kentbruck Green Power Hub (the Project) that is proposed to be developed by Neoen Australia Pty Ltd (the proponent).

The assessment is based on the proposed renewable energy project comprising up to one-hundred and five (105) wind turbines, one (1) main substation and three (3) collector substations (the Project).

Context

Construction of a renewable energy project will generate noise and vibration as a result of activities occurring both on and off the site of the proposed development. On-site works include a range of activities such as construction of access tracks, connection infrastructure, turbine foundations and erection of the turbines. Off-site noise generating activities primarily relate to heavy goods vehicle movements to and from the site. Construction of a renewable energy project mostly occurs at relatively large separating distances from noise sensitive receivers and, as proposed for the Project, the majority of the work would be limited to normal working hours. The only exceptions are for unavoidable works or low-noise managed-works. Unavoidable works outside of normal hours are expected to comprise the delivery of oversized turbine components at times selected to minimise traffic disruption associated with intersection closures, and potentially turbine installation activities that are sensitive to weather conditions (e.g. installation of rotors, turbine foundation pour, etc.).

For the above reasons, noise and vibration associated with the construction of a renewable energy project can usually be satisfactorily addressed through the inclusion of considerate working practices in a construction environmental management plan prepared for the Project. Decommissioning of a renewable energy project generally involves comparable or less intensive activities, and can therefore be acceptably managed in a similar manner to construction.

In addition to the activities directly associated with construction of a renewable energy project, noise will also be generated by an on-site quarry for construction rock that is proposed to be located on the wind farm site for the construction stage of the Project. The key noise generating activities associated with the proposed on-site quarry include excavation (mechanical extraction processes), rock crushing, material handling operations, heavy goods vehicle movements and a number of concrete batching plants. The on-site quarry would only be used during construction of the Project. However, the noise of the on-site quarry is assessed against requirements which apply to permanent extractive operations. The main methods of managing noise levels from the on-site quarry are based on considerate site selection, restriction of operations to daytime hours, and targeted mitigation measures, where required, such as screening and the selection of lower noise emission plant.

It is understood that blasting is not proposed as part of the construction method for the Project.

The key environmental noise consideration associated with the development of a renewable energy project is the operational stage of the Project, with the main sources of environmental noise being the wind turbines. The noise of a modern wind turbine is generally controlled by aerodynamic noise that is produced as the blades pass through the air. The mechanical components such as gearboxes within the turbine's nacelle can also be a source of noise, however modern turbines generally include specific design and construction measures to effectively suppress this type of noise. Mechanical noise is therefore not a typical characteristic of a correctly functioning modern wind farm at typical receiver distances. Substations are a secondary source of operational noise comprising the power transformers and, to a lesser extent, new overhead power lines in proximity to noise sensitive locations as a result of humid or windy conditions.

Operational noise from a renewable energy project is controlled through a combination of equipment selections and layout design directed at achieving acceptable noise levels as defined by relevant policies and guidelines.

Assessment requirements

The *Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement* (Scoping Requirements) set out the matters to be investigated and documented in the Environment Effects Statement (EES), and specifies the EES evaluation objectives.

Since the Scoping Requirements were issued for the Project, a new environmental noise management framework has come into effect (from 1 July 2021). Specifically, the *Environment Protection Act 2017* (EP Act) provides the overarching legislative framework for the protection of the environment in Victoria and establishes a general environmental duty (GED) to minimise the risks of harm to human health or the environment from pollution or waste, including noise, so far as reasonably practicable.

The GED applies to both the construction and operation stages of the Project. The obligations of the GED apply in parallel with guidelines and quantitative assessment criteria.

In accordance with the Scoping Requirements and the current legislative framework, the following methods have been used to quantitatively assess noise and vibration associated with the Project:

- Construction noise has been assessed in accordance with EPA Publication 1834.1 *Civil construction, building and demolition guide* (EPA Publication 1834.1), dated 12 September 2023, supplemented by relevant guidance

  EPA Publication 1834.1 supersedes the content of Section 2 from EPA Publication 1254, referenced in the Scoping Requirements.

- Construction vibration has been assessed in accordance with the NSW Roads and Maritime Service's publication *Construction Noise and Vibration Guideline* dated August 2016 (NSW RMS Construction Noise & Vibration Guideline), in lieu of any Victorian guidance.

- Operational wind turbine noise has been assessed in accordance with New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808) as required by the Victorian Department of Transport and Planning publication *Planning Guidelines for Development of Wind Energy Facilities* dated September 2023 (Victorian Wind Energy Guidelines) and the *Environment Protection Regulations 2021* (EP Regulations)

- Operational noise associated with the substations has been assessed in accordance with the EP Act, the EP Regulations and the EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol)

  The Noise Protocol superseded the EPA Publication 1411 *Noise from Industry in Regional Victoria* dated October 2011, referenced in the Scoping Requirements.

Noise and vibration assessment

The EES evaluation objective for the Kentbruck Green Power Hub with respect to noise and vibration is to manage potential adverse effects for noise sensitive locations, having regard to construction, operation and decommissioning of the Project.

A number of measures are to be used to control the potential adverse effects of noise and vibration at sensitive locations, and address regulatory requirements. With these measures in place, the noise assessment has determined the following:

- Noise generated by construction of the Project can be controlled in accordance with relevant Victorian guidelines provided by EPA Publication 1834.1, using a combination of restricted working hours and good practice working measures;
- Operation of the proposed wind turbines is predicted to result in noise levels below the criteria determined in accordance with NZS 6808 at noise sensitive locations;
- Operational noise levels from the Project's substations and on-site quarry are predicted below the Noise Protocol noise limits and, as such, are not prescribed to be unreasonable in accordance with the EP Regulations;
- The noise generated by decommissioning of the Project can be controlled using similar measures to those implemented for the construction of the Project; and
- Consideration was also given to the GED, as required by the EP Act, by implementing standard forms of engineering control such as selection of equipment with low sound power levels, appropriate site selection and standard noise mitigation treatment such as localised acoustic barriers.

The findings of the noise assessment therefore demonstrate that the proposed Kentbruck Green Power Hub achieves the EES evaluation objective on the basis that the Project can be demonstrated to comply with the requirements of the applicable Victorian policies and guidelines.

Mitigation measures

Based on the assessment findings, mitigation measures are recommended for the control of noise and vibration associated with construction and operation of the Project. The mitigation measures are summarised as follows:

- **MM-NV01:** establishes a requirement to prepare a construction noise and vibration management plan, including provisions for the preparation of a decommission plan.
- **MM-NV02:** establishes noise requirements for the design and operation of all concrete batching plants during construction of the Project.
- **MM-NV03:** establishes noise and vibration requirements for the design and operation of the quarries during construction of the Project.
- **MM-NV04:** establishes a requirement for a pre-construction assessment of operational noise associated with the Project's substations.
- **MM-NV05:** establishes a requirement for a pre-construction assessment of operational noise associated with the Project's wind turbines, based on the final wind farm layout and wind turbine model selection.
- **MM-NV06:** establishes a requirement to prepare a noise management plan (NMP) for operational wind turbine noise in accordance with the EP Regulations, and specifies additional obligations to document a schedule of early testing to verify that the noise emissions (sound power levels) of the installed turbines are consistent with the pre-construction noise assessment prepared under MM-NV05.
- **MM-NV07:** establishes a requirement to conduct post-construction noise monitoring in accordance with the EP Regulations and the NMP prepared under MM-NV06.
- **MM-NV08:** establishes a requirement to prepare annual statements in accordance with the EP Regulations and the NMP prepared under MM-NV06.
- **MM-NV09:** establishes a requirement to conduct regular noise monitoring in accordance with the EP Regulations and the NMP prepared under MM-NV06.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose of the report

This report has been prepared to address the environmental noise and vibration assessment requirements of:

- the *Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement* published by Minister for Planning in January 2020 (Scoping Requirements);
- the Victorian Department of Transport and Planning publication *Planning Guidelines for Development of Wind Energy Facilities* dated September 2023 (Victorian Wind Energy Guidelines); and
- the *Environment Protection Regulations 2021* (EP Regulations).

This report assesses the potential noise and vibration impacts associated with the construction, operation and decommissioning of the Kentbruck Green Power Hub (the Project) and identifies Environmental Performance Requirements suitable to address these impacts.

The assessment is based on determining whether the noise and vibration impact of the Project will be acceptable in planning terms, based on criteria provided by relevant Victorian policies and guidelines which are intended to provide a balance between protecting the amenity of neighbouring noise sensitive locations and enabling the development of new infrastructure.

The assessment considers noise and vibration levels which may be experienced by people at noise sensitive receivers (receivers) around the Project. The potential effects of noise from the Project on fauna are addressed in a separate specialist study.

Acoustic terminology used in this report is presented in Appendix A.

General information about the definition of sound and the ways that different sound characteristics are described is also presented in Appendix B.

1.2 Project description

The Project involves the establishment of a renewable energy project comprising a wind energy facility (wind farm) with four (4) substations. The Project would be mostly located in an actively managed and harvested pine plantation in southwest Victoria, between Portland and Nelson, within the local government area of the Glenelg Shire Council.

The Project would involve two main components:

- A wind farm of up to 600 MW comprising up to one-hundred and five (105) wind turbines and associated permanent and temporary infrastructure.
- A new 275 kV underground transmission line, which would connect the Project to the existing AusNet electricity transmission network. The transmission line would extend from the eastern boundary of the wind farm site to the existing 275/500 kV Heywood Terminal Station and would be up to 26.6 km in length.

  During earlier stages of development, four (4) transmission line options were considered by the proponent to connect the Project to the transmission network. An assessment of noise and vibration associated with the transmission line options, considering operational noise from the substations and construction noise and vibration, is presented in Appendix L.

Permanent infrastructure to be constructed as part of the Project would include:

- Up to one-hundred and five (105) wind turbines, each with a capacity of 4 to 8 MW, tip height of up to 270 metres, rotor diameter of up to 190 metres and minimum distance of rotor tip above ground level of 60 metres;
- Access roads, including:
  - Public roads for site access. Existing site access routes into the commercial forestry operation would be utilised to minimise the need for new site entrances. Some public roads and intersections would need to be upgraded to facilitate delivery of Project components, particularly wind turbine blades.
  - Internal access roads. Existing access tracks within the commercial forestry operation and on land currently used for agricultural purposes would be used where possible. Some of these roads and intersections may need to be upgraded.
- Up to eight (8) meteorological monitoring masts within the wind farm site
- Permanent hardstand areas at each turbine location, with a footprint of approximately 0.4 ha, subject to refinement based on the dimensions of the final wind turbine model selected
- Three (3) collector substations
- Underground powerlines connecting the wind turbines to the collector substations
- One (1) main wind farm substation to which all the collector substations would be connected. The main substation would connect the wind farm to the existing electricity transmission network via a new transmission line.
- A high voltage powerline connecting the collector substations to the main substation, which would be a combination of overhead and underground cabling
- Transition stations at which the high voltage powerline would transition from overhead to underground or vice versa (if needed; see below)
- Up to two (2) permanent site compounds, including thirty (30) carparking spaces at each location.

Temporary infrastructure associated with construction of the wind farm would include:

- Up to three (3) concrete batching plants
- Laydown areas with a footprint of approximately 0.6 ha located at each turbine
- Up to six (6) construction compounds, each containing a site office, carparking, storage, amenities, and a workshop.

Site maps presenting the assessed wind turbines, substations, receivers and construction activities are presented in Figure 1 to Figure 3.

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Figure 1: Site map of proposed wind turbines, substations and receivers

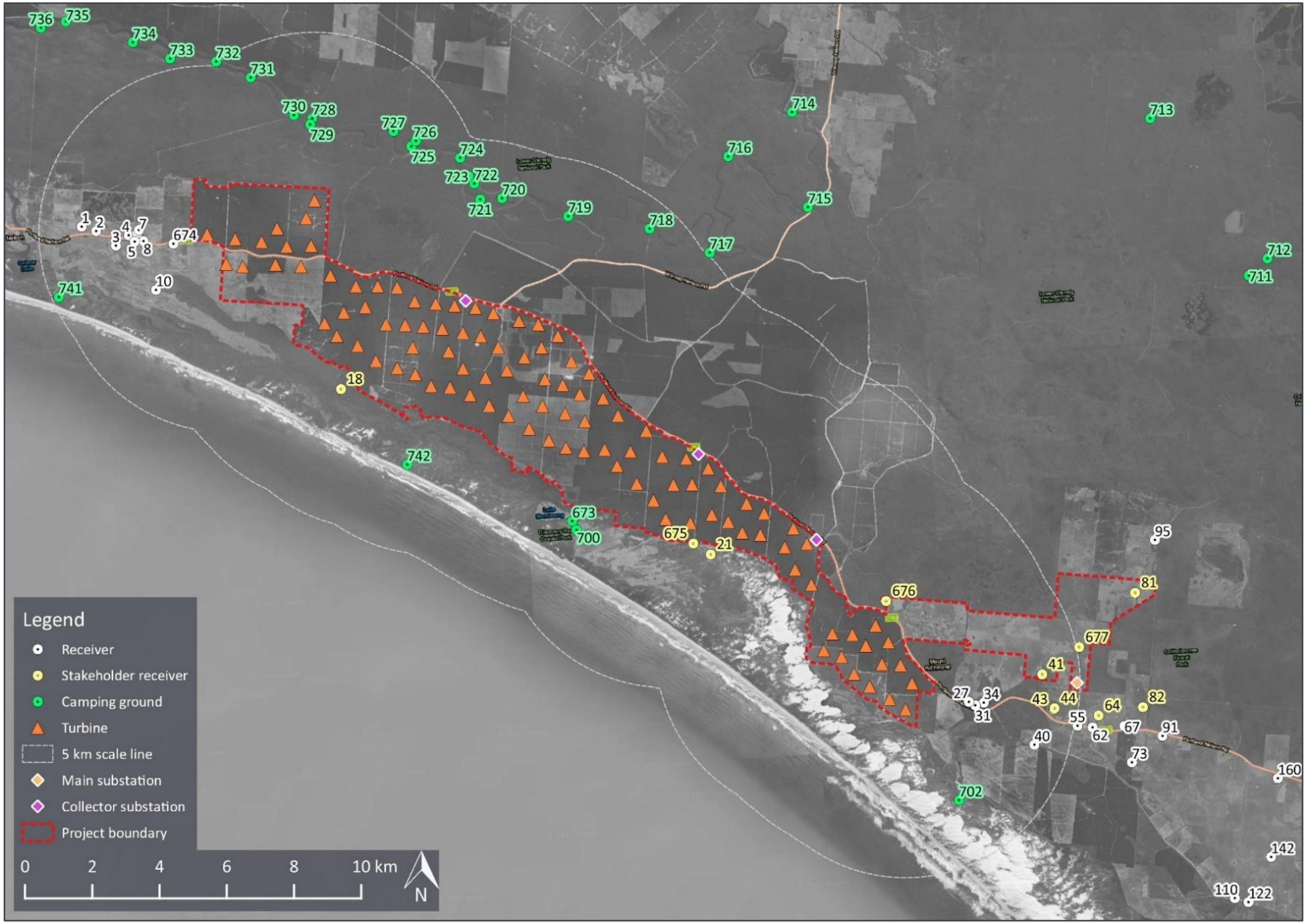
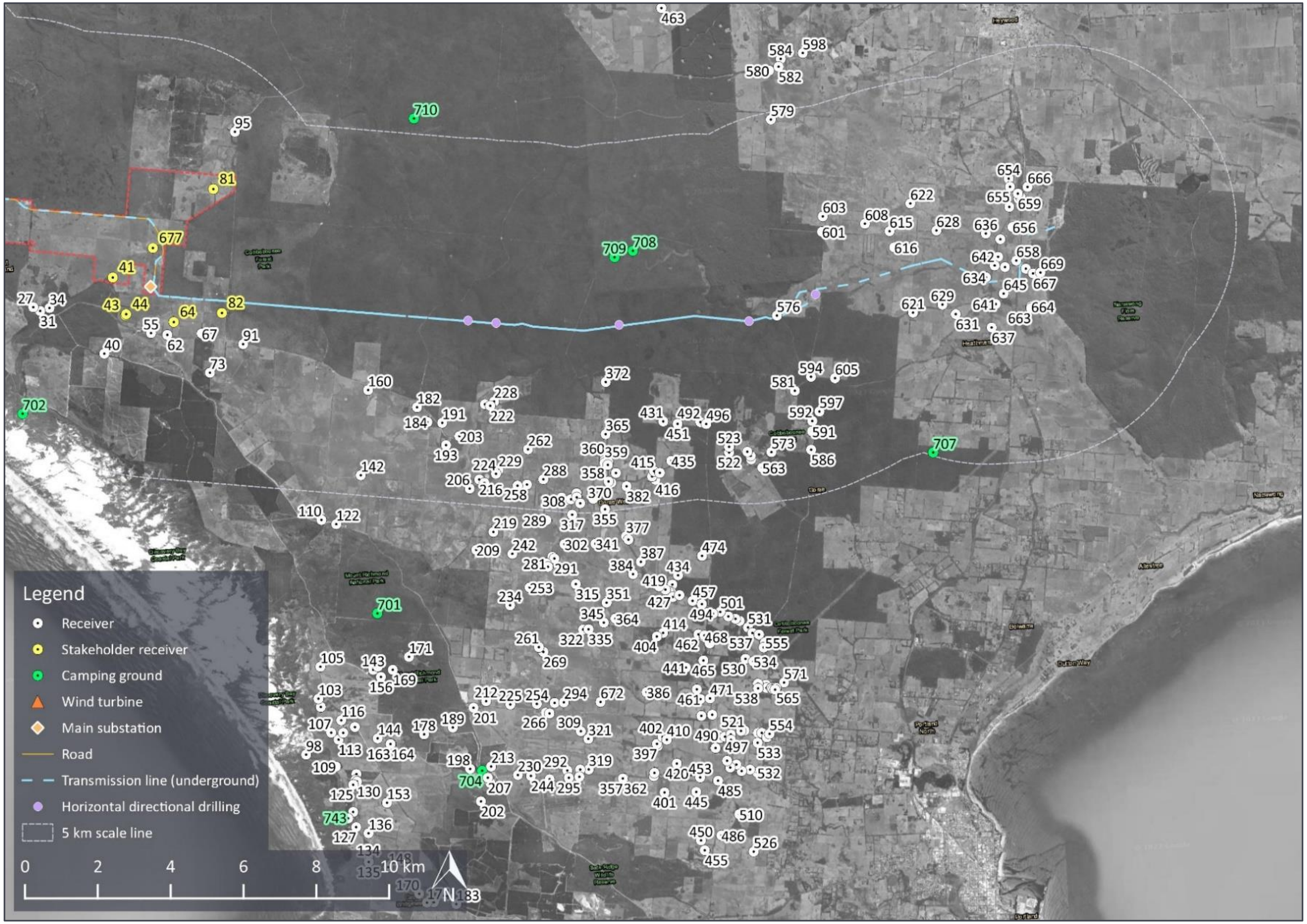


Figure 2: Site map of proposed construction activities and receivers – wind farm area

Figure 3: Site map of proposed construction activities and receivers – transmission line area



2.0 SCOPING REQUIREMENTS

This section reproduces the noise related elements of the Scoping Requirements which specify the EES evaluation objectives and set out the matters to be investigated and documented in the Environment Effects Statement (EES), and specifies the EES evaluation objectives.

2.1 EES evaluation objectives

The following extract from the Scoping Requirements' evaluation objectives is relevant to noise. The evaluation objective identifies the desired outcomes in the relation to the potential noise and vibration effects of the Project.

Table 1: EES evaluation objective including matters relating to noise

Objective	Key legislation
Community amenity, roads and transport. To avoid and minimise adverse effects for community amenity and safety, with regard to construction noise, vibration, dust, traffic and transport, operational turbine noise and fire risk management.	EP Act[1] PE Act[2] RM Act[3] MRSD Act[4]

2.2 Scoping requirements

The following extracts from Section 4.6 of the Scoping Requirements are relevant to the evaluation objective for noise.

Table 2: Scoping requirements related to noise

Aspect	Detail
Key issues	Potential for adverse effects on noise and vibration amenity at sensitive receptors during construction, operation and decommissioning (including on-site quarry).
Existing environment	Characterise the ambient noise environment and its values in adjacent established residential, farming zone, commercial and open space areas and at other sensitive land use and high amenity locations. Identify sensitive receptors within 3 km of wind turbines, associated infrastructure and on-site quarry and concrete batching plants that may be subject to effects to amenity from the Project including, but not limited to, residential dwellings and visitor accommodation (including camping grounds).

[1] *Environment Protection Act 2017*
(*Environment Protection Act 1970* at the time when the Scoping Requirements were issued)

[2] *Planning and Environment Act 1987*

[3] *Road Management Act 2004*

[4] *Mineral Resources (Sustainable Development) Act 1990*

Aspect	Detail
Likely effects	Assess the potential effects of the Project on noise and vibration amenity at sensitive receptors, including information that addresses: ○ how the noise associated with construction of the wind farm will be managed in accordance with relevant guidelines, such as EPA Victoria's *Noise Control Guidelines Publication 1254* and *Noise from Industry in Regional Victoria Publication 1411*; and ○ how the operational wind farm noise will be managed in accordance with relevant guidelines, including Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria, *NZS 6808:2010 Acoustics – Wind Farm Noise* and EPA Victoria's *Noise from Industry in Regional Victoria Publication 1411*. Assess the potential noise and vibration (ground and airborne) effects from the proposed on-site quarry activities on sensitive receptors in accordance with guidelines, such as *The Guidelines for Ground Vibration and Airblast Limits for Blasting in Mines and Quarries*.
Mitigation measures	Describe and evaluate both potential and proposed design responses and/or other mitigation measures (e.g. staging/scheduling of works) which could minimise noise and vibration during construction, operation and decommissioning.
Performance objectives	Describe proposed measures to manage and monitor effects on amenity values and identify likely residual effects, including compliance with standards and proposed trigger levels for initiating contingency measures. Describe contingency measures for responding to unexpected impacts to amenity values resulting from the Project during construction, operation and decommissioning.

Since the Scoping Requirements for the Project were issued, a new environmental noise management framework has come into effect in Victoria (from 1 July 2021).

Where documents referenced in the Scoping Requirements have been superseded, the relevant documents applicable at the time of preparing this report have been used for this assessment. These are discussed in the following section.

3.0 LEGISLATION, POLICY AND GUIDELINES

Legislation and policies for the control of noise are defined by state governments in Australia.

In Victoria, the *Environment Protection Act 2017* (EP Act) provides the overarching legislative framework for the protection of the environment in Victoria.

The EP Act establishes a general environmental duty to minimise the risks of harm to human health or the environment from pollution or waste, including noise related amenity impacts, so far as reasonably practicable.

The EP Act also prohibits the emission of unreasonable noise. Specifically, the EP Act states that:

> *A person must not, from a place or premises that are not residential premises—*
>
> *(a) emit an unreasonable noise; or*
>
> *(b) permit an unreasonable noise to be emitted*

Under the EP Act, unreasonable noise means noise that:

> *(a) is unreasonable having regard to the following—*
>
> > *(i) its volume, intensity or duration;*
> >
> > *(ii) its character;*
> >
> > *(iii) the time, place and other circumstances in which it is emitted;*
> >
> > *(iv) how often it is emitted;*
> >
> > *(v) any prescribed factors; or*
>
> *(b) is prescribed to be unreasonable noise:*

Further information about noises that are prescribed to be unreasonable is separately defined in regulations made under the EP Act.

The *Environment Protection Regulations 2021* (EP Regulations) give effect to the EP Act by establishing prescriptive requirements for a range of environmental considerations including noise.

The noise requirements are defined according to the type of noise generating activity under consideration, and include definitions such as the types of noise sensitive areas where these requirements apply and assessment time periods.

Clause 52.32 of the Glenelg Planning Scheme also sets the framework for the assessment of proposed wind energy facilities in the Glenelg Shire Council.

Detailed guidance relevant to the management of noise associated with construction and operation of renewable energy projects in rural Victoria is provided by the policies and guidelines summarised in Table 3. The assessment requirements that are specific to wind energy facilities are consistent with assessment framework defined in the Glenelg Planning Scheme.

At the planning stage of a renewable energy project, these policies and guidelines are used to assess whether the Project could be constructed and operated in accordance with the recommendations and, where relevant, achieve objective criteria which apply at receivers in the vicinity of the Project.

Table 3: Key policy and guidance

Policy / guidance	Relevance and implications for the Project
EPA Publication 1834.1 *Civil construction, building and demolition guide*, dated 12 September 2023 (EPA Publication 1834.1)	This publication describes recommended measures for managing noise and vibration which are applicable to construction of the Project. One of the primary measures is to restrict the hours of the works wherever possible. The publication also provides guidance for situations when construction activity outside normal working hours may be justified, and noise restrictions that subsequently apply in these situations. The planning permit conditions could define EPA Publication 1834.1 as the relevant guidance which must be referenced to prepare a construction environment management plan. Noise during construction of the Project would then need to be controlled in accordance with this publication.
Planning Guidelines for Development of Wind Energy Facilities dated September 2023 (Victorian Wind Energy Guidelines)	Specifies that potential operational noise levels associated with proposed wind farm developments are to be assessed in accordance with NZS 6808:2010 *Acoustics – Wind farm noise*.
EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*, dated 20 May 2021 (Noise Protocol)	Defines noise limits for the assessment of operational noise levels from the Project's substations, on-site quarry and concrete batching plants which would operate during the construction of the Project.
Environment Reference Standard, dated 25 May 2021 (ERS)	The ERS sets out environmental values for ambient sound that are sought to be achieved and maintained in Victoria and standards to support those values. The indicators and objectives within the standard provide a benchmark for comparing desired outcomes to the actual state of the environment, and a basis for assessing actual and potential risks to the environmental values. The purpose of the Environment Reference Standard (ERS) is to provide assessment and reporting benchmarks for environmental values. There are a range of circumstances in which the EPA or other regulatory decision makers are to consider the ERS, according to legislated requirements. Depending on the approval process and circumstances, this may include proposals for new development. The ERS is primarily relevant for aspects of the environment that are not the subject of prescriptive regulation. These aspects include the noise from commercial premises and construction activities in natural areas, or the additional noise from public roads as a result of traffic associated with commercial activities. Further, in the situations where the ERS is a relevant consideration, it is important to note that the ERS is not a compliance standard. Specifically, the values listed within the ERS are not prescribed noise limits, nor are they design criteria for proposed development

Further details of these policies and guidelines are provided in Appendix C of this report.

4.0 NOISE SENSITIVE LOCATIONS

The study area for this assessment includes all noise sensitive locations, including a number of camping grounds, (generally referred to as *receivers* within this report) identified by the proponent within 5 km of the proposed wind turbines and 2 km of any proposed construction activities. The study area also accounts for receivers located along local traffic routes which may be used by construction traffic associated with the Project and natural areas in accordance with the ERS.

As detailed in Section C4.2 of Appendix C, NZS 6808 requires that the wind turbine noise assessment be undertaken at all noise sensitive locations in the vicinity of the proposed wind farm which it defines as follows:

> *The location of a noise sensitive activity, associated with a habitable space or education space in a building not on the wind farm site. […]*
>
> *In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights.*

Further, based on the above definitions and statutory context detailed in Section C4.2 of Appendix C, NZS 6808 only applies to the assessment of wind turbine noise levels at receivers that are not stakeholders, as defined in Section C2.1 and Section C3 of Appendix C (i.e. receivers within the Project boundary and/or with a noise agreement).

Noise sensitive locations therefore include residential dwellings and camping grounds located outside the Project boundary.

A total of forty (40) receivers were identified by the proponent within 5 km of the proposed wind turbines, comprising the following:

- Thirty-four (34) non-stakeholder receivers on properties that are not associated with the Project, comprising:
  - Fifteen (15) residential dwellings; and
  - Nineteen (19) designated camping grounds.
- Six (6) residential dwellings on properties that are associated with the wind farm (referred to as *stakeholder receivers* herein) including:
  - Two (2) receivers within the Project boundary (Receivers 41 and 676);

    Receiver 676 is an abandoned dwelling owned by a landowner involved with the Project.
  - Two (2) receivers outside the Project boundary where a noise agreement is proposed between the landowner and the proponent (Receivers 21 and 675); and
  - Two (2) receivers outside the Project boundary which have been identified as hosts for either substation or underground cable easements (Receivers 43 and 44).

The construction noise and vibration assessment considers fifty-seven (57) receivers identified by the proponent within 2 km of proposed construction activities, including nine (9) stakeholder receivers and two (2) camping grounds.

In contrast to the assessment of wind turbine noise in accordance with NZS 6808, the assessment of construction noise and vibration levels and operational noise levels from the substations do not differentiate between stakeholder and non-stakeholder receivers.

Furthermore, the relevant types of noise sensitive locations in NZS 6808 are generally consistent with that of noise sensitive areas in the EP Regulations (e.g. inclusion of camping grounds).

The coordinates of all assessed receivers within 5 km of the proposed turbines and within 2 km of construction activities are provided in Appendix F. These receivers are also presented in the site plan provided in Figure 1 to Figure 3 of Section 1.2, together with receivers beyond.

5.0 EXISTING NOISE ENVIRONMENT

Preliminary noise modelling of an earlier wind farm layout, consisting of one hundred and fifty-seven (157) turbines, was undertaken to determine whether background noise monitoring was warranted in accordance with NZS 6808 and, if so, the locations where noise monitoring should be undertaken.

Background noise monitoring was subsequently undertaken at five (5) receivers in the vicinity of the proposed Project, between 19 May and 13 July 2021. Analysis and results of the survey are detailed in MDA Report Rp 002 R03 20200682 *Kentbruck Green Power Hub – Background noise monitoring*, dated 16 July 2024 (Background Noise Report).

The monitoring locations included two (2) substitutes for receivers 10 and 673 where background noise monitoring was not able to be carried out for the following reasons:

- Receiver 10: consent to undertake background noise monitoring was not granted at this receiver.

  An alternative monitoring location was selected to the north of Receiver 10 within an empty paddock with limited vegetation, at a similar distance to the nearest proposed turbines. This monitoring location is referred to herein as *Receiver 10 proxy*.

  With the current wind farm layout, wind turbine noise levels at Receiver 10 are predicted to be below 35 dB L_{A90} and, as such, background noise monitoring would no longer be required in accordance with NZS 6808.

  However, since the background noise monitoring was undertaken, an additional receiver (Receiver 674) was identified closer to the wind turbines, where wind turbine noise levels are predicted above 35 dB L_{A90}. Receiver 674 is located approximately 1.5 km north of Receiver 10 and approximately 530 m to the northeast of Receiver 10 proxy.

  A range of factors contribute to the background noise levels in the area, including coastal noise, wind disturbed vegetation, fauna and road traffic noise at some locations. Given the distance between these locations, background noise levels are likely to be materially different at Receiver 674 and Receiver 10 Proxy. However, given the proximity of Receiver 674 to Portland Nelson Road, on balance the background noise at Receiver 674 is likely to be comparable to, or higher than, the levels measured at Receiver 10 proxy. The measured background noise levels at Receiver 10 proxy therefore provide a conservative representation of the background noise for Receiver 674.

- Receiver 673: a secure location for the noise monitoring equipment was not available within the camping ground.

  An alternative monitoring location was selected to the north of the camping ground on the edge of the pine plantation, between Receiver 673 and the proposed wind turbines near to the 40 dB L_{A90} noise contour. This monitoring location is referred to herein as *Receiver 673 Int*.

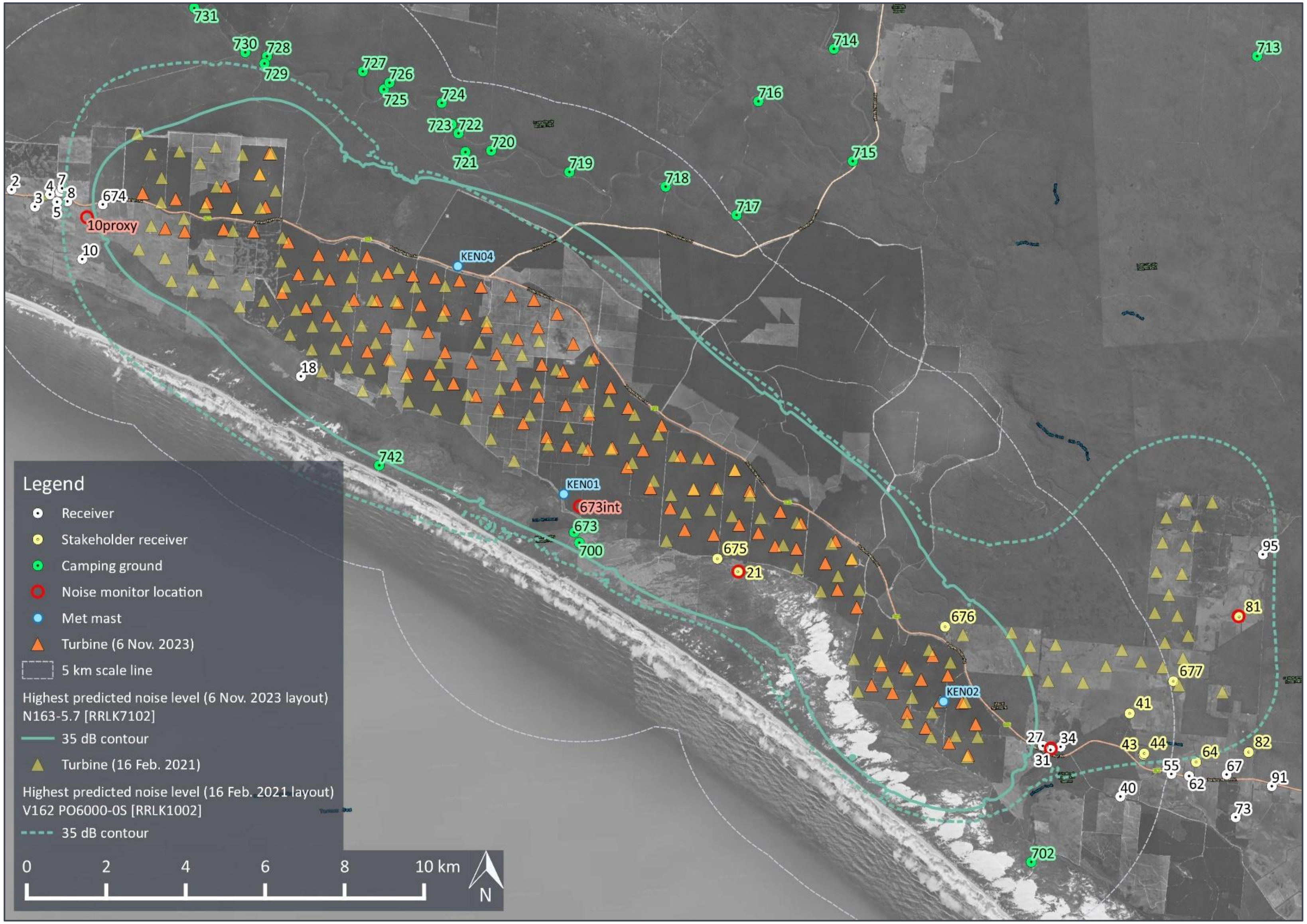
  A range of factors can vary background noise levels between locations around this area such as increased distance from coastal noise but closer distance to trees. However, this was identified as the most suitable and secure location available for obtaining a representation of a similar environment.

The monitoring locations also included two (2) other receivers where background noise monitoring would no longer be required in accordance with NZS 6808:

- Receiver 21: now identified as a stakeholder where a noise agreement is proposed between the landowner and the proponent; and
- Receiver 81: now located approximately 7.2 km from a proposed wind turbine, outside the 5 km study area.

The background noise monitoring locations are presented in Figure 4 with the current wind farm layout and the earlier wind farm layout, used to inform the survey, together with the respective 35 dB L_{A90} noise contours.

Figure 4: Background noise monitoring locations



Consistent with common practice for wind farm noise assessments in Victoria, the background noise levels have been separately analysed for the all-time (day and night combined) and night period or when separate trends were identified. The tabulated data presented in Table 4 summarises the background noise levels determined in accordance with NZS 6808 for the all-time and night period for all monitored receivers except from Receiver 673 Int (discussed separately below).

The data in the following tables is provided for the valid range of key wind speeds relevant to the assessment of wind farm noise. The results for all surveyed wind speeds are illustrated in the graphical data provided for each receiver location in the appendices of the Background Noise Report.

Table 4: Background noise levels at all monitoring locations excluding Receiver 673 Int, dB L_{A90}

Receiver	Hub height wind speed, m/s												
	3	4	5	6	7	8	9	10	11	12	13	14	15
All-time period													
10 proxy [1]	26.4	27.5	28.4	29.1	29.5	29.8	30.0	30.1	30.1	30.3	30.4	30.7	31.2
21 (S) [2]	26.8	27.9	28.8	29.5	30.1	30.5	30.9	31.2	31.6	32.0	32.5	33.2	34.0
31 [3]	30.5	30.5	30.7	31.1	31.7	32.4	33.3	34.2	35.1	36.0	36.9	37.6	38.3
81 (S) [3, 4]	*26.5*	*27.3*	*28.1*	*29.0*	*29.8*	*30.6*	*31.4*	*32.1*	*32.8*	*33.5*	*34.1*	*34.7*	*35.1*
Night period													
10 proxy [1]	- [5]	- [5]	- [5]	- [5]	- [5]	- [5]	- [5]	- [5]	28.1	28.3	28.7	29.1	29.7
21 (S) [2]	- [5]	- [5]	- [5]	- [5]	- [5]	31.4	31.4	31.4	31.6	32.0	32.4	33.1	33.8
31 [3]	- [5]	- [5]	- [5]	30.2	30.2	30.5	31.1	31.9	33.0	34.1	35.3	36.4	37.4
81 (S) [3, 4]	*24.7*	*25.3*	*26.0*	*26.7*	*27.4*	*28.2*	*28.9*	*29.7*	*30.5*	*31.2*	*31.9*	*32.6*	*33.2*

(S) Stakeholder receiver

1 KEN04 met mast – 165 m above ground level at 513762 E, 5786178 N (MGA 94 Zone 54)

2 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

3 KEN02 met mast – 165 m above ground level at 525250 E, 5774470 N (MGA 94 Zone 54)

4 Background noise levels at Receiver 81 are only provided for information as this receiver is no longer located within 5 km of a proposed wind turbine

5 Outside valid range of regression analysis

In relation to Receiver 673 Int, the analysis for this location presented in the Background Noise Report identified unique trends according to time of day and wind direction. As a result, the data for this location was separately assessed for the periods 0700-1700 hrs and 1700-0700 hrs, excluding wind directions ranging from westerlies through to northeasterlies (between 270 and 45°) when noise levels were found to be elevated (noting these directions correspond to downwind conditions from the proposed wind turbine locations, but may relate to factors associated with a pine plantation). Even with these subgroups, the retained data for the night period at Receiver 673 Int still indicates elevated noise levels at low wind speeds. Listening studies for a sample of these elevated data points indicated clearly audible coastal noise which is likely to be a regular feature of the ambient noise environment. However, in recognition of these variations, and the available monitoring location being away from Receiver 673, the background noise levels determined from Receiver 673 Int are provided in Table 5 for indicative purposes only.

Table 5: Indicative background noise levels at Receiver 673 Int, dB L_{A90} - excluding wind directions between 270 and 45°

Time period	Hub height wind speed, m/s [1]												
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
0700-1700 hrs	30.3	31.5	32.8	34.0	35.2	36.4	37.6	38.9	40.1	41.3	42.5	43.7	45.0
1700-0700 hrs	- [2]	- [2]	- [2]	- [2]	- [2]	37.0	37.4	38.0	38.9	40.0	41.2	42.6	44.1

1 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

2 Outside valid range of regression analysis

6.0 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT – CONSTRUCTION ACTIVITY

This section presents an assessment of noise and vibration from the majority of the proposed construction activities. The exception is the on-site quarry and concrete batching plants which are assessed separately in Section 7.0.

6.1 Assessment guidelines

6.1.1 EPA Publication 1834.1

Guidelines for noise and vibration from construction and demolition works are detailed in EPA Publication 1834.1 *Civil construction, building and demolition guide*, dated 12 September 2023.

EPA Publication 1834.1 reflects the general environmental duty introduced by the EP Act, and reiterates the requirement to eliminate or reduce noise and vibration risks associated with construction activity as far as reasonably practicable.

Section 4.1.1 of EPA Publication 1834.1 states the following:

> *Noise from civil construction, building and demolition activities can adversely affect the health and wellbeing of people and animals (considered to be sensitive receivers) when not managed appropriately.*

As well as causing annoyance, environmental noise and vibration is now recognised as a public health issue that can have serious or long-term health impacts which may include:

- inability to sleep or reduced quality of sleep;
- impaired communication;
- reduced cognitive performance (e.g. reduced attention span, memory and concentration in people working and children studying);
- exacerbation of mental health problems (e.g. stress, anxiety and depression);
- changes to the natural behaviour of animals, which affects their ability to survive and reproduce (e.g. reduced ability to hear alarm calls warning of predators); and
- discomfort caused by vibration.

In extreme cases, vibration may also result in damage to buildings and infrastructure.

EPA Publication 1834.1 indicates that noise and vibration should be minimised at all times, and that limiting the times when noisy equipment is used is an effective way of reducing noise and vibration impacts. The guidance also notes that the primary way of minimising the likelihood of noise and vibration causing harm is to limit the frequency of occurrence and its duration. This applies especially when noise and vibration are likely to have a greater impact.

EPA Publication 1834.1 sets out definitions for normal working hours to inform project planning. The guidance states that projects should aim to constrain works to normal working hours.

However, where necessary, EPA publication 1834.1 states that works or activities outside normal working hours may occur for:

- Low-noise impact works which are inherently quiet or unobtrusive and do not have intrusive characteristics;
- Managed-impact works which are controlled through actions specified in a noise and vibration management plan and do not have intrusive characteristics; and
- Unavoidable works that cannot practicably be restricted to normal working hours, due to safety or practical constraints.

EPA Publication 1834.1 states that approval from the relevant authority may be required for justified works outside or normal hours.

Where there is justified out of hours work, which includes low-noise impacts works and managed-impact works, EPA Publication 1834.1 states that the activities are required to follow an outside of normal working hours schedule which specifies noise level restrictions.

For the evening period, these restrictions are defined in terms of an objective criterion related to background noise levels. For the night period, the noise restriction is defined in terms of an inaudibility requirement.

The level of construction noise that corresponds to inaudibility will depend on a range of variables such as the level and character of construction noise, the level and character of the background sound and the hearing threshold of the individual observing the noise. EPA Publication 1834.1 states that inaudibility *is not* meant to be a measurable criterion in dB, it states the following:

> *to predict construction noise, a reference level set at background level +0 dB could be used as a suitable reference level for inaudible. Where this approach is used apply adjustments to consider the potential character of the noise'.*

This approach should therefore only be used to inform the risk assessment regarding the scheduling of works and not for compliance purposes.

The normal working hours and the restrictions that apply to justified construction activity during the evening and night are summarised in Table 6.

Table 6: EPA Publication 1834.1 – construction noise guidance summary

Period	Day of the week	Time Period	Construction activity up to 18 months	Construction activity after 18 months
Normal working hours	Monday – Friday	0700-1800 hrs	Receiver limits do not apply – noise requirements are defined in terms of emission and managerial controls	
	Saturday	0700-1300 hrs		
Weekend/evening work hours	Monday – Friday	1800-2200 hrs	Noise to be less than 10 dB above background (L_{A90}), outside residential dwelling	Noise to be less than 5 dB above background (L_{A90}), outside residential dwelling
	Saturday	1300-2200 hrs		
	Sundays and Public Holidays	0700-2200 hrs		
Night period	Monday – Sunday	2200-0700 hrs	Noise from construction activities must be inaudible inside a habitable room with windows open	

For measurement-based assessments, EPA Publication 1834.1 specifies that construction noise should be assessed as an L_{Aeq} and compared to the background noise at the time of impact. Both construction and background noise should be measured for a period that is representative at the time of impact (a minimum of 5 minutes). If the construction noise contains tonal or impulsive characteristics, an adjustment of 2 to 5 dB applies for each characteristic according to their prominence.

6.1.2 Construction vibration guidelines

There is no standard or regulation that specifies criteria for the control of construction vibration levels in Victoria.

In lieu of Victorian guidance for construction vibration, reference is made to the NSW Roads and Maritime Service's publication *Construction Noise and Vibration Guideline* dated August 2016 (NSW RMS Construction Noise & Vibration Guideline).

Section 7.1 of the NSW RMS Construction Noise & Vibration Guideline sets out minimum working distances from sensitive receivers for typical items of vibration intensive plant. The minimum distances are quoted for effects relating to cosmetic damage and human comfort, based on guidance contained in BS 7385-2:1993[5] and the NSW Department of Environment and Conservation publication *Assessing Vibration: A Technical Guideline* dated February 2006 (NSW DEC Vibration Guideline), respectively.

The minimum working distances are reproduced below in Table 7.

Table 7: Recommended minimum working distances for vibration intensive plant from sensitive receivers (reproduced from Table 2 of Section 7.1 of the NSW RMS Construction Noise & Vibration Guidelines)

Plant item	Rating / Description	Minimum working distance	
		Cosmetic damage	Human response
Vibratory roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m 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
Small hydraulic hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	2 m

The NSW RMS Construction Noise & Vibration Guideline notes that the minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. The guideline also notes the values are defined in relation to cosmetic damage of typical buildings under typical geotechnical conditions, and recommends vibration monitoring to confirm the minimum working distances at specific sites.

[5] BS 7385-2:1993 *Evaluation and measurement for vibration in buildings - Guide to damage levels from groundborne vibration*

In relation to human comfort, the NSW RMS Construction Noise & Vibration Guideline notes that the minimum working distances relate to continuous vibration. The guideline further notes that for most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed.

The data in Table 7 indicates that the minimum working distances for human comfort are significantly greater for than for the avoidance of cosmetic damage. This is based on the thresholds for human exposure to vibration being generally well below accepted thresholds for minor cosmetic damage to lightweight structures.

The NSW DEC Vibration Guideline presents preferred and maximum vibration criteria for use in assessing human response to vibration.

The acceptable values of human exposure to vibration are dependent on, among other things, the time of day. This assessment only considers the period in which construction is expected to normally occur (i.e. 0700-1800 hrs Monday to Friday and 0700-1300 hrs on Saturday).

The vibration criteria are separately specified for the following types of vibration characteristics:

- Continuous: vibration that continues uninterrupted for a period such as the duration of a day
- Impulsive: vibration that comprises a rapid build up to a peak followed by several cycles of progressively reducing vibration
- Intermittent: vibration that comprises interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly.

The types of activities associated with the construction of a wind farm may include both continuous and impulsive vibration sources operating over interrupted periods of a working day. It is therefore expected that vibration would be typically classified as intermittent according to the NSW DEC Vibration Guideline, but may be continuous or impulsive on occasion.

Table 8 summarises the preferred and maximum values for acceptable human exposure to continuous and impulsive vibration. It is noted that the NSW DEC Vibration Guideline provides criteria for the assessment of continuous and impulsive vibration in the form of the weighted acceleration values. Given that empirical vibration data is more readily available in the form peak particle velocity (PPV) data, the criteria are reproduced here in the form of equivalent PPV values sourced from Appendix C of the NSW DEC Vibration Guideline. This is consistent with related guidance contained in BS 5228-2:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Vibration* (BS 5228-2) which states:

> *… for construction, it is considered more appropriate to provide guidance in terms of the PPV, since this parameter is likely to be more routinely measured based upon the more usual concern over potential building damage. Furthermore, since many of the empirical vibration predictors yield a result in terms of PPV, it is necessary to understand what the consequences might be of any predicted levels in terms of human perception and disturbance.*

Table 8: Preferred and maximum values for vibration during daytime (mm/s) 1-80Hz (PPV) – Residences

Type	Preferred Values	Maximum Values
Continuous	0.28	0.56
Impulsive	8.6	17

Table 9 summarises the preferred and maximum values for acceptable human exposure to intermittent vibration. The NSW DEC Vibration Guideline recommends the assessment of intermittent vibration on the basis of a more complex parameter referred to as the vibration dose value (VDV) which relates vibration magnitude to the duration of exposure.

Table 9: Vibration dose values for intermittent vibration during daytime ($m/s^{1.75}$) 1-80Hz

Location	Preferred Values	Maximum Values
Residences	0.2	0.4

6.1.3 Construction traffic noise

There is no Victorian guidance document in relation to the assessment of construction traffic noise levels on public roads.

In the absence of Victorian guidance in relation to the assessment of construction traffic noise levels on public roads, and to provide an indication of potential impact from traffic associated with the construction of the wind farm, construction traffic noise levels have been estimated in accordance with British Standard BS 5228-1:2009.

6.2 Construction hours

The majority of the construction works associated with the Project are proposed to be restricted to normal working hours as defined by EPA Publication 1834.1:

- Monday to Friday: 0700 – 1800 hrs
- Saturday: 0700 – 1300 hrs

In accordance with EPA Publication 1834.1, construction activities that are justified as low-noise, managed or unavoidable works may occur outside normal working hours.

Unavoidable works outside of normal hours are expected to comprise the delivery of oversized turbine components (turbine blades) at times selected to minimise traffic disturbance on surrounding roads, foundation concrete pours during hot days, and may potentially include turbine installation activities that are sensitive to weather conditions (e.g. installation of rotors). No other unavoidable works outside of normal hours are anticipated at this stage in the project. In the event of any other unavoidable works being identified during the detailed construction planning for the Project, these would need to be documented in the construction environmental management plan (CEMP) for the Project.

6.3 Construction noise sources

It is anticipated that a variety of construction equipment would be used for the Project.

Sound power levels for the proposed construction equipment have been determined based on noise level data from previous projects of a similar nature together with data sources including Australian Standard AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* (AS 2436).

Table 10 summarises the noise emissions used to represent key items of plant associated with construction.

Table 10: Construction noise sources sound power data, dB L_{WA}

Noise source	Sound power level
Bulldozer	108
Concrete pump	108
Concrete truck	108
Crane (1,200 t)	115
Crane (200 t)	105
Crane (500 t)	110
Delivery truck	107
Dump truck	117
Excavator	110
Generator	99
Grader	110
Vibratory roller	108

Overall aggregated total sound power levels for key construction tasks have been determined on the basis of an indicative schedule of equipment associated with each task. The actual equipment choices and equipment numbers for each task are not presently defined in detail, and therefore the schedule of equipment listed here does not represent a final or definitive list of plant. The equipment schedule has therefore been adopted in this assessment solely for the purpose of a risk assessment of construction noise levels.

The overall total aggregated sound power levels for each of the key construction tasks are detailed in Table 11, and assume that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period.

Table 11: Overall sound power levels of key construction tasks, dB L_{WA}

Construction task	Plant/Equipment	Approximate overall sound power level
Access road and tracks construction	1 x Bulldozer, 7 x Delivery truck, 2 x Dump truck, 2 x Excavator, 1 x Grader	120
Cable trench digging	1 x Bulldozer, 1 x Dump truck, 1 x Excavator	120
Horizontal directional drilling	1 x Delivery truck, 1 x Generator, 1 x Horizontal drilling	110
Permanent met mast	1 x Bulldozer, 1 x Concrete pump, 1 x Concrete truck, 1 x Crane (500 t), 1 x Excavator	115
Powerline pole	1 x Bulldozer, 1 x Concrete truck, 1 x Crane (200 t), 1 x Excavator	115
Powerline stringing	2 x Crane (200 t), 1 x Delivery truck, 1 x Excavator, 1 x Generator	115
Site compound	1 x Bulldozer, 1 x Concrete pump, 1 x Concrete truck, 1 x Crane (200 t), 1 x Delivery truck, 1 x Excavator, 1 x Generator, 1 x Vibratory roller	115
Substations (main substation and collector substations)	1 x Bulldozer, 1 x Concrete pump, 1 x Concrete truck, 1 x Crane (500 t), 1 x Delivery truck, 1 x Excavator, 1 x Generator, 1 x Vibratory roller	115
Turbine assembly	1 x Crane (1,200 t), 2 x Crane (200 t), 2 x Crane (500 t), 1 x Generator	120
Turbine foundations	1 x Bulldozer, 1 x Concrete pump, 1 x Concrete truck, 1 x Crane (200 t), 1 x Delivery truck, 2 x Excavator, 1 x Generator	115

Construction activities will also include operation of one (1) on-site quarry and up to three (3) concrete batching plants.

The quarry would be a traditional soft rock extraction operation and would not involve any drilling or blasting.

An extraction period of 2-2.5 years is expected for the on-site quarry for construction activities to provide material for road sub-base and base/pavement. It would then have a 30-year life to service any operational requirements (expected to be minor and ad hoc in nature).

The concrete batching plants may also be required to operate over a period of 2 years.

As a result of the projected duration of operation, these activities have been assessed against the noise limits determined in accordance with the Noise Protocol (refer to Section 7.0).

The locations of the construction activities accounted for in this assessment are presented in Figure 2 of Section 1.2.

It is understood that blasting is not proposed as part of the construction method for the Project.

6.4 Predicted construction noise levels

Noise levels associated with each of the main construction tasks have been predicted at the nearest receivers (accounting for all identified noise sensitive locations, including camping grounds) to provide an indication of the upper range of noise levels.

Predicted noise levels have been calculated in general accordance with the method detailed in AS 2436. The AS 2436 method enables the calculation of sound propagation over hard or soft ground, but does not provide the ability to calculate predicted noise levels for mixed ground cover with varied soil conditions. The standard also notes that caution must be applied when considering predicted noise levels at distances beyond 100 m. For these reasons, predicted noise levels have been determined as the arithmetic average of the hard and soft ground prediction methods. This approach is broadly consistent with the equivalent prediction procedure in BS 5228-1 (document referenced in AS 2436) and provides a margin of caution with respect to ground conditions and the typical magnitude of separating distances between construction activities and neighbouring receivers.

Given that the precise equipment selections and methods of working would be determined during the development of a construction plan, and that the noise associated with construction plant and activity varies significantly, the predicted noise levels are provided in the following sections as an indicative range of levels which may occur in practice.

The predicted noise levels for each of the main construction tasks are presented in Table 12, Table 13 and Table 14 for non-stakeholder receivers, camping grounds, and stakeholder receivers, respectively.

Table 12: Indicative range of construction noise predictions – Non-stakeholder receivers

Construction task	Nearest receiver	Distance to nearest receiver, m	Predicted level range, dB L_{Aeq}
Access road and tracks construction	674	1,010	45-50
Cable trench digging	576	30	75-80
Horizontal directional drilling	576	780	40-45
Permanent met mast	27	6,488	20-25
Powerline pole	27	3,413	25-30
Powerline stringing	27	3,413	25-30
Site Compound	27	3,237	30-35
Collector substation	18	4,541	25-30
Substation	55	1,274	40-45
Turbine assembly	674	1,038	40-45
Turbine foundations	674	1,038	40-45

Table 13: Indicative range of construction noise predictions, dB L_{Aeq} – Camping grounds

Construction task	Nearest receiver	Distance to nearest receiver, m	Predicted level range, dB L_{Aeq}
Access road and tracks construction	673	1,921	40-45
Cable trench digging	709	1,884	35-40
Horizontal directional drilling	709	1,853	30-35
Permanent met mast	700	7,088	20-25
Powerline pole	721	2,975	30-35
Powerline stringing	721	2,975	25-30
Site Compound	673	3,695	30-35
Collector substation	721	3,043	30-35
Substation	702	4,949	25-30
Turbine assembly	673	2,105	35-40
Turbine foundations	673	2,105	35-40

Table 14: Indicative range of construction noise predictions, dB L_{Aeq} – Stakeholder receivers

Construction task	Nearest receiver	Distance to nearest receiver, m	Predicted level range, dB L_{Aeq}
Access road and tracks construction	677	276	60-65
Cable trench digging	677	271	55-60
Horizontal directional drilling	82	6,761	15-20
Permanent met mast	676	2,659	30-35
Powerline pole	676	332	50-55
Powerline stringing	676	332	50-55
Site Compound	676	1,064	40-45
Collector substation	675	2,659	30-35
Substation	44	1,012	40-45
Turbine assembly	675	615	45-50
Turbine foundations	675	615	45-50

The predicted noise levels presented above are typical of the range expected for the construction of a wind farm. The highest predicted noise levels are noted to occur during cable trench digging near a non-stakeholder receiver, followed by the construction of access roads. The increased noise levels from these activities occur as a result of the work occurring at reduced separating distances, i.e. when these activities are closest to receivers. However, the works associated with these construction activities progress relatively quickly and therefore these levels would only be expected to be reached for a short period of time (typically significantly less than three to four weeks – less than one week for the highest noise level associated with cable trench digging).

EPA Publication 1834.1 construction noise guidance does not apply receiver noise limits during normal working hours. However, the magnitude of the predicted noise levels is sufficient to warrant the works being restricted to normal working hours. Further, the predicted levels, combined with the scale of the Project, are sufficient to warrant the implementation of EPA Publication 1834.1 requirements with respect to both noise emissions and managerial controls.

Further, the predicted noise levels are above the ERS objective for the day period (Table 44 of Section C7). While the ERS objective is not a design requirement or assessment criterion, it provides a further indication of the potential risk of construction noise, and the need for all reasonably practicable measures to be implemented to minimise the risk of harm from noise, in accordance with the GED under the EP Act.

In terms of potential out of hours work, this would need to be limited low noise works (such as maintenance activities) or unavoidable works which must occur during the evening and night periods for safety and reducing traffic disruption. This approach is consistent with EPA Publication 1834.1.

Prior to construction of the Project, all reasonably practicable measures that would be implemented to minimise the risk of harm from construction noise and vibration should be documented in the CEMP. Given that brief periods of high levels are predicted from some activities, the plan should include provisions to notify receivers of the timing of the nearest construction activities.

6.5 Predicted construction traffic noise levels

Based on the peak hour construction traffic volume estimates detailed in the Traffic Impact Assessment[6], hourly construction traffic noise levels of up to 60 dB $L_{Aeq,1hr}$ have been predicted at dwellings located in proximity of the road (within 20 m). Considering that relevant receivers in the vicinity of the proposed Project are typically located further than 20 m from roads, construction traffic noise levels are expected to be lower than 60 dB L_{Aeq}. An increase of 2 dB in hourly traffic noise levels is predicted due to the proposed construction activities relative the existing peak traffic volumes. Subjectively, such an increase in noise levels is not considered to be perceptible.

6.6 Predicted construction vibration levels

The nearest receiver to construction activities is a non-stakeholder receiver (Receiver 576) located approximately 30 m from the proposed underground powerline route. This distance is greater than minimum working distances for cosmetic damage as detailed in Table 7 of Section 6.1.2 (the minimum working distances for cosmetic damage are all less than 25 m, and the distance of 25 m relates to vibratory rollers which are not expected to be used near this receiver). Cosmetic damage as a result of construction related vibration is therefore unlikely. Receiver 576 is within the range of distances noted in Table 7 of Section 6.1.2 for human comfort and therefore vibration could be perceptible and potentially disruptive for the brief period while cable trench digging activities are occurring at their nearest point to the dwelling. It is noted the minimum working distances relate to continuous vibration, however for most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels occurring over shorter periods are permitted, as discussed in BS 6472-1. Perceptible vibration at this receiver as a result of cable trench digging activities are therefore expected to be manageable via resident consultations, appropriate scheduling, and prioritising efficient work times to minimum the duration of trench digging nearest to the dwelling.

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[6] AECOM report 60591699 Draft v.8 Rev G *Transport Impact Assessment - Kentbruck Green Power Hub Environment Effects Statement*, dated 21 July 2023

In relation to the broader construction activities of the Project, receiver 576 is located more than more than 17 km from longer term areas of working. Vibration considerations for this receiver therefore solely related to the brief period of cable trench digging.

All other receivers around the Project are located more than 100 m from vibration generating construction activities and are therefore beyond the safe working distances for both cosmetic damage and human response.

Vibration is therefore considered a low risk for the Project and, as such, vibration monitoring is not expected to be required.

7.0 CONSTRUCTION NOISE ASSESSMENT – QUARRY AND BATCHING PLANT OPERATIONS

7.1 Operating hours

Hours of operation for the proposed on-site quarry and concrete batching plants have not yet been specified but are expected to only operate within normal working hours, except when unavoidable. As such, as a conservative assumption for the operational noise assessment, it is assumed that they could operate also operate during the night period (2200 to 0700 hrs).

7.2 Assessment criteria

The proposed on-site quarry and concrete batching plants would operate during various periods of the construction stage of the Project. While these activities are temporary operations associated with construction, they may be required to operate over a period of four years, given the size of the Project. As a result of the projected duration of operation, the on-site quarry and concrete batching plants have been assessed against the noise limits determined in accordance with the Noise Protocol. It is however noted that these noise limits do not differentiate between temporary and permanent operations.

The Noise Protocol procedure for determining noise limits depends on whether the noise source or the receivers are located in a rural or urban area. The rural areas procedures of the Noise Protocol apply to the Project. In rural areas, applicable noise limits are generally based on zone levels determined according to the land zoning of the area in which the noise source and receivers are located. These zone levels are then adjusted, where appropriate, for a range of factors.

In accordance with the Noise Protocol, the on-site quarry is considered as an earth resources premises with specific procedures for determining noise limits. The procedures account for the land zoning where the noise receivers are located and, where applicable, the background noise in the area.

Noise limits associated with the operation of the concrete batching plants are based on zone levels determined according to the land zoning of the area in which the noise source and receivers are located. These zone levels are then adjusted, where appropriate, for a range of factors, including background noise.

Adjustments for 'background relevant areas' are not warranted in this instance, as the background noise levels during the relevant assessment conditions for the on-site quarry and concrete batching plants (i.e. low wind speeds) are relatively low; adjustments for background noise levels are therefore not warranted in this instance.

The EP Regulations define the minimum value of the noise limit for both general industry and earth resources in rural areas. These minimum values are referred to as the base noise limits and are detailed in Table 15.

Table 15: EP Regulations base noise limits, dB ENL

Period	Day of week	Start time	End time	Base noise limit
Day	Monday – Saturday	0700 hrs	1800 hrs	45
Evening	Monday – Saturday	1800 hrs	2200 hrs	37
	Sunday, Public holidays	0700 hrs	2200 hrs	
Night	Monday – Sunday	2200 hrs	0700 hrs	32

For brevity of reporting, the assessment presented in the following sections only considers receivers within 5 km of proposed on-site quarry and concrete batching plants.

7.2.1 Quarry

As shown on the land zoning maps presented in Appendix I, the receivers nearest to the proposed on-site quarry location are located within land designated as Farming Zone (FZ) or Public Park and Recreation Zone (PPRZ). Accordingly, the applicable noise limits are:

- Day period: 46 dB ENL
- Evening period: 41 dB ENL
- Night period: 36 dB ENL

7.2.2 Concrete batching plants

Considering that the land zoning is not continuous between the proposed concrete batching plants and five (5) of the nearest receivers, a distance adjustment is applicable as detailed in Table 16.

Table 16: Noise Protocol distance adjustments, dB

Receiver	Source zoning	Receiver zoning	Distance adjustment [1]
27	FZ1	FZ1	0
31	FZ1	FZ1	0
34	FZ1	FZ1	0
41 (S)	FZ1	FZ1	0
676 (S)	FZ1	FZ1	0
719 (C)	FZ1	PPRZ	-9
720 (C)	FZ1	PPRZ	-9
721 (C)	FZ1	PPRZ	-9
722 (C)	FZ1	PPRZ	-9
723 (C)	FZ1	PPRZ	-9

(S) Stakeholder receiver | (C) Camping ground

1 Maximum distance adjustment of -9 dB

Based on the distance adjustments detailed in in Table 16, the night-time noise limits applicable to the on-site concrete batching plants are presented in Table 17.

Table 17: Night-time noise limits applicable to the on-site concrete batching plants, dB ENL

Receiver	Zoning level	Distance adjustment	Night-time noise limit [2]
27	36	0	36
31	36	0	36
34	36	0	36
41 (S)	36	0	36
676 (S)	36	0	36
719 (C) [1]	35	-9	32
720 (C) [1]	35	-9	32
721 (C) [1]	35	-9	32

Receiver	Zoning level	Distance adjustment	Night-time noise limit [2]
722 (C) [1]	35	-9	32
723 (C) [1]	35	-9	32

(S) Stakeholder receiver | (C) Camping ground

1 Zoning level based on Receiving zone defined as Public Park and Conservation (PPCZ) in the Noise Protocol

2 Minimum night-time noise limit of 32 dB ENL, as specified in the EP Regulations

7.3 Noise emissions

A variety of plant would be used at the proposed on-site quarry and concrete batching plants. Sound power levels for the types of equipment expected have been determined primarily based on noise level data from previous projects of a similar nature, together with noise data sourced from AS 2436.

Table 18 summarises the noise emissions used to represent key items of plant associated with the proposed on-site quarry and concrete batching plants.

Table 18: Noise sources sound power data, dB L_{WA}

Noise source	Sound power level (per equipment item)
On-site quarry	
2 x Concrete trucks	108
3 x Dump trucks	117
1 x Excavator (100 to 200 kW)	107
1 x Excavator fitted with pneumatic breaker	118
2 x Front end loaders	113
1 x Generator	99
2 x Rock crushers	120
On-site concrete batching plants	
1 x Batching plant	110
6 x Concrete trucks	108
1 x Concrete pump	108

It is understood that blasting is not proposed as part of quarry operations.

7.4 Predicted noise levels

The design of the on-site quarry and concrete batching plants, the schedule of equipment to be used, and the intensity of operations, would be developed in greater detail during subsequent stages of the Project.

Preliminary information has therefore been modelled to develop estimated noise level predictions based on the example schedule of plant and noise emissions described in the previous section. In the absence of a detailed quarry profile design, a simplified terrain profile has been used for the modelling. Given these inputs, the noise predictions are indicative only, and will be subject to refinement when further information becomes available.

The predicted noise levels have been calculated using the ISO 9613-2: 1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) method described in Section 8.3[7] and are presently based on all plant continuously operating simultaneously within any given 30-minute assessment period. In practice, variations in the duration and intensity of operation of each item of plant are likely to result in lower noise levels. These variations in operating characteristics would need to be accounted for in the detailed design assessment.

An adjustment of +2 dB has then been applied to the predicted noise levels to account for the potential tonal characteristics of mobile plants (i.e. tonal reversing alarms). The relevance and magnitude of the adjustment in practice is dependent on several variables. This is discussed below.

7.4.1 Quarry

Predicted noise levels from the proposed on-site quarry at all three (3) receivers located within 5 km are detailed in Table 19.

Table 19: Estimated noise levels – Quarry

Receiver	Land zoning	Separating distance, m	Estimated noise level, dB ENL
673 (C)	PPRZ	4,290	31
700 (C)	FZ1	4,557	30
719 (C)	PPRZ	4,768	30

(C) Camping ground

The results presented in Table 19 indicate estimated levels that are lower than the most stringent Noise Protocol noise limit of 36 dB ENL applicable to the night period by at least 5 dB.

The above demonstrates that noise from the proposed on-site quarry is not a design constraint for the Project. However, it is recommended that a quarry noise management plan is prepared as part of the quarry work plan, and that this plan includes details of all reasonably practicable mitigation measures to be implemented to fulfil the GED under the EP Act and achieve the noise limits determined in accordance with the Noise Protocol.

7 With the exception of the terrain and screening related corrections which are specific to wind turbine noise propagation calculations. No significant screening effects apply to these calculations.

7.4.2 Concrete batching plant

Predicted noise levels from the proposed concrete batching plants at all ten (10) receivers located within 5 km are detailed in Table 20.

Table 20: Estimated noise levels – concrete batching plant

Receiver	Minimum separating distance, m	Estimated noise level, dB ENL
27	3,151	22
31	3,364	21
34	3,526	20
41 (S)	4,805	16
676 (S)	1,068	37
719 (C)	3,782	19
720 (C)	3,727	20
721 (C)	3,735	20
722 (C)	4,231	18
723 (C)	4,483	17

(S) Stakeholder receiver | (C) Camping ground

The results presented in Table 20 indicate estimated levels that are lower than the most stringent Noise Protocol noise limit of 32 dB applicable to the night period by at least 10 dB at nine (9) of the ten (10) assessed receivers.

Operational noise levels from the proposed eastern concrete batching plant are estimated to be above the night base noise limit by 1 dB at Receiver 676 which is an abandoned dwelling owned by a landowner involved with the Project. It is understood that a noise agreement is in place between the proponent and the landowner covering both the construction and operation of the Project.

The above demonstrates that noise from the proposed on-site concrete batching plants is only a design constraint for the Project at one abandoned dwelling where a noise agreement is in place between the proponent and the landowner.

It is recommended that construction noise and vibration management procedures be developed and documented in the CEMP. The procedures should include details of all reasonably practicable mitigation measures to be implemented to fulfil the GED under the EP Act and achieve the noise limits determined in accordance with the Noise Protocol.

8.0 OPERATIONAL ASSESSMENT METHOD

8.1 Overview

Based on the legislation, policies and guidelines outlined in Section 3.0, assessing the operational noise levels of a proposed renewable energy project (including the turbines and the substations) involves:

- assessing background noise levels at receivers around the Project;
- assessing the land zoning of the Project site and surrounding areas;
- establishing suitable noise criteria accounting for background noise levels and land zoning;
- predicting the level of noise expected to occur as a result of the operation of the proposed turbines and substations; and
- assessing whether the development can achieve the requirements of Victorian policy and guidelines by comparing the predicted noise levels to the noise criteria and taking into consideration the general environmental duty under the EP Act.

8.2 Background noise levels

Background noise levels are used to inform the setting of limits for both the substation and the wind turbine components of a wind farm project. However, in rural areas where wind farms are typically developed, the background noise level data is most relevant to the assessment of the wind turbines. This is due to the need to consider the changes in background noise levels and wind turbine noise levels for different wind conditions.

In accordance with the Victorian Wind Energy Guidelines and NZS 6808, background noise level information is used for setting noise limits for the wind turbine component of a wind farm project.

The procedures for determining background noise levels are defined in NZS 6808. The first step in assessing background noise levels involves determining whether background noise measurements are warranted. For this purpose, Section 7.1.4 of the standard provides the following guidance:

> *Background sound level measurements and subsequent analysis to define the relative noise limits should be carried out where wind farm sound levels of 35 dB $L_{A90(10\,min)}$ or higher are predicted for noise sensitive locations, when the wind turbines are at 95% rated power. If there are no noise sensitive locations within the 35 dB $L_{A90(10\,min)}$ predicted wind farm sound level contour then background sound level measurements are not required.*

The initial stage of a background noise monitoring program in accordance with NZS 6808 therefore comprises:

- Preliminary wind turbine noise predictions to identify all receivers where predicted noise levels are higher than 35 dB L_{A90}
- Identification of selected receivers where background noise monitoring should be undertaken prior to development of the Project, if required.

If required, the surveys involve measurements of background noise levels at receivers, and simultaneous measurement of wind speeds at the site of the proposed wind farm. The survey typically extends over multiple weeks to account for a range of wind speeds and directions.

The results of the survey are then analysed to determine the trend between the background noise levels and site wind speeds at the proposed hub height of the turbines. This trend defines the value of the background noise for the different wind speeds in which the turbines will operate. At the wind speeds when the background noise level is above 35 dB L_{A90} (or 30 dB L_{A90} in special circumstances where high amenity limits apply), the background noise levels are used to set the noise limits for the wind turbines.

8.3 Noise predictions

Operational noise levels from the Project (wind turbines and substations) are predicted using:

- Noise emission data for the wind turbines and substations;
- A 3D digital model of the site and the surrounding environment; and
- International standards used for the calculation of environmental sound propagation.

The method selected to predict noise levels is ISO 9613-2. The prediction method is consistent with the guidance provided by NZS 6808 and has been shown to provide a reliable method of predicting the typical upper levels of the wind turbine noise expected to occur in practice.

The method is generally applied in a comparable manner to noise levels from both wind turbines and substations. For example, for both types of sources, equivalent ground and atmospheric conditions are used for the calculations. However, when applied to wind turbine noise, additional and specific input choices apply, as detailed below.

Key elements of the noise prediction method are summarised in Table 21. Further discussion of the method and the calculation choices is provided in Appendix E.

Table 21: Noise prediction elements

Detail	Description
Software	Proprietary noise modelling software SoundPLANnoise version 9.0
Method	ISO 9613-2 Adjustments to the ISO 9613-2 method are applied on the basis of the guidance contained in the UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (UK Institute of Acoustics guidance). The adjustments are applied within the SoundPLAN modelling software and relate to the influence of terrain screening and ground effects on sound propagation. Specific details of adjustments are noted below and are discussed in Appendix E.
Source characterisation	Each source of operational noise is modelled as a point source of sound. The total sound of the component of the wind farm being modelled (i.e. the wind turbines or the substations) is then calculated on the basis of simultaneous operation of all elements (e.g. all wind turbines) and summing the contribution of each. To model the wind turbine noise, the following specific procedures are noted: • Calculations of wind turbine to receiver distances and average sound propagation heights are made on the basis of the point source being located at the position of the hub of the wind turbine. • Calculations of terrain related screening are made on the basis of the point source being located at the maximum tip height of each wind turbine. Further discussion of terrain screening effects is provided below.
Terrain data	10 m resolution elevation data, downloaded from Spatial Datamart Victoria

Detail	Description
Terrain effects (turbine-specific procedures)	Adjustments for the effects of terrain are determined and applied on the basis of the UK Institute of Acoustics guidance and research outlined in Appendix E. • Valley effects: +3 dB is applied to the calculated noise level of a wind turbine when a significant valley exists between the wind turbine and calculation point. A significant valley is determined to exist when the actual mean sound propagation height between the turbine and calculation point is 50 % greater than would occur if the ground were flat. • Terrain screening effects: only calculated if the terrain blocks line of sight between the maximum tip height of the turbine and the calculation point. The value of the screening effect is limited to a maximum value of -2 dB. The Project is located in a relatively flat area characterised by little variations in ground elevation between the wind turbines and surrounding receivers. Based on comparison of predicted noise levels with and without terrain elevation data included, terrain effects ranging between -1.7 dB and +0.3 dB were calculated for receivers within 5 km of the proposed wind turbines. For reference purposes, the ground elevations at the receivers and turbines are tabled in Appendix F and Appendix G, respectively. The topography of the site is depicted in the elevation map provided in Appendix H.
Ground conditions	Ground factor of G = 0.5 based on the UK Institute of Acoustics guidance and research outlined in Appendix E. The ground around the site corresponds to acoustically soft conditions (G = 1) according to ISO 9613-2. The adopted value of G = 0.5 assumes that 50 % of the ground cover is acoustically hard (G = 0) to account for variations in ground porosity and provide a cautious representation of ground effects.
Atmospheric conditions	Temperature: 10°C, relative humidity 70%, and atmospheric pressure 101.325 kPa These represent conditions which result in relatively low levels of atmospheric sound absorption. The calculations are based on sound speed profiles[8] which increase the propagation of sound from each turbine to each receiver, whether as a result of thermal inversions or wind directed toward each calculation point.
Receiver heights	1.5 m above ground level The UK Institute of Acoustics guidance refers to predictions made at receiver heights of 4 m. Predictions in Australia are generally based on a lower prediction height of 1.5 m which results in lower noise levels. However, importantly, predictions in Australia do not generally subtract a margin recommended by the UK Institute of Acoustics guidance to account for differences between L_{Aeq} and L_{A90} noise levels (this is consistent with NZS 6808 which indicates that predicted L_{Aeq} levels should be taken as the predicted L_{A90} sound level of the wind turbines). The magnitude of these differences is comparable and therefore balance each other out to provide similar predicted noise levels.

8 The sound speed profile defines the rate of change in the speed of sound with increasing height above ground

9.0 OPERATIONAL NOISE ASSESSMENT – WIND TURBINES

This section presents an assessment of operational noise associated with the proposed wind turbines.

A site layout plan illustrating the turbine layout and receivers is provided in Figure 1of Section 1.2.

9.1 Assessment criteria

NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808) provides methods for the prediction, measurement, and assessment of sound from wind turbines.

The criteria detailed in NZS 6808 apply to noise levels at noise sensitive locations and consist of a combination of base limits (i.e. fixed value limits irrespective of wind speed) and relative limits which are defined by an allowable margin above the background noise (i.e. limits which vary with wind speed).

The applicable base limit applied in Victoria is dependent on factors relating to land zoning, background noise levels and whether the receiver is involved with the Project. These factors are discussed in the following subsections.

9.1.1 High amenity areas

NZS 6808 defines a base limit value of 40 dB for most situations, and states that the limit is appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations.

However, NZS 6808 also defines a reduced base limit of 35 dB for special circumstances considered high amenity areas, where the level of amenity protection provided during the evening and night should be greater than is afforded to most residential locations. Specifically, Section 5.3.1 of the standard states:

> *[…] In special circumstances at some noise sensitive locations a more stringent noise limit may be justified to afford a greater degree of protection of amenity during evening and night-time. A high amenity noise limit should be considered where a plan promotes a higher degree of protection of amenity related to the sound environment of a particular area, for example where evening and night-time noise limits in the plan for general sound sources are more stringent than 40 dB $L_{Aeq(15\ min)}$ or 40 dBA L_{10}. A high amenity noise limit should not be applied in any location where background sound levels, assessed in accordance with section 7, are already affected by other specific sources, such as road traffic sound.*

In accordance with NZS 6808, an assessment is required for all receivers located within the predicted 35 dB L_{A90} contour to determine whether a high amenity noise limit may be justified. As detailed in Section C4.4 of Appendix C, this is based on a two-step approach comprising:

1. A land zoning review to determine whether the planning guidance for the area warrants consideration of a high amenity noise limit. If it does, then the second step should be considered;
2. A review of the relationship between the background noise levels and predicted noise levels, using the calculation set out in clause C5.3.1.

Based on the predicted noise level contours presented subsequently in Section 9.3, and the zoning map for the area presented in Appendix I, receivers within the predicted 35 dB L_{A90} contour are located within areas identified as Farming Zone and Public Park and Recreation Zone.

Following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the Victorian Wind Energy Guidelines, receivers within the Farming Zone do not warrant consideration of the high amenity noise limit. Similar guidance concerning the Farming Zone is provided in EPA Victoria's *Wind Energy Facility Turbine Noise Regulation Guidelines* (EPA web guideline) which indicates that the high amenity noise limit should not be applied to the Farming Zone.

The planning panel report[9] for the Golden Plains Wind Farm considered the subject of zones more broadly. In the case of the Golden Plains Wind Farm, the panel confirmed that the high amenity provision was not applicable to the Farming Zone. However, in relation to the Township Zone and Low Density Residential Zone, the panel concluded that the high amenity provision warranted consideration, irrespective of the planning scheme not promoting a higher degree of protection of amenity related to the sound environment. This conclusion was on the basis that those zones encouraged residential living, which correlates to a higher expectation for acoustic amenity.

The nearest Township Zone, corresponding to the Nelson township, is located approximately 5 km from the proposed wind turbines, well outside the predicted 35 dB noise contour.

Based on the above, the high amenity limit is not justified for the majority of locations around the Project.

The residual zone type requiring evaluation is the Public Park and Recreation Zone (PPRZ) where the identified camping grounds (such as Receiver 673) are located. In this respect, the following considerations are noted:

- The PPRZ does not specifically promote higher degree of amenity protection with respect to the sound environment;
- The PPRZ includes provisions for land uses that are not inherently low noise (e.g. helipads);
- Precedents for the application of high amenity noise limits to the PPRZ were not able to be identified as part of this study; and
- The PPRZ is not included in the list of zone types that the EPA web guideline recommends the high amenity noise limits should apply to.

Based on the above considerations, there is no clear precedent, indication or justification for the application of a high amenity limit to a receiver within the PPRZ. Accordingly, the camping grounds within the PPRZ have been assessed in the same way as other receivers around the Project, based on a 40 dB L_{A90} base (minimum) noise limit.

However, while the EPA web guideline does not include the PPRZ among the zone types where high amenity limits warrant consideration, the guidance does state:

> *The Environment Reference Standard* […] *defines natural areas where the environmental value of 'human tranquillity and enjoyment outdoors in natural areas' applies. In some circumstances,* [High Amenity Area] *limits may be applied to campgrounds, caravan parks and tourist establishment in such natural areas, where this environmental value is considered to be relevant.*

Given that wind turbine noise levels in the camping grounds are directly regulated under the EP Regulations, the provisions of the ERS do not apply to the camping grounds. A level of interpretation is therefore required to determined how the environmental value specified in the ERS should inform the types of camping grounds where a high amenity noise limit may be justified. Therefore, while the PPRZ is not included in the EPA web guideline listing of the zones where high amenity limits are recommended to apply, and the camping grounds are assessed in the same way as residential receivers around the Project, the camping grounds have been included in a sensitivity analysis. The objective of the sensitivity analysis is to gauge whether the application of high amenity limits would have any relevance to the design and operation of the Project (i.e. irrespective of whether or not high amenity noise limits are justified). This is provided subsequently in Section 9.4.

9 *EES Inquiry and Planning Permit Application Panel Report - Golden Plains Wind Farm* dated 26 September 2018

9.1.2 Stakeholder receivers

The definition of noise sensitive locations in NZS 6808 specifically excludes dwellings located within a wind farm Project boundary. Further, Section C4.2 of Appendix C provides details of the statutory context of NZS 6808 and indicates the method is not intended to be applied to noise sensitive locations outside the Project boundary where a noise agreement exists or is proposed between the occupants and the proponent of the development.

However, consistent with the Victorian Wind Energy Guidelines, regulation 131B of the EP Regulations specifies a noise limit for stakeholder receivers of 45 dB L_{A90} or background noise (L_{A90}) + 5 dB, whichever is the greater, where a noise agreement between the owner or operator of a wind energy facility and a landowner is made on or after 1 November 2021.

The proponent advised that noise agreements are currently in place or proposed between the landowners and the proponent at three (3) receivers within 5 km of a wind turbine, as presented in Appendix F.

Further, consistent with the Victorian Wind Energy Guidelines, it is recommended that operational wind turbine noise levels not exceed a reference level of 45 dB L_{A90} or background noise (L_{A90}) +5 dB at stakeholder receivers within the Project boundary.

9.1.3 Applicable noise limits

Accounting for the conclusions of the assessment of high amenity detailed in the previous section, the applicable noise limits are detailed in Table 22.

Table 22: Applicable noise limits, dB L_{A90}

Receiver status	Noise limit
Non-stakeholder	40 dB or background L_{A90} + 5 dB, whichever is the greater
Stakeholder with a noise agreement	45 dB or background L_{A90} + 5 dB, whichever is the greater
Stakeholder within the Project boundary	Not applicable Reference level of 45 dB or background L_{A90} + 5 dB, whichever is the greater

Applicable noise limits based on the background noise levels presented in Table 4 of Section 5.0 are summarised in Table 23. As the background noise levels at Receiver 673 Int were provided for indicative purposes only, background noise related limits have not been assigned for this location (see related discussion in Section 5.0). All other receivers not listed in Table 23 are conservatively assessed using the applicable base (minimum) noise limit.

Table 23: Operational wind turbine noise limits at background noise monitoring locations, dB L_{A90}

Receiver	Hub height wind speed (m/s)												
	3	4	5	6	7	8	9	10	11	12	13	14	15
All-time period													
10 proxy [1]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
21 (S) [2]	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
31 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	41.0	41.9	42.6	43.3
Night period													
10 proxy [1]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
21 (S) [2]	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
31 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.3	41.4	42.4

(S) Stakeholder receiver

1 KEN04 met mast – 165 m above ground level at 513762 E, 5786178 N (MGA 94 Zone 54)

2 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

3 KEN02 met mast – 165 m above ground level at 525250 E, 5774470 N (MGA 94 Zone 54)

9.2 Candidate wind turbines

9.2.1 Turbine type

The final turbine model for the site would be selected after a tender process to procure the supply of turbines. The final selection would be based on a range of design requirements including achieving compliance with the planning permit noise limits at surrounding receivers (refer to Appendix D for an overview of the various stages in the noise assessment of a wind farm).

Accordingly, to assess the proposed wind turbines at this stage in the project, it is necessary to consider a candidate turbine model that is representative of the size and type of turbines being considered. The purpose of a candidate turbine model is to assess the viability of achieving compliance with the applicable noise limits, based on noise emission levels that are typical of the size of turbines being considered for the site.

For this assessment, the proponent has nominated four (4) candidate wind turbine models, as detailed in Table 24.

These models are variable speed wind turbines, with the speed of rotation and the amount of power generated by the wind turbines being regulated by control systems which vary the pitch of the wind turbine blades (the angular orientation of the blade relative to its axis).

This assessment has been based on the wind turbines operating in unconstrained modes of generation (i.e. without noise reduced operating modes) and with blade serrations. Blade serrations are now routinely used to reduce wind turbine noise emissions, and it is understood that their use is now the market standard for wind turbines being offered in the Australian market.

Table 24: Candidate wind turbine models

Detail	GE 6.0-164	V162-6.2MW	SG 6.2-170	N163/5.7
Make	General Electric	Vestas	Siemens Gamesa	Nordex
Rated power, MW	6.0	6.2	6.2	5.7
Rotor diameter, m	164	162	170	163
Modelled hub height, m	143	165	143	164
Operating mode	-	PO6200 [1]	AM 0 [2]	Mode 0 [3]
Serrated trailing edge	Yes	Yes	Yes	Yes

1 'PO6200' is a manufacturer designation which indicates an unconstrained, Power Optimised mode of operation to achieve a rated power of 6.2 MW (i.e. without noise curtailment)

2 'AM 0' is a manufacturer designation which indicates an unconstrained mode of operation *Application Mode 0* to achieve a power output of 6.2 MW (i.e. without noise curtailment)

3 'Mode 0' is a manufacturer designation which indicates an unconstrained mode of operation to achieve a power output of 5.7 MW (i.e. without noise curtailment)

The rated power of the candidate turbine is consistent with the proposal for the Project to utilise turbines with a capacity between 4 and 8 MW. The noise emission characteristics of a turbine are ultimately dependent on a range of factors such as the blade design, the rotor size, and the speed of rotation. As such, while turbine sizes and power ratings of contemporary turbines have increased, the noise emissions of the turbines are comparable to, or lower than, previous generations of turbines as a result of design improvements (notably, measures to reduce the speed of rotation of the turbines, and enhanced blade design features such as serrations for noise control). The candidate turbine is therefore considered appropriate to represent the class of turbine being considered for the Project.

The modelled hub heights detailed above are suitable for noise assessment purposes. It is our understanding that the final hub height of the selected wind turbine model may differ slightly. However, the magnitude of the potential changes is expected to be minor and inconsequential with respect to predicted noise levels.

The final hub height would be used for the pre-construction noise assessment once the turbine layout has been finalised and the final turbine model selected.

9.2.2 Noise emissions

The noise emissions of the wind turbines are described in terms of the sound power level for different wind speeds. The sound *power* level is a measure of the total sound energy produced by each turbine and is distinct from the sound *pressure* level which depends on a range of factors such as the distance from the turbine.

Sound power level data for the candidate wind turbine models, including sound frequency characteristics, has been sourced from the manufacturers' documents listed in Table 25.

Table 25: Candidate wind turbine model specification documents

Candidate model	Document No.	Date	Title
GE 6.0-164	0082273 Rev: 2	16 Mar. 2021	*Technical Documentation Wind Turbine Generator Systems Cypress 6.0-164 - 50Hz - Product Acoustic Specifications According to IEC 61400-11*
V162 6.2MW	0105-5200_01	12 May 2023	*Third octave noise emission EnVentus™ V162-6.2MW 50/60 Hz*
SG 6.2-170	D2311679/006	29 Jul. 2021	*Standard Acoustic Emission AM0 - SG 6.2-170*
N163/5.7	F008_276_A14_EN	21 May 2019	*Octave sound power levels - NordexN163/5.X*

To provide a basis for noise modelling, the data sourced from the manufacturer's documentation was converted from third octave band levels to octave band levels (where applicable), and adjusted by addition of +1.0 dB at each wind speed to provide a margin for typical values of test uncertainty.

The overall A-weighted sound power levels (including the +1.0 dB addition) as a function of hub height wind speed are presented in Table 26 with the A-weighted octave band values presented in Table 27. These represent the total noise emissions of each candidate wind turbine model, including the secondary contribution of ancillary plant associated with each wind turbine (e.g. cooling fans).

Table 26: A-weighted sound power levels versus hub height wind speed, dB L_{WA}

Candidate model	Hub height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
GE 6.0-164	94.8	96.7	100.2	103.5	105.7	107.7	108.0	108.0	108.0	108.0	108.0	108.0
V162 6.2MW	95.1	95.3	97.2	100.2	103.0	105.3	105.8	105.8	105.8	105.8	105.8	105.8
SG 6.6-170	93.0	95.5	99.4	102.8	105.7	107.0	107.0	107.0	107.0	107.0	107.0	107.0
N163/5.7	96.5	99.0	103.8	107.9	108.2	108.2	108.2	108.2	108.2	108.2	108.2	108.2

Table 27: A-weighted octave band sound power levels, dB L_{WA}

Candidate model	Octave band centre frequency, Hz									Total
	31.5	63	125	250	500	1000	2000	4000	8000	
GE 6.0-164 [1]	79.8	89.1	94.6	99.1	101.7	103.3	101.1	93.6	77.8	108.0
V162 6.2MW [2]	75.2	87.9	95.7	100.6	101.0	98.3	93.9	86.7	76.4	105.8
SG 6.6-170 [3]	-	87.8	95.7	98.1	97.6	101.0	101.8	97.0	85.8	107.0
N163/5.7 [4]	79.8	89.9	96.1	99.8	102.4	103.1	100.6	93.0	85.0	108.2

1 Based on octave band levels at 10 m/s

2 Based on one-third octave band levels at 11 m/s

3 Based on octave band levels at 9 m/s

4 Based on octave band levels at 8 m/s

These sound power levels are also illustrated in Appendix K.

Review of available sound power data for a range of wind turbine models has shown that there isn't a clear relationship between wind turbine size, or power output, and the noise emission characteristics of a given wind turbine model. In practice, the overall noise emissions of a wind turbine are dependent on a range of factors, including the wind turbine size and power output, and other important factors such as the blade design and rotational speed of the wind turbine. Therefore, while wind turbine sizes and power ratings of contemporary wind turbines have increased, the noise emissions of the wind turbines are comparable to, or lower than, previous generations of wind turbines as a result of design improvements (notably, measures to reduce the speed of rotation of the wind turbines, and enhanced blade design features such as serrations for noise control).

9.2.3 Special audible characteristics

Special audible characteristics relate to potential tonality, amplitude modulation and impulsiveness of a wind turbine.

Information concerning potential tonality is often limited at the planning stage of a wind farm, and test data for tonality is presently unavailable for the selected candidate wind turbine models. However, the occurrence of tonality in the noise of contemporary multi-megawatt wind turbine designs is unusual. This is supported by evidence of operational wind farms in Australia which indicates that the occurrence of tonality at receivers is atypical.

Amplitude modulation and impulsiveness are not able to be predicted, however the evidence of operational wind farms in Australia indicates that their occurrence is limited and atypical.

Given the above, adjustments for special audible characteristics have not been applied to the predicted noise levels presented in this assessment. Notwithstanding this, the subject of special audible characteristics would be addressed in subsequent assessment stages for the Project, following approval of the wind farm, and again following construction of the wind farm.

9.3 Predicted noise levels

This section presents the predicted wind turbine noise levels of the wind turbine component of the Project at surrounding receivers.

Sound levels in environmental assessment work are typically reported to the nearest integer to reflect the practical use of measurement and prediction data. However, in the case of wind farm layout design, significant layout modifications may only give rise to fractional changes in the predicted noise level. This is a result of the relatively large number of sources influencing the total predicted noise level, as well as the typical separating distances between the turbine locations and surrounding assessment positions. It is therefore necessary to consider the predicted noise levels at a finer resolution than can be perceived or measured in practice. It is for this reason that the levels presented in this section are reported to one decimal place.

Noise levels from the Project have been predicted using the sound power level data detailed in Section 9.2.2 for the selected candidate turbine models and are summarised in Table 28 for the wind speeds which result in the highest predicted noise levels.

The locations of the predicted 30, 35, 40 and 45 dB L_{A90} noise contours are illustrated in Figure 5 to Figure 8, corresponding to the hub height wind speed which results in the highest predicted noise levels for each candidate wind turbine model.

Predicted noise levels for each integer wind speed are tabulated in 0 for all considered receivers.

Table 28: Highest predicted wind turbine noise levels, dB L_{A90}

Receiver	GE 6.0-164	V162-6.2MW	SG 6.2-170	N163/5.7
1	25.5	25.3	24.4	26.2
2	26.5	26.2	25.3	27.2
3	27.7	27.5	26.4	28.5
4	29.3	28.9	27.9	29.9
5	30.0	29.6	28.6	30.6
6	30.2	29.8	28.8	30.9
7	30.3	29.9	28.9	31.0
8	30.9	30.4	29.4	31.6
10	31.2	30.8	29.8	31.9
18	37.4	36.7	35.7	38.0
21 (S)	40.5	39.4	38.8	41.0
27	33.1	32.5	31.5	33.7
31	32.0	31.4	30.4	32.6
34	30.8	30.4	29.3	31.5
40	25.1	25.0	24.0	25.9
41 (S)	25.8	25.7	24.7	26.6
43 (S)	25.1	24.8	24.0	25.8
44 (S)	25.0	24.8	24.0	25.7
673 (C)	35.7	35.2	34.2	36.3
674	36.2	35.1	34.5	36.7
675 (S)	42.7	41.1	40.9	43.0
676 (S)	40.2	38.9	38.5	40.6
700 (C)	35.1	34.7	33.6	35.7
702 (C)	26.4	26.3	25.1	27.2
718 (C)	28.9	28.7	27.9	29.6
719 (C)	29.1	29.3	28.1	30.2
720 (C)	31.2	31.1	30.0	31.9
721 (C)	31.4	31.5	30.2	32.3
722 (C)	30.0	30.0	28.8	30.8
723 (C)	28.9	29.1	28.0	29.9
724 (C)	29.3	29.1	28.2	30.0

Receiver	GE 6.0-164	V162-6.2MW	SG 6.2-170	N163/5.7
725 (C)	29.4	29.3	28.3	30.1
726 (C)	29.5	29.4	28.4	30.2
727 (C)	29.1	29.0	28.0	29.9
728 (C)	29.6	29.4	28.3	30.4
729 (C)	30.4	30.1	29.0	31.1
730 (C)	27.7	27.8	26.4	28.8
731 (C)	26.1	26.0	25.0	26.9
741 (C)	24.3	24.0	23.3	25.0
742 (C)	33.5	33.3	32.1	34.3

(S) Stakeholder receiver

(C) Camping ground

The results presented in Table 28 demonstrate that wind turbine noise levels associated with the Project are predicted to comply with the noise limits for all receivers and candidate wind turbine models.

Specifically, for all candidate wind turbine models, the operational wind turbine noise levels are predicted:

- below the applicable base noise limit of 40 dB L_{A90} by at least 2.0 dB at all non-stakeholder receivers
- below the applicable base noise limit of 45 dB L_{A90} by at least 2.0 dB at all stakeholder receivers outside the Project boundary
- below the reference base noise level of 45 dB L_{A90} by at least 4.4 dB at all stakeholder receivers within the Project boundary

9.4 High amenity sensitivity analysis

High amenity considerations for the Project are formally assessed in Section 9.1.1. The conclusion of this assessment, based on all applicable guidance, is that the high amenity noise limit is not justified for the Project.

The objective of the sensitivity analysis presented herein is to gauge whether the application of high amenity limits would have any relevance to the design and operation of the Project (i.e. irrespective of whether or not high amenity noise limits are justified). This is particularly relevant to Receiver 673 within the PPRZ where there is no clear indication of the applicability of high amenity limits, but the EPA web guideline includes a provision to consider high amenity limits in some situations.

The key finding of the sensitivity analysis is that the modelling results indicate that the predicted noise levels at all non-stakeholder receivers, including Receiver 673, are below the high amenity limit for all candidate wind turbines. Specifically, the predicted noise levels for all candidate turbine noise levels are below 35 dB L_{A90} for wind speeds up to 6 m/s inclusive (the EPA web guideline specifies this is the highest wind speed for applying high amenity limits).

These results are evident in the tabulated predicted noise levels presented in Table 49 to Table 52 of Appendix J for each candidate turbine.

In addition, the location of the predicted 35 dB L_{A90} noise contour is illustrated in Figure 9, corresponding to the hub height wind speed of 6 m/s for the candidate wind turbine model with the highest noise emission (N163/5.7). It can be seen from Figure 9 that the predicted wind turbine noise levels at a hub height wind speed of 6 m/s are below the high amenity noise limit of 35 dB L_{A90} at all non-stakeholder receivers, including camping grounds. Accordingly, in addition to the high amenity limits not being considered applicable, their application would be inconsequential to the operational noise management of the Project.

9.5 Cumulative assessment

To our knowledge[10], the nearest approved and/or operating wind farm is the Cape Bridgewater Wind Farm (approximately 20 km to the southeast).

Due to the significant separating distance, cumulative assessment of noise levels from the Project and other surrounding wind farm(s) is not warranted.

10 Based on the Department of Transport and Planning *Renewable Energy Projects Victoria* web page

Figure 5: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164

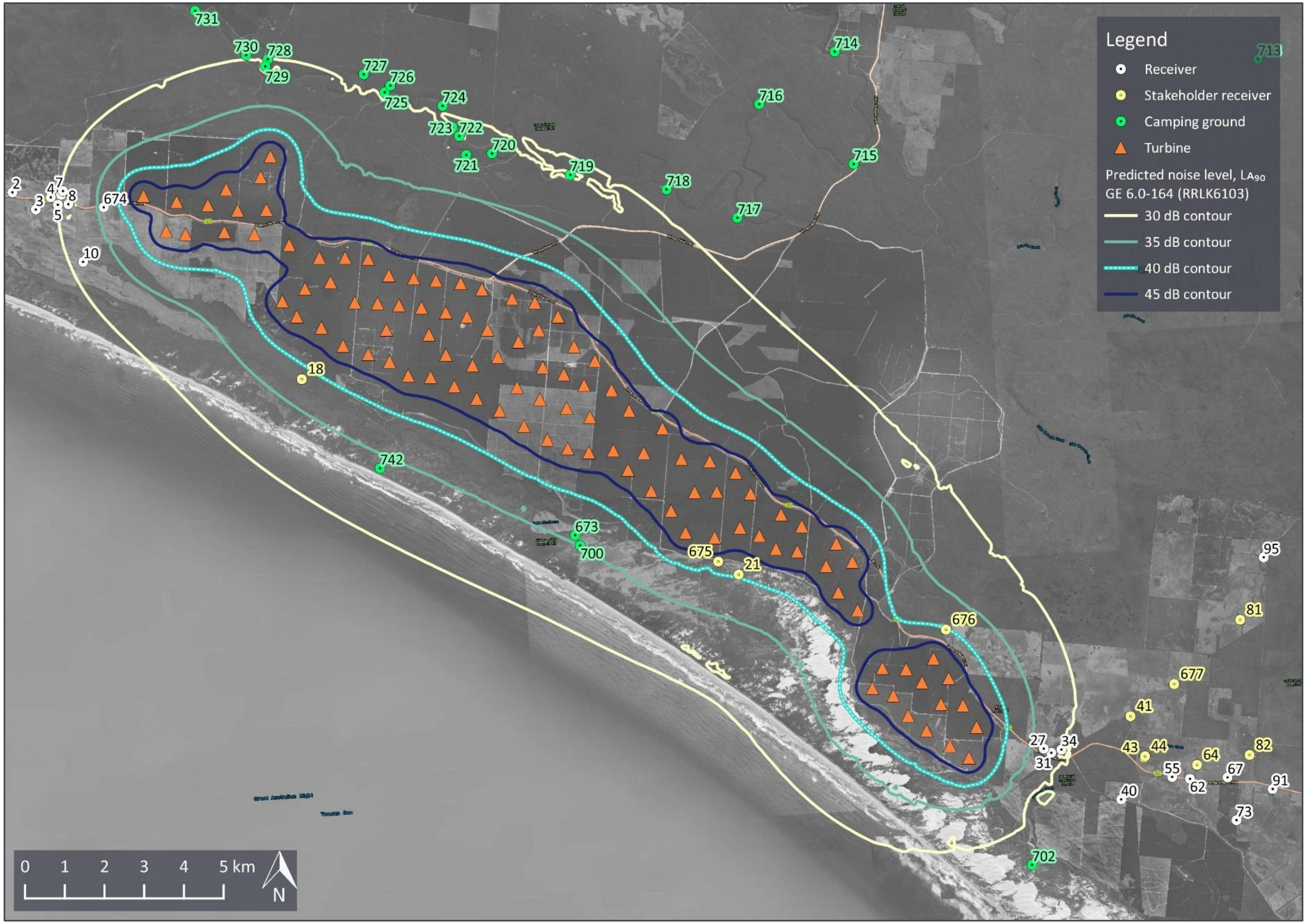


Figure 6: Highest predicted noise level contours, dB L_{A90} – V162-6.2MW

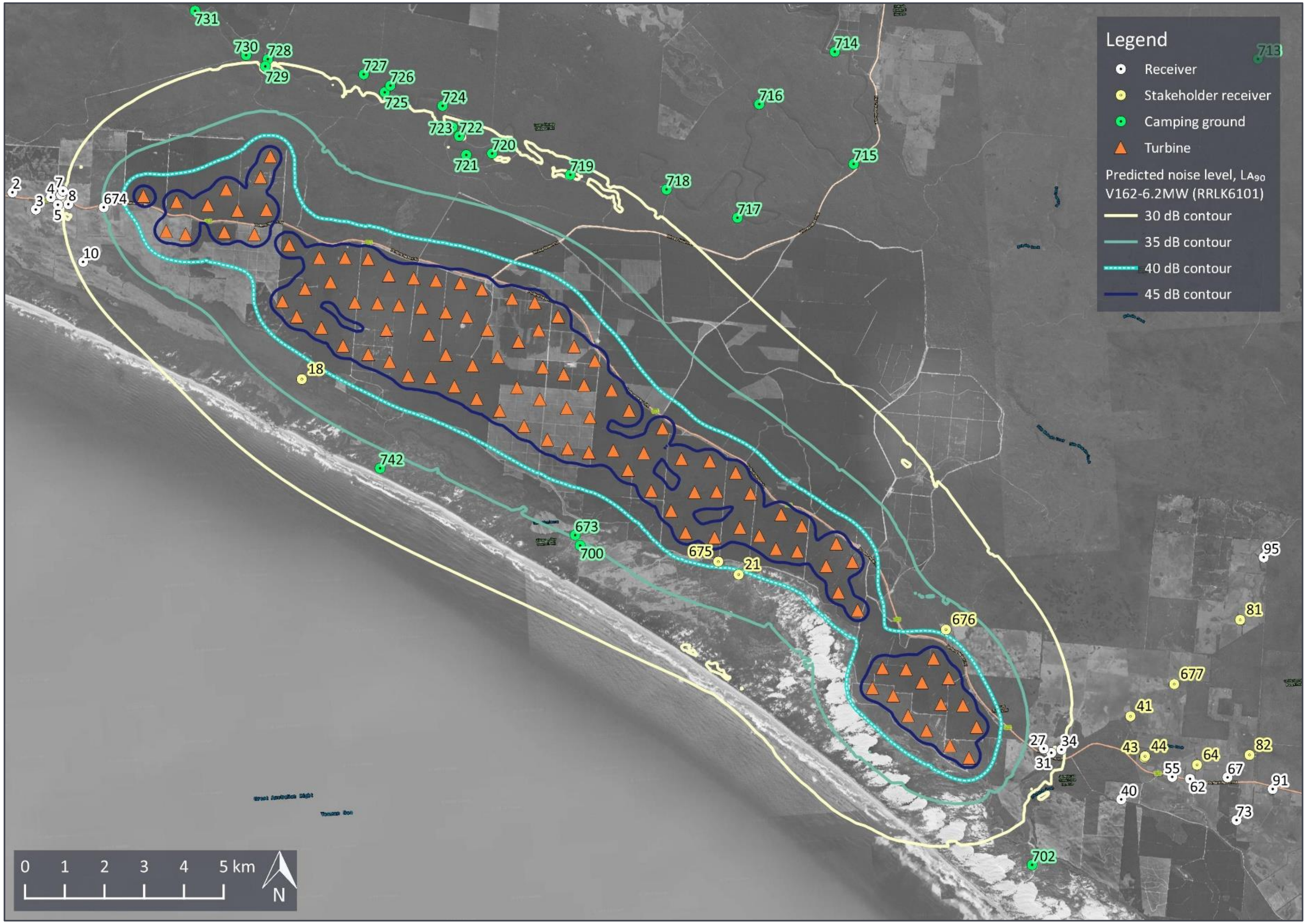


Figure 7: Highest predicted noise level contours, dB L_{A90} – SG 6.2-170

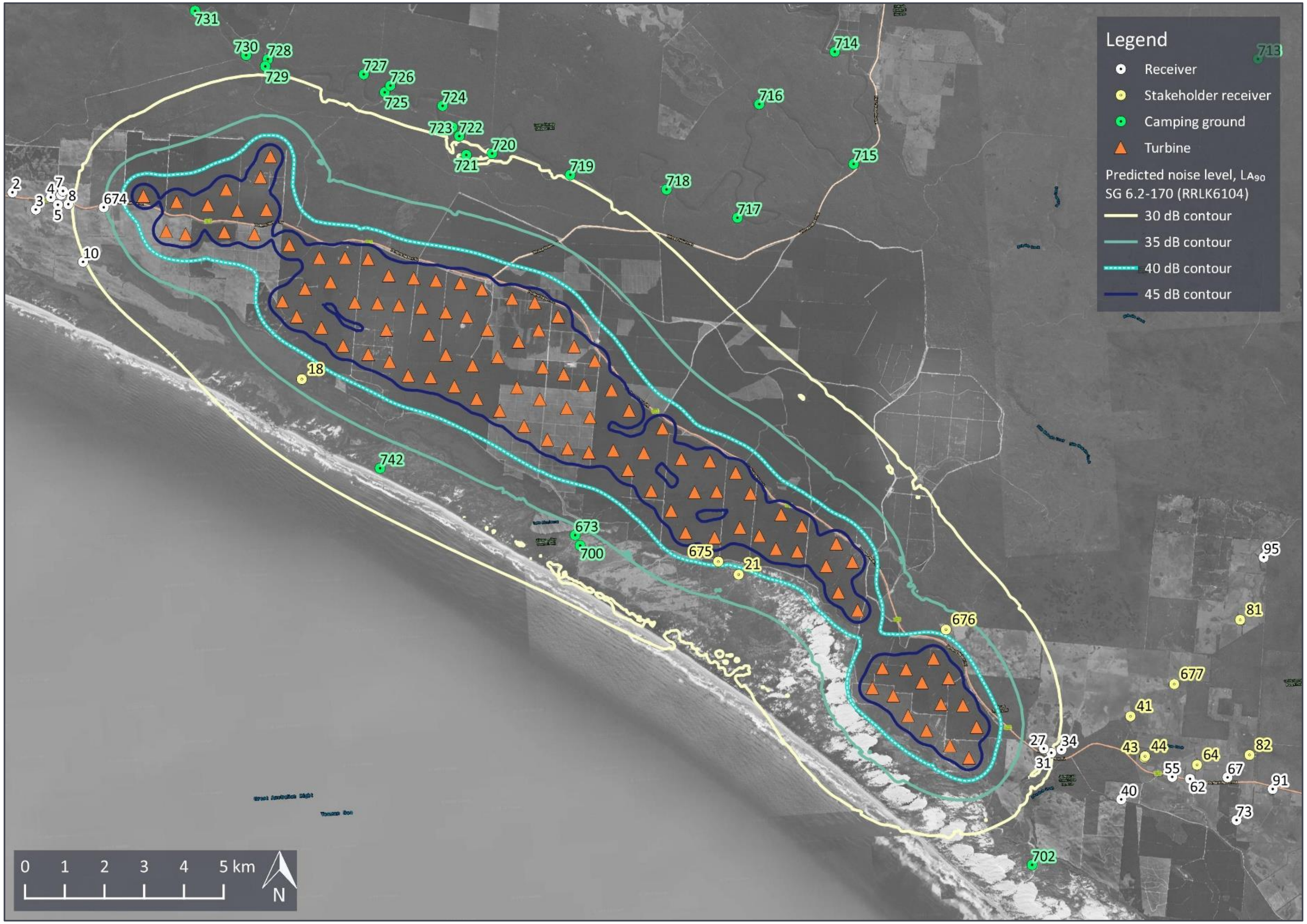


Figure 8: Highest predicted noise level contours, dB L_{A90} – N163/5.7

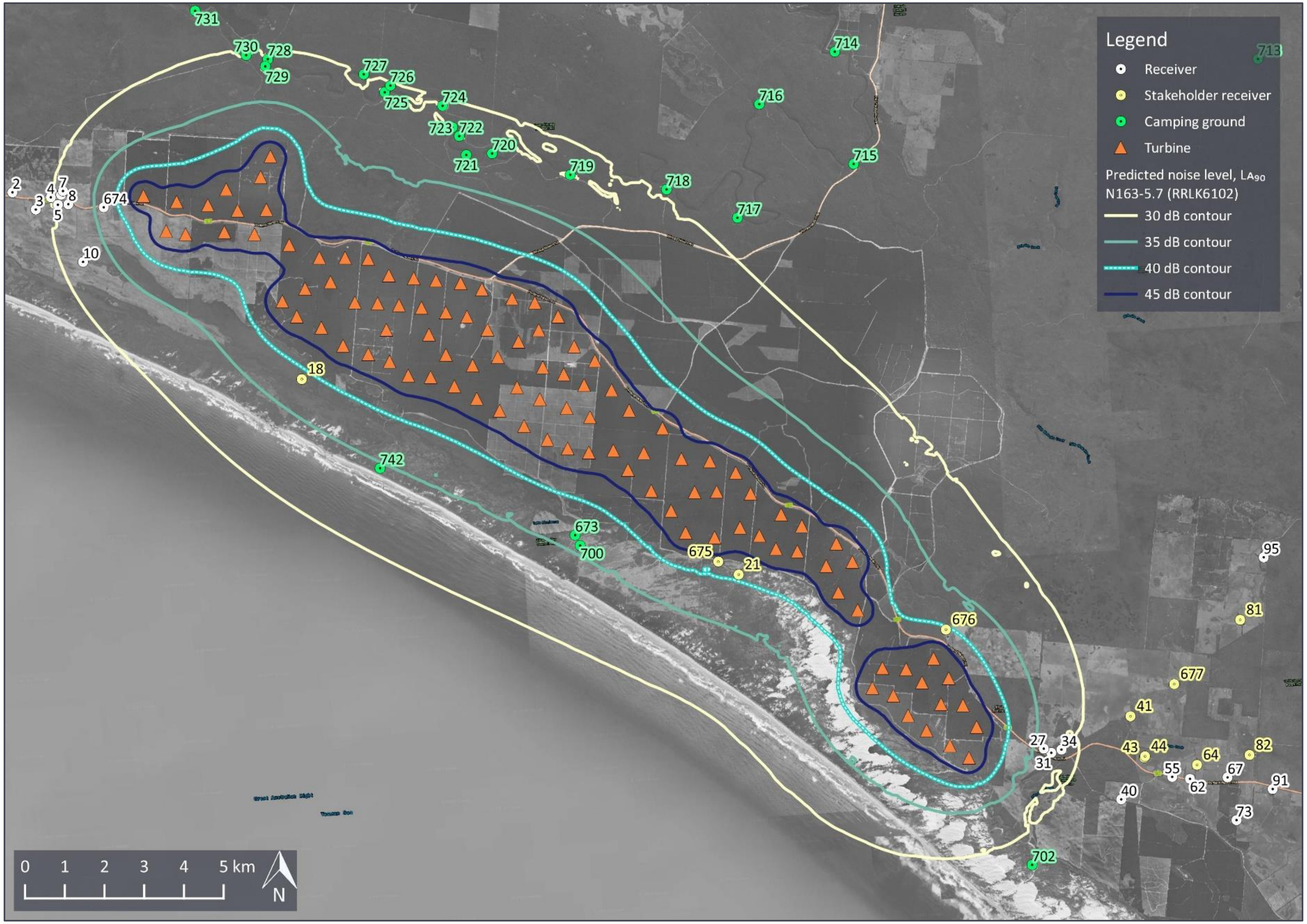


Figure 9: Predicted noise level contours at hub height wind speed of 6 m/s, dB L_{A90} – N163/5.7

10.0 OPERATIONAL NOISE ASSESSMENT – SUBSTATIONS

This section presents an assessment of operational noise from the four (4) substations each including a single transformer with a rating of up to 375 MVA:

- One (1) main substation to the southeast of the Project; and
- Three (3) collector substations to the north of the Project, along Portland Nelson Road.

A site layout plan illustrating the substations and receivers is provided in Figure 1 of Section 1.2.

10.1 Assessment criteria

The Noise Protocol procedure for determining noise limits depends on whether the noise source or the receivers are located in a rural or urban area.

In rural areas, applicable noise limits are generally based on zone levels determined according to the land zoning of the area in which the noise source and receivers are located. These zone levels are then adjusted, where appropriate, for a range of factors.

Adjustments for 'background relevant areas' are not warranted in this instance, as the background noise levels during the relevant assessment conditions for the substations (i.e. low wind speeds) are relatively low; adjustments for background noise levels are therefore not warranted in this instance.

The substations are defined as *utility* in the Victorian Planning Provisions. As such, and considering they are located on land designated as Farming Zone (FZ1) (see land zoning map in Appendix I), the noise limits applicable at the nearest receivers are summarised in Table 29.

Table 29: Noise Protocol time periods and noise limits, dB ENL

Period	Day of week	Start time	End time	Noise limit
Day	Monday - Saturday	0700 hrs	1800 hrs	45
Evening	Monday - Saturday	1800 hrs	2200 hrs	39
	Sunday, Public holidays	0700 hrs	2200 hrs	
Night	Monday - Sunday	2200 hrs	0700 hrs	34

As the substations are proposed to operate 24 hours a day and 7 days a week, meeting the applicable night-time noise limit of 34 dB ENL infers meeting the noise limits during all other time periods.

10.2 Noise emissions

The transformers and any associated cooling equipment will be the main sources of noise located within the substations.

At this stage in the project, specific details of the transformer make and model are yet to be determined. However, to provide a basis for assessing the feasibility of the substations, the proponent advised that each transformer is proposed to have a rating of up to 375 MVA.

In lieu of manufacturer sound power level data for a specific transformer selection, reference has been made to Australian Standard AS 60076-10:2009 *Power transformers – Part 10: Determination of sound levels* (AS 60076-10) which provides a method for estimating transformer sound power levels. Specifically, Figure ZA1 from AS 60076-10 has been used to determine an estimated sound power level of 102 dB L_{WA}, for a 375 MVA transformer. The sound power levels include the noise contribution from auxiliary plant such as cooling plant.

AS 60076-10:2009 does not provide estimated sound frequency spectra for transformer noise emissions. However, the noise emissions of transformers and ancillary plant typically exhibit tonal characteristics which must be accounted for in the noise assessment. This is addressed in the following section.

Sound power level data used in this assessment for the equipment associated with the substations is summarised in Table 30.

Table 30: Octave band sound power level, dB L_W

	Octave band centre frequency, Hz							
Item	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**Total**
375 MVA transformer	100	111	108	99	90	81	74	102

10.3 Predicted noise levels

Predicted noise levels have been determined on the basis of:

- the indicative equipment noise emission data detailed in Section 10.2; and
- the ISO 9613-2 noise prediction method described in Section 8.3.

An adjustment of +2 dB has then been applied to the predicted noise levels to account for the potential tonal characteristics of transformer noise. The relevance and magnitude of the adjustment in practice is dependent on several variables. This is discussed below.

Predicted effective noise levels (including the +2 dB adjustment) at the nearest receiver from each of the substations are presented in Table 31.

Table 31: Substations - predicted noise levels, dB ENL

Source item	Nearest receiver	Distance to the nearest receiver, m	Predicted noise level [1]
Main substation	44 (S)	1,012	27
Collector substation #1	721 (C)	3,043	15
Collector substation #2	675 (S)	2,659	18
Collector substation #3	676 (S)	2,758	17

(S) Stakeholder receiver | (C) Camping ground

1 Cumulative noise level from all substations (including tonality adjustment)

The predicted effective noise levels are below the noise limits applicable to the day, evening and night periods by a reasonable margin. The following contextual notes are provided:

- The predicted effective noise level is at least 7 dB below the night-time noise limit; and
- The predicted effective noise level is very low and would be comparable to or less than background noise levels in most instances. The adjustment for tonality is therefore not expected to be applicable at most, if not all, locations.

These results indicate that noise levels from the proposed substations associated with the wind farm are unlikely to be a significant design consideration. However, noise levels should be reviewed at the time when equipment selections are finalised, accounting for manufacturer noise emission data.

Further, the low predicted noise level indicates noise from the transformer station(s) is unlikely to represent a risk of harm to the environment as a result of noise. The general environmental duty under the EP Act is therefore expected to be addressed by selecting transformers with noise emissions equivalent to, or lower than, the AS 60076-10 empirical values referenced in this assessment. Given that actual noise emission values for contemporary transformer designs are usually lower than the empirical values of the standard, this is considered a reasonably practicable noise mitigation measure for the purposes of the EP Act.

10.4 Cumulative predicted noise levels

In accordance with the Noise Protocol, the noise limits detailed in the preceding sections apply to the noise level generated by all activities under consideration (i.e. substations, on-site quarry and concrete batching plants).

The precise timing when the on-site quarry and concrete batching plants would cease operation, and the substations commence operation, is presently not defined. Given that the on-site quarry and concrete batching plants are primarily for the supply of material for construction of the Project, it is unlikely that they would still be operating when the substations become operational. However, to account for any potential brief period of overlapping operation, cumulative noise levels are presented in Table 32 for receivers detailed in Sections 7.4.1, 7.4.2 and 10.3.

Table 32: Cumulative estimated noise levels, dB ENL [1]

Receiver	Substations	Quarry	Concrete batching plant	Cumulative	Applicable noise limit [2]
27	15	12	22	23	36
31	15	12	21	22	34
34	16	12	20	22	34
41 (S)	29	11	16	29	34
44 (S)	27	10	14	27	34
673 (C)	13	31	12	31	34
675 (S)	18	26	12	27	34
676 (S)	17	17	37	37	36
700 (C)	12	30	12	30	34
719 (C)	13	30	19	30	32
720 (C)	15	27	20	28	34
721 (C)	15	27	20	28	34
722 (C)	14	25	18	26	34
723 (C)	13	25	17	26	34

(S) Stakeholder receiver | (C) Camping ground

1 Estimated effective noise levels include a +2 dB adjustment for the potential presence of tonality

2 Night-time noise limit applicable to the nearest noise source

The results presented in Table 20 indicate cumulative estimated levels that are lower than the applicable night-time noise limit by at least 3 dB at thirteen (13) of the fourteen (14) assessed receivers.

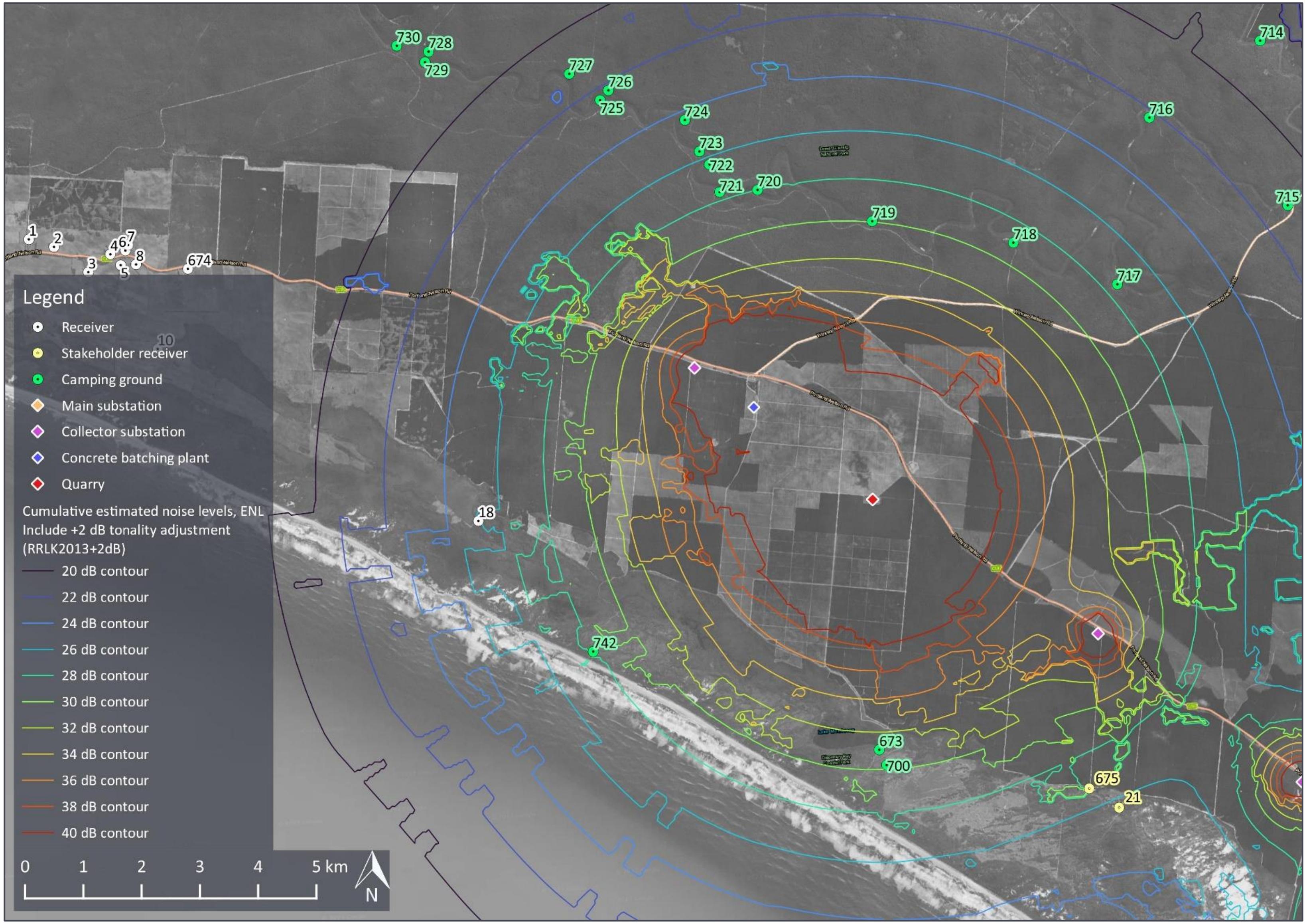
At Receiver 676, operational noise levels from the proposed eastern concrete batching plant are estimated to be above the night base noise limit by 1 dB. As discussed in Section 7.4.2, this receiver is an abandoned dwelling owned by a landowner involved with the Project.

It should be noted that, considering the separation distances between each considered noise sources and the assessed receivers, the predicted cumulative levels presented in the above table are likely to be overestimated due in part to the influence of weather conditions and intervening local screening not included in the calculations.

Noise contour maps showing cumulative estimated noise levels from the proposed substations, on-site quarry and concrete batching plants is presented in Figure 10 and Figure 11.

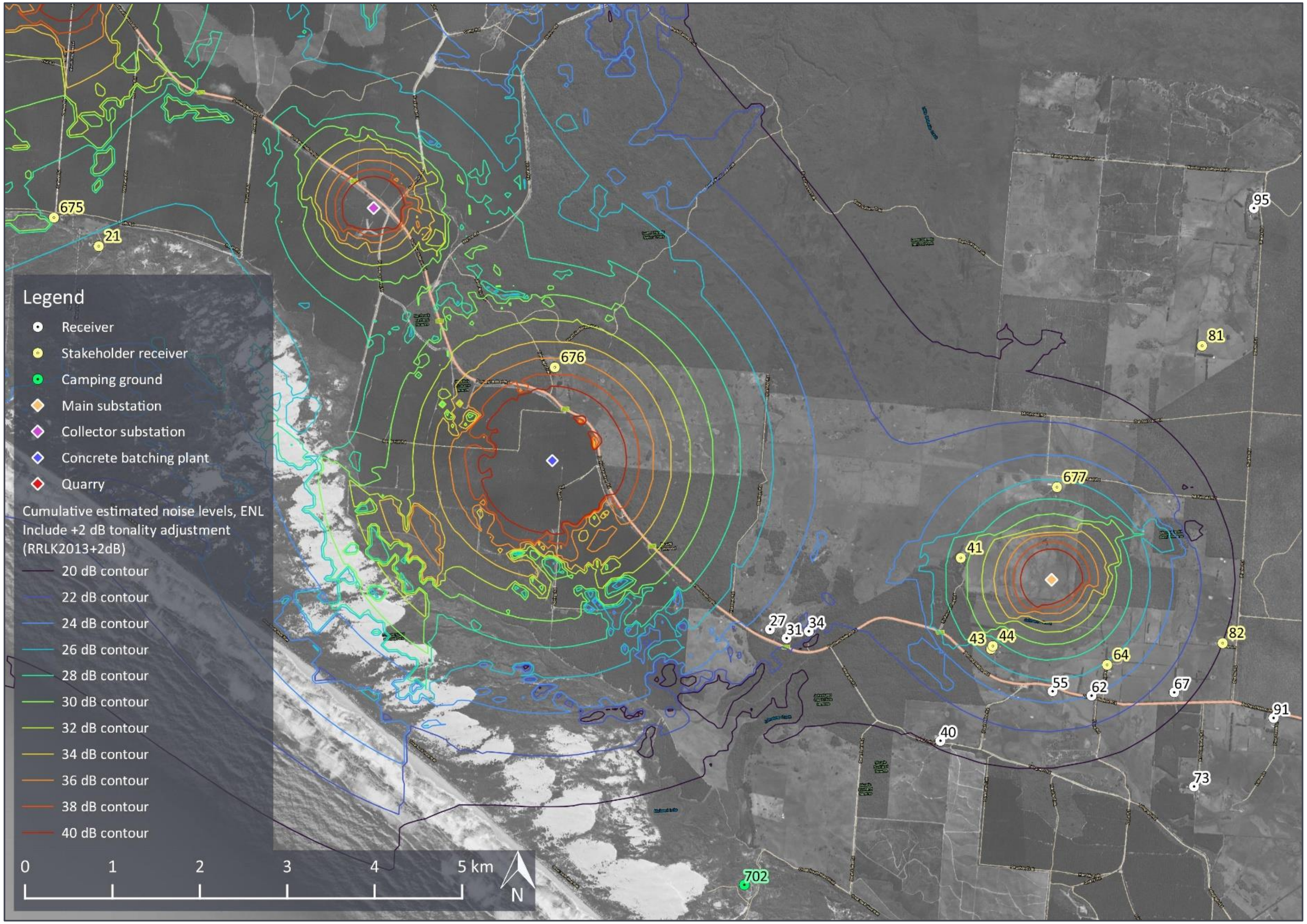
The results therefore demonstrate that the even if the substations were to begin operating before the operation of the quarry and concrete batching plants stop, the cumulative noise is predicted to be lower than the noise limits determined in accordance with the Noise Protocol.

Figure 10: Cumulative estimated operational noise levels from the substations, on-site quarry and concrete batching plants – Western section



MARSHALL DAY Acoustics

Figure 11: Cumulative estimated operational noise levels from the substations, on-site quarry and concrete batching plants – Eastern section



11.0 ENVIRONMENT REFERENCE STANDARD

The Environment Reference Standard (ERS) is a relevant consideration for natural areas located in the vicinity of the Project and are addressed in this section.

11.1 Identified natural areas

Natural areas are a land-use category for which the ERS details desired outcomes in terms of noise level to be achieved or maintained in Victoria. The ERS defines natural areas as national parks, state parks, state forests, nature conservation reserves and wildlife reserves.

The following natural areas, identified by the proponent and presented in Figure 13, have been considered in this assessment:

- Lower Glenelg National Park to the north;
- Cobboboonee National Park to the east
- Cobboboonee Forest Park to the east;
- Mount Richmond National Park to the southeast;
- Discovery Bay Coastal Park to the south; and
- Various reserves to the north and southeast.

In addition to identified natural areas, the Great South West Walk runs around the Project.

11.2 Guidance on noise in natural areas

Clause 7 of the ERS sets out the environmental values for the ambient sound environment that are to be achieved or maintained in Victoria. The ERS also sets out the indicators and objectives to support those values.

The environmental value relevant to natural areas and the indicator to support this value is contained in Table 33.

Table 33: Environmental values of the ambient sound environment

Environmental value	Description of environmental value
Human tranquillity and enjoyment outdoors in natural areas	An ambient sound environment that allows for the appreciation and enjoyment of the environment for its natural condition and the restorative benefits of tranquil soundscapes in natural areas

11.3 Existing noise environment in natural areas

The natural areas identified in Section 11.1 extend over relatively large areas and encompass a broad range of ambient sound environments. The map in Figure 13 provides an overview to illustrate the Project site and the key land uses in the surrounding area, including both natural areas and forestry plantations.

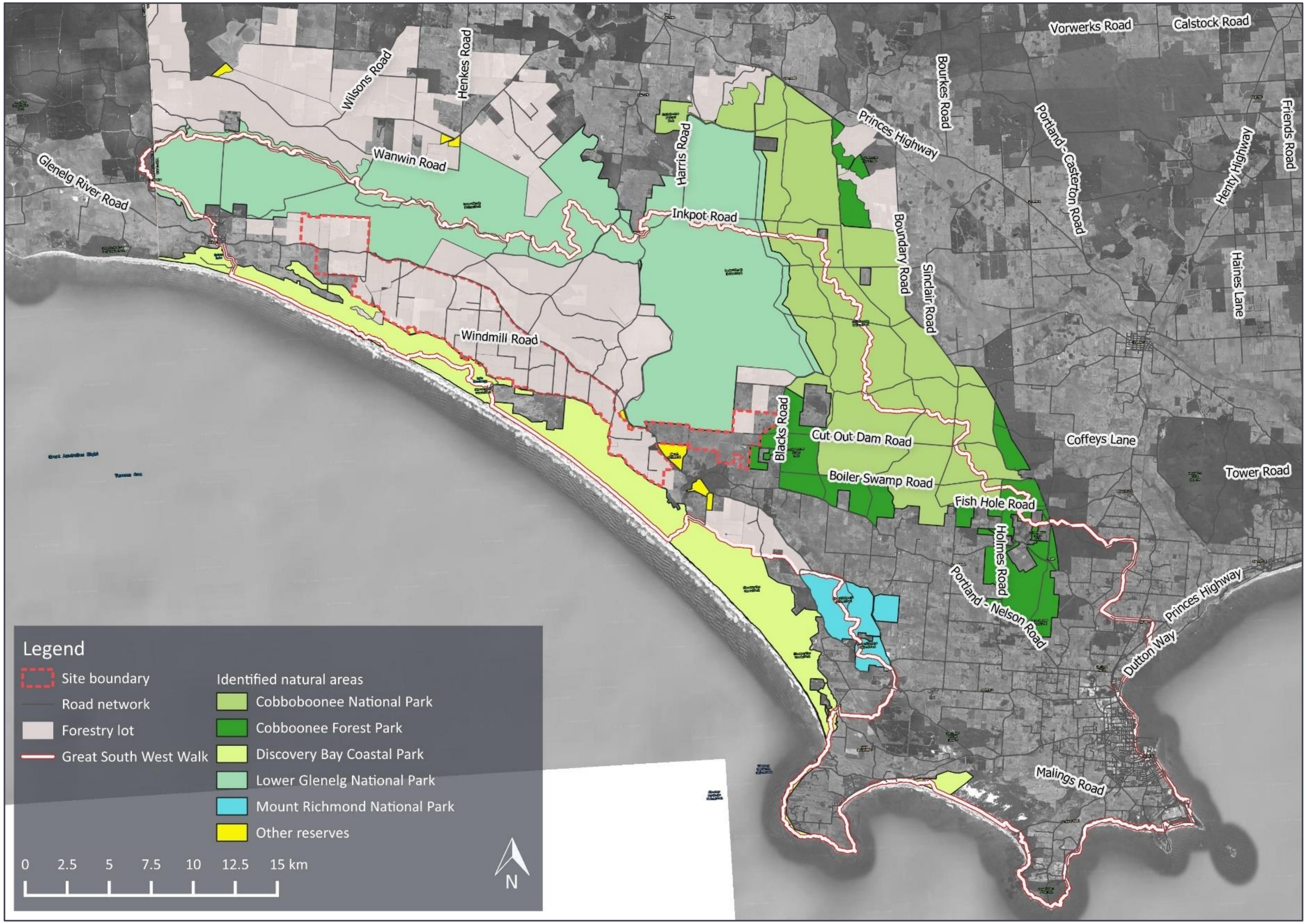
At the Discovery Bay Coastal Park to the south of the project, the sound environment would generally be characterised by natural sources related to coastal processes (e.g. surf noise) and wind.

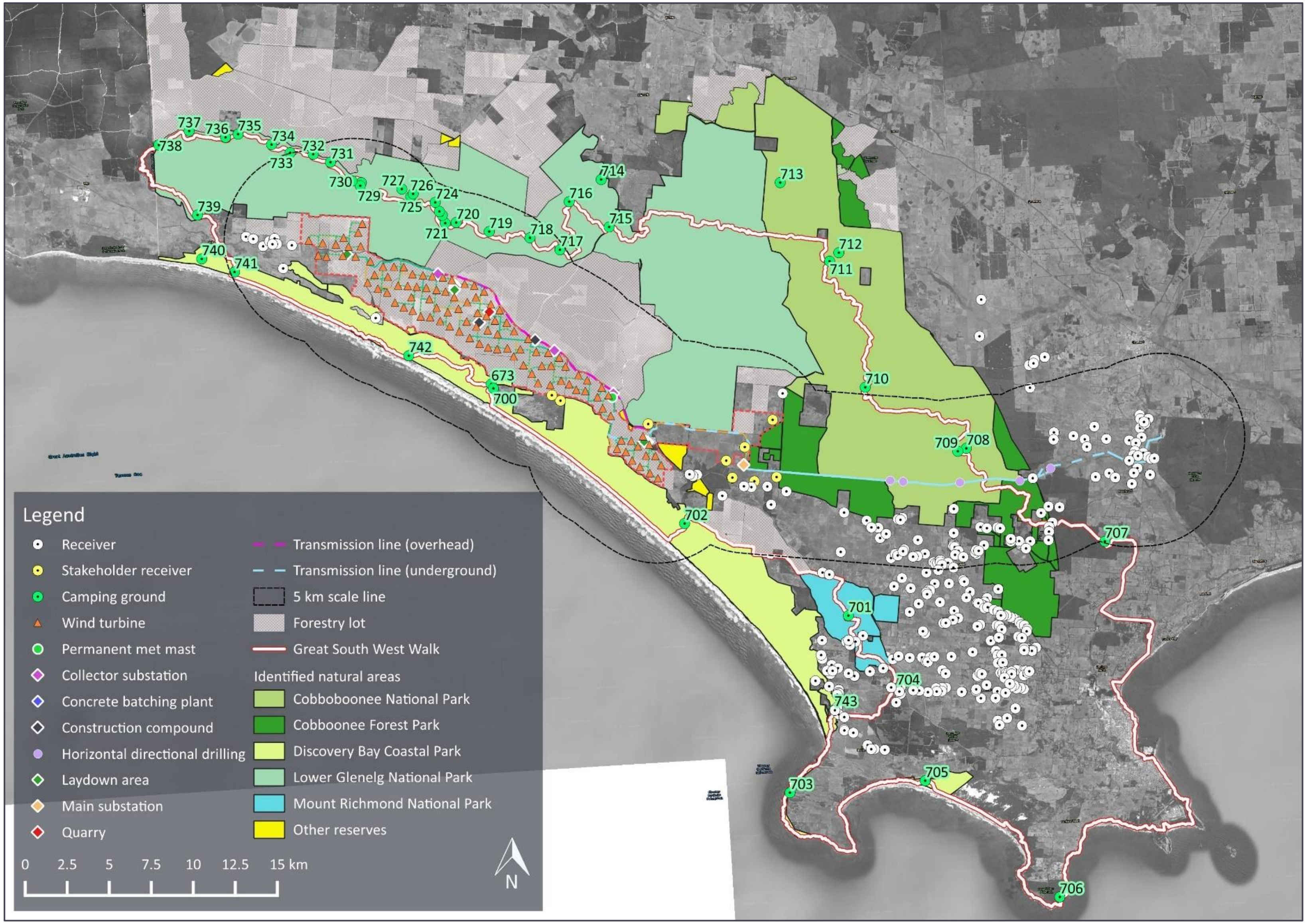
At the inland natural areas, the sound environment would be characterised by a varying mix of natural sounds and intermittent anthropogenic noise sources. For example, at the southern sections of the Glenelg River National Park, immediately to the north of the Project, the sound environment would include intermittent road traffic movements on Port Nelson Road and agricultural activity such as ongoing forestry operations. At central and northern sections of the inland natural areas, the sound environment would mainly be related to natural sources such as fauna and wind disturbance of vegetation. However, at the northern periphery of natural areas such as the Glenelg River National Park, the influence of intermittent agricultural activities would be more prominent due to the proximity of forestry plantation areas to the north.

As a result of these factors, and the extent of the natural areas, background noise levels are likely to vary significantly. At locations immediately adjacent to the coast, the background noise levels would be elevated by the effect of coastal influences and wind. At other locations where wind disturbance of vegetation is a key influence, the background noise would vary significantly according to factors such as ground elevation (in turn affecting exposure to the wind) and the type and density of vegetation in the surrounding area.

Background noise monitoring in the areas around the Project were primarily used to quantify noise levels at locations where the data is used to establish quantitative noise criteria. However, the results of the noise monitoring presented in presented in Section 5.0 generally demonstrate low background noise levels across the wind speed range for locations that are setback from the coast. For example, even at the wind speeds comparable to the speed when the turbines would be approaching their maximum noise emissions, background noise levels are generally comparable to or lower than 35 dB L_{A90}. These results support that background noise levels across the natural areas located away from the coast are generally expected to be low. Conversely, adjacent to the coast, background noise levels are expected to be regularly above 35 dB L_{A90}, and frequently significantly higher, due to the combined effects of coastal influences and wind.

Figure 12: Map of project area and surrounding key surrounding land uses




Legend
Receiver
Stakeholder receiver
Camping ground
Wind turbine
Permanent met mast
Collector substation
Concrete batching plant
Construction compound
Horizontal directional drilling
Laydown area
Main substation
Quarry
Transmission line (overhead)
Transmission line (underground)
5 km scale line
Forestry lot
Great South West Walk
Identified natural areas
Cobboboonee National Park
Cobboonee Forest Park
Discovery Bay Coastal Park
Lower Glenelg National Park
Mount Richmond National Park
Other reserves
0 2.5 5 7.5 10 12.5 15 km
N
737
736
735
734
733
732
731
738
730
729
727
726
725
724
721
720
719
718
717
716
715
714
713
712
711
739
740
741
742
673
700
710
709
708
702
707
701
704
743
703
705
706

11.4 Project noise levels in natural areas

Noise from construction and operation of the Project would be audible in sections of the natural areas around the Project and has the potential to impact the environmental value of *human tranquillity and enjoyment outdoors* in these locations. Importantly, given than the environmental value relates to subjective impression of the soundscape's characteristics, impacts can occur at very low levels of audible noise from the Project; particularly if the character and pattern of the noise is significantly different from the existing environment.

Audibility of the Project in the identified natural areas will be highly dependent on a range of factors, including:

- Proximity and scale of the Project;
- Proximity and scale of activities associated with construction of the Project;
- The level and character of the noise associated with construction of the project;
- Timing and duration of activities associated with construction of the Project;
- Operating conditions of the Project;
- The level and character of the noise associated with operation of the Project;
- Extent of the identified natural areas that are reasonably accessible to the public;
- Natural background noise sources (e.g. ocean, vegetation, fauna, etc.)
- Anthropogenic background noise sources (e.g. road traffic, farming and forestry activities, etc.); and
- Wind conditions (e.g. wind speed and wind direction).

The proximity of the identified natural areas to the Project is such that there will be parts of these areas where activities associated with both construction and operation of the Project will contribute to the soundscape.

11.4.1 Operational noise

With respect to operational noise of the Project in natural areas, the primary consideration is noise from wind turbines. In contrast, the extent of natural areas potentially affected by the proposed substations is limited as the predicted noise levels are low (see Section 10.3).

The Project will most likely be audible on some occasions at the locations where wind turbine noise levels are above 30 dB L_{A90}. Below that level, wind turbine noise may still be audible at times, but it would be much dependent on wind conditions and the specific characteristics of the background environment, and any audible wind turbine noise would be increasingly difficult to distinguish from the ambient sound environment.

As an indication, wind turbine noise levels above 30 dB L_{A90} are predicted to occur in areas within approximately 2 km of the Project's wind turbines. Conversely, where predicted wind turbine noise levels are higher than 40 dB L_{A90}, the Project is expected to be regularly audible.

The distribution of wind turbine noise levels in the identified natural areas is presented in Figure 13.

Figure 13: Map of natural areas identified by the proponent with predicted operational wind turbine noise levels

Predicted operational wind turbine noise levels along the Great South West Walk are presented in Table 34.

Table 34: Predicted operational wind turbine noise levels along the Great South West Walk

Predicted noise level range, dB L_{A90}	Cumulative track length, km	Proportion of the track
< 20	156	61 %
20 to 25	33	13 %
25 to 30	24	9 %
30 to 35	35	14 %
35 to 40	7	3 %
> 40	0	0%

11.4.2 Construction noise – construction activities

Construction activities represent a temporary source of undesirable noise in sections of the natural areas around the Project.

The overall construction period for the project is approximately 2 to 2.5 years, from enabling works through to commissioning. Within this period, the location of the works will be constantly varying as the work front for each construction stage progress through the project area. As a result, at a given location within the neighbouring natural areas, construction noise would only be experienced for a portion of the overall construction period. As the construction activities move further away from a given location within the natural area, the intermittent noise of construction would progressively reduce and the noise would be akin to that of distant/intermittent agricultural activity in the surrounding area.

In terms of this extent of areas affected, the likelihood of very low background noise levels at distant and sheltered parts of the natural areas means there is the potential for construction activities to be audible over distances of up to 3 to 5 km from the work sites. A buffer distance of 5 km around all of the proposed construction work sites is shown in Figure 14 to provide an indication of the extent where construction noise could potentially be audible. The actual distance at which construction activities could be heard in practice will depend on a range of factors, particularly atmospheric conditions and background sound levels. This is particularly relevant for the coastal locations adjacent to the Project where background noise levels would be elevated and construction activity is only like to be audible when it is occurring at the nearest sections of the Project.

The sections of the natural areas that are within the indicated 5 km include points of interest where people make use of natural areas, such as the Great South West Walk, camping grounds, picnic location and lookouts. Conversely, a significant portion of the areas within the indicated buffer would relate to locations which are either accessed infrequently, or not accessible.

The camping grounds in the adjoining natural areas are typically located near to other points of interest in natural areas where people may reside, such as lookouts and picnic ground. Therefore, to provide an indication of potential construction noise levels at key points of interest in natural areas, predicted noise levels for each type of construction activity have been determined for each of the camping grounds. The distance to the nearest camping ground from each work site is presented in Table 35. The range of predicted noise levels at the camping ground for each construction activity are summarised in Table 36.

The results demonstrate predicted noise levels up to 45 dB L_{Aeq} as a result of access track construction (an activity which only occurs briefly near a sensitive location as construction of the track progresses). For most construction activities, the predicted construction noise levels at camping grounds are less than 35 dB L_{Aeq}.

It is important to note that these represent worst case predicted noise levels for the nearest work site to each location, all equipment associated with the activity operating continuously, and for conditions which favour sound propagation. Actual noise levels from a given work site would be lower in practice, and would be significantly lower as the construction work front moves to other sections of the Project.

The predicted noise levels are therefore low for temporary sources of noise, and would be comparable to the range of noise levels that would occur when occasional forestry operations are occurring in surrounding plantations. However, while the predicted noise levels are low, the noise of construction activity is distinct from that of the natural sound environment, in terms of both the frequency and temporal characteristics of the noise. Construction activity and equipment that are characterised by tonal or impulsive sources would be most prominent and are likely to represent the greatest source of impact on natural soundscapes. Construction activity would therefore impact the value of the soundscape in these natural areas when the works are occurring.

Based on the above, while construction noise impacts to the environmental value would be temporary, the effects of construction noise on *human tranquillity and enjoyment outdoors* should be accounted for in the preparation and implementation of the CNVMP for the Project. Specifically, the effects of noise on natural areas where people reside should be factored in the development of reasonable and practical measures to fulfil the GED. The key measures for addressing the noise of construction are as follows:

- Selection of low noise emission plant for construction activity throughout the project (i.e. wider adoption of the noise mitigation and management measures which would typically be implemented when working near residential locations);
- Selection of construction equipment to minimise any distinctive undesirable characteristics which could be more intrusive over wider areas, such as tonal reversing signals and low frequency noise emissions;
- Maintenance of site equipment and infrastructure to minimise noise emissions, particularly with respect to site access tracks where surface deterioration can lead to excess impact noise from the carriages of heavy vehicles;
- Education of the construction teams to raise awareness of the proximity of natural areas where natural soundscapes are valued and identify all relevant considerate working practices;
- Planning for the most efficient way to complete the works and minimise the duration of the noise;
- Restriction of construction activities to normal working hours wherever practical do so (particularly relevant for avoiding sensitive evening and night periods at camping grounds); and
- Consultation with Parks Victoria to communicate when and where construction works are planned and identify any opportunities for improvement of the noise mitigation and management measures, consistent with the requirements of the GED.

Adoption of these measures will enable the extent of natural areas affected by construction activity, and the duration the areas are affected for, to be practicably minimised.

Figure 14: Map of natural areas identified by the proponent, forestry lots, construction activities, Great South West Walk and camping grounds

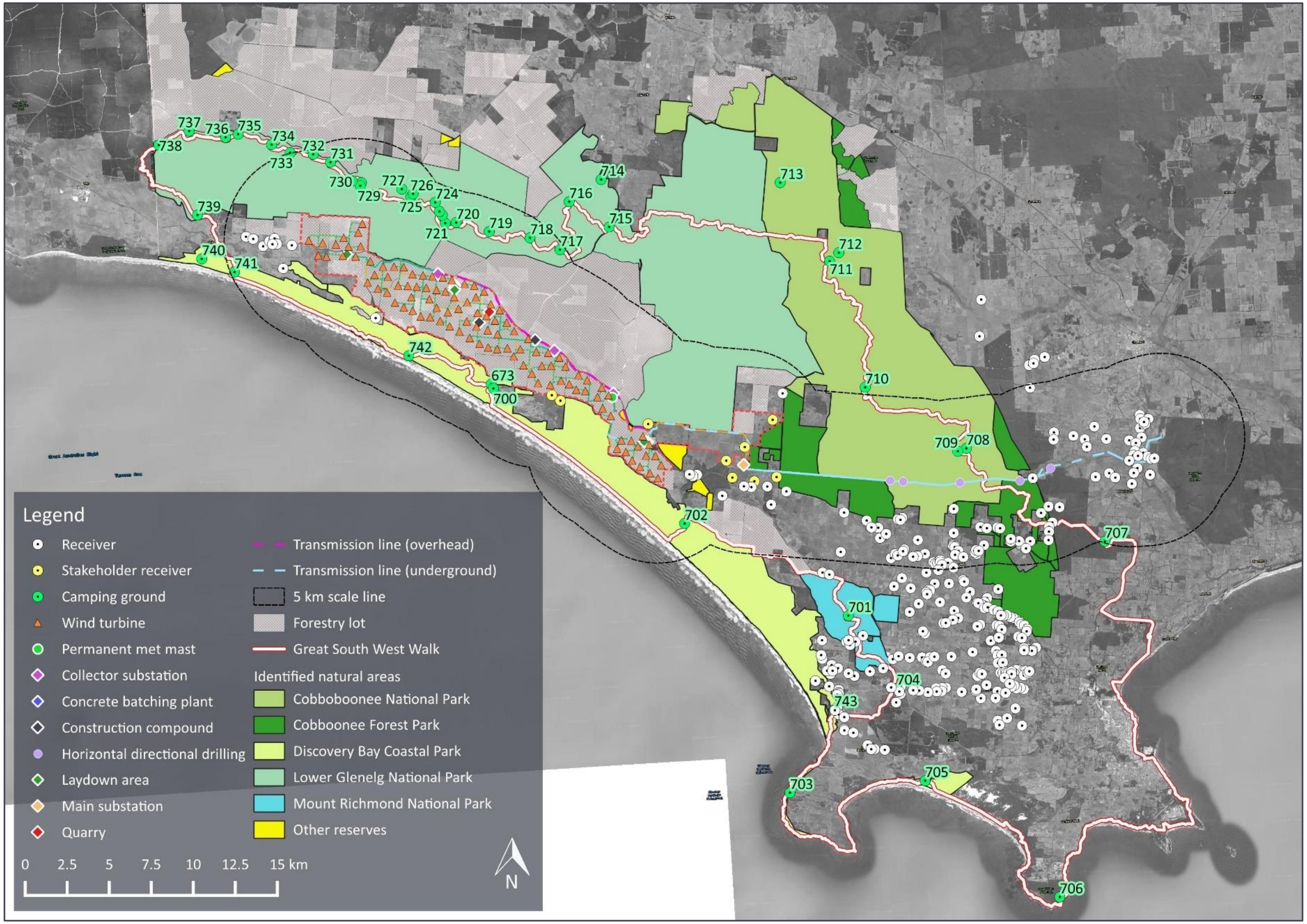


Table 35: Nearest camping ground from each construction activity

	Access road and tracks construction	Cable trench digging	Horizontal drilling	Permanent met mast	Powerline pole	Powerline stringing	Site compound	Collector substation	Substation	Turbine assembly	Turbine foundations
Nearest camping ground	673	709	709	700	721	721	673	721	702	673	673
Distance to nearest camping ground, m	1,921	1,884	1,853	7,088	2,975	2,975	3,695	3,043	4,949	2,105	2,105

Table 36: Number of camping grounds within each range of predicted construction noise levels

Predicted construction noise level range, dB L_{Aeq}	Access road and tracks construction	Cable trench digging	Horizontal drilling	Permanent met mast	Powerline pole	Powerline stringing	Site compound	Collector substation	Substation	Turbine assembly	Turbine foundations
<10	-	-	32	1	2	3	1	1	3	-	-
10-15	-	1	6	20	9	11	4	7	20	3	3
15-20	1	3	2	17	11	10	16	11	15	9	10
20-25	6	7	2	3	7	6	8	8	3	4	5
25-30	8	8	-	-	8	8	8	8	-	9	8
30-35	9	13	2	-	4	3	4	6	-	12	11
35-40	12	8	-	-	-	-	-	-	-	4	4
40-45	3	1	-	-	-	-	-	-	-	-	-
>45	-	-	-	-	-	-	-	-	-	-	-

11.4.3 Construction noise – quarry and batching plant

Operation of the temporary quarry and batching plants is a relevant consideration for natural areas during the construction period. These elements of the Project would operate for a greater portion of the construction period than other types of construction activity.

As with other types of construction activity, the extent of areas in which the noise would be audible will be highly variable. However, natural areas within the predicted 25 dB L_{Aeq} contour are likely to experience audible noise from these sites when background noise levels are low and conditions favour the propagation of sound from the quarry and concrete batching plants.

To provide an indication of the extent of the areas in which construction noise may be audible, the predicted cumulative noise of the quarry and concrete batching plants is presented in Figure 15.

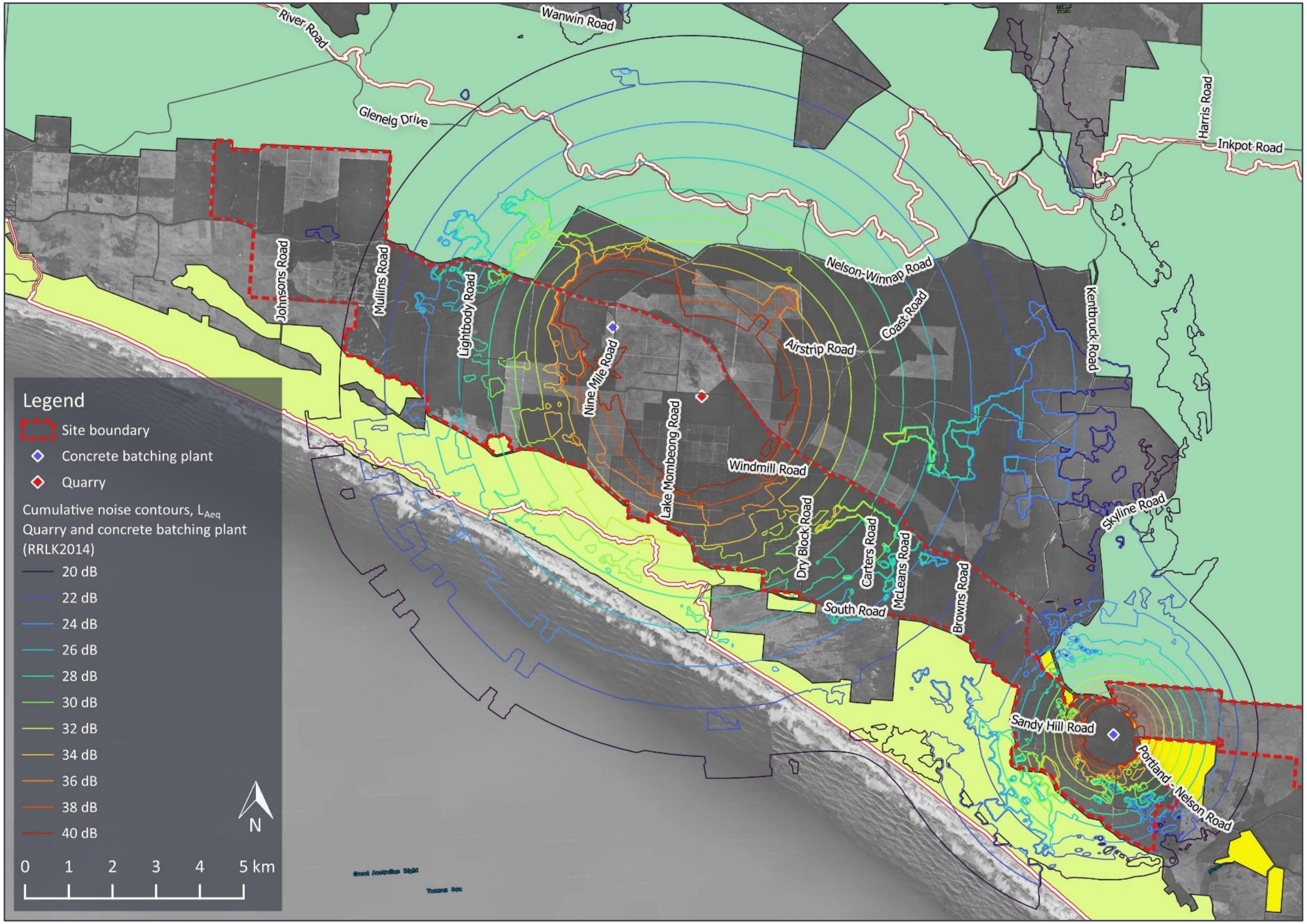
In terms of points of interest within the natural areas where people reside, predicted noise levels in the vicinity of the camping grounds are provided in Table 32 of Section 10.4.

The results indicate that operation of the quarry and concrete batching plants may be audible in some parts of the surrounding natural areas during the construction stage of the project; mainly within a section of the Glenelg River National Park directly to the north of the quarry.

Consistent with the requirements of the GED and the recommended noise management measures for general construction activity (see Section 11.4.2), the extent and nature of the effect can be reduced by:

- selecting low noise emission equipment;
- minimising distinctive undesirable characteristics which could be more intrusive over wider areas, such as tonal reversing signals and low frequency noise emissions; and
- maintaining site equipment and infrastructure to minimise noise emissions, particularly with respect to access and site roads where surface deterioration can lead to excess impact noise from the carriages of heavy vehicles.

Figure 15: Cumulative estimated operational noise levels from on-site quarry and concrete batching plants



12.0 MITIGATION MEASURES

Based on the assessment findings presented in this preceding sections, the recommended mitigation measures for the control of noise and vibration associated with construction and operation of the Project are detailed in Table 37. The mitigation measures establish requirements at each stage of the Project from design through to ongoing operation and decommissioning.

The objective of the mitigation measures is to minimise the risk of harm from noise and vibration associated with construction and operation of the Project, so far as reasonably practicable, in accordance with the GED under the EP Act. The risks to be minimised, under the EP Act, include adverse effects on both human health and amenity.

Table 37: Recommended noise and vibration mitigation measures

MM ID	Mitigation measure
MM-NV01	Construction noise and vibration management plan Before commencement of development, a construction noise and vibration management plan (CNVMP) will be prepared to address the effects of construction noise related to on-site activities and off-site traffic movements, and construction vibration associated with any activities expected to occur at less than 100 m from a receiver. The CNVMP will include: • A clear overview of the proposed construction program and demonstrate all reasonably practicable measures proposed to fulfil the general environmental duty under the *Environmental Protection Act 2017* (EP Act), accounting for guidance under EPA Publication 1834.1 *Civil construction, building and demolition guide.* • A schedule of noise emission data for the major plant items to be used for construction of the Project, and a comparison of the data with the noise emission ranges set out in AS 2436 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (Reconfirmed 2016)*. • Define all unavoidable work and low-noise managed-impact works which may occur outside of normal working hours, such as out of hours deliveries or turbine installation activities that are subject to weather constraints. • Details relating to proposed routing and timing of construction traffic, including protocols to minimise noise along local roads to the extent reasonably practicable. • Details of the measures to be implemented to address noise characteristics such as tonality, impulsive noise and low frequency noise, including consideration of residential receivers and noise levels in natural areas. • The proposed scheduling of any out of hours works, and provide evidence to support that low-noise managed-impact works meet the criteria defined in EPA Publication 1834.1. • Identify specific activities which warrant notification of neighbouring residents in advance of the work occurring, such as unavoidable works outside of normal working hours and activities with potential to cause perceptible vibration. • Identify specific activities and construction stages which warrant notification of Parks Victoria of noise impacts to natural areas of state and national parks. The CNVMP will be prepared in consultation with EPA Victoria and Parks Victoria. An EPA appointed independent environmental auditor (IEA) would be engaged to prepare a report verifying the CNVMP. Both the CNVMP and the IEA's verification report must be made available to EPA Victoria on request. Prior to decommissioning, a decommissioning noise and vibration management plan (DNVMP) would be prepared and submitted to the responsible authority for endorsement. This plan would include the following: • An assessment of the potential impacts of decommissioning noise and vibration from Project activities. • The proposed decommissioning program and how the proposed noise and vibration management controls are compliant with the legislation and policy requirements at the time of decommissioning. An EPA appointed independent environmental auditor (IEA) would be engaged to prepare a report verifying the DNVMP. Both the DNVMP and the IEA's verification report must be made available to EPA Victoria on request.

MM ID	Mitigation measure
MM-NV02	Concrete batching plants All temporary concrete batching plants will be designed and operated in accordance with the general management measures in EPA Publication 1806 *Reducing risk in the premixed concrete industry.* The design and operation of the batching plants will implement measures to: • Minimise the risk of harm from operational noise so far as reasonably practicable, in accordance with the general environmental duty under the *Environmental Protection Act 2017* (EP Act). • Prevent prescribed unreasonable noise by complying with noise limits determined in accordance with EPA publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol). • Prevent unreasonable noise according to the factors defined in part (a) of the definition of unreasonable noise in section 3(1) of the EP Act, accounting for the low frequency guidance of EPA Publication 1997 *Noise guidelines: assessing low frequency noise* (as amended or replaced from time to time).
MM-NV03	Quarry work plan Before commencement of development, a Quarry Work Plan will be prepared in consultation with relevant authorities and endorsed as part of the Work Authority. The quarry work plan will document measures to: • Minimise the risk of harm from operational noise so far as reasonably practicable, in accordance with the general environmental duty under the *Environmental Protection Act 2017* (EP Act). • Prevent prescribed unreasonable noise by complying with noise limits determined in accordance with EPA publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol). • Prevent unreasonable noise according to the factors defined in part (a) of the definition of unreasonable noise in section 3(1) of the EP Act, accounting for the low frequency guidance of EPA Publication 1997 *Noise guidelines: assessing low frequency noise* (as amended or replaced from time to time).
MM-NV04	Pre-construction noise assessment of substations Before development starts, a pre-development noise assessment is to be submitted to the Responsible Authority demonstrating that the design and operation of the substations include measures to: • Minimise the risk of harm from operational noise so far as reasonably practicable, in accordance with the general environmental duty under the *Environmental Protection Act 2017* (EP Act). • Prevent prescribed unreasonable noise by complying with noise limits determined in accordance with EPA publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol). • Prevent unreasonable noise according to the factors defined in part (a) of the definition of unreasonable noise in section 3(1) of the EP Act, accounting for the low frequency guidance of EPA Publication 1997 *Noise guidelines: assessing low frequency noise* (as amended or replaced from time to time).

MM ID	Mitigation measure
MM-NV05	Pre-construction noise assessment of wind turbines Prior to the commencement of construction, a pre-construction noise assessment will be completed and approved by the responsible authority. This assessment will be undertaken to assess the final project layout and equipment selection to ensure that the noise criteria are achieved at all non-stakeholder receivers under all wind speeds prior to construction commencing. The pre-development noise assessment will be based on the final wind turbine layout, representative noise emission data for the final selected wind turbine model and the location of all receivers around the wind farm (existing or approved noise sensitive receivers at the date of the wind farm's approval). The pre-development noise assessment will identify all stakeholder receivers where noise agreements have been established. The pre-development noise assessment will be prepared in accordance with the assessment and documentation requirements of NZS 6808:2010 *Acoustics – Wind farm noise*. The pre-development noise assessment will be accompanied by a report prepared by an independent environmental auditor appointed under Part 8.3 the *Environment Protection Act 2017* that verifies if the acoustic assessment undertaken for the purpose of the pre-development noise assessment has been conducted in accordance with NZS 6808:2010. Both the pre-development noise assessment and the IEA's verification will be provided to EPA Victoria within 10 days of the completion of the IEA's verification report.
MM-NV06	Noise management plan Before development starts, a noise management plan (NMP) will be prepared for operational wind turbine noise in accordance with the requirements of regulation 131E of the *Environment Protection Regulations 2021* (EP Regulations). In addition to the requirements of the EP Regulations, the NMP will also: • Address the guidance of EPA Publication 2061 *Wind Energy Facility Turbine Noise Regulation Guidelines.* • Document a schedule of sound power level testing which will be undertaken to verify that the noise emissions of the installed turbines are consistent with the findings presented in the pre-construction noise assessment prepared under MM-NV05.
MM-NV07	Post-construction noise assessment of wind turbine noise A post-construction noise assessment will be undertaken by a suitably qualified and experienced acoustic consultant to demonstrate operation of the Project is compliant with applicable noise limits. The assessment will be undertaken in accordance with the Environment Protection Regulations 2021 and the noise management plan prepared under MM-NV06. An EPA appointed independent environmental auditor (IEA) would be engaged to prepare a report verifying the assessment. Both the post-construction noise assessment and the IEA's verification report will be provided to EPA Victoria within 10 days of the completion of the IEA's verification report.
MM-NV08	Annual statement Annual statements would be prepared annually in accordance with regulation 131F of the *Environment Protection Regulations 2021* and as detailed in the noise management plan prepared under MM-NV06.
MM-NV09	Noise monitoring Regular wind turbine noise monitoring would be undertaken in accordance with regulation 131G of the *Environment Protection Regulations 2021* and as detailed in the noise management plan prepared under MM-NV06.

13.0 SUMMARY

An assessment has been undertaken of the potential noise and vibration impacts associated with construction, operation and decommissioning of the Kentbruck Green Power Hub within the study area.

The assessment addresses the environmental noise and vibration assessment requirements of the *Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement* published by the Minister for Planning in January 2021. It is based on evaluation of potential noise and vibration impacts in accordance with applicable Victorian assessment criteria.

The EES evaluation objective for the Kentbruck Green Power Hub with respect to noise and vibration is to manage potential adverse effects for noise sensitive locations, having regard to both construction and operation of the wind farm.

The findings of the noise assessment demonstrate that the Kentbruck Green Power Hub is consistent with the EES evaluation objective on the basis that the Project is able to comply with the criteria and recommendations of the applicable Victorian policies and guidelines, provided that appropriate noise mitigation measures are implemented.

In particular, the results of the modelling demonstrate that the proposed wind turbines are predicted to achieve compliance with the applicable noise limits determined in accordance with NZS 6808 for all receivers and all selected candidate wind turbine models.

The assessment has also considered operational noise associated with the proposed substations, in accordance with EP Act and EP Regulations. The assessment demonstrates that the operational noise levels from the substations are predicted below the noise limits determined in accordance with the Noise Protocol. Consideration was also given to the general environmental duty, as required by the EP Act.

Noise and vibration during the construction and decommissioning of the Project has been assessed and can be satisfactorily addressed with good practice measures, accounting for the guidance of EPA Publication 1834.1.

Implementation of the recommended Environmental Performance Requirements will minimise the noise and vibration impact of the Kentbruck Green Power Hub to nearby noise sensitive locations.

APPENDIX A GLOSSARY OF TERMINOLOGY

Term	Definition	Abbreviation
Amplitude modulation	Sound that is characterised by a rhythmic and higher than normal rise and fall in sound level at regular intervals.	-
A-weighting	A method of adjusting sound levels to reflect the human ear's varied sensitivity to different frequencies of sound.	See discussion below this table.
A-weighted 90th centile	The A-weighted pressure level that is exceeded for 90 % of a defined measurement period. It is used to describe the underlying background sound level in the absence of a source of sound that is being investigated, as well as the sound level of steady, or semi steady, sound sources.	L_{A90}
Decibel	The unit of sound level.	dB
Effective noise level	The effective noise level from commercial, industrial or trade premises determined in accordance EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industry and trade premises and entertainment venues*. This is the L_{Aeq} noise level over a 30-minute period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency and impulsiveness.	ENL
Equivalent noise level	The equivalent continuous A-weighted pressure level. Commonly referred to as the average sound level and is measured in dB.	L_{Aeq}
Hertz	The unit for describing the frequency of a sound in terms of the number of cycles per second.	Hz
Impulsiveness	Sound that is characterised by a distinct and very rapid rise in sound level (e.g. a car door closing or the impact sound of a hammer)	-
Octave Band	A range of frequencies. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.	-
Peak particle velocity	The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.	PPV
Sound power level	A measure of the total sound energy emitted by a source, expressed in decibels.	L_W
Sound pressure level	A measure of the level of sound expressed in decibels.	L_p
Special audible characteristics	A term used to define a set group of Sound characteristics that increase the likelihood of adverse reaction to the sound. The characteristics comprise tonality, impulsiveness and amplitude modulation.	SAC
Tonality	A characteristic to describe sounds which are composed of distinct and narrow groups of audible sound frequencies (e.g. whistling or humming sounds).	-
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).	-

Term	Definition	Abbreviation
Vibration Dose Value	Based on British Standard BS 6472:1992 *Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)* and provides guidelines for the evaluation of whole-body exposure to intermittent vibration. VDV can be used to take into account the weighted measured RMS vibration from many vibration sources including rail vehicles, construction equipment such as jackhammers and industry. VDV takes into account the duration of each event and the number of events per day, either at present or in the foreseeable future and calculates a single value index.	VDV

The basic quantities used within this document to describe noise adopt the conventions outlined in ISO 1996-1:2016 *Acoustics - Description measurement and assessment of environmental noise – Basic quantities and assessment procedures*. Accordingly, all frequency weighted sound pressure levels are expressed as decibels (dB) in this report. For example, sound pressure levels measured using an “A” frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report.

APPENDIX B DESCRIBING SOUND

Sound is an important feature of the environment in which we live; it provides information about our surroundings and influences our overall perception of amenity and environmental quality.

While sound is a familiar concept, its description can be complex. This appendix provides general information about the definition of sound and the ways that different sound characteristics are described.

B1 Definition of sound

Sound is a term used to describe very small and rapid changes in the pressure of the atmosphere. Importantly, for pressure fluctuations to be considered sound, the rise and fall in pressure needs to be repeated at rates ranging from tens to thousands of times per second.

These small and repetitive fluctuations in pressure can be caused by many things such as a vibrating surface in contact with the air (e.g. the cone of a speaker) or turbulent air movement patterns. The common feature is a surface or region of disturbance that displaces the adjacent air, causing a very small and localised compression of the air, followed by a small expansion of the air.

These repeated compressions and expansions then spread into the surrounding air as waves of pressure changes. Upon reaching the ear of an observer, these waves of changing pressure cause structures within the ear to vibrate; these vibrations then generate signals which are able to be perceived as sounds.

The waves of pressure changes usually occur as complex patterns, comprising varied rates and magnitudes of pressure changes. The pattern of these changes will determine how a sound spreads through the air and how the sound is ultimately perceived when it reaches the ear of an observer.

B2 Physical description of sound

There are many situations where it can be useful to objectively describe sound, such as the writing or recording of music, hearing testing, measuring the sound environment in an area or evaluating new man-made sources of sound.

Sound is usually composed of complex and varied patterns of pressure changes. As a result, a number of attributes are used to describe sound. Two of the most fundamental sound attributes are:

- sound pressure
- sound frequency

Each of these attributes is explained in the following sections, followed by a discussion about how each of these attributes varies.

B2.1 Sound pressure

The compression and expansion of the air that is associated with the passage of a sound wave results in changes in atmospheric pressure. The pressure changes associated with sound represent very small and repetitive variations that occur amidst much greater pressures associated with the atmosphere.

The magnitude of these pressure changes influences how quiet or loud a sound will be; the smaller the pressure change, the quieter the sound, and vice versa. The perception of loudness is complex though, and different sounds can seem quieter or louder for reasons other than differences in pressure changes.

To provide some context, Table 38 lists example values of pressure associated with the atmosphere and different sounds. The key point from these example values is that even an extremely loud sound equates to a change in pressure that is thousands of times smaller than the typical pressure of the atmosphere.

Table 38: Atmospheric pressure versus sound pressure – example values of pressure

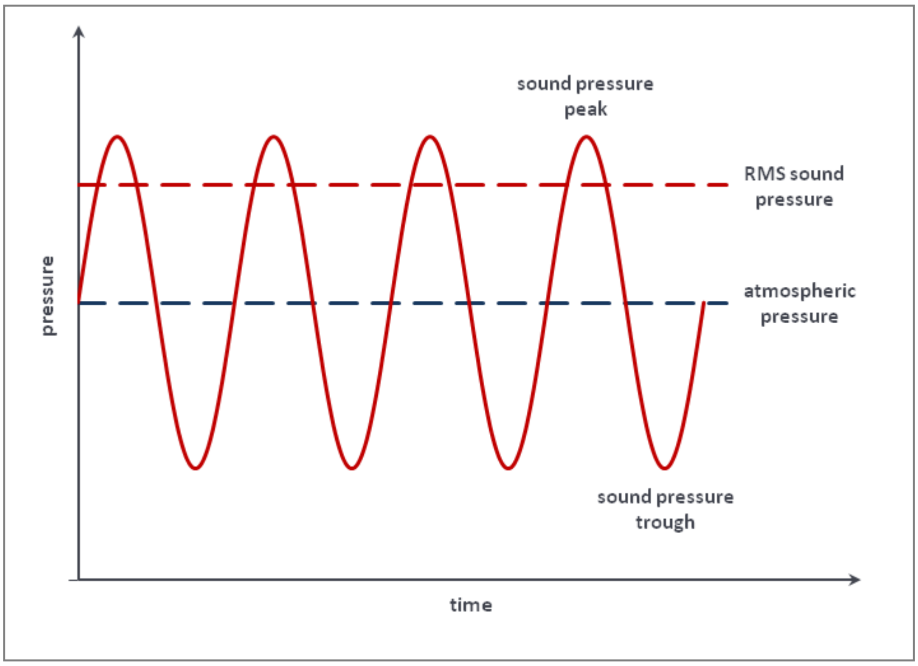
Example	Pascals, Pa	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.0000000002	0.000000003

The pressure values in Table 38 also show that the range of pressure changes associated with quiet and loud sounds span over a very large range, albeit still very small changes compared to atmospheric pressure. To make the description of pressure changes more practical, sound pressure is expressed in decibels or dB.

To illustrate the pressure variation associated with sound, Figure 16 shows the repetitive rise and fall in pressure of a very simple and steady sound. This figure illustrates the peaks and troughs of pressure changes relative to the underlying pressure of the atmosphere in the absence of sound. The magnitude of the change in pressure caused by the sound is then described as the sound pressure level. Since the magnitude of the change is constantly varying, the sound pressure may be defined in terms of:

- Peak sound pressure levels: the maximum change in pressure relative to atmospheric pressure i.e. the amplitude as defined by the maximum depth or height of the peaks and troughs respectively; or
- Root Mean Square (RMS) sound pressure levels: the average of the amplitude of pressure changes, accounting for positive changes above atmospheric pressure, and negative pressure changes below atmospheric pressure.

Figure 16: Pressure changes relative to atmospheric pressure associated with sound



B2.2 Frequency

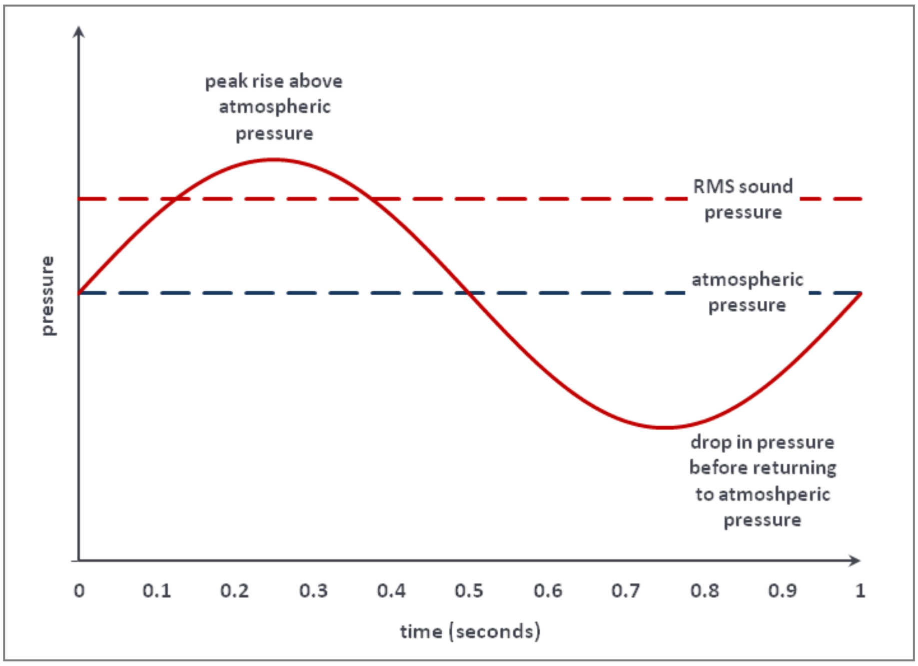
Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period of time. The rate of change in pressure is an important feature that determines whether it is able to be perceived as a sound by the human ear.

Repetitive changes in pressure can occur as a result of a range of factors with widely varying rates of fluctuation. However, only a portion of these fluctuations are able to be perceived as sound. In many cases, the rate of fluctuation will either be too slow or too fast for the human ear to detect the pressure change as a sound. For example, local fluctuations in atmospheric pressure can be created by someone waving their hands back and forth through the air; the reason this cannot be perceived as a sound is the rate of fluctuation is too slow.

At the rates of fluctuation that can be detected as sound, the rate will influence the character of the sound that is perceived. For example, slow rates of pressure change correspond to rumbling sounds, while fast rates correspond to whistling sounds.

The rate of fluctuation is numerically described in terms of the number of pressure fluctuations that occur in a single second. Specifically, it is the number of cycles per second of the pressure rising above, falling below, and then returning to atmospheric pressure. The number of these cycles per second is expressed in Hertz (Hz). This concept of cycles per second is illustrated in Figure 17 which illustrates a 1 Hz pressure fluctuation. The figure provides a simple illustration of a single cycle of pressure rise and fall occurring in a period of a single second.

Figure 17: Illustration of a pressure fluctuation with a frequency of 1Hz

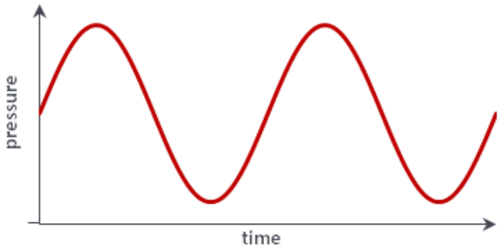


The rate that sound pressure rises and falls will vary depending on the source of the sound. For example, the surface of a tuning fork vibrates at a specific rate, in turn causing the pressure of the adjacent air to fluctuate at the same rate. Recalling the idea of pressure fluctuations from someone waving their hands, the pressure would fluctuate at the same rate as the hands move back and forth; a few times a second translating to a very low frequency below our hearing range (termed an infrasonic frequency). Examples of low and high frequency sound are easily recognisable, such as the low frequency sound of thunder, and the high frequency sound of crashing cymbals. To demonstrate the differences in the patterns of different frequencies of sound, Figure 18 illustrates the relative rates of pressure change for low, mid and high frequency sounds. Note that in each case the amplitude of the pressure changes remains the same; the only change is the number of fluctuations in pressure that occur over time.

Figure 18: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies

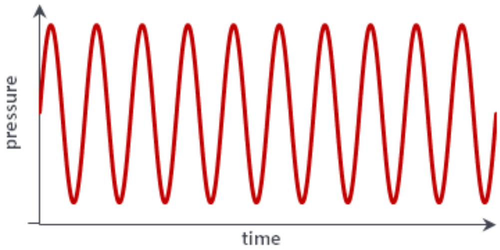
Low frequency sounds:

20 to 200 Hz



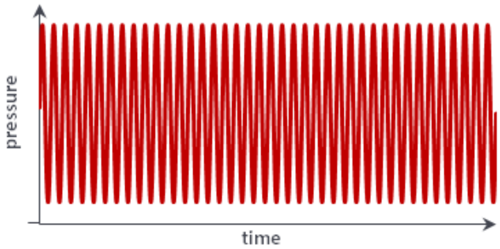
Mid-frequency sounds:

200 to 800 Hz



High frequency sounds:

greater than 800 Hz



B2.3 Sound pressure and frequency variations

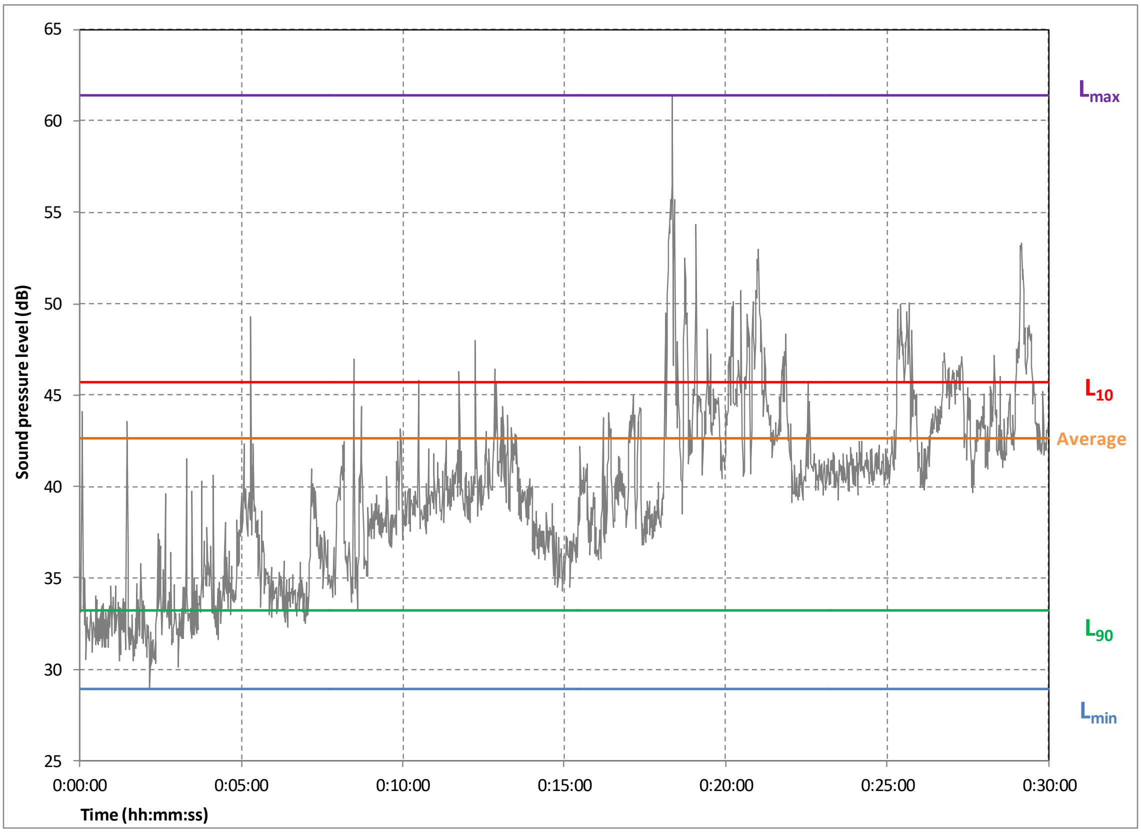
The preceding sections describe important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

The simplest type of sound comprises a single constant sound pressure level and a single constant frequency. However, most sounds are made up of many frequencies, and may include low, mid and high frequencies. Sounds that are made up of a relatively even mix of frequencies across a broad range of frequencies are referred to as being ‘broad band’. Common examples of broad band sounds include flowing water, the rustling of leaves, ventilation fans and traffic noise.

Further, sound quite often changes from moment to moment, in terms of both pressure levels and frequencies. The time varying characteristics of sound are important to how we perceive sound. For example, rapid changes in sound level produced by voices provide the component of sound that we interpret as intelligible speech. Variations in sound pressure levels and frequencies are also features which can draw our attention to a new source of sound in the environment.

To demonstrate this, Figure 19 illustrates an example time-trace of total sound pressure levels which varies with time. This variation presents challenges when attempting to describe sound pressure levels. As a result, multiple metrics are generally needed to describe sound pressure, such as the average, minimum or maximum noise levels. Other ways of describing sound include statistics for describing how often a defined sound pressure level is exceeded; for example, typical upper sound levels are often described as an L_{10} which refers to the sound pressure exceeded for 10 % of the time, or typical lower levels or lulls which are often described as an L_{90} which refers to the sound exceeded for 90 % of the time.

Figure 19: Example of noise metrics that may be used to measure a time-varying sound level



This example illustrates variations in terms of just total sound pressure levels, but the variations can also relate to the frequency of the sound, and frequently the number of sources affecting the sound.

These types of variations are an inherent feature of most sound fields and are an important point of context in any attempt to describe sound.

B3 Hearing and perception of sound

This section provides a discussion of:

- The use of the decibel to practically describe sound levels in a way that corresponds to the pressure levels the human ear is able to detect as sounds
- The relationship between sound frequency and human hearing.

The section concludes with a discussion of some of the complicating non-acoustic factors that influence our perception of sound.

B3.1 Sound pressure and the Decibel

Previous sections discussed the wide range of small pressure fluctuations that the ear is able to detect as sound. Owing to the wide range of these fluctuations, the way we hear sound is more practically described using the decibel (dB). The decibel system serves two key purposes:

- Compressing the numerical range of the quietest and loudest sounds commonly experienced.

  As an indication of this benefit, the pressure of the loudest sound that might be encountered is around a million times greater than the quietest sound that can be detected. In contrast, the decibel system reduces this to a range of approximately 0-120 dB.

- Consistently representing sound pressure level changes in a way that correlate more closely with how we perceive sound pressure level changes.

  For example, a 10 dB change from 20-30 dB will generally be subjectively perceived as a similar to a 10 dB change from 40-50 dB. However, expressed in units of pressure as Pascals, the 40-50 dB change is ten times greater than the 20-30 dB change. For this reason, sound pressure changes cannot be meaningfully communicated in terms of units of pressure such as Pascals.

Sound pressure levels in most environments are highly variable, so it can be misleading to describe what different ranges of sound pressure levels correspond to. However, as a broad indication, Table 39 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 39: Example sound pressure levels that might be experienced in different environments

Environment	Example Sound Pressure Level	
Outside in an urban area with traffic noise	50-70 dB	0.006-0.06 Pa
Outside in a rural area with distant sounds or moderate wind rustling leaves	30-50 dB	0.0006-0.006 Pa
Outside in a quiet rural environment in calm conditions	20-30 dB	0.0002-0.0006 Pa
Inside a quiet bedroom at night	<20 dB	0.0002 Pa

The impression of how much louder or quieter a sound is will be influenced by the magnitude of the change in sound pressure. Other important factors will also influence this, such as the frequency of the sound which is discussed in the following section. However, to provide a broad indication, Table 40 provides some examples of how different changes in sound pressure levels can be perceived.

Table 40: Perceived changes in sound pressure levels

Sound pressure level change	Indicative change in perceived sound
1 dB	Unlikely to be noticeable
2-3 dB	Likely to be just noticeable
4-5 dB	Clearly noticeable change
10 dB	Distinct change - often subjectively described as halving or doubling the loudness

The example sound pressure level changes in Table 40 are based on side-by-side comparison of a steady sample of sound heard at different levels. In practice, changes in sound pressure levels may be more difficult to perceive for a range of reasons, including the presence of other sources of sound, or gradual changes which occur over a longer period of time.

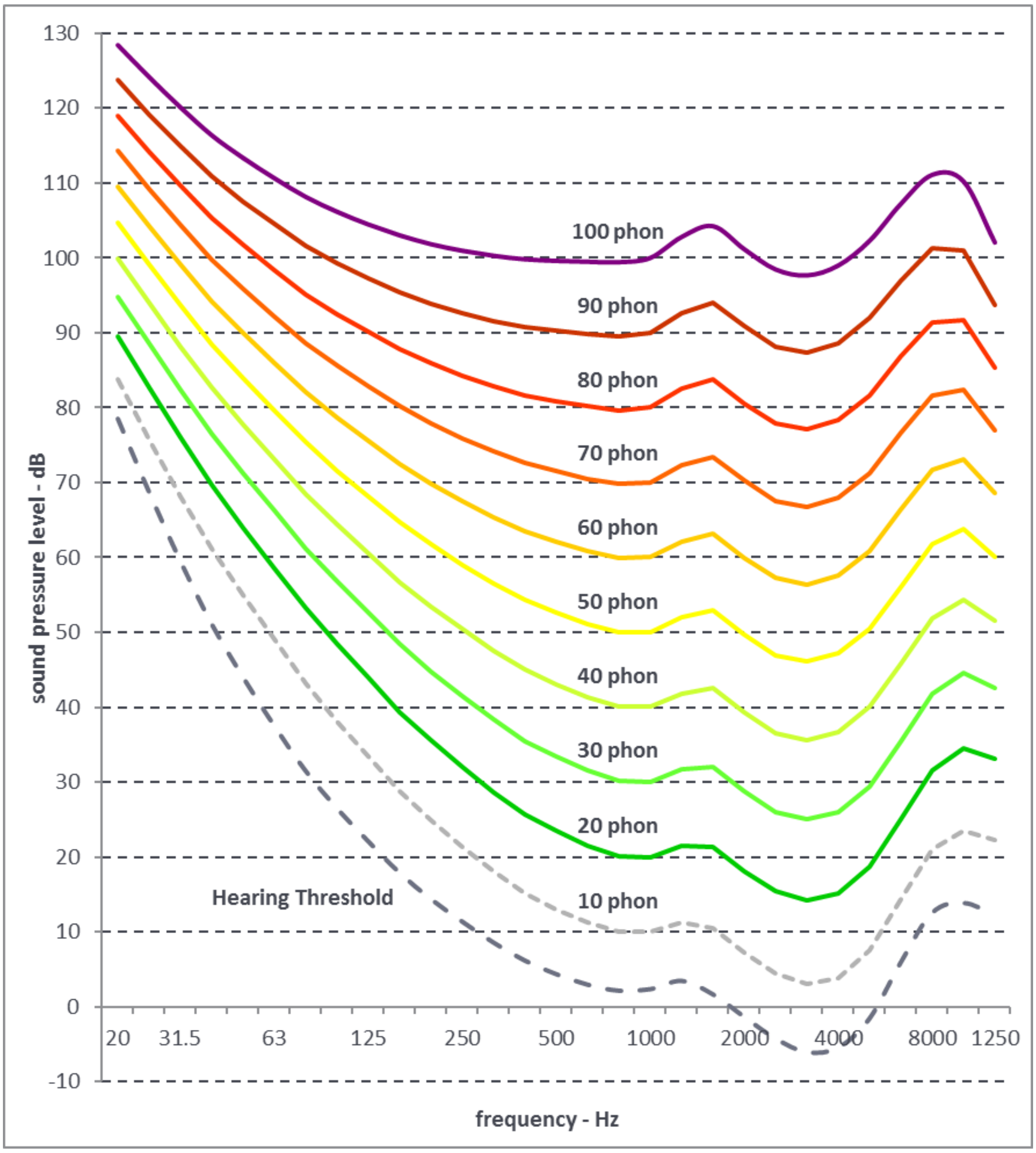
B3.2 Sound frequency and loudness

Although sound pressure level and the sensation of loudness are related, the sound pressure level is not a direct measure of how loud a sound appears to humans. Human perception of sound varies and depends on a number of physical attributes, including frequency, level and duration.

An example of the relationship between the sensation of loudness and frequency is demonstrated in Figure 20. The chart presents equal loudness curves for sounds of different frequencies expressed in 'phons'. Each point on the phon curves represents a sound of equal loudness. For example, the 40 phon curve shows that a sound level of 100 dB at 20 Hz (a very low frequency sound) would be of equal loudness to a level of 40 dB at 1,000 Hz (a whistling sound) or approximately 50 dB at just under 8,000 Hz (a very high pitch sound). The information presented is based on an international standard[11] that defines equal loudness levels for sounds comprising individual frequencies. In practice, sound is usually composed of a large number of different frequencies, so this type of data can only be used as an indication of how different frequencies of sound may be perceived. An individual's perceptions of sound can also vary significantly. For example, the lower dashed line in Figure 20 shows the threshold of hearing, which represents the sounds an average listener could correctly identify at least 50 % of the time. However, these thresholds represent the average of the population. In practice, an individual's hearing threshold can vary significantly from these values, particularly at the low frequencies.

[11] ISO 226:2003 *Acoustics - Normal equal-loudness-level contours*

Figure 20: Equal loudness contours for pure tone sounds



The noise curves in Figure 20 demonstrate that human hearing is most sensitive at frequencies from 500 to 4,000 Hz, which usefully corresponds to the main frequencies of human speech. The contours also demonstrate that sounds at low frequencies must be at much higher sound pressure levels to be judged equally loud as sounds at mid to high frequencies.

To account for the sensitivity of the ear to different frequencies, a set of adjustments were developed to enable sound levels to be measured in a way that more closely aligns with human hearing. Sound levels adjusted in this way are referred to as A-weighted sound levels.

B3.3 Interpretation of sound and noise

Human interpretation of sound is influenced by many factors other than its physical characteristics, such as how often the sound occurs, the time of day it occurs and a person's attitude towards the source of the sound.

For example, the sound of music can cause very different reactions, from relaxation and pleasure through to annoyance and stress, depending on individual preferences, the type of music and the circumstances in which the music is heard. This example illustrates how sound can sometimes be considered noise; a term broadly used to describe unwanted sounds or sounds that have the potential to cause negative reactions.

The effects of excess environmental sound are varied and complicated, and may be perceived in various ways including sensations of loudness, interference with speech communication, interference with working concentration or studying, disruption of resting/leisure periods, and disturbance of sleep. These effects can give rise to behavioural changes such as avoiding the use of exposed external spaces, keeping windows closed, or timing restful activities to avoid the most intense periods of disruption. Prolonged annoyance or interference with normal patterns can lead to possible effects on mental and physical health. In this respect, the World Health Organization (preamble to the *Constitution of the World Health Organization*, 1946) defines health in the following broad terms:

> *A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*

The World Health Organization Guidelines for Community Noise (Berglund, Lindvall, & Schwela, 1999) documents a relationship between the definition of health and the effects of community noise exposure by noting that:

> *This broad definition of health embraces the concept of well-being, and thereby, renders noise impacts such as population annoyance, interference with communication, and impaired task performance as 'health' issues.*

The reaction that a community can have to sound is highly subjective and depends on a range of factors including:

- The hearing threshold of individuals across the audible frequency range. These thresholds vary widely across the population, particularly at the lower and upper ends of the audible frequency range. For example, at low frequencies the distribution of hearing thresholds varies above and below the mean threshold by more than 10 dB
- The attitudes and sensitivities of individuals to sound, and their expectations of what is considered an acceptable level of sound or intrusion. This in turn depends on a range of factors such as general health and the perceived importance of sound amongst other factors relevant to overall amenity perception
- The absolute sound pressure level of the sound in question. The threshold for the onset of community annoyance varies according to the type of sound; above such thresholds, the percentage of the population annoyed generally increases with increasing sound pressure level
- The sound pressure level of the noise relative to background noise conditions in the area, and the extent to which general background noise may offer beneficial masking effects
- The characteristics of the sound in question such as whether the sound is constant, continually varies, or contains distinctive audible features such as tones, low frequency components or impulsive sound which may draw attention to the noise
- The site location and the compatibility of the source in question with other surrounding land uses. For example, whether the source is in an industrial or residential area

- The attitudes of the community to the source of the sound. This may be influenced by factors such as the extent to which those responsible for the sound are perceived to be adopting reasonable and practicable measures to reduce their emissions, whether the activity is of local or national significance and whether the noise producer actively consults and/or liaises with the community
- The times when the sound is present, the duration of exposure to increased sound levels, and the extent of respite periods when the sound is reduced or absent (for example, whether or not the sound ceases at weekends).

The combined influence of the above considerations means that physical sound levels are only one factor influencing community reaction to sound. Importantly, this means that individual reactions and attitudes to the same type and level of sound will vary within a community.

APPENDIX C VICTORIAN REGULATIONS AND GUIDELINES

The following publications are relevant to the assessment of operational noise from proposed wind farm developments in Victoria:

- *Environment Protection Act 2017*;
- *Environment Protection Regulations 2021*;
- Victorian Department of Environment, Land, Water and Planning publication *Policy and planning guidelines for development of wind energy facilities in Victoria* dated November 2021;
- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise*; and
- EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* dated May 2021.

The relevant publication for the assessment of construction noise in Victoria is the EPA Publication 1834.1 *Civil construction, building and demolition guide*, dated 12 September 2023 (EPA Publication 1834.1).

There is no standard or regulation that specifies criteria for the control of construction vibration levels in Victoria. In lieu of Victorian guidance for construction vibration, reference is made to NSW guidance documents.

Details of the guidance and noise criteria provided by the above publications are provided in the following sections.

C1 Environment Protection Act 2017

The *Environment Protection Act 2017* (EP Act) provides the overarching legislative framework for the protection of the environment in Victoria.

The EP Act establishes a general environmental duty to minimise the risks of harm to human health or the environment from pollution or waste, including noise related amenity impacts, so far as reasonably practicable.

The EP Act also prohibits the emission of unreasonable noise from commercial and industrial trade premises. Specifically, the EP Act states that:

> *A person must not, from a place or premises that are not residential premises—*
>
> *(a) emit an unreasonable noise; or*
>
> *(b) permit an unreasonable noise to be emitted*

Under the EP Act, unreasonable noise means noise that:

> *(a) is unreasonable having regard to the following—*
>
> > *(i) its volume, intensity or duration;*
> >
> > *(ii) its character;*
> >
> > *(iii) the time, place and other circumstances in which it is emitted;*
> >
> > *(iv) how often it is emitted;*
> >
> > *(v) any prescribed factors; or*
>
> *(b) is prescribed to be unreasonable noise:*

Further information about noises that are prescribed to be unreasonable is separately defined in regulations made under the EP Act (see next section).

C2 Environment Protection Regulations 2021

The *Environment Protection Regulations 2021* (EP Regulations) give effect to the EP Act by establishing prescriptive requirements for a range of environmental considerations including noise.

The noise requirements are defined according to the type of noise generating activity under consideration, and include definitions such as the types of noise sensitive areas where these requirements apply and assessment time periods.

C2.1 Wind turbine noise

Part 5.3 Division 5 of the EP Regulations nominates NZS 6808 as the relevant standard for assessing operational wind turbine noise in Victoria and introduces additional measures to demonstrate compliance post-construction.

Specifically, the EP Regulations outline the following:

- Noise agreements

  An owner or operator of a wind energy facility may enter into a written agreement with a relevant landowner to modify the noise limits which apply at the premises of the relevant landowner. These locations are referred to as 'stakeholder receivers'.

  If a noise agreement is made after 1 November 2021, an increased base noise limit of 45 dB L_{A90} would apply. If a noise agreement was made prior to 1 November 2021, the noise limit can be modified as specified in the noise agreement.

- Wind energy facility operators' duties

  The duties of wind energy facility operators comprise ensuring compliance with NZS 6808 and a suite of actions to manage and monitor noise from the wind farm, as prescribed in regulation 131C.

  Providing that the operator of a wind farm complies with the requirements of regulation 131C, their duty with respect to the general environmental duty under the EP Act has been addressed.

In accordance with the EP Regulations, noise levels from a wind farm are prescribed to be *unreasonable* for the purposes of the EP Act, if they exceed the relevant applicable noise limits.

C2.2 Industry noise

In relation to noise from commercial, industrial and trade premises (industry), the EP Regulations specify that the prediction, measurement, assessment or analysis of noise within a noise sensitive area must be conducted in accordance with the Noise Protocol (see Section C5). Noise from industry is prescribed by the EP Regulations to be unreasonable for the purposes of the EP Act if it exceeds a noise limit or alternative assessment criterion determined in accordance with the Noise Protocol.

C3 Victorian Wind Energy Guidelines

The Victorian Department of Transport and Planning publication *Planning Guidelines for Development of Wind Energy Facilities* dated September 2023 (Victorian Wind Energy Guidelines) provide advice to responsible authorities, proponents and the community about suitable sites to locate wind energy facilities and to inform planning decisions about a wind energy facility proposal.

The Victorian Wind Energy Guidelines set out:

- *a framework to provide a consistent and balanced approach to the assessment of wind energy projects across the state*
- *a set of consistent operational performance standards to inform the assessment and operation of a wind energy facility project*
- *guidance as to how planning permit application requirements might be met*
- *a framework for the regulation of wind turbine noise.*

Section 4.3.2 of the Victorian Wind Energy Guidelines outlines the application requirements for a wind energy facility. Specifically, to following written reports are required to be submitted to address potential noise impacts:

- *A pre-construction (predictive) noise assessment report prepared by a suitably qualified and experienced acoustician that:*
    - *reports on a pre-construction (predictive) noise assessment conducted following New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise*
    - *provides an assessment of whether the proposed wind energy facility will comply with the noise limit for that facility*
    - *where the proposed wind energy facility will be the subject of a wind turbine noise agreement under the Environment Protection Regulations 2021, specifies the premises of the relevant landowner (including any particular buildings) to which the agreement relates and provides an assessment of whether the proposed wind energy facility will comply with the modified noise limit for that facility specified in the agreement*
    - *is prepared on the basis that the relevant noise standard will be the New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise and includes an assessment of whether a high amenity noise limit is applicable under Section 5.3 of the standard.*
- *A report prepared by an environmental auditor appointed under Part 8.3 of the Environment Protection Act 2017 that verifies whether or not the pre-construction (predictive) noise assessment was conducted under New Zealand Standard NZS6808:2010, Acoustics – Wind Farm Noise*

In Section 5.1.2, the Victorian Wind Energy Guidelines outlines the key criteria for evaluating the planning merits of a wind energy facility. The following guidance is provided for the assessment of noise levels from proposed new wind farm developments:

> *A wind energy facility must comply with the noise limits in the New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise (the Standard).* […]
>
> *The Standard specifies a general 40 decibel limit (40 dB $L_{A90(10min)}$) for wind energy facility sound levels outdoors at noise sensitive locations, or that the sound level should not exceed the background sound level by more than five decibels (referred to as 'background sound level +5 dB'), whichever is the greater.* […]

Noise sensitive locations are defined in the Standard as, "The location of a noise sensitive activity, associated with a habitable space or education space in a building not on a wind farm site", and include:

- *any part of land zoned predominantly for residential use*
- *residential land uses included in the accommodation group at clause 73.03, Land use terms of the VPP and all planning schemes*
- *education and child care uses included in the child care centre group and education centre group at clause 73.03 of the of the VPP and all planning schemes.*

A 45-decibel limit is recommended for stakeholder dwellings. A stakeholder dwelling is a dwelling located on the same land as the wind energy facility, or one that has an agreement with the wind energy facility to exceed the noise limit. […]

Under Section 5.3 of the Standard, a 'high amenity noise limit' of 35 decibels may be justified in special circumstances. All wind energy facility applications must be assessed using Section 5.3 of the Standard to determine whether a high amenity noise limit is justified for specific locations, following procedures outlined in 5.3.1 of the Standard. Guidance can be found on this issue in the VCAT determination for the Cherry Tree Wind Farm[12]*.*

Measurement and compliance assessment methods are set out in the Standard. The assessment must be made without relying on noise reduction operation modes to achieve compliance.

Clause 73.03 of the Victoria Planning Provisions (VPP) defines *Accommodation* as *land used to accommodate persons* and lists the following uses:

- *Camping and caravan park*
- *Corrective institution*
- *Dependent person's unit*
- *Dwelling*
- *Group accommodation*
- *Host farm*
- *Residential aged care facility*
- *Residential building*
- *Residential village*
- *Retirement village*

Consideration must also be given to whether a high amenity noise limit is warranted to reflect special circumstances at specific locations.

12 *Cherry Tree Wind Farm v Mitchell Shire Council* (2013)

C4 NZS 6808

The New Zealand Standard NZS 6808 provides methods for the prediction, measurement, and assessment of sound from wind turbines. The following sections provide an overview of the objectives of NZS 6808 and the key elements of the standard's assessment procedures.

C4.1 Objectives

The foreword of NZS 6808 provides guidance about the objectives of the noise limits outlined within the standard:

> *Wind farm sound may be audible at times at noise sensitive locations, and this Standard does not set limits that provide absolute protection for residents from audible wind farm sound. Guidance is provided on noise limits that are considered reasonable for protecting sleep and amenity from wind farm sound received at noise sensitive locations.*

The *Outcome Statement* of NZS 6808 then goes on to provide information about the objective of the standard in a planning context:

> *This Standard provides suitable methods for the prediction, measurement, and assessment of sound from wind turbines. In the context of the* [New Zealand] *Resource Management Act, application of this Standard will provide reasonable protection of health and amenity at noise sensitive locations.*

Section C1.1 of the standard provides further information about the intent of the standard, which is:

> [...] *to avoid adverse noise effects on people caused by the operation of wind farms while enabling sustainable management of natural wind resources.*

Based on the objectives outlined above, NZS 6808 addresses health and amenity considerations at noise sensitive locations by specifying noise limits which are to be used to assess wind farm noise.

C4.2 Noise sensitive locations

The provisions of NZS 6808 are intended to protect noise sensitive locations (also generally referred to as *receivers* herein) that existed before the development of a wind farm. Noise sensitive locations are defined by the Standard as:

> *The location of a noise sensitive activity, associated with a habitable space or education space in a building not on the wind farm site. Noise sensitive locations include:*
>
> *(a) Any part of land zoned predominantly for residential use in a district plan;*
>
> *(b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f);*
>
> *(c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities …*
>
> *(d) Teaching areas and sleeping rooms in educational institutions …*
>
> *(e) Teaching areas and sleeping rooms in buildings for licensed kindergartens, childcare, and day-care centres; and*
>
> *(f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.*
>
> *In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights.*

For the purposes of an assessment according to the Standard, the notional boundary is defined as:

> *A line 20 metres from any side of a dwelling or other building used for a noise sensitive activity or the legal boundary where this is closer to such a building.*

NZS 6808 was prepared to provide methods of assessment in the statutory context of New Zealand. Specifically, NZS 6808 notes that in the context of the New Zealand Resource Management Act, application of the Standard will provide reasonable protection of health and amenity at noise sensitive locations. This is an important point of context, as the New Zealand Resource Act states:

> *(3)(a)(ii): A consent authority must not, when considering an application, have regard to any effect on a person who has given written approval to the application.*

Based on the above definitions and statutory context, noise predictions are normally prepared for stakeholder receivers irrespective of whether they are inside or outside of the Project boundary. However, the noise limits specified in the Standard are not applied to these locations on account of their participation with the Project.

C4.3 Noise limit

Section 5.2 *Noise limit* of NZS 6808 defines acceptable noise limits as follows:

> *As a guide to the limits of acceptability at a noise sensitive location, at any wind speed wind farm sound levels ($L_{A90(10\,min)}$) should not exceed the background sound level by more than 5 dB, or a level of 40 dB $L_{A90(10\,min)}$, whichever is the greater.*

This arrangement of limits requires the noise associated with a wind farm to be restricted to a permissible margin above background noise, except in instances when both the background and source noise levels are low. In this respect, the criteria indicate that it is not necessary to continue to adhere to a margin above background when the background noise levels are below the range of 30-35 dB.

The criteria specified in NZS 6808 apply to the combined noise level of all wind farms influencing the environment at a receiver. Specifically, section 5.6.1 states:

> *The noise limits … should apply to the cumulative sound level of all wind farms affecting any noise sensitive location.*

C4.4 High amenity

Section 5.3.1 of NZS 6808 states that the base noise limit of 40 dB L_{A90} detailed in Section 9.1 is *appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations*. It goes on to note that the application of a high amenity noise limit may require additional consideration:

> […] *In special circumstances at some noise sensitive locations a more stringent noise limit may be justified to afford a greater degree of protection of amenity during evening and night-time. A high amenity noise limit should be considered where a plan promotes a higher degree of protection of amenity related to the sound environment of a particular area, for example where evening and night-time noise limits in the plan for general sound sources are more stringent than 40 dB $L_{Aeq(15\,min)}$ or 40 dBA L_{10}. A high amenity noise limit should not be applied in any location where background sound levels, assessed in accordance with section 7, are already affected by other specific sources, such as road traffic sound.*

The definition of the high amenity noise limit provided in NZS 6808 is specific to New Zealand planning legislation and guidelines. A degree of interpretation is therefore required when determining how to apply the concept of high amenity in Victoria.

In accordance with Section 5.3 of NZS 6808, if a high amenity noise limit is justified, wind farm noise levels (L_{A90}) during evening and nigh-time periods should not exceed the background noise level (L_{A90}) by more than 5 dB or 35 dB L_{A90}, whichever is the greater. The standard recommends that this reduced noise limit would typically apply for wind speeds below 6 m/s at hub height. A high amenity noise limit is not applicable during the daytime period.

The method for assessing the applicability of the high amenity noise limit, detailed in NZS 6808, is a two-step approach as follows:

1. Determination of whether the planning guidance for the area warrants consideration of a high amenity noise limit

   First and foremost, for a high amenity noise limit to be considered, the land zoning of a receiver must promote a higher degree of acoustic amenity.

2. Evaluation of whether a high amenity noise limit is justified

   Following the guidance presented in C5.3.1, if the planning guidance for the area warrants consideration of a high amenity noise limit, and the receiver is located within the predicted 35 dB L_{A90} noise contour, then a calculation should be undertaken to determine whether background noise levels are sufficiently low.

C4.5 Special audible characteristics

Section 5.4.2 of NZS 6808 requires the following:

> *Wind turbine sound levels with special audible characteristics (such as tonality, impulsiveness and amplitude modulation) shall be adjusted by arithmetically adding up to +6dB to the measured level at the noise sensitive location.*

Notwithstanding this, the standard requires that wind farms be designed with no special audible characteristics at nearby residential properties while concurrently noting in Section 5.4.1 that:

> [...] *as special audible characteristics cannot always be predicted, consideration shall be given to whether there are any special audible characteristics of the wind farm sound when comparing measured levels with noise limits.*

NZS 6808 emphasises assessment of special audible characteristics during the post-construction measurement phase of a project. An indication of the potential for tonality to be a characteristic of the noise emission from the assessed turbine model is sometimes available from tonality audibility assessments conducted as part of manufacturer turbine noise emission testing. However, this data is frequently not available at the planning stage of an assessment.

C5 EPA Publication 1826.4 (Noise Protocol)

EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol) sets noise limits that apply to commercial, industrial and trade premises and entertainment venues in Victoria. Compliance with the noise limits is mandatory under the EP Act.

The proposed substation is considered a 'commercial, industrial and trade premises' under the EP Act.

The Noise Protocol describes a procedure for determining noise limits that are used to assess whether a noise is prescribed to be unreasonable in accordance with the EP Regulations.

The noise limits apply at a 'noise sensitive area', which is defined in Section 4 of the EP Regulations as being *within 10 metres of the outside of the external walls* of buildings including dwellings, hotels, schools and campgrounds.

The procedures for setting noise limits are defined separately for urban and rural areas. However, in both cases, the noise limits are defined by considering the land zoning in the area and the noise environment of the receiver. The noise limits are defined separately for day, evening and night periods.

In contrast to NZS 6808 and Part 5.3 Division 5 of the EP Regulations, the Noise Protocol does not differentiate between stakeholder and non-stakeholder receivers.

The measurement and analysis procedures outlined in the Noise Protocol include adjustments which are to be applied to noise that is characterised by audible tones, impulses or intermittency. Further details of the noise limits applicable to the Project are provided in Section 6.1 of this report.

C6 EPA Publication 1834.1

EPA Publication 1834.1 *Civil construction, building and demolition guide*, dated 12 September 2023 (EPA Publication 1834.1) defines normal working hours for construction activities and outlines controls for scheduling works, consultation with affected people and managing noise impacts.

The primary way of minimising the likelihood of noise and vibration causing harm is to limit the frequency of occurrence and its duration. This applies especially when noise and vibration are likely to have a greater impact.

Table 41: Working hours schedule for construction, building and demolition noise

Minimise noise and vibration as far as possible in any situation	
Normal working hours for all civil construction, building and demolition activities.	
AM → PM **Monday to Friday, 7 am – 6 pm**	
AM → PM **Saturday, 7 am – 1 pm**	AM → PM **Saturday, 9 am – 1 pm**
Normal working hours for: • works for commissioning or construction of **major infrastructure projects** • commercial and industrial construction and demolition sites • demolition works on an existing commercial or industrial site that is intended for residential redevelopment • construction works for **large-scale residential developments** in non-residential zones • commercial and industrial land subdivision.	Normal working hours for: • residential construction and demolition sites • residential or mixed-use development in **residential zones**, including urban infill and redevelopments • land preparation on infill and smaller residential developments • land preparation for residential subdivision, not including works to construct or upgrade a road • residential construction in a **large-scale fringe residential subdivision**, once the road servicing the residential development is complete.
Limited works apply on Saturday, 7 am – 9 am to: • land preparation and infrastructure works for a large-scale fringe residential subdivision **before** the road servicing of the future residential subdivision is completed. See Table 4.2.	Normal working hours for: • land preparation and infrastructure works for a large-scale fringe residential subdivision **after** the road servicing the residential development is complete.

Noise control measures for construction activities outlined in EPA Publication 1834.1 include the following:

- Scheduling works
  - Undertaking work during normal working hours
  - Avoiding work when there are special events
  - Scheduling noisy works together to reduce the overall duration of exposure
  - Scheduling noisy activities for less sensitive times, for example, delay a rock-breaking task to later in the morning or afternoon
  - Avoiding work that coincides with sensitive ecological processes, if required[13]
  - Optimising the number of vehicle trips to and from site

13 This would normally be subject to advice and recommendations of a project ecologist as to whether or not the impact of the proposed activity is sufficient to warrant rescheduling.

  - Promoting good driver behaviour, to prevent sudden acceleration and unjustified use of compression engine brakes
  - Consulting and informing potentially noise-affected residences regarding designated access routes to your site. Ensure drivers are aware and use nominated vehicle routes
  - Schedule deliveries to nominated hours only
- Community information and consultation
  - In the early stages of planning, identify and assess those potentially impacted by noise, then document and maintain the information for the duration of the Project
  - Engage community to keep them informed, for example community meetings with community and workers
  - Notify community before and during construction, communicating information such as start and finish times, the type of noise and measures to reduce noise impacts and contact details for information and complaints
  - Install and maintain a site information board at the front of the site with contact details of operations, after hours emergency contact details and regular information updates visible from the outside boundary
  - Maintain a process for managing complaints
- Controlling noise at the source
  - Undertake preparatory work offsite where possible
  - Connect to the electricity grid as soon as possible to avoid reliance on diesel generators
  - Plan vehicle movement to avoid manoeuvres and idling at locations close to noise-sensitive areas
  - Use quieter equipment or methods (including installation of mufflers, avoiding metal-to-metal contact, utilising electric or hydraulic substitutes for diesel-powered activities, turning off equipment when not in use)
  - Use low-noise emitting generators
  - Use non-tonal alarms
  - Maintain equipment (e.g. by inspecting regularly to maintain good working order, checking seals on equipment and doors to make sure they seal properly and maintaining air lines on pneumatic equipment to make sure they don’t leak)
  - Limit noise caused by people on site (e.g. avoiding yelling and shouting, minimising the use and volume of radios, stereos or public address systems)
- Noise reduction between source and receiver
  - Plan to increase separating distances between source and receiver where possible
  - Maximise shielding by taking into account topography of the site, existing structures and material stockpiles, construction of barriers or bunds and avoiding placing noise sources close to reflecting surfaces
- Reducing noise impacts offsite
  - Increasing sound insulation at receivers by retrofitting acoustic glazing
  - Provide respite offers that reflect the level of impact.

C7 Environment Reference Standard

The Environment Reference Standard (ERS) is a legislative instrument made under the EP Act.

The ERS is an environmental benchmark. It brings together a collection of environmental values, indicators and objectives that describe environmental and human health outcomes to be achieved or maintained in the whole or in parts of Victoria. These values, indicators and objectives are used to assess and report on changing environmental conditions by providing a reference point for decision makers to consider whether a proposal or activity is consistent with the environmental values identified in the ERS. The ERS also allows decision makers to evaluate potential impacts on human health and the environment that may result from a proposal or activity. The ERS does not specify requirements that must be met by environmental managers or other duty holders.

Indicators and objectives within the ERS are generally not relevant considerations where they relate to an aspect of the environment that is the subject of prescriptive regulation. For example, the ambient sound indicators and objectives will not be relevant when considering noise from wind turbines and commercial, industrial and trade premises at noise sensitive areas, as defined in the EP Regulations. This is because noise in these circumstances is regulated by specific provisions and noise limits in the EP Regulations and the associated Noise Protocol and NZS 6808.

The environmental values presented in the ERS and a description of each is provided in Table 42.

Table 42: Environmental values of the ambient sound environment

Environmental value	Description of environmental value
Sleep during the night	An ambient sound environment that supports sleep during the night
Domestic and recreational activities	An ambient sound environment that supports recreational and domestic activities in a residential setting
Normal conversation	An ambient sound environment that allows for normal conversation indoors without the need to raise voices
Child learning and development	An ambient sound environment that supports cognitive development and learning in children
Human tranquillity and enjoyment outdoors in natural areas	An ambient sound environment that allows for the appreciation and enjoyment of the environment for its natural condition and the restorative benefits of tranquil soundscapes in natural areas
Musical entertainment	An ambient sound environment that recognises the community's demand for a wide range of musical entertainment.

The ERS land use categories and their descriptions are provided in Table 43.

Table 43: Land use categories for the ambient sound environment

Land use category	General description	Planning zones
Category I	An urban form with distinctive features or characteristics of taller buildings, high commercial and residential intensity and high site coverage.	Industrial Zone 1 (IN1Z) Industrial Zone 2 (IN2Z) Port Zone (PZ) Road 1 Zone (RDZ1) Capital City Zone (CCZ) Docklands Zone (DZ)
Category II	Medium rise building form with a strong urban or commercial character. Typically contains mixed land uses including activity centres and larger consolidated sites, and an active public realm.	Industrial Zone 3 (IN3Z) Commercial 1 Zone (C1Z) Commercial 2 Zone (C2Z) Commercial 3 Zone (C3Z) Activity Centre Zone (ACZ) Mixed Use Zone (MUZ) Road 2 Zone (RDZ2)
Category III	Lower rise building form including lower density residential development and detached housing typical of suburban residential settings or in towns of district or regional significance.	Residential Growth Zone (RGZ) General Residential Zone (GRZ) Neighbourhood Residential Zone (NRZ) Urban Floodway Zone (UFZ) Public Park and Recreation Zone (PPRZ) Urban Growth Zone (UGZ)
Category IV	Lower density or sparse populations with settlements that include smaller hamlets, villages and small towns that are generally unsuited for further expansion. Land uses include primary industry and farming.	Low Density Residential Zone (LDRZ) Township Zone (TZ) Rural Living Zone (RLZ) Green Wedge A Zone (GWAZ) Rural Conservation Zone (RCZ) Public Conservation and Resource Zone (PCRZ) Green Wedge Zone (GWZ) Farming Zone (FZ) Rural Activity Zone (RAZ)
Category V	Unique combinations of landscape, biodiversity and geodiversity. These natural areas typically provide undisturbed species habitat and enable people to see and interact with native vegetation and wildlife.	Natural areas are classified as land within Category V irrespective of the planning zones that apply to that land.
Category I, II, III or IV depending on surrounding land uses and the intent of the specific planning zone (which may have a diversity of uses) as specified in a schedule to the planning zone		Comprehensive Development Zone (CDZ) Priority Development Zone (PDZ) Special Use Zone (SUZ) Public Use Zone (PUZ)

Note: Urban Growth Zone (UGZ) is a Category III land use until the relevant precinct structure plan is adopted, at which time the approved land uses will determine the land use category.

The ERS indicators and objectives relevant to each land use category are described in Table 44.

Table 44: Indicators and objectives for the ambient sound environment

Land use category	Indicators	Objectives
Category I	Outdoor $L_{Aeq,8h}$ from 2200 hrs to 0600 hrs	55 dB L_{Aeq}
	Outdoor $L_{Aeq,16hr}$ from 0600 hrs to 2200 hrs	60 dB L_{Aeq}
Category II	Outdoor $L_{Aeq,8h}$ from 2200 hrs to 0600 hrs	50 dB L_{Aeq}
	Outdoor $L_{Aeq,16hr}$ from 0600 hrs to 2200 hrs	55 dB L_{Aeq}
Category III	Outdoor $L_{Aeq,8h}$ from 2200 hrs to 0600 hrs	40 dB L_{Aeq}
	Outdoor $L_{Aeq,16hr}$ from 0600 hrs to 2200 hrs	50 dB L_{Aeq}
Category IV	Outdoor $L_{Aeq,8h}$ from 2200 hrs to 0600 hrs	35 dB L_{Aeq}
	Outdoor $L_{Aeq,16hr}$ from 0600 hrs to 2200 hrs	40 dB L_{Aeq}
Category V	Qualitative	A sound quality that is conducive to human tranquillity and enjoyment having regard to the ambient natural soundscape

APPENDIX D WIND TURBINE NOISE ASSESSMENT STAGES

The management of environmental noise from a wind farm project involves assessments and checks at multiple stages of the Project, starting from the Project inception and carrying through into the operational stage of the Project.

The key stages of the environmental noise management process for a wind farm are summarised in Table 45. The Project is currently at the pre-consent assessment stage shaded in green. This overall process illustrates the additional assessment stages which would follow if the Project is granted a planning permit.

Table 45: Wind turbine noise assessment stages (current stage shaded green)

Stage	Description
Preliminary noise assessment	Involves: identifying sensitive receivers, assessing existing noise conditions and modelling noise levels for alternative wind turbine layouts and turbine sizes Primary purpose: informing the preliminary design development and determining if, and where, background noise surreys are required
Pre-consent noise assessment	Involves: assessing the wind turbine layout proposed in the planning application, accounting for a candidate model that is representative of the envelope of turbines that is being applied for Primary purpose: demonstrating whether the proposed wind farm can be designed and operated within the noise requirements which apply in Victoria – provides information to support the relevant authorities' consideration of the planning application
Detailed design & turbine procurement	Involves: noise modelling to check minor turbine location changes and establishing noise obligations in the turbine supply contract Primary purpose: to verifying that minor turbine locations are carried out within the noise requirements, and that the turbine supply contract includes noise control clauses that address the requirement of the EP Regulations
Pre-construction noise assessment	Involves: modelling the final wind turbine layout and selected model and assessing compliance with the noise requirements of the EP Regulations Primary purpose: to provide evidence to the responsible authority to demonstrate that noise has been addressed during the detailed design and turbine procurement, and that the wind farm can be designed to comply with the operational noise requirement
Noise management plan	Involves: identifying controls to minimise the risk of harm to the to the environment and human health as a result of wind turbine noise, so far as reasonably practicable. This includes documenting the locations and procedures that will be used to measure, analyse and assess wind turbine noise levels after the wind farm starts operating, and ongoing controls for the life of the Project Primary purpose: to document how the general environmental duty under the EP Act would be fulfilled with respect to wind turbine noise, and to enable verification of the proposed testing by an independent environmental auditor before the wind farm commences operation
Post-construction noise assessment	Involves: measuring noise levels around the development site after the wind farm commences operating Primary purpose: to assess whether noise levels in practice are compliant with the noise requirements established in the EP Regulations

Stage	Description
Operational noise investigations	Involves: recording and monitoring any complaints relating to noise and, where necessary, conducting noise measurements to assess whether noise levels in practice remain compliant with noise requirements Primary purpose: address normal planning permit requirements for the management of complaints, and for the wind farm to remain complaint with the noise requirements for the duration of the Project's life
Annual statements	The operator of the wind farm would need to provide a statement in accordance with the EP Regulations to the Authority within 4 months of the end of each financial year. The statement would need to address a range of noise related matters, including verification that the wind farm remains compliant with the applicable noise limits.
Routing noise monitoring	Within 3 months of the fifth anniversary of a wind farm commencing operation, and every subsequent 5 years, the operator would need to commission noise monitoring to verify compliance with the applicable limits, engage an independent auditor to review the noise monitoring report, and submit the findings to the Authority for review.

APPENDIX E NOISE PREDICTION MODEL

Environmental noise levels associated with wind farms are predicted using engineering methods. The international standard ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors* (ISO 9613-2) has been chosen as the most appropriate method to calculate the level of broadband A-weighted wind farm noise expected to occur at surrounding receptor locations. This method is considered the most robust and widely used international method for the prediction of wind farm noise.

The use of this standard is supported by international research publications, measurement studies conducted by Marshall Day Acoustics and direct reference to the standard in NZS 6808:2010 *Acoustics – Wind farm noise*, AS 4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators*, the South Australian EPA *Wind farms environmental noise guidelines* and the Queensland *State code 23: Wind farm development – Planning guideline*.

The standard specifies an engineering method for calculating noise at a known distance from a variety of sources under meteorological conditions favourable to sound propagation. The standard defines favourable conditions as downwind propagation where the source blows from the source to the receiver within an angle of ±45 degrees from a line connecting the source to the receiver, at wind speeds between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground. Equivalently, the method accounts for average propagation under a well-developed moderate ground based thermal inversion. In this respect, it is noted that at the wind speeds relevant to noise emissions from wind turbines, atmospheric conditions do not favour the development of thermal inversions throughout the propagation path from the source to the receiver.

To calculate far-field noise levels according to the ISO 9613-2, the noise emissions of each wind turbine are firstly characterised in the form of octave band frequency levels. A series of octave band attenuation factors are then calculated for a range of effects including:

- Geometric divergence
- Air absorption
- Reflecting obstacles
- Screening
- Vegetation
- Ground reflections.

The octave band attenuation factors are then applied to the noise emission data to determine the corresponding octave band and total calculated noise level at receivers.

Calculating the attenuation factors for each effect requires a relevant description of the environment into which the sound propagation such as the physical dimensions of the environment, atmospheric conditions and the characteristics of the ground between the source and the receiver.

Wind farm noise propagation has been the subject of considerable research in recent years. These studies have provided support for the reliability of engineering methods such as ISO 9613-2 when a certain set of input parameters are chosen in combination. Specifically, the studies to date tend to support that the assignment of a ground absorption factor of G = 0.5 for the source, middle and receiver ground regions between a wind farm and a calculation point tends to provide a reliable representation of the upper noise levels expected in practice, when modelled in combination with other key assumptions; specifically all wind turbines operating at identical wind speeds, emitting sound levels equal to the test measured levels plus a margin for uncertainty (or guaranteed values), at a temperature of 10 ^{o}C and relative humidity of 70 % to 80 %, with specific adjustments for screening and ground effects as a result of the ground terrain profile.

In support of the use of ISO 9613-2 and the choice of G = 0.5 as an appropriate ground characterisation, the following references are noted:

- A factor of G = 0.5 is frequently applied in Australia for general environmental noise modelling purposes as a way of accounting for the potential mix of ground porosity which may occur in regions of dry/compacted soils or in regions where persistent damp conditions may be relevant
- NZS 6808 refers to ISO 9613-2 as an appropriate prediction method for wind farm noise, and notes that soft ground conditions should be characterised by a ground factor of G = 0.5
- In 1998, a comprehensive study (commonly cited as the Joule Report), part funded by the European Commission found that the ISO 9613-2 model provided a robust representation of upper noise levels which may occur in practice, and provided a closer agreement between predicted and measured noise levels than alternative methods such as CONCAWE and ENM. Specifically, the report indicated the ISO 9613-2 method generally tends to marginally over predict noise levels expected in practice
- The UK Institute of Acoustics journal dated March/April 2009 published a joint agreement between practitioners in the field of wind farm noise assessment (UK IOA 2009 joint agreement), including consultants routinely employed on behalf of both developers and community opposition groups, and indicated the ISO 9613-2 method as the appropriate standard and specifically designated G = 0.5 as the appropriate ground characterisation. This agreement was subsequently reflected in the recommendations detailed in the UK Institute of Acoustics publication A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (UK IOA good practice guide). It is noted that these publications refer to predictions made at receiver heights of 4 m. Predictions in Australia are generally based on a lower prediction height of 1.5 m which tends to result in higher ground attenuation for a given ground factor, however conversely, predictions in Australia do not generally incorporate a -2 dB factor (as applied in the UK) to represent the relationship between L_{Aeq} and L_{A90} noise levels. The result is that these differences tend to balance out to a comparable approach and thus supports the use of G = 0.5 in the context of Australian prediction methods.

A range of measurement and prediction studies[14, 15, 16] for wind farms in which Marshall Day Acoustics' staff have been involved in have provided further support for the use of ISO 9613-2 and G = 0.5 as an appropriate representation of typical upper noise levels expected to occur in practice.

The findings of these studies demonstrate the suitability of the ISO 9613-2 method to predict the propagation of wind turbine noise for:

- The types of noise source heights associated with a modern wind farm, extending the scope of application of the method beyond the 30 m maximum source heights considered in the original ISO 9613-2;
- The types of environments in which wind farms are typically developed, and the range of atmospheric conditions and wind speeds typically observed around wind farm sites. Importantly, this supports the extended scope of application to wind speeds in excess of 5 m/s.

[14] Bullmore, Adcock, Jiggins & Cand – *Wind Farm Noise Predictions: The Risks of Conservatism*; Presented at the Second International Meeting on Wind turbine Noise in Lyon, France September 2007.

[15] Bullmore, Adcock, Jiggins & Cand – *Wind Farm Noise Predictions and Comparisons with Measurements*; Presented at the Third International Meeting on Wind turbine Noise in Aalborg, Denmark June 2009.

[16] Delaire, Griffin, & Walsh – *Comparison of predicted wind farm noise emission and measured post-construction noise levels at the Portland Wind Energy Project in Victoria, Australia*; Presented at the Fourth International Meeting on Wind turbine Noise in Rome, April 2011.

In addition to the choice of ground factor referred to above, adjustments to the ISO 9613-2 standard for screening and valleys effects are applied based on recommendations of the Joule Report, UK IOA 2009 joint agreement and the UK IOA Good Practice Guide. The following adjustments are applied to the calculations:

- Screening effects as a result of terrain are limited to 2 dB
- Screening effects are assessed based on each wind turbine being represented by a single noise source located at the maximum tip height of the wind turbine rotor
- An adjustment of 3 dB is added to the predicted noise contribution of a wind turbine if the terrain between the wind turbine and receiver in question is characterised by a significant valley. A significant valley is defined as a situation where the mean sound propagation height is at least 50 % greater than it would be otherwise over flat ground.

The adjustments detailed above are implemented in the wind turbine calculation procedure of the SoundPLANnoise 9.0 software used to conduct the noise modelling. The software uses these definitions in conjunction with the digital terrain model of the site to evaluate the path between each wind turbine and receiver pairing, and then subsequently applies the adjustments to each wind turbine's predicted noise contribution where appropriate.

The prediction method inherently accounts for uncertainty through a combination of an uncertainty margin added to the input sound power level, and the use of conservative input parameters to the model, as described in this appendix, which have been shown to enable a reliable prediction of upper wind farm noise levels.

As an example of this, the ISO 9613-2 indicates an uncertainty margin of the order of +/-3 dB in relation to calculated noise levels at distances between 100 m and 1000 m for situations with an average propagation height between 5 m and 30 m (noting the information provided earlier in this appendix regarding the validation work undertaken to support the application of ISO 9613-2 to greater propagation heights). However, the uncertainty margins are noted for a prediction conducted in accordance with the inputs described in ISO 9613-2. A strict application of ISO 9613-2 would involve designating a ground factor of G = 1 (instead of the more conservative G = 0.5 ground factor used in the calculations) to represent the porous ground conditions around the site which ISO 9613-2 defines as follows:

> ***Porous ground**, which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. For porous ground G = 1.*

A prediction based on a ground factor of G = 1 instead of G = 0.5 used in the modelling would typically result in predicted noise levels approximately 3 dB lower, thus effectively offsetting the quoted uncertainty margin. This also does not account for the other conservative aspects of the model, such as the assumption that all wind turbines are operating simultaneously at their maximum noise emissions and that each receiver is simultaneously downwind of every wind turbine at all times (in contrast to NZS 6808 compliance procedures which are based on assessing noise levels for a range of wind directions, consistent with broader Victorian noise assessment policies which do not evaluate compliance based solely on downwind noise levels).

Given the above, it is not necessary to apply uncertainty margins to the prediction results, as the results represent the upper predicted noise levels associated with the operation of the wind farm when measured and assessed in accordance with NZS 6808. This finding is supported by extensive post-construction noise compliance monitoring undertaken at wind farm sites across Australia.

APPENDIX F RECEIVER COORDINATES

The following table sets out the forty (40) assessed receivers located within 5 km of the proposed turbines considered in the environmental noise assessment together with their respective distance to the nearest turbine and land zoning.

See site map in Figure 1 of Section 1.2.

(Coordinates supplied by the proponent on 11 December2023).

Table 46: Receiver coordinates within 5 km of the proposed turbines– MGA 94 zone 54

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
1	502,261	5,788,984	24	3,736	24	PPRZ
2	502,684	5,788,826	16	3,299	24	FZ1
3	503,242	5,788,357	10	2,733	24	FZ1
4	503,639	5,788,638	30	2,334	24	FZ1
5	503,805	5,788,441	30	2,167	24	FZ1
6	503,901	5,788,686	30	2,076	24	FZ1
7	503,954	5,788,776	30	2,033	24	FZ1
8	504,068	5,788,437	22	1,905	24	FZ1
10	504,345	5,786,967	10	2,230	118	FZ1
18	509,644	5,783,671	20	1,474	59	FZ1
21 (S)	520,295	5,778,058	39	1,117	27	FZ1
27	527,673	5,773,194	121	1,782	42	PCRZ
31	527,856	5,773,079	116	1,994	42	PCRZ
34	528,115	5,773,142	120	2,214	42	PCRZ
40	529,536	5,771,796	140	3,976	37	PPRZ
41 (S)	529,904	5,773,866	133	3,884	42	FZ1
43 (S)	530,183	5,772,806	140	4,292	42	PPRZ
44 (S)	530,204	5,772,838	140	4,305	42	PPRZ
673 (C)	516,253	5,779,314	10	2,111	115	FZ1
674	504,951	5,788,303	30	1,049	24	FZ1
675 (S)	519,804	5,778,418	39	632	55	FZ1
676 (S)	525,410	5,776,340	130	803	12	FZ1
700 (C)	516,363	5,779,044	15	2,254	81	FZ1
702 (C)	527,191	5,770,299	10	3,130	37	PPRZ
718 (C)	519,110	5,787,835	15	4,202	22	FZ1
719 (C)	516,717	5,788,359	10	3,338	15	TRZ1
720 (C)	514,789	5,789,021	10	3,359	9	FZ1

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine	Land zoning
721 (C)	514,139	5,789,026	10	3,230	9	FZ1
722 (C)	513,993	5,789,509	10	3,678	7	FZ1
723 (C)	513,836	5,789,743	10	3,877	7	FZ1
724 (C)	513,623	5,790,297	10	4,282	70	FZ1
725 (C)	512,193	5,790,730	10	3,300	103	FZ1
726 (C)	512,345	5,790,888	12	3,506	103	FZ1
727 (C)	511,695	5,791,215	15	3,127	103	FZ1
728 (C)	509,311	5,791,750	20	2,445	103	FZ1
729 (C)	509,237	5,791,574	10	2,267	103	FZ1
730 (C)	508,773	5,791,886	10	2,617	103	FZ1
731 (C)	507,563	5,793,080	10	4,119	103	FZ1
741 (C)	501,448	5,786,943	10	4,788	24	PPRZ
742 (C)	511,465	5,781,310	25	2,438	67	FZ1

(S) Stakeholder receiver

(C) Camping ground

The following table sets out the fifty-nine (59) receivers located within 2 km of a proposed construction activity considered in the environmental noise assessment together with their respective land zoning.

See site maps in Figure 2 and Figure 3of Section 1.2.

(Coordinates supplied by the proponent on 11 December 2023).

Table 47: Receiver coordinates within 2 km of a proposed activity– MGA 94 zone 54

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Land zoning	Nearest construction activity
8	504,068	5,788,437	22	FZ1	Access road and tracks construction
18	509,644	5,783,671	20	FZ1	Access road and tracks construction
21 (S)	520,295	5,778,058	39	FZ1	Cable trench digging
27	527,673	5,773,194	121	FZ1	Turbine assembly
31	527,856	5,773,079	116	FZ1	Turbine assembly
41 (S)	529,904	5,773,866	133	FZ1	Substation
43 (S)	530,183	5,772,806	140	FZ1	Substation
44 (S)	530,204	5,772,838	140	FZ1	Substation
55	530,853	5,772,277	134	FZ1	Cable trench digging
62	531,295	5,772,199	132	FZ1	Cable trench digging
64 (S)	531,495	5,772,538	134	FZ1	Cable trench digging
67	532,241	5,772,175	130	FZ1	Cable trench digging
73	532,397	5,771,087	120	FZ1	Cable trench digging
81 (S)	532,815	5,776,106	144	FZ1	Access road and tracks construction
82 (S)	532,830	5,772,700	131	FZ1	Cable trench digging
91	533,356	5,771,809	125	FZ1	Cable trench digging
372	543,223	5,770,129	65	FZ1	Cable trench digging
576	548,032	5,771,642	40	PCRZ	Cable trench digging
594	548,858	5,769,907	70	PCRZ	Cable trench digging
601	549,416	5,773,855	40	FZ1	Cable trench digging
603	549,464	5,774,275	40	FZ1	Cable trench digging
608	550,607	5,773,999	38	FZ1	Cable trench digging
615	551,268	5,773,750	32	FZ1	Cable trench digging
616	551,365	5,773,300	30	FZ1	Cable trench digging
621	551,767	5,771,480	32	FZ1	Cable trench digging
622	551,888	5,774,473	35	FZ1	Cable trench digging
628	552,553	5,773,687	30	FZ1	Cable trench digging
629	552,587	5,771,648	29	FZ1	Cable trench digging

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Land zoning	Nearest construction activity
631	552,935	5,771,362	27	FZ1	Cable trench digging
634	553,828	5,772,318	22	FZ1	Cable trench digging
636	553,903	5,773,516	29	FZ1	Cable trench digging
637	553,894	5,770,933	23	FZ1	Cable trench digging
641	554,050	5,771,566	21	FZ1	Cable trench digging
642	554,086	5,772,623	24	FZ1	Cable trench digging
643	554,198	5,772,857	27	FZ1	Cable trench digging
644	554,291	5,773,334	30	FZ1	Cable trench digging
645	554,284	5,771,839	20	FZ1	Cable trench digging
649	554,368	5,772,562	26	FZ1	Cable trench digging
653	554,594	5,774,203	30	FZ1	Cable trench digging
654	554,625	5,774,978	30	FZ1	Cable trench digging
655	554,647	5,774,753	30	FZ1	Cable trench digging
656	554,643	5,773,647	30	FZ1	Cable trench digging
658	554,690	5,772,721	29	FZ1	Cable trench digging
659	554,851	5,774,551	30	FZ1	Cable trench digging
660	554,863	5,774,407	30	FZ1	Cable trench digging
661	554,919	5,774,455	30	FZ1	Cable trench digging
662	554,937	5,772,482	29	FZ1	Cable trench digging
663	555,010	5,771,396	20	FZ1	Cable trench digging
664	555,014	5,771,439	20	FZ1	Cable trench digging
666	555,129	5,774,717	30	FZ1	Cable trench digging
667	555,126	5,772,340	31	FZ1	Cable trench digging
669	555,331	5,772,351	36	FZ1	Cable trench digging
673 (C)	516,253	5,779,314	10	PPRZ	Access road and tracks construction
674	504,951	5,788,303	30	FZ1	Access road and tracks construction
675 (S)	519,804	5,778,418	39	FZ1	Turbine assembly
676 (S)	525,410	5,776,340	130	FZ1	Powerline pole
677 (S)	531,054	5,774,601	140	FZ1	Cable trench digging
708 (C)	544,201	5,773,671	60	PCRZ	Cable trench digging
709 (C)	543,686	5,773,528	79	PCRZ	Horizontal drilling

(S) Stakeholder receiver

(C) Camping ground

APPENDIX G TURBINE COORDINATES

The following table sets out the coordinates of the proposed turbine layout.

See site map in Figure 1 of Section 1.2.

(Coordinates dated 6 November 2023 and supplied by the proponent on 5 December 2023).

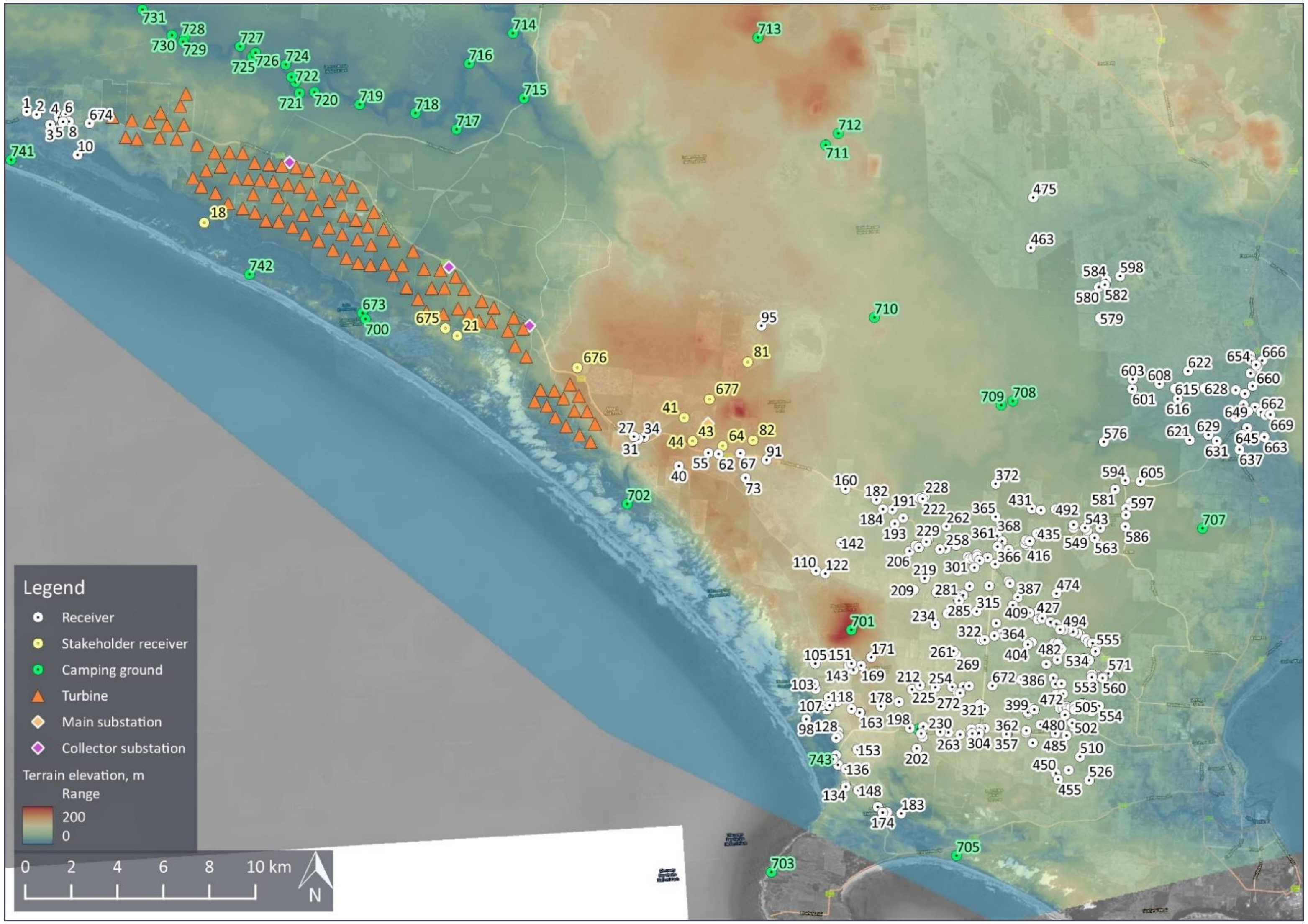
Table 48: Turbine coordinates – MGA 94 zone 54

Turbine	Easting, m	Northing, m	Terrain elevation, m	Turbine	Easting, m	Northing, m	Terrain elevation, m
1	508,690	5,787,385	40	61	516,206	5,781,499	20
2	513,955	5,783,738	30	62	519,029	5,779,194	35
3	515,713	5,783,577	40	63	521,959	5,779,172	70
4	514,311	5,785,631	40	64	522,798	5,778,676	40
5	515,053	5,785,349	40	66	511,875	5,783,969	34
6	513,368	5,785,108	40	67	512,322	5,783,588	22
7	513,172	5,785,926	37	68	506,962	5,787,496	30
9	513,787	5,785,818	40	69	511,670	5,785,447	30
10	523,753	5,775,480	31	70	511,504	5,786,578	40
11	523,171	5,778,194	40	71	510,928	5,786,647	40
12	525,052	5,775,636	133	72	522,506	5,778,131	44
13	525,321	5,773,427	25	73	517,349	5,781,375	25
14	524,320	5,774,246	20	77	515,148	5,782,134	20
15	515,619	5,785,209	40	78	509,749	5,786,238	40
16	516,535	5,784,048	40	79	517,403	5,782,894	48
17	519,322	5,780,198	34	80	517,811	5,782,353	43
18	518,621	5,781,852	30	81	517,686	5,780,864	25
19	507,939	5,787,487	40	82	519,045	5,781,052	32
20	507,567	5,788,188	58	83	523,982	5,774,773	20
22	516,180	5,784,826	40	84	523,468	5,774,998	23
23	512,881	5,783,513	20	85	512,204	5,785,367	30
24	505,966	5,788,524	21	86	520,387	5,780,618	50
25	513,463	5,783,246	20	87	519,754	5,780,948	46
26	511,847	5,784,771	40	88	521,458	5,779,498	70
27	520,877	5,779,000	50	91	516,247	5,782,517	27
28	514,005	5,782,898	20	92	521,806	5,778,546	70
29	511,997	5,786,129	30	93	506,790	5,788,321	40
30	512,908	5,784,580	34	96	519,878	5,780,173	46
31	509,545	5,787,056	31	97	522,771	5,777,451	50
32	514,558	5,782,557	20	98	516,817	5,782,249	29
33	524,722	5,775,056	70	99	508,054	5,788,555	40

Turbine	Easting, m	Northing, m	Terrain elevation, m	Turbine	Easting, m	Northing, m	Terrain elevation, m
34	525,400	5,775,115	140	100	509,305	5,785,802	30
35	525,715	5,774,415	118	102	509,890	5,785,402	20
37	525,779	5,773,089	27	103	509,218	5,789,311	46
39	521,273	5,778,644	56	104	516,721	5,783,062	41
40	510,522	5,786,060	40	108	517,033	5,783,656	50
41	510,282	5,786,688	45	109	511,353	5,784,189	30
42	526,022	5,773,849	114	110	513,891	5,784,970	47
43	511,101	5,785,508	30	111	518,111	5,781,265	30
44	509,030	5,787,978	40	112	523,225	5,776,971	50
45	508,938	5,788,808	55	113	508,305	5,788,005	50
48	513,301	5,784,047	40	114	512,764	5,785,267	33
49	515,710	5,781,752	22	115	516,732	5,781,365	20
50	525,165	5,774,480	76	117	512,618	5,786,019	30
51	515,034	5,783,116	30	118	506,478	5,787,604	20
52	516,229	5,783,367	40	119	520,405	5,779,235	58
53	515,673	5,784,516	40	120	518,701	5,779,770	30
54	515,145	5,784,259	33	123	524,345	5,775,412	54
55	519,751	5,779,032	41	124	520,726	5,780,069	49
56	515,588	5,782,780	21	126	524,758	5,773,839	20
58	510,218	5,784,929	20	127	514,387	5,784,609	35
59	510,735	5,784,444	31	128	514,599	5,783,909	30
60	518,235	5,780,302	29				

APPENDIX H SITE TOPOGRAPHY

Figure 21: Terrain elevation map for the Project and surrounding area



APPENDIX I ZONING MAP

Figure 22: Zoning map for the wind turbines, substations and surrounding area

APPENDIX J TABULATED PREDICTED NOISE LEVEL DATA

Table 49: Predicted noise levels, dB L_{A90} – GE 6.0-164

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
1	12.3	14.2	17.7	21.0	23.2	25.2	25.5	25.5	25.5	25.5	25.5	25.5
2	13.3	15.2	18.7	22.0	24.2	26.2	26.5	26.5	26.5	26.5	26.5	26.5
3	14.5	16.4	19.9	23.2	25.4	27.4	27.7	27.7	27.7	27.7	27.7	27.7
4	16.1	18.0	21.5	24.8	27.0	29.0	29.3	29.3	29.3	29.3	29.3	29.3
5	16.8	18.7	22.2	25.5	27.7	29.7	30.0	30.0	30.0	30.0	30.0	30.0
6	17.0	18.9	22.4	25.7	27.9	29.9	30.2	30.2	30.2	30.2	30.2	30.2
7	17.1	19.0	22.5	25.8	28.0	30.0	30.3	30.3	30.3	30.3	30.3	30.3
8	17.7	19.6	23.1	26.4	28.6	30.6	30.9	30.9	30.9	30.9	30.9	30.9
10	18.0	19.9	23.4	26.7	28.9	30.9	31.2	31.2	31.2	31.2	31.2	31.2
18	24.2	26.1	29.6	32.9	35.1	37.1	37.4	37.4	37.4	37.4	37.4	37.4
21 (S)	27.3	29.2	32.7	36.0	38.2	40.2	40.5	40.5	40.5	40.5	40.5	40.5
27	19.9	21.8	25.3	28.6	30.8	32.8	33.1	33.1	33.1	33.1	33.1	33.1
31	18.8	20.7	24.2	27.5	29.7	31.7	32.0	32.0	32.0	32.0	32.0	32.0
34	17.6	19.5	23.0	26.3	28.5	30.5	30.8	30.8	30.8	30.8	30.8	30.8
40	11.9	13.8	17.3	20.6	22.8	24.8	25.1	25.1	25.1	25.1	25.1	25.1
41 (S)	12.6	14.5	18.0	21.3	23.5	25.5	25.8	25.8	25.8	25.8	25.8	25.8
43 (S)	11.9	13.8	17.3	20.6	22.8	24.8	25.1	25.1	25.1	25.1	25.1	25.1
44 (S)	11.8	13.7	17.2	20.5	22.7	24.7	25.0	25.0	25.0	25.0	25.0	25.0
673 (C)	22.5	24.4	27.9	31.2	33.4	35.4	35.7	35.7	35.7	35.7	35.7	35.7
674	23.0	24.9	28.4	31.7	33.9	35.9	36.2	36.2	36.2	36.2	36.2	36.2
675 (S)	29.5	31.4	34.9	38.2	40.4	42.4	42.7	42.7	42.7	42.7	42.7	42.7
676 (S)	27.0	28.9	32.4	35.7	37.9	39.9	40.2	40.2	40.2	40.2	40.2	40.2
700 (C)	21.9	23.8	27.3	30.6	32.8	34.8	35.1	35.1	35.1	35.1	35.1	35.1
702 (C)	13.2	15.1	18.6	21.9	24.1	26.1	26.4	26.4	26.4	26.4	26.4	26.4
718 (C)	15.7	17.6	21.1	24.4	26.6	28.6	28.9	28.9	28.9	28.9	28.9	28.9
719 (C)	15.9	17.8	21.3	24.6	26.8	28.8	29.1	29.1	29.1	29.1	29.1	29.1
720 (C)	18.0	19.9	23.4	26.7	28.9	30.9	31.2	31.2	31.2	31.2	31.2	31.2
721 (C)	18.2	20.1	23.6	26.9	29.1	31.1	31.4	31.4	31.4	31.4	31.4	31.4
722 (C)	16.8	18.7	22.2	25.5	27.7	29.7	30.0	30.0	30.0	30.0	30.0	30.0
723 (C)	15.7	17.6	21.1	24.4	26.6	28.6	28.9	28.9	28.9	28.9	28.9	28.9

Receiver	Hub-height wind speed, m/s											
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
724 (C)	16.1	18.0	21.5	24.8	27.0	29.0	29.3	29.3	29.3	29.3	29.3	29.3
725 (C)	16.2	18.1	21.6	24.9	27.1	29.1	29.4	29.4	29.4	29.4	29.4	29.4
726 (C)	16.3	18.2	21.7	25.0	27.2	29.2	29.5	29.5	29.5	29.5	29.5	29.5
727 (C)	15.9	17.8	21.3	24.6	26.8	28.8	29.1	29.1	29.1	29.1	29.1	29.1
728 (C)	16.4	18.3	21.8	25.1	27.3	29.3	29.6	29.6	29.6	29.6	29.6	29.6
729 (C)	17.2	19.1	22.6	25.9	28.1	30.1	30.4	30.4	30.4	30.4	30.4	30.4
730 (C)	14.5	16.4	19.9	23.2	25.4	27.4	27.7	27.7	27.7	27.7	27.7	27.7
731 (C)	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
741 (C)	11.1	13.0	16.5	19.8	22.0	24.0	24.3	24.3	24.3	24.3	24.3	24.3
742 (C)	20.3	22.2	25.7	29.0	31.2	33.2	33.5	33.5	33.5	33.5	33.5	33.5

(S) Stakeholder receiver

(C) Camping ground

Table 50: Predicted noise levels, dB L_{A90} – V162-6.2MW

Receiver	Hub-height wind speed, m/s										
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	14.6	14.8	16.7	19.7	22.5	24.8	25.3	25.3	25.3	25.3	25.3	25.3
2	15.5	15.7	17.6	20.6	23.4	25.7	26.2	26.2	26.2	26.2	26.2	26.2
3	16.8	17.0	18.9	21.9	24.7	27.0	27.5	27.5	27.5	27.5	27.5	27.5
4	18.2	18.4	20.3	23.3	26.1	28.4	28.9	28.9	28.9	28.9	28.9	28.9
5	18.9	19.1	21.0	24.0	26.8	29.1	29.6	29.6	29.6	29.6	29.6	29.6
6	19.1	19.3	21.2	24.2	27.0	29.3	29.8	29.8	29.8	29.8	29.8	29.8
7	19.2	19.4	21.3	24.3	27.1	29.4	29.9	29.9	29.9	29.9	29.9	29.9
8	19.7	19.9	21.8	24.8	27.6	29.9	30.4	30.4	30.4	30.4	30.4	30.4
10	20.1	20.3	22.2	25.2	28.0	30.3	30.8	30.8	30.8	30.8	30.8	30.8
18	26.0	26.2	28.1	31.1	33.9	36.2	36.7	36.7	36.7	36.7	36.7	36.7
21 (S)	28.7	28.9	30.8	33.8	36.6	38.9	39.4	39.4	39.4	39.4	39.4	39.4
27	21.8	22.0	23.9	26.9	29.7	32.0	32.5	32.5	32.5	32.5	32.5	32.5
31	20.7	20.9	22.8	25.8	28.6	30.9	31.4	31.4	31.4	31.4	31.4	31.4
34	19.7	19.9	21.8	24.8	27.6	29.9	30.4	30.4	30.4	30.4	30.4	30.4
40	14.3	14.5	16.4	19.4	22.2	24.5	25.0	25.0	25.0	25.0	25.0	25.0
41 (S)	15.0	15.2	17.1	20.1	22.9	25.2	25.7	25.7	25.7	25.7	25.7	25.7
43 (S)	14.1	14.3	16.2	19.2	22.0	24.3	24.8	24.8	24.8	24.8	24.8	24.8
44 (S)	14.1	14.3	16.2	19.2	22.0	24.3	24.8	24.8	24.8	24.8	24.8	24.8
673 (C)	24.5	24.7	26.6	29.6	32.4	34.7	35.2	35.2	35.2	35.2	35.2	35.2
674	24.4	24.6	26.5	29.5	32.3	34.6	35.1	35.1	35.1	35.1	35.1	35.1
675 (S)	30.4	30.6	32.5	35.5	38.3	40.6	41.1	41.1	41.1	41.1	41.1	41.1
676 (S)	28.2	28.4	30.3	33.3	36.1	38.4	38.9	38.9	38.9	38.9	38.9	38.9
700 (C)	24.0	24.2	26.1	29.1	31.9	34.2	34.7	34.7	34.7	34.7	34.7	34.7
702 (C)	15.6	15.8	17.7	20.7	23.5	25.8	26.3	26.3	26.3	26.3	26.3	26.3
718 (C)	18.0	18.2	20.1	23.1	25.9	28.2	28.7	28.7	28.7	28.7	28.7	28.7
719 (C)	18.6	18.8	20.7	23.7	26.5	28.8	29.3	29.3	29.3	29.3	29.3	29.3
720 (C)	20.4	20.6	22.5	25.5	28.3	30.6	31.1	31.1	31.1	31.1	31.1	31.1
721 (C)	20.8	21.0	22.9	25.9	28.7	31.0	31.5	31.5	31.5	31.5	31.5	31.5
722 (C)	19.3	19.5	21.4	24.4	27.2	29.5	30.0	30.0	30.0	30.0	30.0	30.0
723 (C)	18.4	18.6	20.5	23.5	26.3	28.6	29.1	29.1	29.1	29.1	29.1	29.1
724 (C)	18.4	18.6	20.5	23.5	26.3	28.6	29.1	29.1	29.1	29.1	29.1	29.1

Receiver	Hub-height wind speed, m/s											
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
725 (C)	18.6	18.8	20.7	23.7	26.5	28.8	29.3	29.3	29.3	29.3	29.3	29.3
726 (C)	18.7	18.9	20.8	23.8	26.6	28.9	29.4	29.4	29.4	29.4	29.4	29.4
727 (C)	18.3	18.5	20.4	23.4	26.2	28.5	29.0	29.0	29.0	29.0	29.0	29.0
728 (C)	18.7	18.9	20.8	23.8	26.6	28.9	29.4	29.4	29.4	29.4	29.4	29.4
729 (C)	19.4	19.6	21.5	24.5	27.3	29.6	30.1	30.1	30.1	30.1	30.1	30.1
730 (C)	17.1	17.3	19.2	22.2	25.0	27.3	27.8	27.8	27.8	27.8	27.8	27.8
731 (C)	15.3	15.5	17.4	20.4	23.2	25.5	26.0	26.0	26.0	26.0	26.0	26.0
741 (C)	13.3	13.5	15.4	18.4	21.2	23.5	24.0	24.0	24.0	24.0	24.0	24.0
742 (C)	22.6	22.8	24.7	27.7	30.5	32.8	33.3	33.3	33.3	33.3	33.3	33.3

(S) Stakeholder receiver

(C) Camping ground

Table 51: Predicted noise levels, dB L_{A90} – SG 6.2-170

Receiver	Hub-height wind speed, m/s										
	4	5	6	7	8	9	10	11	12	13	14	15
1	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
2	11.3	13.8	17.7	21.1	24.0	25.3	25.3	25.3	25.3	25.3	25.3	25.3
3	12.4	14.9	18.8	22.2	25.1	26.4	26.4	26.4	26.4	26.4	26.4	26.4
4	13.9	16.4	20.3	23.7	26.6	27.9	27.9	27.9	27.9	27.9	27.9	27.9
5	14.6	17.1	21.0	24.4	27.3	28.6	28.6	28.6	28.6	28.6	28.6	28.6
6	14.8	17.3	21.2	24.6	27.5	28.8	28.8	28.8	28.8	28.8	28.8	28.8
7	14.9	17.4	21.3	24.7	27.6	28.9	28.9	28.9	28.9	28.9	28.9	28.9
8	15.4	17.9	21.8	25.2	28.1	29.4	29.4	29.4	29.4	29.4	29.4	29.4
10	15.8	18.3	22.2	25.6	28.5	29.8	29.8	29.8	29.8	29.8	29.8	29.8
18	21.7	24.2	28.1	31.5	34.4	35.7	35.7	35.7	35.7	35.7	35.7	35.7
21 (S)	24.8	27.3	31.2	34.6	37.5	38.8	38.8	38.8	38.8	38.8	38.8	38.8
27	17.5	20.0	23.9	27.3	30.2	31.5	31.5	31.5	31.5	31.5	31.5	31.5
31	16.4	18.9	22.8	26.2	29.1	30.4	30.4	30.4	30.4	30.4	30.4	30.4
34	15.3	17.8	21.7	25.1	28.0	29.3	29.3	29.3	29.3	29.3	29.3	29.3
40	10.0	12.5	16.4	19.8	22.7	24.0	24.0	24.0	24.0	24.0	24.0	24.0
41 (S)	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
43 (S)	10.0	12.5	16.4	19.8	22.7	24.0	24.0	24.0	24.0	24.0	24.0	24.0
44 (S)	10.0	12.5	16.4	19.8	22.7	24.0	24.0	24.0	24.0	24.0	24.0	24.0
673 (C)	20.2	22.7	26.6	30.0	32.9	34.2	34.2	34.2	34.2	34.2	34.2	34.2
674	20.5	23.0	26.9	30.3	33.2	34.5	34.5	34.5	34.5	34.5	34.5	34.5
675 (S)	26.9	29.4	33.3	36.7	39.6	40.9	40.9	40.9	40.9	40.9	40.9	40.9
676 (S)	24.5	27.0	30.9	34.3	37.2	38.5	38.5	38.5	38.5	38.5	38.5	38.5
700 (C)	19.6	22.1	26.0	29.4	32.3	33.6	33.6	33.6	33.6	33.6	33.6	33.6
702 (C)	11.1	13.6	17.5	20.9	23.8	25.1	25.1	25.1	25.1	25.1	25.1	25.1
718 (C)	13.9	16.4	20.3	23.7	26.6	27.9	27.9	27.9	27.9	27.9	27.9	27.9
719 (C)	14.1	16.6	20.5	23.9	26.8	28.1	28.1	28.1	28.1	28.1	28.1	28.1
720 (C)	16.0	18.5	22.4	25.8	28.7	30.0	30.0	30.0	30.0	30.0	30.0	30.0
721 (C)	16.2	18.7	22.6	26.0	28.9	30.2	30.2	30.2	30.2	30.2	30.2	30.2
722 (C)	14.8	17.3	21.2	24.6	27.5	28.8	28.8	28.8	28.8	28.8	28.8	28.8
723 (C)	14.0	16.5	20.4	23.8	26.7	28.0	28.0	28.0	28.0	28.0	28.0	28.0
724 (C)	14.2	16.7	20.6	24.0	26.9	28.2	28.2	28.2	28.2	28.2	28.2	28.2

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
725 (C)	14.3	16.8	20.7	24.1	27.0	28.3	28.3	28.3	28.3	28.3	28.3	28.3
726 (C)	14.4	16.9	20.8	24.2	27.1	28.4	28.4	28.4	28.4	28.4	28.4	28.4
727 (C)	14.0	16.5	20.4	23.8	26.7	28.0	28.0	28.0	28.0	28.0	28.0	28.0
728 (C)	14.3	16.8	20.7	24.1	27.0	28.3	28.3	28.3	28.3	28.3	28.3	28.3
729 (C)	15.0	17.5	21.4	24.8	27.7	29.0	29.0	29.0	29.0	29.0	29.0	29.0
730 (C)	12.4	14.9	18.8	22.2	25.1	26.4	26.4	26.4	26.4	26.4	26.4	26.4
731 (C)	11.0	13.5	17.4	20.8	23.7	25.0	25.0	25.0	25.0	25.0	25.0	25.0
741 (C)	9.3	11.8	15.7	19.1	22.0	23.3	23.3	23.3	23.3	23.3	23.3	23.3
742 (C)	18.1	20.6	24.5	27.9	30.8	32.1	32.1	32.1	32.1	32.1	32.1	32.1

(S) Stakeholder receiver

(C) Camping ground

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Table 52: Predicted noise levels, dB L_{A90} – N163/5.7

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
1	14.5	17.0	21.8	25.9	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
2	15.5	18.0	22.8	26.9	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2
3	16.8	19.3	24.1	28.2	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
4	18.2	20.7	25.5	29.6	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
5	18.9	21.4	26.2	30.3	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
6	19.2	21.7	26.5	30.6	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9
7	19.3	21.8	26.6	30.7	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
8	19.9	22.4	27.2	31.3	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6
10	20.2	22.7	27.5	31.6	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
18	26.3	28.8	33.6	37.7	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
21 (S)	29.3	31.8	36.6	40.7	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0
27	22.0	24.5	29.3	33.4	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7
31	20.9	23.4	28.2	32.3	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
34	19.8	22.3	27.1	31.2	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
40	14.2	16.7	21.5	25.6	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9
41 (S)	14.9	17.4	22.2	26.3	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
43 (S)	14.1	16.6	21.4	25.5	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8
44 (S)	14.0	16.5	21.3	25.4	25.7	25.7	25.7	25.7	25.7	25.7	25.7	25.7
673 (C)	24.6	27.1	31.9	36.0	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
674	25.0	27.5	32.3	36.4	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7
675 (S)	31.3	33.8	38.6	42.7	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
676 (S)	28.9	31.4	36.2	40.3	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6
700 (C)	24.0	26.5	31.3	35.4	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7
702 (C)	15.5	18.0	22.8	26.9	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2
718 (C)	17.9	20.4	25.2	29.3	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6
719 (C)	18.5	21.0	25.8	29.9	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
720 (C)	20.2	22.7	27.5	31.6	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
721 (C)	20.6	23.1	27.9	32.0	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3
722 (C)	19.1	21.6	26.4	30.5	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8
723 (C)	18.2	20.7	25.5	29.6	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
724 (C)	18.3	20.8	25.6	29.7	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
725 (C)	18.4	20.9	25.7	29.8	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1
726 (C)	18.5	21.0	25.8	29.9	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
727 (C)	18.2	20.7	25.5	29.6	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
728 (C)	18.7	21.2	26.0	30.1	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4
729 (C)	19.4	21.9	26.7	30.8	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1
730 (C)	17.1	19.6	24.4	28.5	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
731 (C)	15.2	17.7	22.5	26.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
741 (C)	13.3	15.8	20.6	24.7	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
742 (C)	22.6	25.1	29.9	34.0	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3

(S) Stakeholder receiver

(C) Camping ground

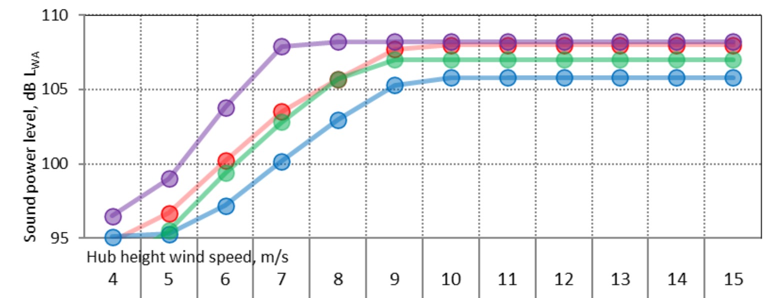
APPENDIX K NZS 6808 DOCUMENTATION

(a) Map of the site showing topography, turbines and residential properties: See Appendix H

(b) Noise sensitive locations: See Section 4.0 and Appendix F

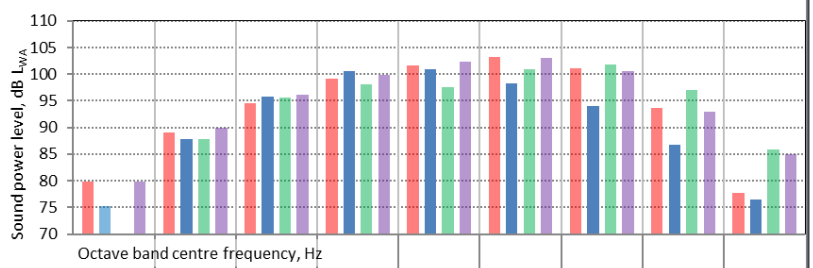
(c) Wind turbine sound power levels: See Section 9.2.2

Sound power levels (manufacturer specification +1 dB margin for uncertainty), dB L_{WA}



Hub height wind speed, m/s	4	5	6	7	8	9	10	11	12	13	14	15
GE 6.0-164	94.8	96.7	100.2	103.5	105.7	107.7	108.0	108.0	108.0	108.0	108.0	108.0
V162-6.2MW	95.1	95.3	97.2	100.2	103.0	105.3	105.8	105.8	105.8	105.8	105.8	105.8
SG 6.2-170	93.0	95.5	99.4	102.8	105.7	107.0	107.0	107.0	107.0	107.0	107.0	107.0
N163/5.7	96.5	99.0	103.8	107.9	108.2	108.2	108.2	108.2	108.2	108.2	108.2	108.2

Reference octave band spectra adjusted to the highest sound power level detailed above dB L_{WA}



Octave band centre frequency, Hz	31.5	63	125	250	500	1000	2000	4000	8000
GE 6.0-164	79.8	89.1	94.6	99.1	101.7	103.3	101.1	93.6	77.8
V162-6.2MW	75.2	87.9	95.7	100.6	101.0	98.3	93.9	86.7	76.4
SG 6.2-170		87.8	95.7	98.1	97.6	101.0	101.8	97.0	85.8
N163/5.7	79.8	89.9	96.1	99.8	102.4	103.1	100.6	93.0	85.0

(d) Wind turbine model: See Table 24 of Section 9.2.1

(e) Turbine hub height: See Table 24 of Section 9.2.1

(f) Distance of noise sensitive locations from the wind turbines: See Appendix F

(g) Calculation procedure used: ISO 9613-2 prediction algorithm as implemented in SoundPLANnoise v9.0 (See Section 8.3 and Appendix E)

(h) Meteorological conditions assumed: See Table 21 of Section 8.3

(i) Air absorption parameters:

	Octave band mid frequency, Hz							
Description	63	125	250	500	1k	2k	4k	8k
Atmospheric attenuation, dB/km	0.12	0.41	1.04	1.93	3.66	9.66	32.8	116.9

(j) Topography/screening: 10 m resolution elevation contours – See Appendix H

(k) Predicted far-field wind farm sound levels: See Section 9.3 and 0.

APPENDIX L TRANSMISSION LINE OPTION ASSESSMENT

On 26 May 2023, Umwelt issued a document titled *Kentbruck Green Power Hub Guidance to specialists on assessing the transmission line options* (Umwelt guidance document).

The Umwelt guidance document describes four (4) transmission line options which were considered for connection of the Project to the existing transmission network:

- Option 1A: Underground transmission line from the main substation to Forest Park and then overhead to the existing Heywood Terminal Station

  This option is identified as a viable alternative route that would be considered by the proponent in the event that the preferred option (1B) is unable to be pursued.

- Option 1B: Underground transmission line from the main substation to the existing Heywood Terminal Station

  This option is identified as the preferred route and assessed within this report.

- Option 2A: Overhead transmission line from the main substation to a new terminal station adjacent to the Heywood-Portland 500 kV line, north of Portland

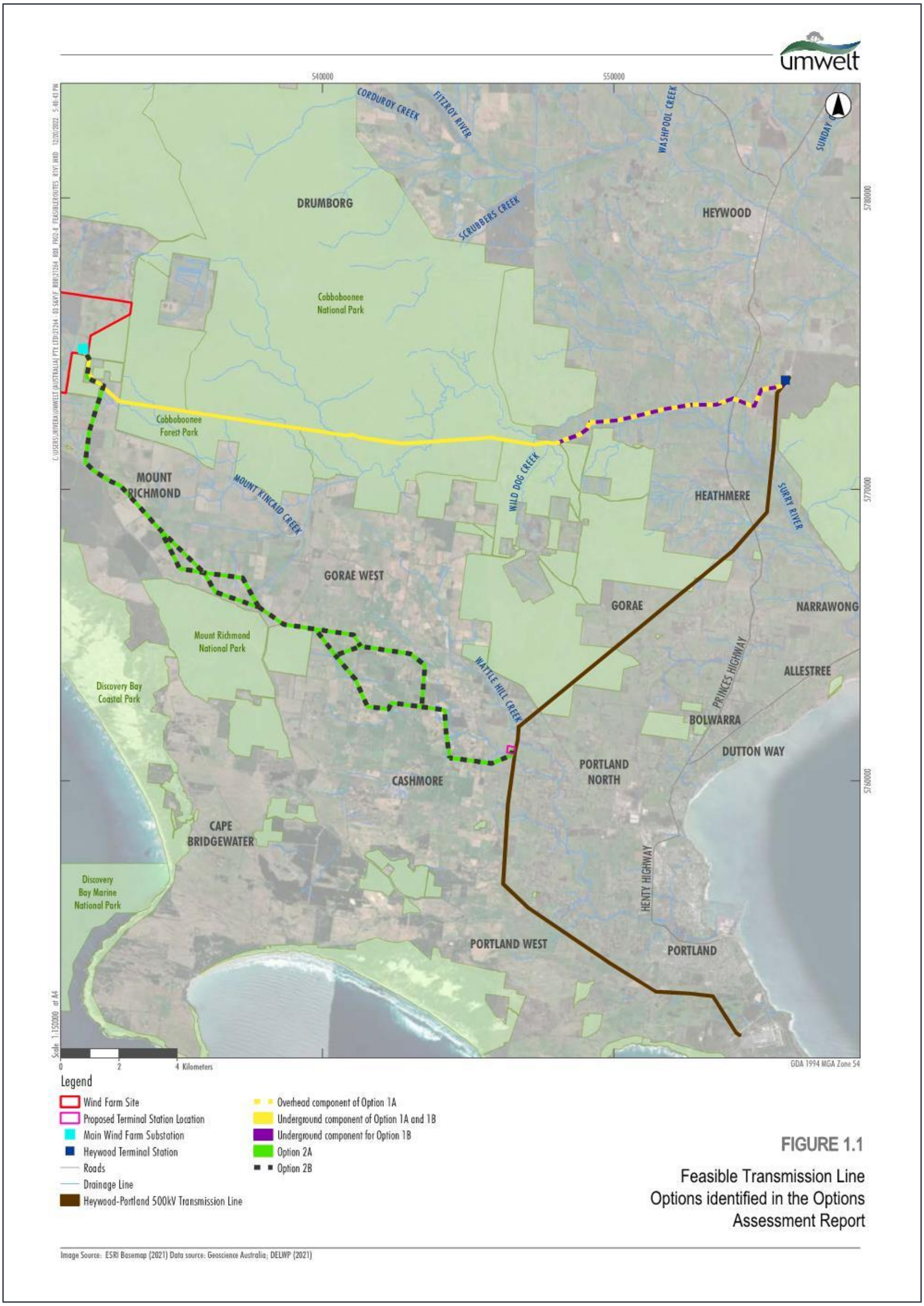
  This option is identified as a non-viable route and was formally removed from the Project in 2021.

- Option 2B: Underground transmission line from the main substation to a new terminal station adjacent to the Heywood-Portland 500 kV line, north of Portland

  This option is identified as a non-viable route and was formally removed from the Project in 2021.

A map showing the four (4) transmission line options is presented in Figure 23.

Figure 23: Transmission line options



For each of the transmission line options, Table 31 lists the elements considered in the assessment of operational noise assessment from substations and terminal stations and construction noise and vibration.

Table 53: Elements considered for each type of assessment

Option	Operational noise assessment	Construction noise and vibration assessment
1A	Substations as assessed in Section 10.0	Underground and overhead power line from the main substation to the existing Heywood Terminal Station
1B	Substations as assessed in Section 10.0	Underground power line from the main substation to the existing Heywood Terminal Station
2A	Substations as assessed in Section 10.0 in addition to a new terminal station north of Portland	Overhead power line from the main substation to a new terminal station north of Portland
2B	Substations as assessed in Section 10.0 in addition to a new terminal station north of Portland	Underground power line from the main substation to a new terminal station north of Portland

L1 Operational noise assessment

L1.1 Options 1A and 1B

As detailed in Section 10.1, the night-time noise limit of 34 dB ENL is applicable for operational noise from the substations associated with Options 1A and 1B.

Results of the operational noise assessment for the substations detailed in Section 10.3 are representative of Options 1A and 1B.

The highest operational noise level of 27 dB ENL is predicted at Receiver 44, 7 dB below the lowest applicable noise limit.

L1.2 Options 2A and 2B

The substations associated Options 2A and 2B consist of a new terminal station north of Portland, in addition to the three (3) collector substations and the main substations, accounted for in the operational noise assessment for Options 1A and 1B.

As detailed in Section 10.1, the rural areas procedures specified in the Noise Protocol apply to the Project and are based on zone levels determined according to the land zoning of the area in which the noise source and receivers are located. These zone levels are then adjusted, where appropriate, for a range of factors.

The zone levels are determined on the basis of the new terminal station and surrounding residential receivers both being located on land designated as Rural Conservation Zone (RCZ2) (see land zoning map in Figure 24). Considering that adjustments for distance or background noise are not applicable in this instance, the lowest noise limit applicable at the receivers nearest to the new terminal station is 33 dB ENL.

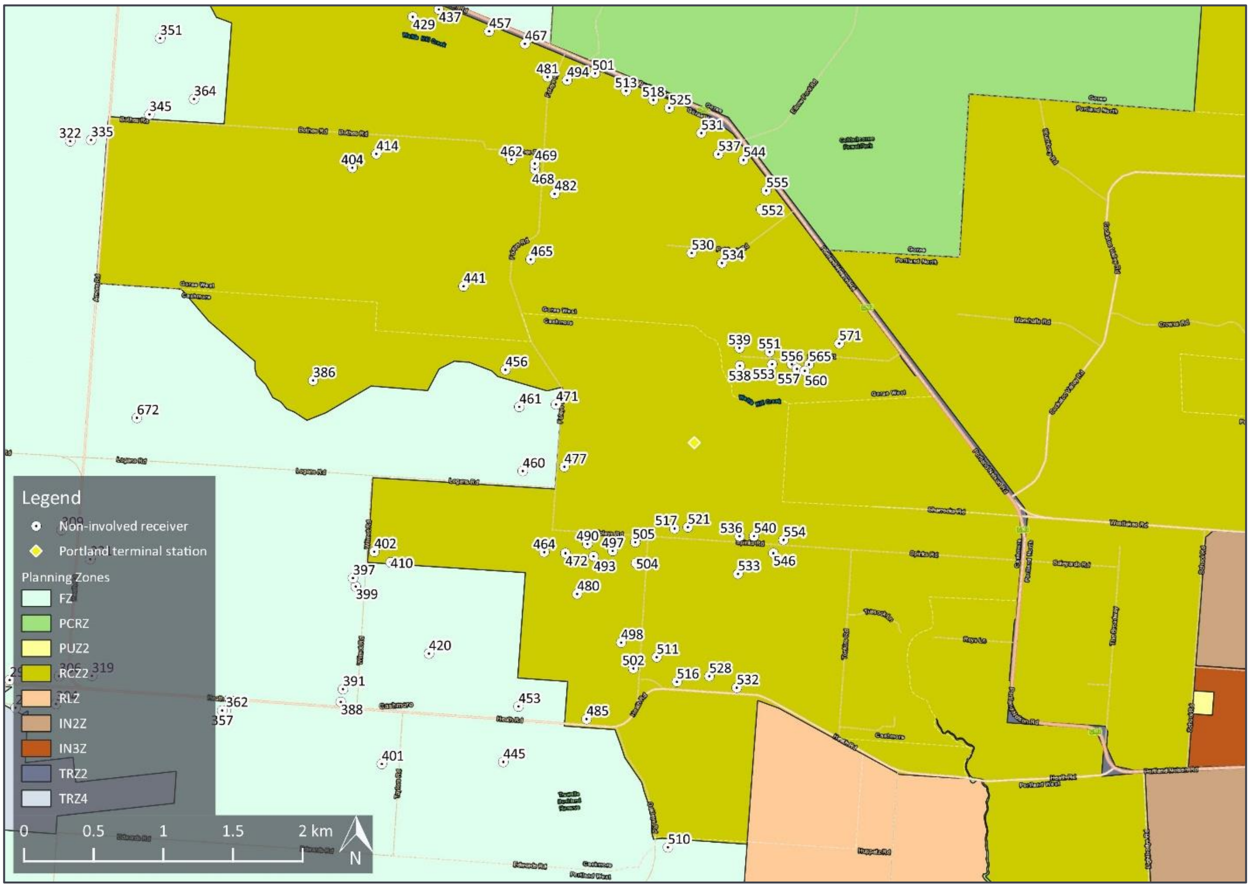
It is understood that the new terminal station would include a single 650 MVA transformer. As detailed in Section 10.2, Figure ZA1 from AS 60076-10:2009 has been used to determine an estimated standard maximum sound power level of 105 dB L_{WA}.

Sound power level data used in this assessment for the equipment associated with the new terminal station is summarised in Table 30.

Table 54: Octave band sound power levels, dB L_W

	Octave band centre frequency, Hz							
Item	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**A-weighted total**
New terminal station	103	114	111	102	93	84	77	105

Figure 24: Location of the terminal station near Portland associated with Option 2A and 2B



Operational noise level from the new terminal station at the nearest receiver (521), located approximately 600 m to the south, is predicted at 39 dB ENL, 6 dB above the applicable noise limit.

As such, Options 2A and 2B would not be acceptable with regard to operational noise levels.

L2 Construction noise and vibration assessment

L2.1 Assessment criteria

The assessment criteria applicable to construction noise and vibration from the Project are detailed in Section 6.1.

L2.2 Option 1B

Predicted construction noise and vibration levels for Option 1B are presented in Section 6.4 and Section 6.6, respectively.

L2.3 Option 1A

Option 1A follows the same route as the preferred option (1B) with the transmission line being overhead, instead of underground, from Forest Park to the Heywood Terminal Station. As such, construction noise from activities associated with powerline pole erection and powerline stringing were only assessed at the nearest receiver along the transmission route between Forest Park and the Heywood Terminal Station.

The highest predicted construction noise levels from powerline pole erection and powerline stringing range from 60-65 dB L_{Aeq} at Receiver 634, located approximately 95 m from the Option 1A transmission route.

In comparison, for Option 1B, the predicted construction noise levels from cable trench digging range from 65-70 dB L_{Aeq} at Receiver 634.

The separation distance between construction activities and receivers is equivalent for Options 1A and 1B. As such, the predicted vibration levels for Option 1A are not expected to be higher than those presented in Section 6.6.

L2.4 Options 2A and 2B

Options 2A and 2B follow the same route between the main wind farm substation and a new terminal station north of Portland, with the transmission line overhead for Option 2A and underground for Option 2B.

As such, construction noise levels were predicted for the following activities at the nearest receiver along the proposed route:

- Powerline pole erection (Option 2A);
- Powerline stringing (Option 2A); and
- Cable trench digging (Option 2B).

For Option 2A, construction noise levels from cable trench digging activities are predicted to be highest at Receiver 460 (located approximately 154 m from the Option 2 transmission route) and range from 80-85 dB L_{Aeq}. For Option 1B, the construction noise levels from these activities were predicted to be marginally lower (75-80 dB L_{Aeq}) at the nearest receiver to the Option 1 transmission route (Receiver 576).

For Option 2B, construction noise levels from activities associated with powerline pole erection and powerline stringing are predicted to be highest at Receiver 460 and range from 60-65 dB L_{Aeq}. For Option 1B, the construction noise levels from these activities were predicted to be marginally higher at the nearest receiver to the Option 1 transmission route (Receiver 634).

The separation distance between construction activities and receivers is equivalent for Options 1 and 2. As such, the predicted vibration levels for Options 2A and 2B are not expected to be higher than those presented in Section 6.6.

L3 Conclusion

Predicted operational noise levels from the substations and terminal stations (where relevant) associated with the different transmission route options demonstrate that only Options 1A and 1B would result in compliance with the applicable noise limits determined in accordance with the Noise Protocol.

Construction noise level predictions indicate a similar level of impact between the different transmission route options and construction vibration levels are not envisaged to be a material consideration for the transmission route options considered.