MT FYANS
WIND FARM

APPENDIX L

ENVIRONMENTAL NOISE REPORT

MARSHALL DAY

AUGUST 2022

MARSHALL DAY
Acoustics

MT FYANS WIND FARM
ENVIRONMENTAL NOISE ASSESSMENT

Rp 001 20190964 | 15 August 2022

MARSHALL DAY
Acoustics

Marshall Day Acoustics Pty Ltd
ABN: 53 470 077 191
6 Gipps Street
Collingwood VIC 3066
Australia
T: +613 9416 1855
www.marshallday.com

Project: **Mt Fyans Wind Farm**
Environmental Noise Assessment

Prepared for: **Hydro Tasmania**
4 Elizabeth Street
Hobart TAS 7000

Attention: **David Procter**

Report No.: **Rp 001 R01 20190964**

Disclaimer

Reports produced by Marshall Day Acoustics Pty Ltd are based on a specific scope, conditions and limitations, as agreed between Marshall Day Acoustics and the Client. Information and/or report(s) prepared by Marshall Day Acoustics may not be suitable for uses other than the specific project. No parties other than the Client should use any information and/or report(s) without first conferring with Marshall Day Acoustics.

The advice given herein is for acoustic purposes only. Relevant authorities and experts should be consulted with regard to compliance with regulations or requirements governing areas other than acoustics.

Document Control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Complete	-	Issued to client	12 Aug. 2022	C. Delaire	J. Adcock A. Stoker
Complete	01	Fixed table of content	15 Aug. 2022	C. Delaire	-

EXECUTIVE SUMMARY

This report presents the results of an assessment of environmental noise associated with the Mt Fyans Wind Farm that is proposed to be developed by Mount Fyans Wind Farm Pty Ltd (the proponent). The assessment is based on the proposed wind farm layout comprising eighty-one (81) multi-megawatt wind turbines and related infrastructure, including an on-site substation located centrally within the wind farm and an off-site grid substation located to the southwest of the wind farm.

The planning application for the wind farm seeks approval to develop wind turbines with a maximum tip height of 200 m. The actual wind turbine which would be used at the site would be determined at a later stage in the project, after the project has been granted planning approval. The final selection would be based on a range of design requirements including achieving compliance with the applicable noise limits at surrounding noise sensitive locations (receivers). In advance of a final selection, this assessment considers three (3) candidate wind turbine models that are representative of the size and type of wind turbine which could be used at the site. For this purpose, the Siemens Gamesa SG 6.6-170, General Electric GE 6.0-164 and Vestas V162-6.8MW, with a hub height modelled at 115 m and rotor diameters ranging between 162 and 170 m, have been nominated by the proponent.

Operational noise from the proposed wind turbines has been assessed in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808), as required by the *Environment Protection Regulations 2021* and the Victorian Department of Environment, Land, Water and Planning publication *Development of Wind Energy Facilities in Victoria – Policy and Planning Guidelines* dated November 2021. The operational wind farm noise assessment considers the base (minimum) noise limits determined in accordance with NZS 6808, accounting for the land zoning of the area.

Manufacturer specification data for the candidate wind turbine models has been used as the basis for the assessment. The specification provides noise emission data in accordance with the international standard referenced in NZS 6808. The noise emission data is consistent with the range of values expected for comparable types of multi megawatt wind turbine models that are being considered for the site.

The noise emission data has been used with international standard ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) to predict the level of noise expected to occur at neighbouring receivers. The ISO 9613-2 standard has been applied using well-established input choices and adjustments, based on research and international guidance, that are specific to wind farm noise assessment.

The results of the noise modelling demonstrate that the predicted noise levels for the proposed wind turbine layout and candidate wind turbine models achieve the base noise limits determined in accordance with NZS 6808 at all neighbouring receivers.

The limits determined in accordance with NZS 6808:2010 apply to the total combined operational wind farm noise level, including the contribution of any neighbouring wind farm developments. The assessment has therefore considered other approved and operational wind farm projects in the broader surrounding area, including the Salt Creek Wind Farm to the north, the Mortlake South Wind Farm to the south and the Dundonnell Wind Farm to the northeast. An assessment of the predicted noise levels for each wind farm has demonstrated that cumulative wind farm noise considerations are not applicable to the project. Specifically, the noise contribution of the other wind farms in the area are sufficiently low to be inconsequential to the noise assessment for the Mt Fyans Wind Farm. Conversely, the predicted noise contribution of the Mt Fyans Wind Farm at the receiver locations of the other wind farms would not affect the noise assessment for these projects.

The assessment has also considered the operational noise of the two substations associated with the wind farm. Noise levels from the substations have been assessed 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*, dated May 2021 (the Noise Protocol). The assessment demonstrates that the substations can be designed and operated to achieve the noise limits determined in accordance with the Noise Protocol.

Consideration was also given to the general environmental duty introduced by the *Environment Protection Act 2017* (the EP Act) in July 2021.

The noise assessment therefore demonstrates that the proposed Mt Fyans Wind Farm, and the associated substations, can be designed and developed to achieve Victorian policy requirements.

TABLE OF CONTENTS

1.0 INTRODUCTION

Mount Fyans Wind Farm Pty Ltd (the proponent), is proposing to develop a wind farm known as the Mt Fyans Wind Farm (the project) within the Victorian local government area of the Moyne Shire Council, approximately 5 km to the north of the Mortlake township.

The wind farm is proposed to comprise eighty-one (81) wind turbines and associated substations. Throughout this report, the term 'wind farm' refers to both the wind turbines and the substations.

This report presents the results of an assessment of operational wind turbine noise in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808), as required by the *Environment Protection Regulations 2021* (the EP Regulations) and the Victorian Department of Environment, Land, Water and Planning publication *Development of Wind Energy Facilities in Victoria – Policy and Planning Guidelines* dated November 2021 (the Victorian Wind Energy Guidelines).

Operational noise of the proposed substations has been assessed 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* dated May 2021 (Noise Protocol), as required by the EP Regulations.

The noise assessment presented in this report is based on:

- Operational noise limits determined in accordance with NZS 6808 and the Noise Protocol, accounting for local land zoning;
- Predicted noise levels for the wind turbines, based on the proposed site layout and three (3) candidate wind turbine models that are representative of the size and type of wind turbine that the planning application seeks consent for;
- Predicted noise levels for the proposed substations, based on empirical noise emission data;
- A comparison of the predicted noise levels with the applicable base noise limits determined in accordance with NZS 6808 and the noise limits defined by the Noise Protocol; and
- A review of the predicted noise levels of the substations in the context of the general environmental duty of the EP Act.

This report also provides information about construction noise including details of relevant Victorian guidelines and the types of activities that are expected to be associated with construction of the wind farm. This information is primarily intended as a reference for matters that should be considered as part of the preparation of a construction environmental management plan for the project.

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.

2.0 PROJECT DESCRIPTION

The wind farm is proposed to comprise eighty-one (81) wind turbines which extend over an area spanning approximately 12 km from north to south and 16 km from east to west. The coordinates of the proposed wind turbines are tabulated in Appendix C.

The proponent is seeking consent for a wind farm comprising wind turbines extending to a tip height of up to 200 m. Three (3) candidate wind turbine models that are representative of the size and type of wind turbine which could be used at the site have been nominated by the proponent with rotor diameters ranging between 162 and 170 m. The assessment is based on a turbine hub height of 115 m for all three (3) candidate turbine models. Further details of the candidate wind turbine models are presented in Section 6.2.

Two substations have also been proposed for the project (see coordinates in Appendix C):

- an on-site substation located at the centre of the site; and
- an off-site substation located approximately 8 km to the southwest of the site to connect to the network through the substation at the Mortlake Power Station.

A total of one hundred and forty-nine (149) noise sensitive locations (generally referred to as *receivers* herein) located within 5 km of the proposed wind turbines have been considered in this noise assessment. This includes twenty (20) receivers where a noise agreement is in place or proposed between the landowners and the proponent (subsequently referred to as *involved receivers* and referenced with the prefix "i" herein).

The coordinates of the receivers are tabulated in Appendix D.

A site layout plan illustrating the wind turbine layout, substations and receivers is provided in Appendix E.

3.0 VICTORIAN LEGISLATION & 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*, dated 11 November 2021
- Victorian Department of Environment, Land, Water and Planning publication *Development of Wind Energy Facilities in Victoria – Policy and Planning Guidelines* dated November 2021
- New Zealand Standard 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 May 2021.

Details of the guidance and noise limits provided by these publications are provided below.

3.1 Environment Protection Act 2017

The *Environment Protection Act 2017* (the 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 are separately defined in regulations made under the EP Act (see next section).

3.2 Environment Protection Regulations 2021

The *Environment Protection Regulations 2021*, dated 11 November 2021 (the 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.

3.2.1 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 within this assessment as 'involved 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.

3.2.2 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 3.6). 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.

3.3 Victorian Wind Energy Guidelines

The Victorian Department of Environment, Land, Water and Planning publication *Development of Wind Energy Facilities in Victoria – Policy and Planning Guidelines* dated November 2021 (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; and*
- *a framework for the regulation of wind turbine noise.*

Section 5 of 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*[1]*.*
>
> *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.*

[1] *Cherry Tree Wind Farm v Mitchell Shire Council* (2013)

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.

3.4 EPA Victoria webpage Wind Energy Facility Turbine Noise Regulation Guidelines

The EPA Victoria webpage titled *Victoria Wind Energy Facility Turbine Noise Regulation Guidelines*[2] (the EPA web guidelines) provides an outline of the requirements that apply to wind turbines under the EP Regulations. The EPA web guidelines are not formally published guidelines, and do not represent statutory requirements or impose compliance obligations; they are intended as a general guide to assist wind farm operators.

In particular, relevant to this assessment, the EPA web guidelines provide guidance with respect to the application of the high amenity area noise limit.

3.5 NZS 6808

New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (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.

3.5.1 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.*

2 weblink

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.

3.5.2 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 Management Act states the following at Section 104:

> *(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 involved receivers irrespective of whether they are inside or outside of the boundary. However, the noise limits specified in the Standard do not apply to these locations on account of their participation with the wind farm.

3.5.3 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 noise limits 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 L_{A90}.

The noise limits specified in NZS 6808 apply to the combined wind turbine 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.*

3.5.4 High amenity

Section 5.3.1 of NZS 6808 states that the base noise limit of 40 dB L_{A90} detailed in Section 3.5.3 above 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 of NZS 6808, 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.

3.5.5 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 wind turbine model is sometimes available from tonality audibility assessments conducted as part of manufacturer wind turbine noise emission testing. However, this data is frequently not available at the planning stage of an assessment.

3.6 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 substations are considered 'commercial, industrial and trade premises' under the EP Act.

The Noise Protocol prescribes 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 involved and non-involved 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 this project are provided in Section 7.1 of this report.

3.7 EPA Publication 1834

Guidelines for noise and vibration from construction and demolition works are detailed in EPA Publication 1834 *Civil construction, building and demolition guide*, dated November 2020.

EPA Publication 1834 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 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 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 sets out definitions for normal working hours to inform project planning. For works that occur outside of normal working hours, additional guidance is provided in terms of restriction of noise levels.

For the evening period these restrictions are defined in terms of an objective criterion related to background noise levels, with further penalties applying to works that extend beyond 18 months. For works that occur during 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.

While EPA Publication 1834 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'.*

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

The normal working hours and additional restrictions that apply for construction activity during the evening and night are summarised in Table 1. While it is not explicitly stated in EPA Publication 1834, these targets are typically applicable outside of residential dwellings.

Table 1: EPA Publication 1834 – 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	0900-1300 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	

In accordance with EPA Publication 1834, exceptions to the general evening and night requirements detailed above apply to the following types of work:

- Unavoidable works that cannot practicably be restricted to normal working hours; or
- Low-noise or managed-impact works (activities that are approved by the local authority).

It is important to note that while the EPA Publication 1834 does not specify statutory requirements, under the general environmental duty, civil construction, building and, demolition industries are obliged to eliminate or reduce potential risks from noise and vibration to human health and the environment as far as reasonably practicable.

3.8 Environment Reference Standard

The *Environment Reference Standard* (ERS), dated 25 May 2021, is a legislative instrument made under the EP Act which 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 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.

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.

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 2.

Table 2: 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 3.

Table 3: 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 4.

Table 4: 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

4.0 ASSESSMENT METHOD

4.1 Overview

Based on the legislation and guidelines outlined in Section 3.0, assessing the operational noise levels of the proposed wind turbines and substations involves:

- assessing background noise levels at noise sensitive locations around the wind farm;
- assessing the land zoning of the project site and surrounding areas;
- establishing suitable noise limits accounting for background noise levels and land zoning;
- predicting the level of noise expected to occur as a result of the proposed wind turbines and substations;
- assessing whether the development can achieve the requirements of Victorian policy and guidelines by comparing the predicted noise levels to the noise limits; and
- recommending reasonably practicable measures to minimise the risk of noise impact.

4.2 Background noise levels

Background noise level information is 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 wind farm, 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 a period of several weeks to enable a range of wind speeds and directions to be measured.

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 wind turbines. This trend defines the value of the background noise for the different wind speeds in which the wind 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 farm.

4.3 Noise predictions

Operational wind farm noise levels (wind turbines and associated substations) are predicted using:

- Noise emission data for the wind turbines and associated 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 International Standard ISO 9613-2: 1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (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 both wind turbine and substation noise levels. 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 5. Further discussion of the method and the calculation choices is provided in Appendix H.

Table 5: Noise prediction elements

Detail	Description
Software	Proprietary noise modelling software SoundPLAN version 8.2
Method	International Standard ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation* (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* (the 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 the adjustments are noted below and are discussed in Appendix H.

Detail	Description
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 components of the wind farm, 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 within the site and surrounds, obtained from Spatial Datamart Victoria.
Terrain effects (wind 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 H. • 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 wind 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 wind 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, with the exception of a hill to the northwest of the project. Based on comparison of predicted noise levels with and without terrain elevation data included, calculated terrain effects range between -1.7 dB and +0.3 dB for receivers within 5 km of the proposed wind turbines. For reference purposes, the ground elevations at the wind turbines and receivers are tabled in Appendix C and Appendix D respectively. The topography of the site is depicted in the elevation map provided in Appendix F.
Ground conditions	Ground factor of G = 0.5 on the basis of the UK Institute of Acoustics guidance and research outlined in Appendix H. 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.

Detail	Description
Atmospheric conditions	Temperature: 10 °C / relative humidity: 70 % / 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[3] which increase the propagation of sound from each wind 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 It is noted that 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 farm). The magnitude of these differences is comparable and therefore balance each other out to provide similar predicted noise levels.

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

5.0 EXISTING NOISE ENVIRONMENT

Based on preliminary noise modelling of earlier wind farm layouts and proposed turbine selections, a survey of background noise levels in accordance with the methodology detailed in NZS 6808:2010 was carried out at a total of seventeen (17) receivers around the wind farm.

The background noise monitoring was conducted at different times during the development of the project, including monitoring carried out in 2012, 2013 and 2017. Due to the time that has passed since these earlier surveys were undertaken, as well as improvements in contemporary measurement practices since the 2012/2013 survey, the results are provided for reference purposes only in Appendix I.

As such, the applicable base (minimum) noise limits determined in accordance with NZS 6808 have been adopted for this assessment. This approach is conservative, as the background noise monitoring results would only increase the noise limits above the applicable base limit values.

It is however recommended that background noise monitoring be undertaken prior to construction of the wind farm to derive background noise dependant noise limits that would ultimately be used for a post-construction compliance assessment.

6.0 WIND TURBINE ASSESSMENT

6.1 Noise limits

6.1.1 High amenity

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 3.5.4, 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 of Section 6.4, and the zoning map for the area presented in Appendix G, the area within the predicted 35 dB L_{A90} contour is identified as Farming Zone.

Following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the Victorian Wind Energy Guidelines, the areas within the Farming Zone do not warrant consideration of the high amenity noise limit. Similar guidance concerning the Farming Zone is provided in the EPA web guidelines which indicates that the high amenity noise limit should not apply to the Farming Zone.

Based on the above, the high amenity noise limit is not justified for the proposed wind farm.

6.1.2 Involved receivers

The definition of noise sensitive locations in NZS 6808 specifically excludes dwellings located within a wind farm site boundary. The discussion earlier in this report in Section 3.5.2 also 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 site boundary where a noise agreement exists 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 involved 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.

6.1.3 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 6.

Table 6: Applicable noise limits, dB L_{A90}

Receiver status	Noise limit
Non-involved	40 dB or background L_{A90} + 5 dB, whichever is the greater
Involved	45 dB or background L_{A90} + 5 dB, whichever is the greater

In the absence of recent background noise data for the project, the wind farm has been conservatively assessed using the relevant base (minimum) noise limits presented above.

6.2 Wind turbine model

The final wind turbine model for the site would be selected after a tender process to procure the supply of wind turbines. The final selection would be based on a range of design requirements including achieving compliance with the applicable noise limits at surrounding receivers.

Accordingly, to assess the proposed wind farm at this stage in the project, it is necessary to consider a candidate wind turbine model that is representative of the size and type of wind turbines being considered. The purpose of a candidate wind 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 wind turbines being considered for the site.

For this assessment, the proponent has nominated three (3) candidate wind turbine models as detailed in Table 7.

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 an unconstrained mode 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 7: Candidate wind turbine model details

Detail	SG 6.6-170	GE 6.0-164	V162 6.8MW
Rated power, MW	6.6	6.0	6.8
Rotor diameter, m	170	164	162
Modelled hub height, m	115	115	115
Operating mode	AM 0 [1]	-	PO6800 [2]
Serrated trailing edge	Yes	Yes	Yes

1 It is our understanding that 'AM 0' is a manufacturer designation which indicates *Application Mode 0* to achieve a power output of 6,600 kW – this is an unconstrained mode of operation (i.e., without noise reduction)

2 It is our understanding that 'PO6800' is a manufacturer designation which indicates a Power Optimisation mode to achieve a power output of 6,800 kW – this is an unconstrained mode of operation (i.e., without noise reduction)

The modelled hub height of 115 m is 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.

If the project is approved, a pre-construction noise assessment would need to be conducted using the final hub height once the wind turbine layout has been finalised and the final wind turbine model selected.

6.3 Wind turbine noise emissions

6.3.1 Sound power levels

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 wind turbine and is distinct from the sound *pressure* level which depends on a range of factors such as the distance from the wind 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 8.

Table 8: Candidate wind turbine model specification documents

Candidate model	Document No.	Date	Title
SG 6.6-170	D2830475/016	8 Jul. 2022	*Developer Package SG 6.6-170*
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 6.8MW	0111-1246_01	7 Jan. 2022	*Third octave noise emission EnVentus™ V162-6.8MW 50/60Hz*

Based on the data sourced from the manufacturer's documentation, the noise modelling undertaken for this assessment involved conversion of third octave band levels to octave band levels (where applicable), and adjustment 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 9 with the octave band values presented in Table 10. 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 9: Sound power levels versus hub height wind speed, dB L_{WA}

	Hub height wind speed, m/s											
Candidate model	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
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
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 6.8MW	95.0	95.0	96.0	99.3	102.5	104.3	104.3	104.4	104.8	105.1	105.3	105.5

Table 10: Octave band sound power levels, dB L_{WA}

	Octave band centre frequency, Hz									
Candidate model	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Total**
SG 6.6-170 [1]	-	87.5	94.4	97.1	98.9	102.8	100.9	94.3	84.0	107.0
GE 6.0-164 [2]	79.8	89.1	94.6	99.1	101.7	103.3	101.1	93.6	77.8	108.0
V162 6.8MW [3]	75.6	86.0	93.6	98.4	100.5	99.7	96.2	89.8	80.7	105.5

1 Based on octave band levels at 9 m/s

2 Based on octave band levels at 10 m/s

3 Based on one-third octave band levels at 15 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).

6.3.2 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 model. 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.

6.4 Predicted noise levels

This section of the report presents the predicted noise levels of the wind farm 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 wind 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 proposed wind farm have been predicted using the sound power level data detailed in Section 6.3.1 for the selected candidate wind turbine models and are summarised in Table 11 for the hub height wind speed which results in the highest predicted noise levels (15 m/s).

The locations of the predicted 30, 35, 40 and 45 dB L_{A90} noise contours are illustrated in Figure 1 to Figure 3, for 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 Appendix J for all considered receivers, including receivers where the highest predicted noise level is below 30 dB L_{A90}.

Table 11: Highest predicted noise level at receivers with predicted levels 30 dB L_{A90} or above

Receiver	SG 6.6-170	GE 6.0-164	V162 6.8MW
i1	37.4	38.8	36.9
i7	37.4	38.8	36.8
i8	39.2	40.5	38.5
i9	32.4	33.9	32.1
i10	32.0	33.6	31.8
i11	38.1	39.4	37.5
i12	36.4	37.8	35.9
i14	37.0	38.4	36.4
i15	38.0	39.4	37.4
i16	37.2	38.6	36.6
i17	35.8	37.3	35.4
i18	34.9	36.3	34.5
i19	36.3	37.6	35.7
i20	34.0	35.5	33.7
i21	30.4	31.9	30.3
i22	29.7	31.2	29.5
i24	42.5	43.7	41.4
u14	28.5	30.1	28.4
u15	30.9	32.5	30.7
u17	37.1	38.6	36.7
u18	34.1	35.6	33.8
u19	34.0	35.5	33.8
u20	36.0	37.5	35.6
u21	29.0	30.6	28.9
u22	35.4	36.9	35.0
u28	29.8	31.3	29.6
u31	34.3	35.8	33.9
u36	31.0	32.6	30.8
u38	36.2	37.6	35.7
u40	29.0	30.5	28.8
u41	31.7	33.2	31.5
u42	30.9	32.4	30.7

Receiver	SG 6.6-170	GE 6.0-164	V162 6.8MW
u43	30.5	32.0	30.3
u44	29.9	31.4	29.7
u47	37.0	38.5	36.6
u49	32.3	33.9	32.1
u50	31.0	32.6	31.0
u51	36.3	37.7	35.7
u53	31.5	33.1	31.3
u57	30.6	32.1	30.3
u58	36.9	38.3	36.4
u62	30.1	31.7	29.9
u63	30.2	31.7	30.0
u64	30.1	31.6	29.9
u65	30.0	31.6	29.8
u66	32.3	33.8	32.0
u70	29.7	31.3	29.7
u71	29.3	30.9	29.2
u90	31.7	33.2	31.5
u91	31.6	33.1	31.4
u157	29.1	30.7	28.9
u158	30.1	31.6	29.9
u159	30.4	31.9	30.2
u160	34.4	35.9	34.0
u161	31.2	32.8	31.1
u162	31.6	33.2	31.5
u163	34.6	36.1	34.3
u164	34.3	35.8	34.0
u169	28.5	30.1	28.4
u170	29.7	31.3	29.6
u216	28.9	30.5	28.8
u295	30.4	32.0	30.3
u298	32.3	33.9	32.1

(i) Involved receiver

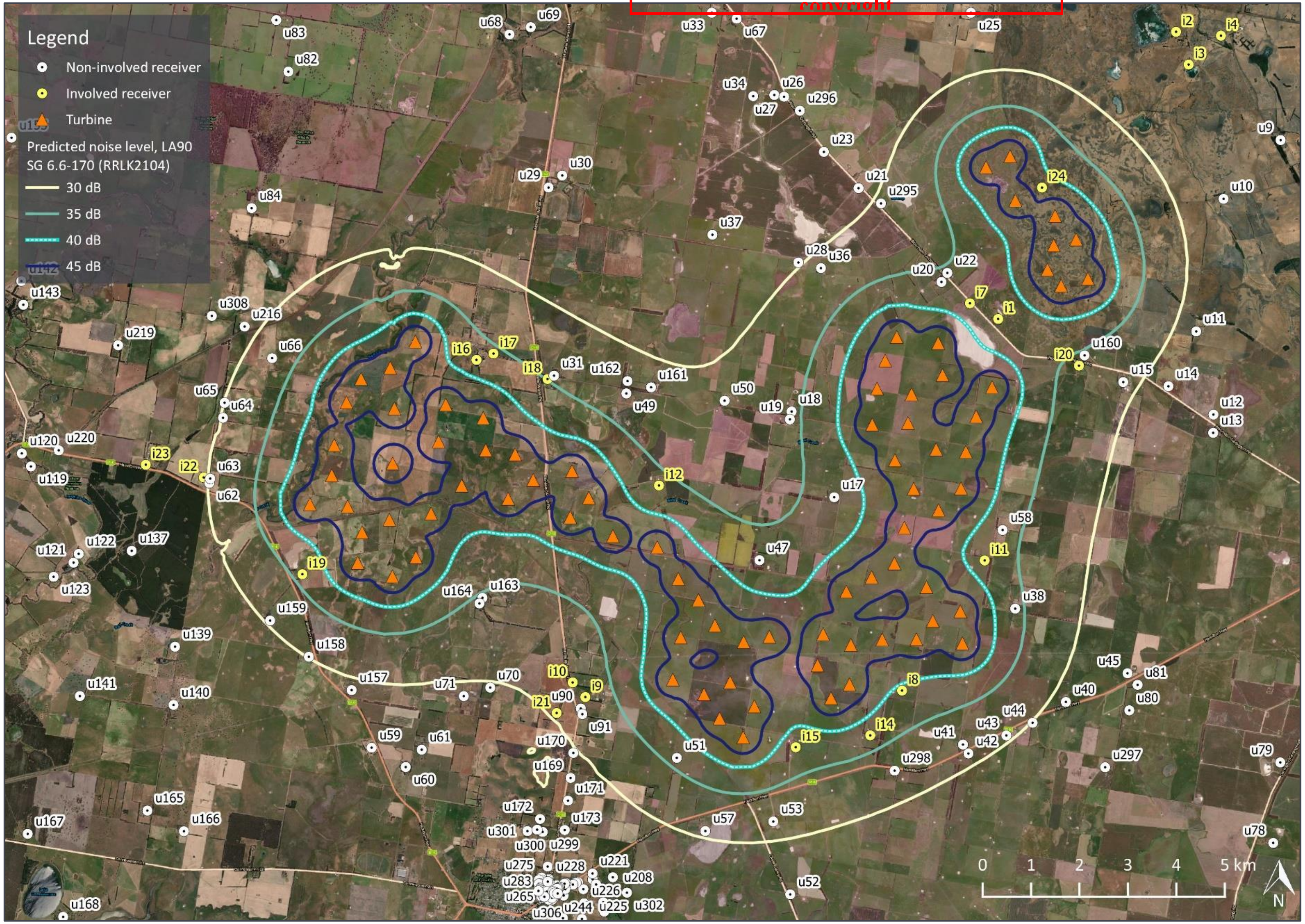
(u) Non-involved receiver

The following can be concluded from the predicted noise levels detailed in Table 11:

- Compliance with the applicable base noise limit of 40 dB L_{A90} by at least 1.4 to 3.3 dB at non-involved receivers, depending on the candidate wind turbine model; and
- Compliance with the applicable base noise limit of 45 dB L_{A90} by at least 1.3 to 3.6 dB at involved receivers, depending on the candidate wind turbine model.

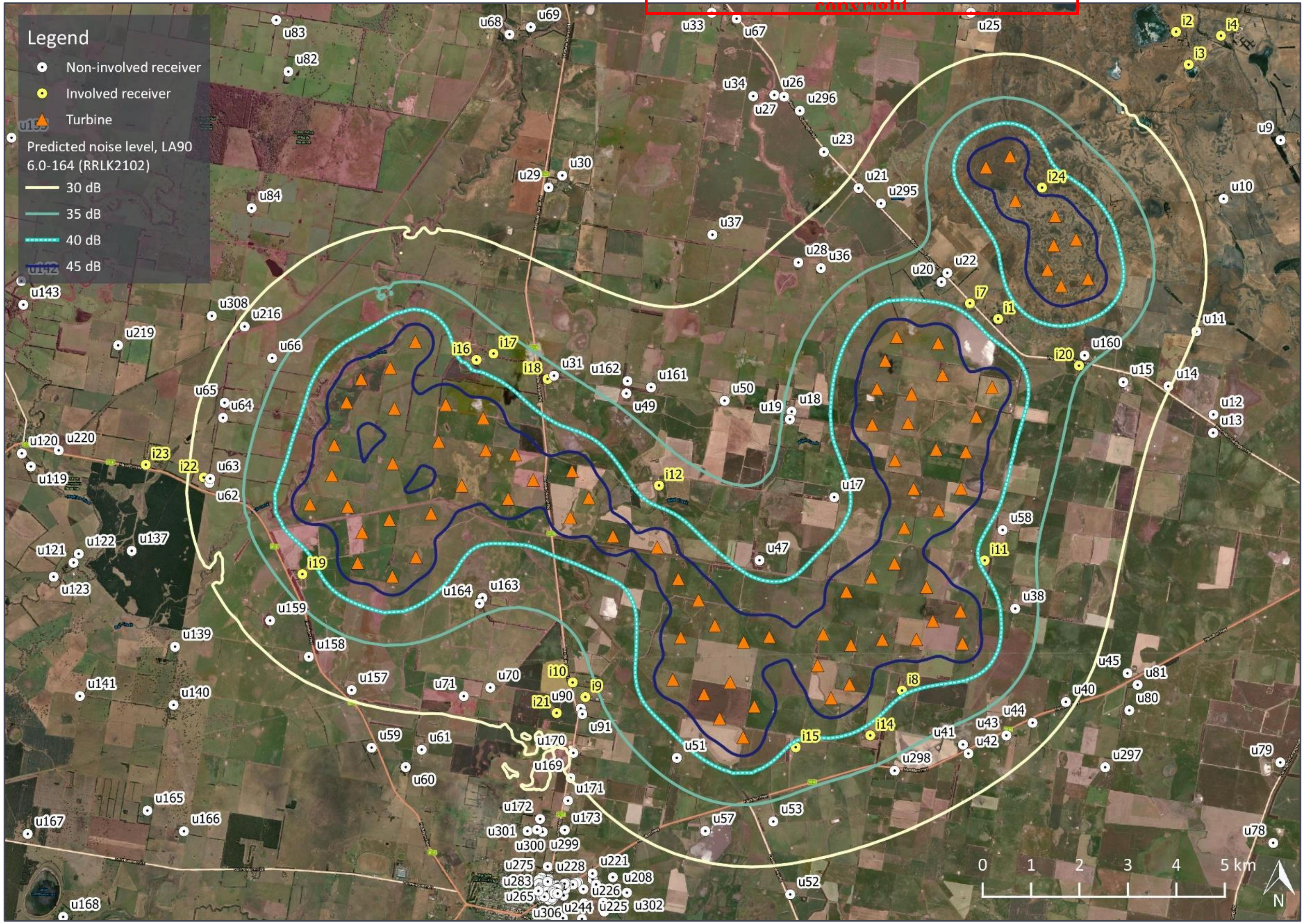
MARSHALL DAY Acoustics

Figure 1: Highest predicted noise level contours, dB L_{A90} – SG 6.6-170



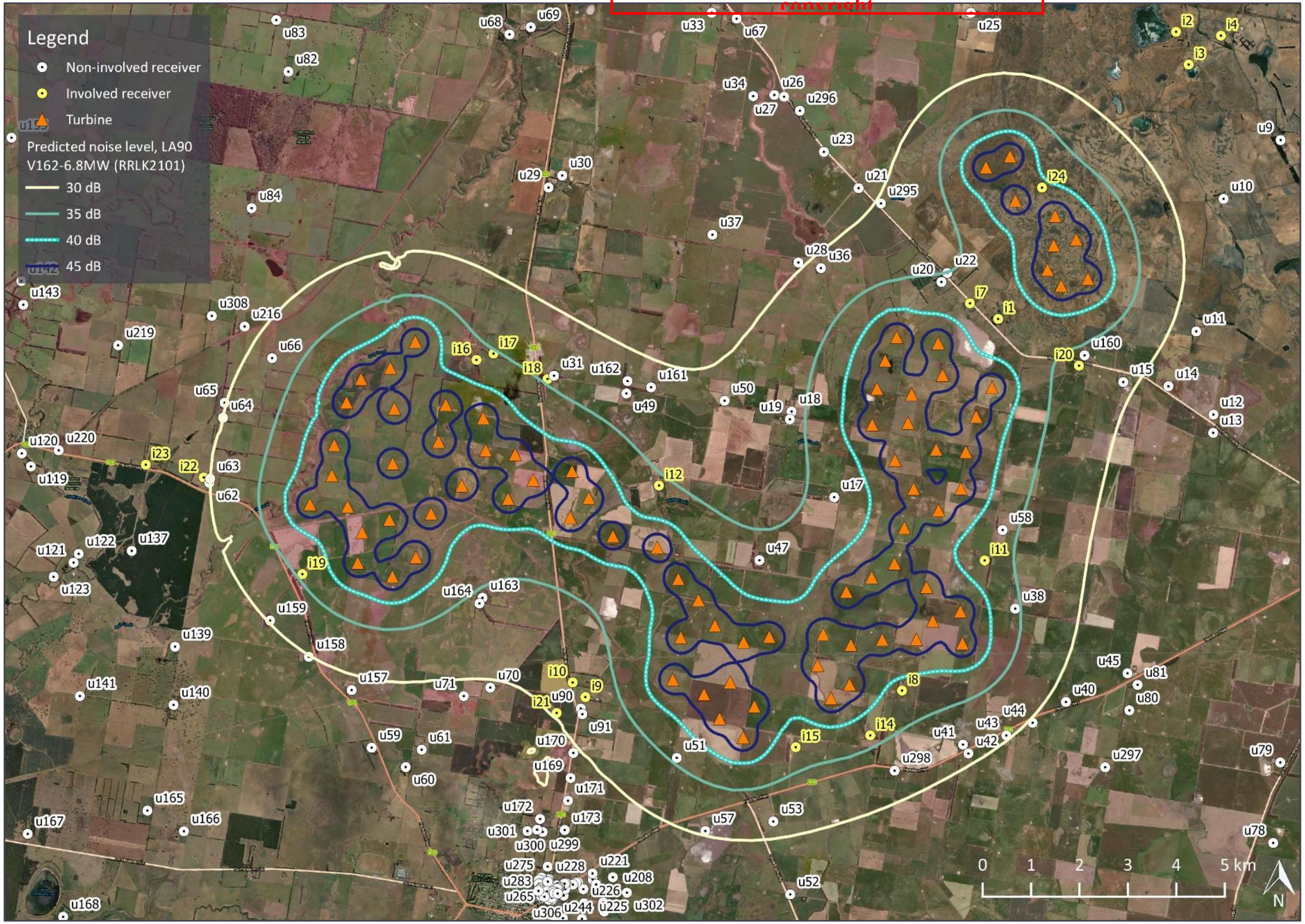
MARSHALL DAY Acoustics

Figure 2: Highest predicted noise level contours, dB L_{A90} – GE 6.0-164



MARSHALL DAY Acoustics

Figure 3: Highest predicted noise level contours, dB L_{A90} – V162-6.0MW



6.5 Cumulative assessment

The noise limits determined in accordance with NZS 6808 apply to the total combined operational wind turbine noise level, including the contribution of any neighbouring wind farm developments. The assessment has therefore considered other wind farm projects in the surrounding area.

Based on publicly available information[4], three (3) wind farms have been identified within 10 km of the proposed wind farm for the review of potential cumulative noise considerations. These wind farms are detailed in Table 12.

Table 12: Wind farm development in the broader area around the Mt Fyans Wind Farm

Wind Farm Name	Status	Approximate distance to nearest turbine
Dundonnell Wind Farm	Operational since 2021	5 km to the north-northwest
Mortlake South Wind Farm	Under construction	9 km to the south
Salt Creek Wind Farm	Operational since 2018	5 km to the north-northeast

Wind farms located farther than 10 km from the proposed project, would not have cumulative effects likely to affect the assessment outcome.

6.5.1 Dundonnell Wind Farm

The Dundonnell Wind Farm commenced operation in early 2021 and comprises eighty (80) Vestas V150-4.2MW wind turbines with a hub height of 114 m[5]. The coordinates of the wind turbines were provided by the project developers, Tilt Renewables.

The noise emissions for the Vesta V150-4.2MW wind turbines of the Dundonnell Wind Farm have been represented for this study with data sourced from the publicly available noise assessment report[6] for the Golden Plains Wind Farm.

The planning permit[7] for the Dundonnell Wind Farm establishes a minimum operational noise limit of 40 dB for receivers around the wind farm.

6.5.2 Mortlake South Wind Farm

The Mortlake South Wind Farm is currently under construction, comprising thirty-five (35) Nordex N149/4.0-4.5 wind turbines with a hub height of 105 m[8].

The amended planning permit[9] establishes a minimum operational noise limit of 40 dB for receivers around the wind farm.

The application to amend the planning permit was accompanied by a noise assessment[10] for a forty-two (42) wind turbine layout using a Nordex N131/3000 candidate wind turbine with a hub height of 114 m. This information has been referenced in the present study as it is expected to be a conservative prediction of potential noise levels for the Mortlake South Wind Farm.

4 https://www.energy.vic.gov.au/renewable-energy/wind-energy/wind-projects

5 weblink

6 MDA Report Rp 003 R01 20170122 *Golden Plains Wind Farm - Environmental Noise & Vibration Assessment*, dated 23 February 2018

7 Planning Permit no. 2015/23858/A

8 weblink / weblink

9 Planning Permit no. 2008/0538/A

10 MDA Report Rp 001 2015582ML *Mortlake South Wind Farm – NZS 6808:2010 Noise Assessment*, dated 29 March 2016

6.5.3 Salt Creek Wind Farm

The planning permit[11] for the Salt Creek Wind Farm allows for the development of a wind farm comprising fifteen (15) turbines with a maximum tip height of 150 m. The planning permit establishes a minimum operational noise limit of 40 dB for receivers around the wind farm.

The wind farm began operating as of 2018 and comprises Vestas V126 3.6MW turbines with a hub height of 87 m.

Coordinates of the turbines have been provided by the project developers, Tilt Renewables, and noise emission data for the Vestas V126 3.6MW turbine has been sourced from specification documents[12] provided by Vestas.

6.5.4 Assessment

To inform the assessment of potential cumulative noise considerations, reference is made to Clause 5.6.4 of NZS 6808 which states:

> *For the purposes of 5.6.1, if the predicted wind farm sound levels for a new wind farm are at least 10 dB below any existing wind farm sound levels permitted by any resource consent or plan, then the cumulative effect shall not be taken into account.*

Additional contextual information is provided in the commentary to Clause 5.6.4 which notes:

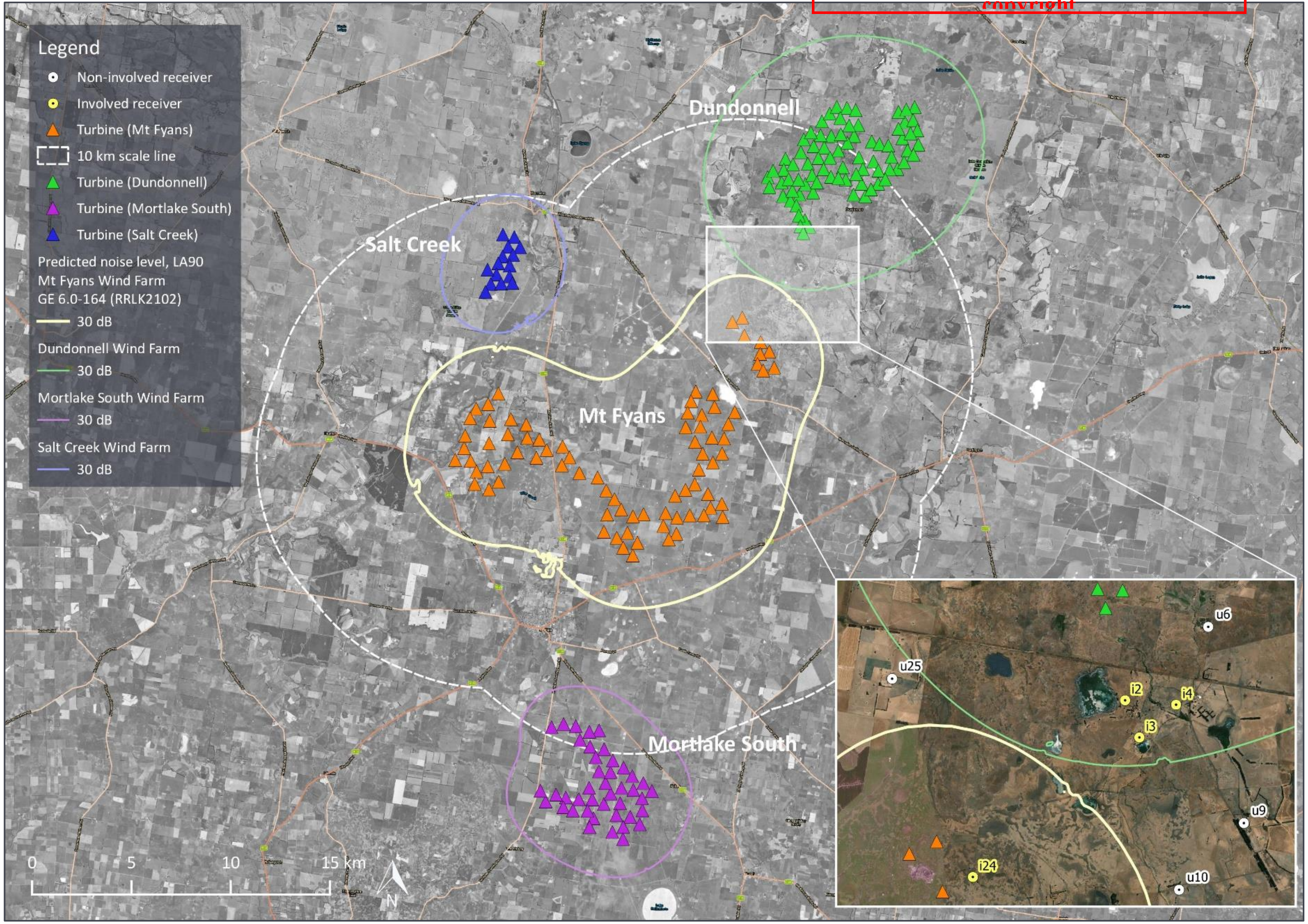
> *If an existing wind farm sound level is say 40 dB and the predicted wind farm sound level for a new wind farm is say 30 dB then the combined level would be 40.4 dB. This increase of less than 0.5 dB cannot be reliably measured and would be undetectable to people, and will therefore not give rise to any adverse cumulative effect.*

Based on this guidance, a simplified assessment of potential cumulative noise considerations can be made by comparing the individual predicted 30 dB L_{A90} contours of each wind farm operating in isolation, as presented in Figure 4. The GE 6.0164 wind turbine model has been referenced for the Mt Fyans Wind Farm to provide a conservative basis for the assessment (i.e., by accounting for the candidate turbine model which results in the highest predicted noise levels).

11 Planning Permit no. PL06/304.01 (weblink)

12 Vestas document 0056-4782 V02 V126 3.6 MW 50/60 Hz High Torque (HTq) variant dated 21 October 2016. The sound power data has been adjusted by the addition of +1.0 dB at each wind speed to provide a margin for typical values of test uncertainty.

Figure 4: Predicted 30 dB L_{A90} contours for the Mt Fyans Wind Farm and neighbouring wind farms



The results demonstrate that the predicted 30 dB L_{A90} contour of the Mt Fyans Wind Farm (using the GE 6.0-164 candidate turbine model) do not overlap with the predicted 30 dB L_{A90} contour of the three (3) approved or operational wind farms identified within 10 km of the project.

Based on this finding, the following can be concluded:

- At any receiver where the predicted noise level of one of the wind farms is between 30 and 40 dB, the predicted noise level from an adjoining wind farm will be less than 30 dB, and significantly lower in most cases
- At any receiver where the predicted noise level from one of the wind farms approaches the 40 dB base noise limit applicable to each site, the predicted noise level associated with each of neighbouring wind farms will be more than 10 dB lower.

  Accordingly, based on the guidance of NZS 6808, the cumulative effect does not need to be taken in account for the nearest receivers to each of these wind farm developments.

The predicted noise levels therefore demonstrate that cumulative wind farm noise considerations are not applicable to the Mt Fyans Wind Farm and the three (3) wind farms identified within 10 km of the project. Specifically, the noise contribution of the identified neighbouring wind farms is sufficiently low to be inconsequential to the noise assessment for the Mt Fyans Wind Farm. Conversely, the predicted noise contribution of the Mt Fyans Wind Farm at the receivers in the vicinity of the identified neighbouring wind farms would not affect the compliance outcomes for these developments.

7.0 SUBSTATION NOISE ASSESSMENT

7.1 Noise limits

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

The procedures for rural areas, applicable for the subject site, are based on determining the zone levels 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 substations and surrounding residential receivers both being located on land designated as Farming Zone (FZ) (see land zoning map in Appendix G).

Considering that the land zoning is continuous between the substations and the receivers, a distance adjustment is not applicable.

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 expected to be relatively low.

Based on the above and considering that substations are defined in the Victorian Planning Provisions as *utility*, the noise limits applicable at the nearest receivers, are summarised in Table 13.

Table 13: Noise Protocol time periods and noise limits, dB L_{eff}[13]

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 L_{eff} infers meeting the noise limits during all other time periods.

[13] L_{eff} is the effective noise level of commercial or industrial noise determined in accordance with the Noise Protocol. This is the L_{Aeq} noise level over a half-hour period, adjusted for the character of the noise. Adjustments are made for tonality, intermittency, and impulsiveness.

7.2 Transformer noise emissions

Two substations have been proposed for the Mt Fyans Wind Farm:

- an on-site substation located at the centre of the site; and
- an off-site substation located approximately 8 km to the southwest of the site to connect to the network through the substation at the Mortlake Power Station.

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 proposed substations, the proponent has provided indicative equipment transformer numbers and capacity ratings. Consideration has been given to the on-site substation incorporating two transformers, each rated to 180 MVA, and the off-site substation incorporating a single transformer rated to 360 MVA.

In lieu of measured 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 60076-10:2009) which provides a method for estimating transformer sound power levels. Specifically, Figure ZA1 from AS 60076-10:2009 has been used to determine the estimated standard maximum sound power levels.

The indicative transformer details and derived sound power levels are detailed in Table 14. The sound power levels include the noise from ancillary plant such as cooling plant.

Table 14: Indicative substation details and estimated maximum sound power levels

Substation	No. of transformers	Indicative capacity per transformer, MVA	Sound power level, dB L_{WA}
On-site substation	2	180	98
Off-site substation	1	360	102

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 subsequent sections of the report.

7.3 Predicted noise levels

Predicted noise levels have been determined on the basis of:

- the indicative equipment noise emission data detailed in Section 7.2; and
- the ISO 9613-2 noise prediction method described in Section 4.3.

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.

The nearest receivers and the predicted effective noise levels (including the +2 dB adjustment) are detailed in Table 15.

Table 15: Substation predicted noise levels

Substation	Nearest receiver	Separating distance, m	Effective noise level, dB L_{eff}
On-site substation	u47	1,457	22
Off-site substation	u167	1,467	23

The predicted effective noise levels in Table 15 are below the applicable noise limits for the day, evening and night periods by a significant margin. The following contextual notes are provided:

- The predicted effective noise levels are at least 11 dB below the applicable night-time noise limit of 34 dB;
- The predicted effective noise levels are very low and would be comparable to or less than background noise levels in many instances.

  The adjustment for tonality may therefore not be applicable if the noise of the transformer is not clearly audible. Conversely, in the unlikely event that the character of the noise warranted a larger adjustment of +5 dB (the maximum potential adjustment, which would only be triggered in the event that the selected transformers were atypically tonal and the noise was observed during very low background noise levels), the predicted margin of compliance would still be at least 8 dB
- The proposed off-site substation is to be located to the east of an existing substation and the Mortlake Power Station. The Noise Protocol noise limits apply to the cumulative noise of all commercial and industrial sources of noise, and would therefore apply to the combined noise of the existing substation, Mortlake Power Station and the proposed off-site substation. However, given that the predicted effective noise level of the off-site substation is 11 dB lower than the applicable noise limit for the night period, the contribution of the proposed new transformers is inconsequential with respect to cumulative noise levels and compliance. Specifically, even if the existing substation and Mortlake Power Station were producing noise levels at the applicable noise limit, the contribution of the proposed would be negligible (less than 0.5 dB – a difference that could not be practically measured or discerned) and would therefore be inconsequential to the compliance status of the existing substation and Mortlake Power Station.

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 and the noise levels of the existing substation and Mortlake Power Station near to the proposed off-site substation.

Further, the low predicted noise level indicates the substations are 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 a transformer 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.

8.0 CONSTRUCTION NOISE

Construction of a wind farm project will generate noise and vibration as a result of activities occurring both on and off the site of the proposed development.

Off-site noise generating activities primarily relate to heavy goods vehicle movements to and from the site. On-site works include a range of activities such as construction of access tracks, connection infrastructure, turbine foundations and erection of the turbines.

Construction of a wind farm mostly occurs at relatively large separating distances from receivers and, as proposed for this project, the majority of the work is 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). For these reasons, and consistent with the EPA Publication 1834, noise associated with construction of a wind farm can usually be satisfactorily addressed by the adoption of good practice and considerate working practices. These measures are normally documented and agreed in a Construction Environmental Management Plan (CEMP) which is prepared for review and approval by the responsible authority prior to commencing the work.

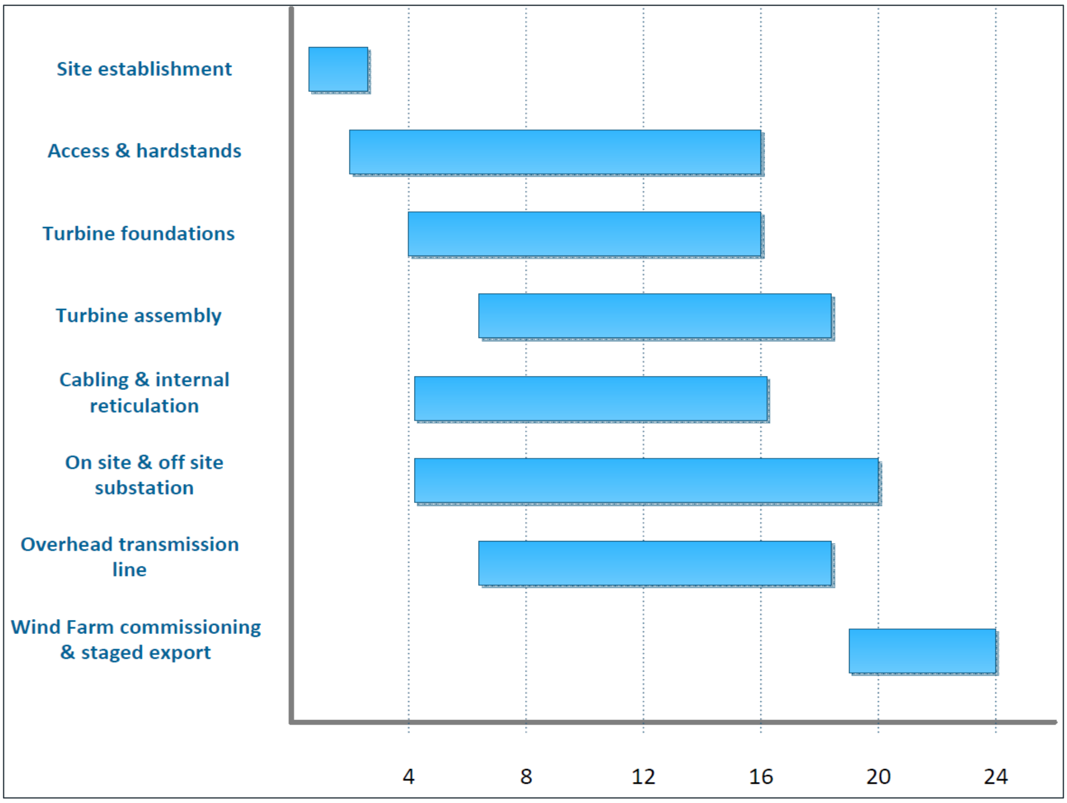
This section therefore provides general information about the types of activities that are expected to be associated with construction of the wind farm and reference data which should be considered as part of the preparation of a CEMP for the project.

8.1 Construction program

The construction stage of the project is likely to occur over an 18 to 24 month period, including a 5 to 6 month period following the completion of turbine assembly.

An indicative construction program has been provided by the proponent and is reproduced below.

Figure 5: Indicative construction program



8.2 Typical construction plant & noise emissions

The types of equipment involved at different stages of construction include excavation plant, pneumatic equipment and lifting equipment. A detailed schedule of noise emissions for typical construction equipment is provided in Appendix L on the basis of reference data from relevant Australian and international standards. This data is also grouped in Appendix L to provide an indication of the total aggregated noise emissions of key working stages of the project. This data indicates the aggregated noise emissions for key working stages typically ranges from 115 to 120 dB L_{WA}.

The construction activity that would typically occur nearest to a receiver is access road construction. This activity involves a brief period of elevated noise while work is carried out to improve existing roads (where required), create new intersections at site access points, and initiate site access tracks. During these initial works, construction noise levels of the order of 70 to 75 dB L_{Aeq} could be expected for brief periods when road and access work is carried out at distances less than 100 m from a receiver. These noise levels are comparable to, and typical of, noise levels produced by general road maintenance works and activity.

Once the initial work for access road construction is complete, the majority of the work occurs in proximity to the turbine locations, substation locations and on-site cabling routes. These works therefore typically occur at much larger separating distances. As a result, construction noise levels are then significantly lower. For example, at distances comparable to 1,000 m, construction noise levels of the order of 50 to 55 dB L_{Aeq} would be expected for receivers located downwind of the work.

However, depending on background noise levels and wind directions, construction noise associated with more distant works would still be audible at surrounding receiver locations at times. In particular, given the low background noise levels that occur in rural environments at low wind speeds (as demonstrated by the background noise monitoring), construction noise could be significantly higher than the background noise levels on some occasions.

It is for this reason that the majority of works would need to be restricted to normal working hours (see Table 1 of Section 3.7), as is proposed for the project. Any general construction work that occurred outside of these hours would need to adhere to limits determined on the basis of background noise levels. For example, if general works needed to occur on Saturday afternoons (a period considered outside of normal working hours according to Victorian guidance contained in EPA Publication 1834), construction works would need to achieve a level not more than 5 to 10 dB above the background, depending on the actual duration of the construction program. This means that any work outside of normal hours would need to be limited to low noise activities and/or works at significantly increased distances from receiver locations. Exemptions would apply for works that are classified as unavoidable, such as timing oversized deliveries to avoid hazardous traffic conditions, or some aspects of turbine assembly which must occur in still wind conditions for safety reasons.

In preparing the CEMP, it would also be prudent to consider the use of lower noise emission construction equipment, primarily for activities that generate the highest noise levels, and particularly for any plant that may be used outside of normal working hours. The CEMP should also address considerate working practices for maintenance activities, timing of the noisiest works during the least sensitive periods of normal working hours wherever possible, and community notification and communication protocols.

General experience of wind farm development has indicated that construction noise tends to represent a limited risk factor. With the above types of measures implemented, it is expected that construction noise associated with the Mt Fyans Wind Farm can be acceptably managed.

9.0 ENVIRONMENTAL REFERENCE STANDARD

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

9.1 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. To provide an indication of the proximity of natural areas to the project, reference has been made to the land zoning of the surrounding area. Specifically, areas zoned as PCRZ and PPRZ, can be used an indication of where the ERS would be relevant.

For this project, the nearest identified natural area (Lake Keilambete) is located approximately 17 km from the project's wind turbines.

9.2 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 16.

Table 16: 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

9.3 Project noise levels in natural areas

The potential for the environmental value of *human tranquillity and enjoyment outdoors in natural areas* to be affected by noise is dependent on the audibility of the noise. 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;
- Extent of the identified natural areas;
- Natural background noise sources (e.g., 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).

Given the large separation distance between the project and the identified natural area, activities associated with both construction and operation of the project are not expected to contribute to the soundscape.

The distribution of wind turbine noise levels in the identified natural areas is presented in Figure 14 of Appendix G.

10.0 RECOMMENDED NOISE MANAGEMENT MEASURES

Providing that the operator of a wind farm complies with the requirements of Regulation 131C, their obligations with respect to the general environmental duty (GED) under the EP Act will be addressed with regard to wind turbine noise.

Specifically, to address the GED under the EP Act with respect to wind turbine noise, the operator of the wind farm:

- Must ensure that wind turbine noise complies with NZS 6808; and
- Must implement all applicable actions under Division 5.3 of the EP Regulations to manage and review wind turbine noise from the facility, including:
  - preparation of a noise management plan;
  - conducting noise compliance testing when the wind farm begins operating;
  - preparing annual compliance statements; and
  - conducting verification wind turbine noise monitoring every 5 years.

In addition to the above, the following noise management measures should be implemented as part of the subsequent stages of development:

- The transformer equipment should be specified and selected to achieve noise emissions not exceeding the empirical values specified in AS 60076-10
- A detailed noise assessment should be prepared by a qualified acoustic consultant, prior to construction, addressing:
  - the final wind turbine selection and layout;
  - the final location and equipment selection for the substations;
  - compliance with the applicable noise limits at surrounding receivers; and
  - recommendation of reasonably practicable noise mitigation measures to control noise from the substations.

- Before development starts, a Construction Environmental Management Plan (CEMP) is to be prepared for endorsement by the Responsible Authority.

  The plan is 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 CEMP is to provide a clear overview of the proposed construction program and demonstrate that all reasonably practicable measures are proposed to fulfil the general environmental duty under the EP Act, accounting for the guidance of EPA Publication 1834. This shall include a schedule of noise emission data for the major plant items selected for construction of the Project, and a comparison of the data with the noise emission ranges set out in AS 2436.

  The plan is to clearly define all unavoidable works 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. The plan is to describe 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. The plan shall also identify the 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 the potential to give rise perceptible vibration at neighbouring locations (e.g., access track construction near to houses).

11.0 SUMMARY

An assessment of operational noise for the proposed Mt Fyans Wind Farm has been carried out. The assessment is based on the proposed wind farm layout comprising eighty-one (81) multi-megawatt wind turbines and two (2) substations.

Operational noise associated with the proposed wind turbines has been assessed in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808), as required by the *Environment Protection Regulations 2021* and the Victorian Department of Environment, Land, Water and Planning publication *Development of Wind Energy Facilities in Victoria – Policy and Planning Guidelines* dated November 2021.

Noise modelling was carried out based on three (3) candidate wind turbine models which have been selected by the proponent as being representative of the size and type of wind turbines which could be used at the site.

The assessment has also considered other approved and operational wind farm projects in the surrounding area, including the Dundonnell Wind Farm to the north-northeast, the Mortlake South Wind Farm to the south and the Salt Creek Wind Farm to the north-northwest. Based on an assessment of predicted noise levels for each wind farm, it has been demonstrated that cumulative wind farm noise considerations are not applicable to the Mt Fyans Wind Farm.

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 selected candidate wind turbine models.

The assessment has also considered operational noise associated with the proposed substations. These noise levels have been assessed in accordance with the *Environment Protection Act 2017* (EP Act) and EP Regulations. The assessment demonstrates that the substation is expected to result in noise levels below the noise limits determined in accordance with Victorian 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 assessment demonstrates that the substations are expected to result in noise levels significantly lower than the noise limits determined in accordance with the Noise Protocol.

Consideration was also given to the general environmental duty, as required by the *Environment Protection Act 2017*. and reasonably practicable measures have been recommended to control the noise of the substations.

The noise assessment therefore demonstrates that the proposed Mt Fyans Wind Farm can be designed and developed to achieve Victorian policy requirements for operational noise.

The report also provides information about construction noise associated with the project, including relevant Victorian guidelines and the nature of the proposed works. This information has been provided as a reference for the matters that should be considered as part of the preparation of a Construction Environmental Management Plan for the project.

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}
A-weighted average noise level	The equivalent continuous (time-averaged) A-weighted sound level.	L_{Aeq}
Decibel	The unit of sound level.	dB
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.	-
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).	-

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 DESCRIPTION OF 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. A glossary of terms and abbreviations is provided in Appendix A.

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 can 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, several 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 17 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 17: Atmospheric pressure versus sound pressure – example values of pressure

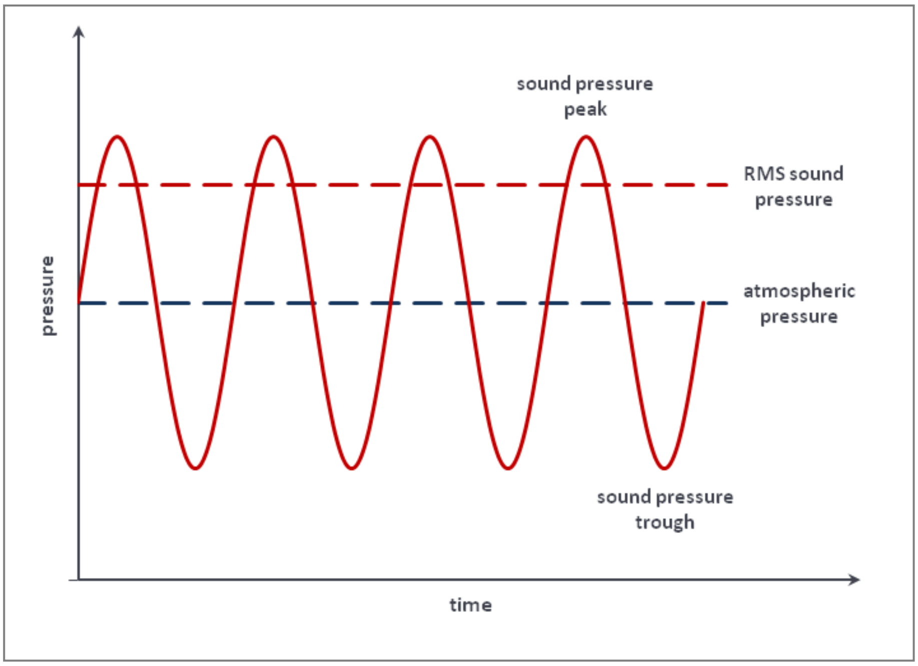
Example	Pascals (Pa)	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.0000000002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

The pressure values in Table 17 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 6 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 6: Pressure changes relative to atmospheric pressure associated with sound



B2.2 Frequency

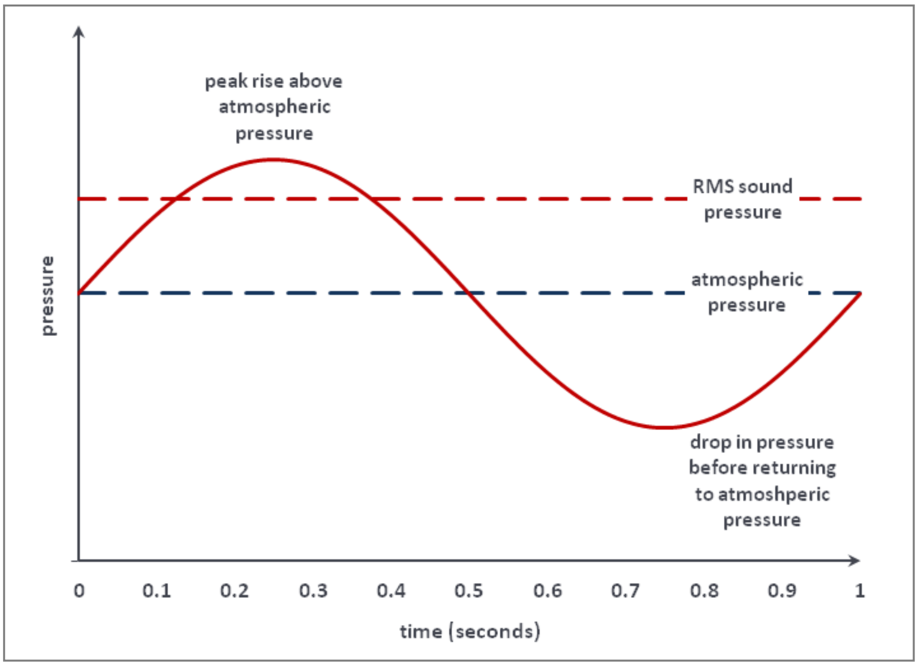
Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period. The rate of change in pressure is an important feature that determines whether it can be perceived as a sound by the human ear.

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 can 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 7 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 7: Illustration of a pressure fluctuation with a frequency of 1Hz

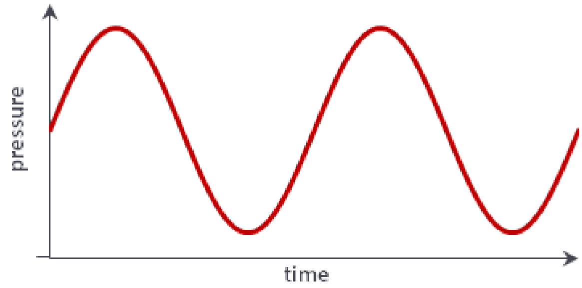


The rate that sound pressure rises and falls will vary depending on the source of the sound. For example, the surface of a tuning fork vibrates at a specific rate, in turn causing the pressure of the adjacent air to fluctuate at the same rate. Recalling the idea of pressure fluctuations from someone 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 8 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 8: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies

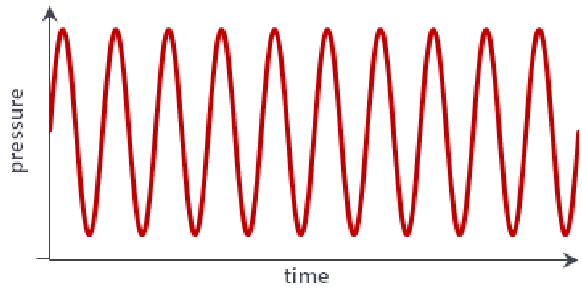
Low frequency sounds:

20 to 200 Hz



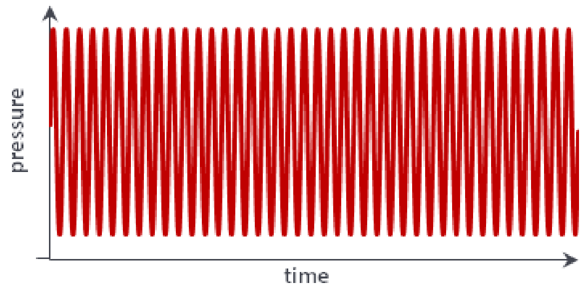
Mid-frequency sounds:

200 to 800 Hz



High frequency sounds:

greater than 800 Hz



B2.3 Sound pressure and frequency variations

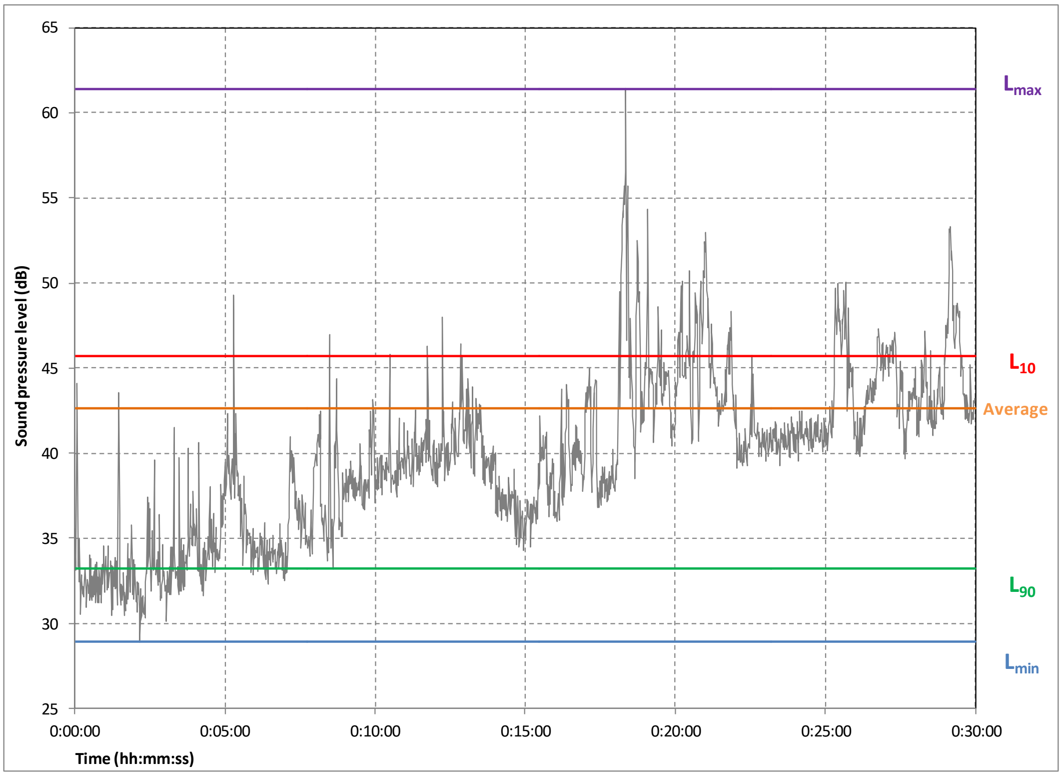
The preceding sections describe important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

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 9 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 9: 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 can 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 can 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 be generally be subjectively like 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 18 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 18: 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 19 provides some examples of how changes in sound pressure levels, for a sound with the same character, can be perceived.

Table 19: 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 19 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.

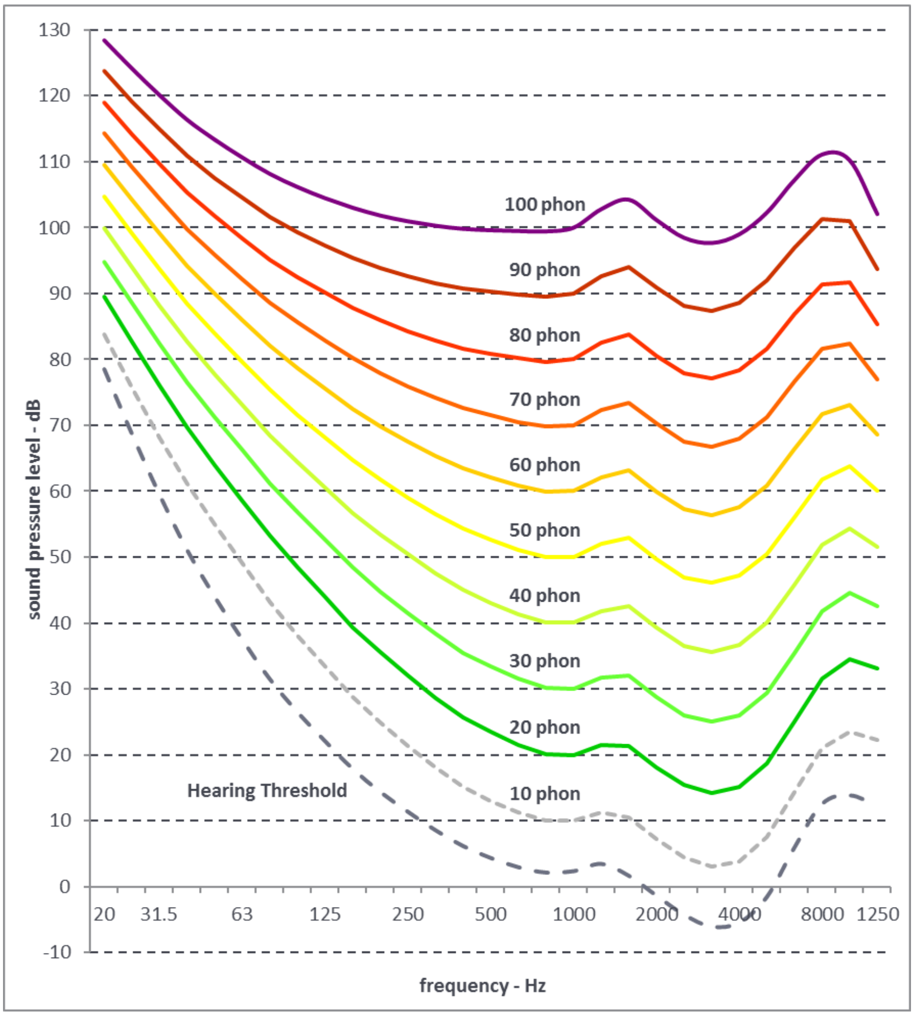
B3.2 Sound frequency and loudness

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 10. 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[14] that defines equal loudness levels for sounds comprising individual frequencies. In practice, sound is usually composed of many 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 10 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.

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

Figure 10: Equal loudness contours for pure tone sounds



The noise curves in Figure 10 demonstrate that human hearing is most sensitive at frequencies from 500 to 4000 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 has 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 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 SOURCE COORDINATES

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

(Reference 20220603, supplied by the proponent on 15 June 2022)

Table 20: Wind turbine coordinates – MGA 94 zone 54

Wind turbine	Easting, m	Northing, m	Terrain elevation, m
A01	654,220	5,792,117	137
A02	655,861	5,791,796	146
A03	655,207	5,790,907	141
A04	655,298	5,791,536	145
A05	655,923	5,790,627	139
A06	654,999	5,792,071	144
A07	654,672	5,792,711	140
A08	654,722	5,793,338	141
A09	656,408	5,791,021	139
A10	656,721	5,791,922	142
A11	655,929	5,792,960	149
A12	654,975	5,794,218	149
A13	655,277	5,794,701	151
A14	655,964	5,794,091	151
A15	655,879	5,794,930	155
A16	656,397	5,795,472	159
A17	656,877	5,793,409	145
A18	657,025	5,794,171	152
A19	657,354	5,792,501	144
A20	657,799	5,793,896	149
A21	657,850	5,793,230	146
A22	658,458	5,793,144	150
A23	658,313	5,792,228	149
A24	658,830	5,792,616	146
A25	659,632	5,792,797	145
A26	659,595	5,791,846	147
A27	659,978	5,792,247	145
B28	660,477	5,791,459	147
B30	661,391	5,791,230	147

Wind turbine	Easting, m	Northing, m	Terrain elevation, m
B31	661,826	5,790,575	152
B32	662,242	5,790,139	151
B33	661,877	5,789,367	151
B34	662,582	5,789,614	153
B35	661,713	5,788,497	149
B36	662,357	5,788,194	149
B37	662,896	5,788,444	154
B38	662,679	5,787,695	152
B39	663,397	5,787,946	150
B40	663,166	5,787,306	152
B41	663,175	5,789,275	149
B42	664,701	5,788,792	149
B43	663,705	5,789,380	150
B44	664,980	5,788,114	149
B45	665,362	5,788,397	147
B46	664,817	5,789,436	150
B47	665,389	5,789,213	150
B48	666,037	5,789,323	148
B49	666,743	5,789,328	152
B50	667,081	5,789,708	151
B51	667,693	5,789,246	153
B52	667,649	5,789,905	152
B53	666,950	5,790,403	150
B54	665,296	5,790,313	152
B55	665,818	5,790,610	152
B56	666,288	5,790,894	153
B58	666,493	5,791,631	154
B59	667,200	5,791,992	158
B60	667,663	5,792,443	156
B61	666,686	5,792,435	156
B62	666,299	5,793,024	160
B63	667,150	5,793,248	161
B64	667,763	5,793,196	158

Wind turbine	Easting, m	Northing, m	Terrain elevation, m
B65	665,830	5,793,760	156
B66	666,569	5,793,792	159
B67	666,642	5,794,385	158
B68	665,929	5,794,501	156
B69	666,098	5,795,080	159
B70	666,336	5,795,566	156
B71	667,192	5,795,441	159
B72	667,282	5,794,782	157
B73	667,977	5,793,926	160
B74	668,304	5,794,530	161
C77	669,731	5,796,626	169
C78	670,284	5,796,768	170
C79	669,449	5,796,956	167
C80	669,578	5,797,459	171
C81	670,041	5,797,581	173
C82	669,606	5,798,065	170
C83	668,786	5,798,385	171
C84	668,180	5,799,072	171
C85	668,677	5,799,296	174

The following table sets out the coordinates of the proposed substations supplied by the proponent on 11 May 2018.

Table 21: Substations coordinates – MGA 94 zone 54

Item	Easting, m	Northing, m	Terrain elevation, m
On-site substation	662,050	5,791,066	152
Off-site substation	647,063	5,785,933	115

APPENDIX D RECEIVER COORDINATES

The following table sets out the one hundred and forty-nine (149) assessed receivers located within 5 km of the proposed wind turbines considered in the environmental noise assessment, and their distance to the nearest wind turbine. This includes twenty (20) involved receivers.

(Data supplied by the proponent on 15 June 2022).

Table 22: Receivers within 5 km of the proposed wind turbines – MGA 94 zone 54

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest wind turbine, m	Nearest wind turbine
i1	668,431	5,795,940	162	1,340	B71
i2	672,104	5,801,865	189	4,284	C85
i3	672,364	5,801,189	184	4,146	C85
i7	667,848	5,796,262	160	1,057	B71
i8	666,446	5,788,270	149	1,098	B45
i9	659,907	5,788,137	153	1,845	B35
i10	659,646	5,788,438	151	2,071	B35
i11	668,152	5,790,956	156	1,171	B52
i12	661,427	5,792,502	150	1,278	B30
i14	665,790	5,787,346	148	1,122	B44
i15	664,251	5,787,101	151	1,110	B40
i16	657,659	5,795,094	165	1,126	A18
i17	658,010	5,795,224	161	1,350	A20
i18	659,127	5,794,699	151	1,556	A20
i19	654,065	5,790,672	139	1,172	A03
i20	670,099	5,794,975	167	1,695	C77
i21	659,314	5,787,808	167	2,498	B35
i22	652,028	5,792,668	140	2,264	A01
i23	650,832	5,792,931	127	3,487	A01
i24	669,336	5,798,650	176	621	C83
u9	674,263	5,799,631	168	4,695	C81
u10	673,085	5,798,418	167	3,160	C81
u11	672,521	5,795,682	164	2,489	C78
u12	672,876	5,793,966	161	3,819	C78
u13	672,870	5,793,589	161	4,100	C78
u14	671,946	5,794,550	162	2,774	C78
u15	671,014	5,794,636	164	2,256	C78

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest wind turbine, m	Nearest wind turbine
u17	665,046	5,792,260	158	1,472	B62
u18	664,166	5,794,029	152	1,689	B65
u19	664,130	5,793,868	152	1,707	B65
u20	667,260	5,796,702	163	1,268	B71
u21	665,548	5,798,638	166	2,669	C84
u22	667,381	5,796,888	165	1,464	B71
u23	664,833	5,799,387	169	3,364	C84
u24	666,344	5,803,239	187	4,555	C84
u25	667,868	5,802,257	184	3,072	C85
u26	663,809	5,800,561	170	4,619	C84
u27	664,011	5,800,525	171	4,416	C84
u28	664,306	5,797,104	161	2,550	B70
u29	659,147	5,798,651	163	4,205	A16
u30	659,430	5,798,900	164	4,578	A16
u31	659,260	5,794,768	154	1,705	A20
u36	664,772	5,796,988	160	2,117	B70
u37	662,531	5,797,677	167	4,353	B70
u38	668,783	5,789,961	153	1,141	B52
u40	669,830	5,788,036	157	2,458	B51
u41	667,704	5,787,156	153	2,093	B51
u42	667,817	5,786,972	151	2,280	B51
u43	668,600	5,787,345	154	2,109	B51
u44	669,142	5,787,606	155	2,192	B51
u45	671,101	5,788,627	153	3,466	B51
u47	663,503	5,790,960	151	1,509	B32
u49	660,754	5,794,401	148	1,961	A25
u50	662,782	5,794,252	150	3,089	B65
u51	661,796	5,786,881	148	1,206	B38
u52	664,138	5,784,064	140	3,386	B40
u53	663,788	5,785,568	147	1,849	B40
u57	662,385	5,785,372	137	2,089	B40
u58	668,523	5,791,583	158	1,221	B60
u59	655,494	5,787,092	135	3,563	A05

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest wind turbine, m	Nearest wind turbine
u60	656,198	5,786,692	132	3,946	A05
u61	656,528	5,787,050	137	3,630	A05
u62	652,144	5,792,555	140	2,125	A01
u63	652,162	5,792,645	139	2,128	A01
u64	652,426	5,793,899	133	2,366	A08
u65	652,458	5,794,210	131	2,428	A08
u66	653,440	5,795,130	142	1,789	A12
u70	657,944	5,788,331	147	3,061	A05
u71	657,398	5,788,156	149	2,880	A05
u80	671,139	5,787,862	153	3,715	B51
u81	671,310	5,788,388	153	3,719	B51
u84	653,017	5,798,226	154	4,189	A13
u90	659,813	5,787,900	155	1,994	B35
u91	659,845	5,787,783	155	2,003	B35
u122	649,447	5,791,092	124	4,883	A01
u137	650,540	5,791,154	129	3,805	A01
u139	651,436	5,789,175	127	4,052	A01
u140	651,404	5,787,974	122	4,804	A03
u157	655,082	5,788,280	139	2,496	A05
u158	654,199	5,788,968	138	2,189	A03
u159	653,399	5,789,715	138	2,169	A03
u160	670,215	5,795,187	167	1,522	C77
u161	661,264	5,794,527	148	2,382	A25
u162	660,778	5,794,657	149	2,188	A25
u163	657,783	5,790,185	138	1,613	A09
u164	657,720	5,790,068	139	1,626	A09
u169	659,602	5,786,467	171	2,931	B35
u170	659,659	5,786,983	174	2,554	B35
u171	659,549	5,785,999	166	3,307	B35
u172	658,973	5,785,621	182	3,974	B35
u173	659,481	5,785,393	154	3,825	B35
u202	662,729	5,782,706	129	4,622	B40
u203	663,160	5,782,590	130	4,718	B40

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest wind turbine, m	Nearest wind turbine
u204	663,921	5,782,999	134	4,374	B40
u205	664,203	5,782,960	136	4,470	B40
u208	660,475	5,784,418	133	3,949	B40
u216	652,872	5,795,783	140	2,624	A12
u219	650,261	5,795,396	140	4,861	A12
u221	660,056	5,784,496	145	4,138	B38
u222	660,058	5,784,375	145	4,231	B38
u223	660,130	5,784,269	142	4,272	B38
u224	660,276	5,783,900	134	4,468	B40
u225	659,962	5,783,817	143	4,736	B38
u226	659,880	5,783,881	143	4,732	B38
u227	659,129	5,784,638	148	4,645	B35
u228	659,153	5,784,383	146	4,839	B38
u229	659,866	5,784,173	144	4,509	B38
u230	659,650	5,784,266	144	4,576	B38
u231	659,716	5,784,304	145	4,504	B38
u232	659,756	5,784,315	145	4,470	B38
u233	659,460	5,784,041	144	4,871	B38
u234	659,454	5,784,095	144	4,834	B38
u235	659,493	5,784,174	144	4,750	B38
u236	659,501	5,784,297	145	4,654	B38
u237	659,477	5,784,284	145	4,680	B38
u238	659,146	5,784,364	146	4,857	B38
u239	659,154	5,784,315	146	4,885	B38
u240	659,131	5,784,326	146	4,894	B38
u241	659,314	5,784,252	146	4,816	B38
u242	659,373	5,784,215	145	4,802	B38
u243	659,322	5,784,063	145	4,948	B38
u244	659,307	5,784,056	145	4,963	B38
u245	659,339	5,784,191	145	4,842	B38
u246	659,322	5,784,181	145	4,861	B38
u247	659,273	5,784,170	145	4,904	B38
u248	659,360	5,784,081	145	4,908	B38

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest wind turbine, m	Nearest wind turbine
u250	659,118	5,784,258	146	4,950	B38
u251	659,109	5,784,205	145	4,994	B38
u257	659,180	5,784,130	145	4,996	B38
u260	659,216	5,784,110	145	4,986	B38
u261	659,240	5,784,120	145	4,962	B38
u266	660,297	5,783,712	133	4,600	B40
u271	659,267	5,784,089	145	4,966	B38
u272	659,267	5,784,089	145	4,966	B38
u273	659,336	5,784,081	145	4,924	B38
u274	658,946	5,784,362	140	4,977	B35
u275	659,002	5,784,412	146	4,904	B35
u276	659,020	5,784,348	146	4,948	B35
u278	659,061	5,784,252	146	4,995	B38
u295	666,011	5,798,323	164	2,297	C84
u296	664,337	5,800,236	170	4,017	C84
u297	670,640	5,786,688	156	3,904	B51
u298	666,293	5,786,618	145	1,993	B44
u299	659,026	5,785,354	168	4,136	B35
u300	658,912	5,785,399	163	4,178	B35
u301	658,711	5,785,371	165	4,336	B35
u302	660,766	5,784,099	132	4,007	B40
u307	659,355	5,784,204	145	4,822	B38
u308	652,196	5,796,002	143	3,305	A12

(i) Involved receiver

(u) Non-involved receiver

MARSHALL DAY Acoustics

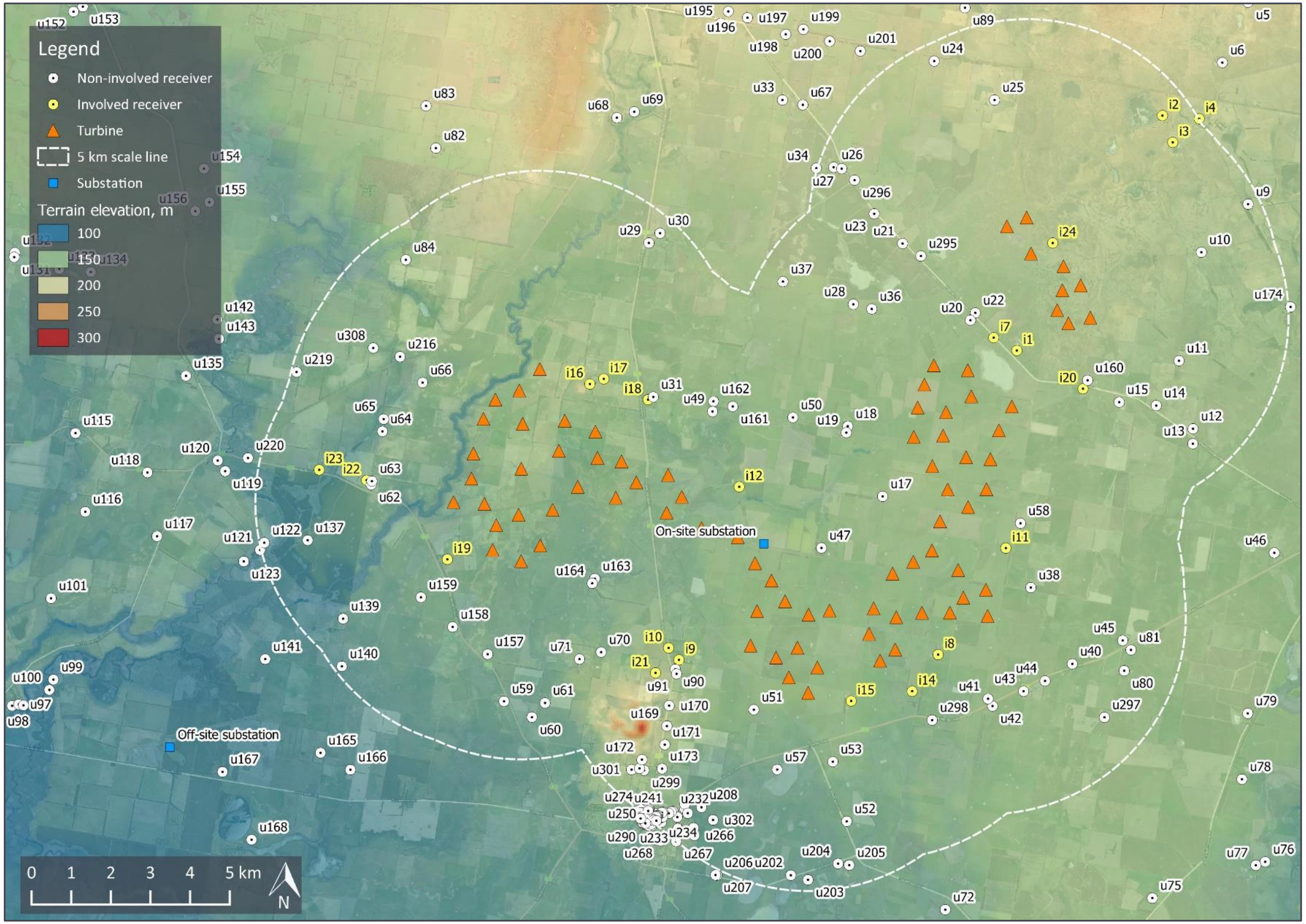
APPENDIX E SITE LAYOUT PLAN

Figure 11: Proposed wind turbine layout, substations and receivers

MARSHALL DAY Acoustics

APPENDIX F SITE TOPOGRAPHY

Figure 12: Terrain elevation map for the wind farm and surrounding area



APPENDIX G ZONING MAPS

Figure 13: Zoning map for the wind farm and surrounding area

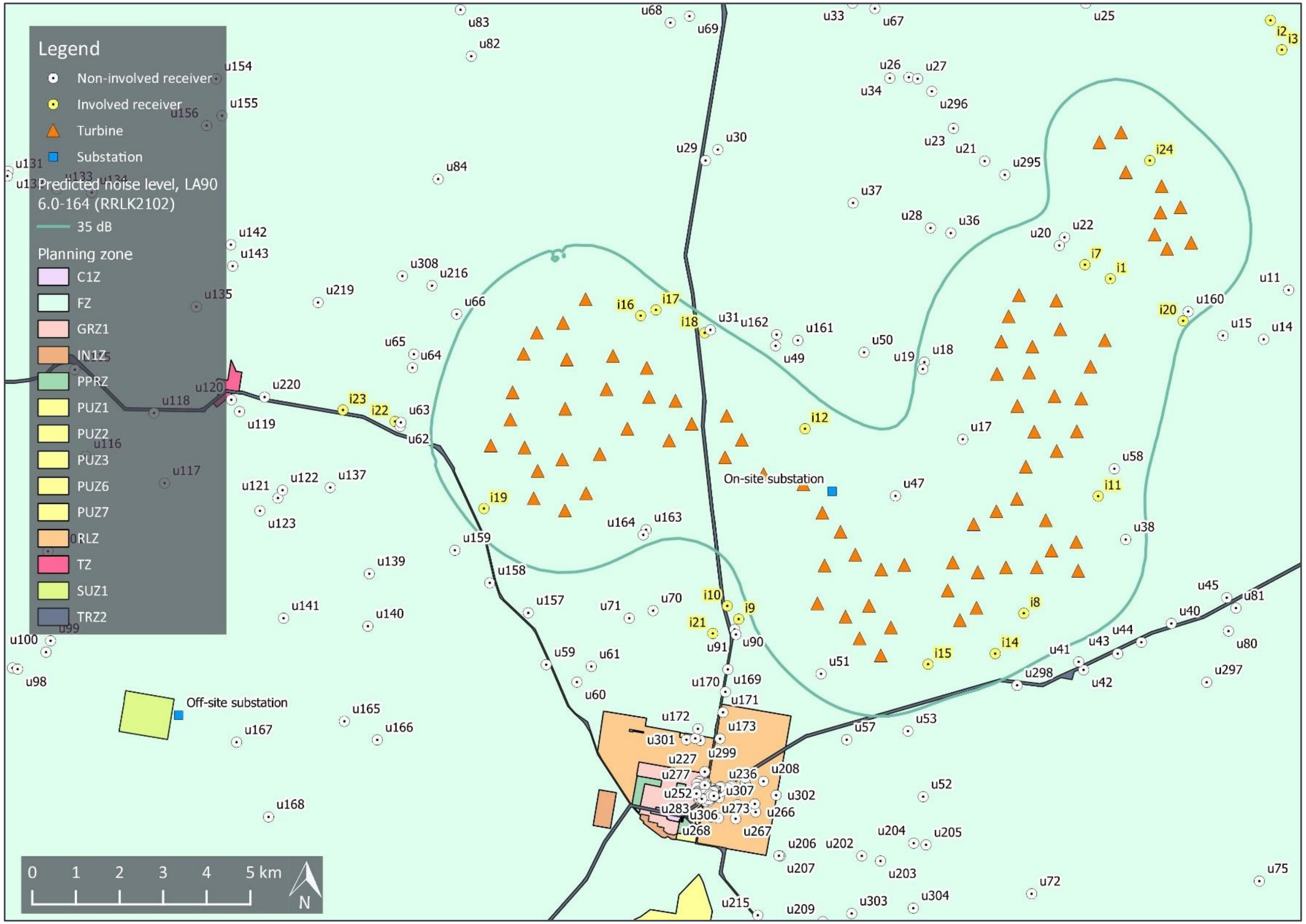
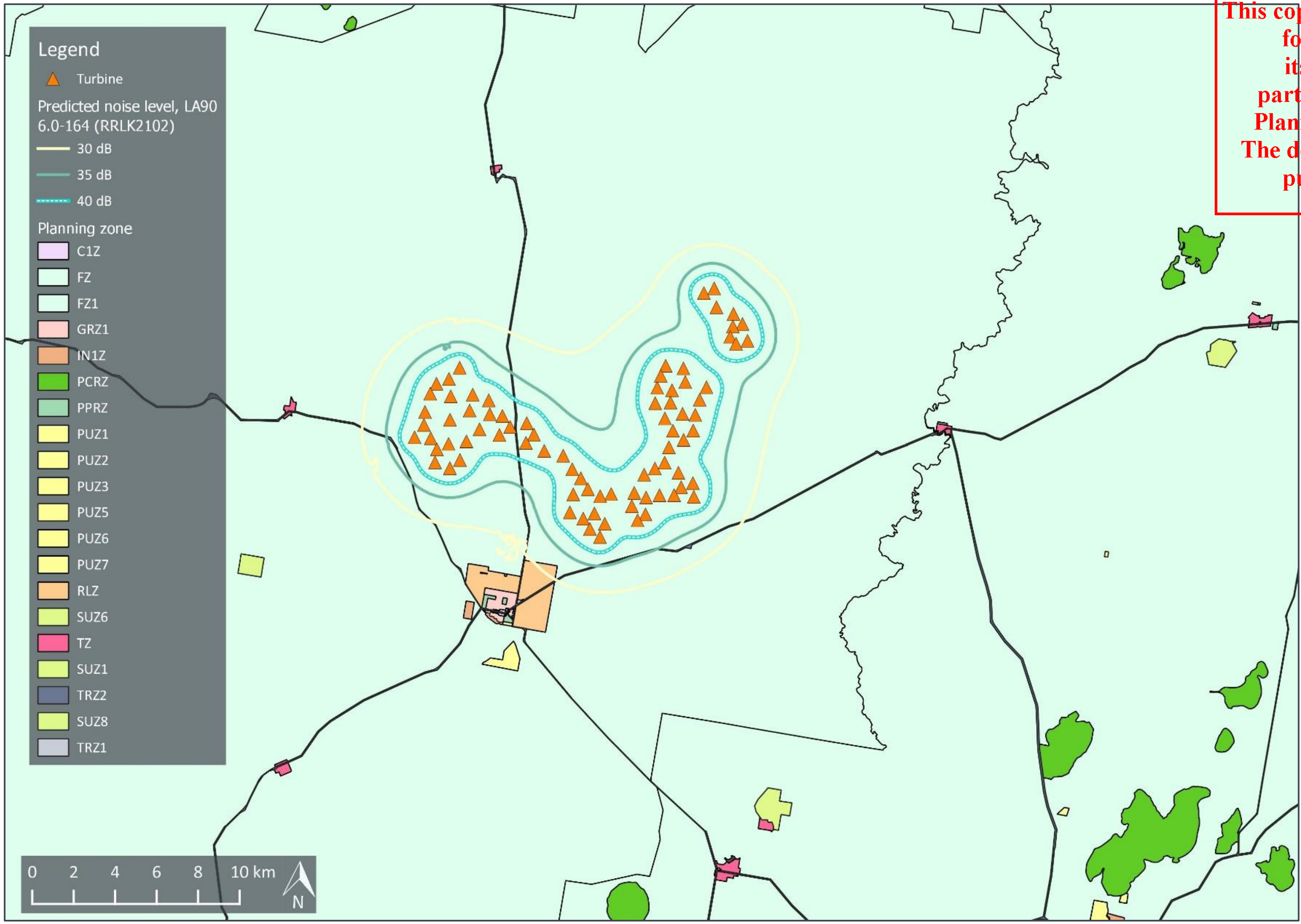


Figure 14: Zoning map for the wind farm and extended surrounding area



APPENDIX H 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* and the South Australian EPA 2009 wind farm noise guidelines.

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 °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 (the 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[15, 16, 17] 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.

15 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.

16 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.

17 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 SoundPLAN 8.2 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 I BACKGROUND NOISE MONITORING RESULTS (FOR INFORMATION)

Due to the time that has passed since these earlier surveys were undertaken, as well as improvements in contemporary measurement practices, the data from the surveys conducted in 2012, 2013 and 2017 are provided for reference purpose only (i.e. background noise related limits are not derived from this data). The primary use of this data is to provide an indication of underlying background conditions at low wind speeds, and the extent to which background noise levels are influenced by changes in wind speed.

Neither NZS 6808, the Victorian Wind Energy Guidelines, nor the EP Regulations define separate time periods for the analysis of background noise levels or assessment of wind farm noise. However, previous Victorian wind farm planning permits have often required separate analysis for the night period. Given that the background noise levels measured at the Mt Fyans Wind Farm showed significant variations between day and night noise levels at some locations, a separate analysis was conducted for the night period. Consistent with previous wind farm planning permits which refer to night period analysis, the data sets are considered for separate time periods as follows:

- All-time period: no restriction on hours (i.e. day and night hours data combined); and
- Night period: 2200 to 0700 hours.

Full details of the survey, analysis methodology and measurement results are documented in a separate report titled *Mt Fyans Wind Farm – Background Noise Monitoring* dated 20 July 2018 (MDA document reference Rp 002 2012102ML).

It should be noted that the analysis of the 2012 and 2013 survey data was referenced to the 79 m hub height which was being considered at the time. As the data from this period is not used for establishing background noise related limits, the data has not been retrospectively reanalysed to correlate the measured noise levels with the current proposed hub height. Accordingly, the reference data provided for these periods cannot be directly compared with the latest measurement results obtained in 2017.

Derived background noise levels for the all-time and night-time periods respectively are summarised in the following tables:

- Table 23 and Table 24 for the background noise survey conducted from 9 May to 31 May 2012;
- Table 25 and Table 26 for the background noise survey conducted from 1 February to 1 March 2013; and
- Table 27 and Table 28 for the background noise survey conducted from 10 August to 27 September 2017.

Table 23: 2012 - All-time period background noise levels, dB L_{A90}

Location	Hub height wind speed, m/s [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i1	22.4	23.0	24.1	25.6	27.4	29.5	31.9	34.4	37.0	39.6	42.2	44.8	47.2
i8	24.1	24.9	26.1	27.8	29.8	32.1	34.6	37.1	39.6	42.1	44.4	46.5	48.2
i9	24.2	24.6	25.5	26.8	28.4	30.3	32.4	34.6	37.0	39.5	42.0	44.5	46.9
i11	22.4	23.6	25.4	27.6	30.2	32.9	35.9	38.9	41.9	44.9	47.6	50.1	52.3
i12	24.5	25.3	26.5	28.1	30.0	32.1	34.4	36.8	39.2	41.7	44.0	46.2	48.2
i14	24.4	25.4	26.8	28.7	30.9	33.4	36.0	38.8	41.6	44.4	47.0	49.5	51.7
i15	23.9	25.1	26.7	28.7	31.0	33.6	36.3	39.1	41.9	44.7	47.3	49.6	51.7

Note 1: 79 m above ground level

Table 24: 2012 - Night-time period background noise levels, dB L_{A90}

Location	Hub height wind speed, m/s [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i1	16.7	17.6	18.9	20.6	22.7	25.1	27.6	30.3	33.0	35.6	38.2	40.7	42.8
i8	18.9	19.5	20.8	22.7	25.0	27.7	30.4	33.2	35.7	37.8	39.5	40.4	40.6
i9	19.0	19.3	20.0	21.3	22.9	24.7	26.8	29.1	31.4	33.8	36.1	38.3	40.3
i11	18.9	20.1	22.0	24.3	26.9	29.8	32.8	35.7	38.6	41.1	43.4	45.1	46.2
i12	17.4	18.7	20.7	23.3	26.2	29.1	31.8	34.0	35.5	36.1	35.4	33.3	29.5
i14	17.5	18.4	20.2	22.6	25.4	28.5	31.7	34.9	37.8	40.4	42.4	43.7	44.2
i15	17.5	18.6	20.7	23.4	26.7	30.1	33.4	36.5	38.9	40.5	41.1	40.2	37.8

Note 1: 79 m above ground level

Table 25: 2013 - All-time period background noise levels, dB L_{A90}

Location	Hub height wind speed, m/s [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i16	32	33	34.6	36.5	38.7	40.9	42.9	44.6	45.9	46.5	-	-	-
i18	32.8	33.1	34.3	36.1	38.2	40.5	42.6	44.2	45.2	45.3	-	-	-
i19	27.1	28.5	30.5	32.9	35.5	38.2	40.7	43	44.8	-	-	-	-
u16	28.4	30.1	32.2	34.5	37	39.5	41.9	44.1	46	47.4	-	-	-
u47	26.8	27.7	29.3	31.6	34.3	37.2	40.2	43	45.4	-	-	-	-
u160	28.3	30.2	32.6	35.4	38.3	41.2	43.9	46.3	48.2	-	-	-	-
u163	32.1	33	34.4	36.1	38	40.1	42.2	44.2	46	47.5	-	-	-

Note 1: 79 m above ground level

Table 26: 2013 - Night-time period background noise levels, dB L_{A90}

Location	Hub height wind speed, m/s [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i16	21.1	21.9	23.2	24.9	26.8	28.9	31.1	33.2	35.0	-	-	-	-
i18	22.0	21.9	23.8	26.6	29.6	31.9	32.6	30.9	25.7	-	-	-	-
i19	20.9	20.7	21.2	22.3	23.7	25.4	27.2	28.9	30.4	-	-	-	-
u16	22.6	23.1	24.8	27.3	30.6	34.6	39.0	43.7	-	-	-	-	-
u47	24.2	24.5	26.2	28.9	32.0	34.9	37.4	38.8	-	-	-	-	-
u160	20.3	20.6	22.0	24.3	27.4	31.0	35.0	-	-	-	-	-	-
u163	21.9	23.0	24.3	25.8	27.6	29.5	31.7	34.2	-	-	-	-	-

Note 1: 79 m above ground level

Table 27: 2017 – All-time period background noise levels, dB L_{A90}

Location	Hub height wind speed, m/s [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
u17	28.8	29.8	31.0	32.2	33.7	35.2	36.9	38.7	40.6	42.6	44.7	46.9	49.2
u31	32.9	33.5	34.2	35.1	36.2	37.3	38.7	40.1	41.7	43.3	45.1	47.0	49.0
u47	28.7	29.3	30.1	31.0	32.1	33.4	34.8	36.4	38.1	40.0	42.0	44.1	46.4
u51	35.3	36.7	38.0	39.1	40.1	41.0	41.8	42.6	43.5	44.4	45.4	46.6	47.9

Note 1: 125 m above ground level at 663440 E, 5789538 N (MGA 94 Zone 54)

Table 28: 2017- Night-time period background noise levels, dB L_{A90}

Location	Hub height wind speed, m/s [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
u17	24.4	25.0	26.0	27.3	28.8	30.5	32.5	34.7	37.1	39.6	42.3	45.0	47.9
u31	28.0	28.3	28.9	29.9	31.1	32.6	34.3	36.3	38.4	40.7	43.1	45.5	48.1
u47	25.9	26.5	27.1	27.9	28.9	30.1	31.5	33.1	34.9	37.0	39.4	42.0	45.0
u51	27.8	29.3	30.8	32.4	34.0	35.6	37.2	38.8	40.4	42.0	43.5	44.9	46.3

Note 1: 125 m above ground level at 663440 E, 5789538 N (MGA 94 Zone 54)

The results presented in Table 27 and Table 28 are generally consistent with the range of background sound levels expected in a rural setting. However, the environment at u51 was affected by a range of domestic sources located around the property including pets, livestock, two small wind turbines and a diesel generator. Periods affected by diesel generator noise were identified and removed from the dataset using the low frequency noise characteristics associated with diesel generators. However, other sources of noise at the property are less distinct in terms of time periods or their contribution to the measured levels, and therefore remain in the data as part of the total sound around the dwelling. While the results are a true representation of the noise levels which occurred at the dwelling during the survey period, the elevated levels cannot be assumed to be an enduring long-term characteristic of the sound environment at the dwelling.

APPENDIX J TABULATED PREDICTED NOISE LEVEL DATA

Table 29: Predicted noise levels, dB L_{A90} – SG 6.6-170

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
i1	23.4	25.9	29.8	33.2	36.1	37.4	37.4	37.4	37.4	37.4	37.4	37.4
i2	9.5	12.0	15.9	19.3	22.2	23.5	23.5	23.5	23.5	23.5	23.5	23.5
i3	10.2	12.7	16.6	20.0	22.9	24.2	24.2	24.2	24.2	24.2	24.2	24.2
i7	23.4	25.9	29.8	33.2	36.1	37.4	37.4	37.4	37.4	37.4	37.4	37.4
i8	25.2	27.7	31.6	35.0	37.9	39.2	39.2	39.2	39.2	39.2	39.2	39.2
i9	18.4	20.9	24.8	28.2	31.1	32.4	32.4	32.4	32.4	32.4	32.4	32.4
i10	18.0	20.5	24.4	27.8	30.7	32.0	32.0	32.0	32.0	32.0	32.0	32.0
i11	24.1	26.6	30.5	33.9	36.8	38.1	38.1	38.1	38.1	38.1	38.1	38.1
i12	22.4	24.9	28.8	32.2	35.1	36.4	36.4	36.4	36.4	36.4	36.4	36.4
i14	23.0	25.5	29.4	32.8	35.7	37.0	37.0	37.0	37.0	37.0	37.0	37.0
i15	24.0	26.5	30.4	33.8	36.7	38.0	38.0	38.0	38.0	38.0	38.0	38.0
i16	23.2	25.7	29.6	33.0	35.9	37.2	37.2	37.2	37.2	37.2	37.2	37.2
i17	21.8	24.3	28.2	31.6	34.5	35.8	35.8	35.8	35.8	35.8	35.8	35.8
i18	20.9	23.4	27.3	30.7	33.6	34.9	34.9	34.9	34.9	34.9	34.9	34.9
i19	22.3	24.8	28.7	32.1	35.0	36.3	36.3	36.3	36.3	36.3	36.3	36.3
i20	20.0	22.5	26.4	29.8	32.7	34.0	34.0	34.0	34.0	34.0	34.0	34.0
i21	16.4	18.9	22.8	26.2	29.1	30.4	30.4	30.4	30.4	30.4	30.4	30.4
i22	15.7	18.2	22.1	25.5	28.4	29.7	29.7	29.7	29.7	29.7	29.7	29.7
i23	12.1	14.6	18.5	21.9	24.8	26.1	26.1	26.1	26.1	26.1	26.1	26.1
i24	28.5	31.0	34.9	38.3	41.2	42.5	42.5	42.5	42.5	42.5	42.5	42.5
u9	9.0	11.5	15.4	18.8	21.7	23.0	23.0	23.0	23.0	23.0	23.0	23.0
u10	12.5	15.0	18.9	22.3	25.2	26.5	26.5	26.5	26.5	26.5	26.5	26.5
u11	14.4	16.9	20.8	24.2	27.1	28.4	28.4	28.4	28.4	28.4	28.4	28.4
u12	12.2	14.7	18.6	22.0	24.9	26.2	26.2	26.2	26.2	26.2	26.2	26.2
u13	12.0	14.5	18.4	21.8	24.7	26.0	26.0	26.0	26.0	26.0	26.0	26.0
u14	14.5	17.0	20.9	24.3	27.2	28.5	28.5	28.5	28.5	28.5	28.5	28.5
u15	16.9	19.4	23.3	26.7	29.6	30.9	30.9	30.9	30.9	30.9	30.9	30.9
u17	23.1	25.6	29.5	32.9	35.8	37.1	37.1	37.1	37.1	37.1	37.1	37.1
u18	20.1	22.6	26.5	29.9	32.8	34.1	34.1	34.1	34.1	34.1	34.1	34.1
u19	20.0	22.5	26.4	29.8	32.7	34.0	34.0	34.0	34.0	34.0	34.0	34.0

Receiver	Hub-height wind speed, m/s										
	4	5	6	7	8	9	10	11	12	13	14	15
u20	22.0	24.5	28.4	31.8	34.7	36.0	36.0	36.0	36.0	36.0	36.0	36.0
u21	15.0	17.5	21.4	24.8	27.7	29.0	29.0	29.0	29.0	29.0	29.0	29.0
u22	21.4	23.9	27.8	31.2	34.1	35.4	35.4	35.4	35.4	35.4	35.4	35.4
u23	12.9	15.4	19.3	22.7	25.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9
u24	8.7	11.2	15.1	18.5	21.4	22.7	22.7	22.7	22.7	22.7	22.7	22.7
u25	11.4	13.9	17.8	21.2	24.1	25.4	25.4	25.4	25.4	25.4	25.4	25.4
u26	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u27	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
u28	15.8	18.3	22.2	25.6	28.5	29.8	29.8	29.8	29.8	29.8	29.8	29.8
u29	11.6	14.1	18.0	21.4	24.3	25.6	25.6	25.6	25.6	25.6	25.6	25.6
u30	11.2	13.7	17.6	21.0	23.9	25.2	25.2	25.2	25.2	25.2	25.2	25.2
u31	20.3	22.8	26.7	30.1	33.0	34.3	34.3	34.3	34.3	34.3	34.3	34.3
u36	17.0	19.5	23.4	26.8	29.7	31.0	31.0	31.0	31.0	31.0	31.0	31.0
u37	12.9	15.4	19.3	22.7	25.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9
u38	22.2	24.7	28.6	32.0	34.9	36.2	36.2	36.2	36.2	36.2	36.2	36.2
u40	15.0	17.5	21.4	24.8	27.7	29.0	29.0	29.0	29.0	29.0	29.0	29.0
u41	17.7	20.2	24.1	27.5	30.4	31.7	31.7	31.7	31.7	31.7	31.7	31.7
u42	16.9	19.4	23.3	26.7	29.6	30.9	30.9	30.9	30.9	30.9	30.9	30.9
u43	16.5	19.0	22.9	26.3	29.2	30.5	30.5	30.5	30.5	30.5	30.5	30.5
u44	15.9	18.4	22.3	25.7	28.6	29.9	29.9	29.9	29.9	29.9	29.9	29.9
u45	12.7	15.2	19.1	22.5	25.4	26.7	26.7	26.7	26.7	26.7	26.7	26.7
u47	23.0	25.5	29.4	32.8	35.7	37.0	37.0	37.0	37.0	37.0	37.0	37.0
u49	18.3	20.8	24.7	28.1	31.0	32.3	32.3	32.3	32.3	32.3	32.3	32.3
u50	17.0	19.5	23.4	26.8	29.7	31.0	31.0	31.0	31.0	31.0	31.0	31.0
u51	22.3	24.8	28.7	32.1	35.0	36.3	36.3	36.3	36.3	36.3	36.3	36.3
u52	12.9	15.4	19.3	22.7	25.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9
u53	17.5	20.0	23.9	27.3	30.2	31.5	31.5	31.5	31.5	31.5	31.5	31.5
u57	16.6	19.1	23.0	26.4	29.3	30.6	30.6	30.6	30.6	30.6	30.6	30.6
u58	22.9	25.4	29.3	32.7	35.6	36.9	36.9	36.9	36.9	36.9	36.9	36.9
u59	12.5	15.0	18.9	22.3	25.2	26.5	26.5	26.5	26.5	26.5	26.5	26.5
u60	12.1	14.6	18.5	21.9	24.8	26.1	26.1	26.1	26.1	26.1	26.1	26.1
u61	12.9	15.4	19.3	22.7	25.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u62	16.1	18.6	22.5	25.9	28.8	30.1	30.1	30.1	30.1	30.1	30.1	30.1
u63	16.2	18.7	22.6	26.0	28.9	30.2	30.2	30.2	30.2	30.2	30.2	30.2
u64	16.1	18.6	22.5	25.9	28.8	30.1	30.1	30.1	30.1	30.1	30.1	30.1
u65	16.0	18.5	22.4	25.8	28.7	30.0	30.0	30.0	30.0	30.0	30.0	30.0
u66	18.3	20.8	24.7	28.1	31.0	32.3	32.3	32.3	32.3	32.3	32.3	32.3
u70	15.7	18.2	22.1	25.5	28.4	29.7	29.7	29.7	29.7	29.7	29.7	29.7
u71	15.3	17.8	21.7	25.1	28.0	29.3	29.3	29.3	29.3	29.3	29.3	29.3
u80	12.0	14.5	18.4	21.8	24.7	26.0	26.0	26.0	26.0	26.0	26.0	26.0
u81	12.1	14.6	18.5	21.9	24.8	26.1	26.1	26.1	26.1	26.1	26.1	26.1
u84	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
u90	17.7	20.2	24.1	27.5	30.4	31.7	31.7	31.7	31.7	31.7	31.7	31.7
u91	17.6	20.1	24.0	27.4	30.3	31.6	31.6	31.6	31.6	31.6	31.6	31.6
u122	8.9	11.4	15.3	18.7	21.6	22.9	22.9	22.9	22.9	22.9	22.9	22.9
u137	11.0	13.5	17.4	20.8	23.7	25.0	25.0	25.0	25.0	25.0	25.0	25.0
u139	11.0	13.5	17.4	20.8	23.7	25.0	25.0	25.0	25.0	25.0	25.0	25.0
u140	9.6	12.1	16.0	19.4	22.3	23.6	23.6	23.6	23.6	23.6	23.6	23.6
u157	15.1	17.6	21.5	24.9	27.8	29.1	29.1	29.1	29.1	29.1	29.1	29.1
u158	16.1	18.6	22.5	25.9	28.8	30.1	30.1	30.1	30.1	30.1	30.1	30.1
u159	16.4	18.9	22.8	26.2	29.1	30.4	30.4	30.4	30.4	30.4	30.4	30.4
u160	20.4	22.9	26.8	30.2	33.1	34.4	34.4	34.4	34.4	34.4	34.4	34.4
u161	17.2	19.7	23.6	27.0	29.9	31.2	31.2	31.2	31.2	31.2	31.2	31.2
u162	17.6	20.1	24.0	27.4	30.3	31.6	31.6	31.6	31.6	31.6	31.6	31.6
u163	20.6	23.1	27.0	30.4	33.3	34.6	34.6	34.6	34.6	34.6	34.6	34.6
u164	20.3	22.8	26.7	30.1	33.0	34.3	34.3	34.3	34.3	34.3	34.3	34.3
u169	14.5	17.0	20.9	24.3	27.2	28.5	28.5	28.5	28.5	28.5	28.5	28.5
u170	15.7	18.2	22.1	25.5	28.4	29.7	29.7	29.7	29.7	29.7	29.7	29.7
u171	13.6	16.1	20.0	23.4	26.3	27.6	27.6	27.6	27.6	27.6	27.6	27.6
u172	12.0	14.5	18.4	21.8	24.7	26.0	26.0	26.0	26.0	26.0	26.0	26.0
u173	12.4	14.9	18.8	22.2	25.1	26.4	26.4	26.4	26.4	26.4	26.4	26.4
u202	10.2	12.7	16.6	20.0	22.9	24.2	24.2	24.2	24.2	24.2	24.2	24.2
u203	10.1	12.6	16.5	19.9	22.8	24.1	24.1	24.1	24.1	24.1	24.1	24.1
u204	10.8	13.3	17.2	20.6	23.5	24.8	24.8	24.8	24.8	24.8	24.8	24.8

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u205	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
u208	12.0	14.5	18.4	21.8	24.7	26.0	26.0	26.0	26.0	26.0	26.0	26.0
u216	14.9	17.4	21.3	24.7	27.6	28.9	28.9	28.9	28.9	28.9	28.9	28.9
u219	9.8	12.3	16.2	19.6	22.5	23.8	23.8	23.8	23.8	23.8	23.8	23.8
u221	11.7	14.2	18.1	21.5	24.4	25.7	25.7	25.7	25.7	25.7	25.7	25.7
u222	11.5	14.0	17.9	21.3	24.2	25.5	25.5	25.5	25.5	25.5	25.5	25.5
u223	11.4	13.9	17.8	21.2	24.1	25.4	25.4	25.4	25.4	25.4	25.4	25.4
u224	10.9	13.4	17.3	20.7	23.6	24.9	24.9	24.9	24.9	24.9	24.9	24.9
u225	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u226	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u227	10.9	13.4	17.3	20.7	23.6	24.9	24.9	24.9	24.9	24.9	24.9	24.9
u228	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u229	11.0	13.5	17.4	20.8	23.7	25.0	25.0	25.0	25.0	25.0	25.0	25.0
u230	10.9	13.4	17.3	20.7	23.6	24.9	24.9	24.9	24.9	24.9	24.9	24.9
u231	11.0	13.5	17.4	20.8	23.7	25.0	25.0	25.0	25.0	25.0	25.0	25.0
u232	11.1	13.6	17.5	20.9	23.8	25.1	25.1	25.1	25.1	25.1	25.1	25.1
u233	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u234	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u235	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u236	10.8	13.3	17.2	20.6	23.5	24.8	24.8	24.8	24.8	24.8	24.8	24.8
u237	10.8	13.3	17.2	20.6	23.5	24.8	24.8	24.8	24.8	24.8	24.8	24.8
u238	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u239	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u240	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u241	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u242	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u243	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u244	10.3	12.8	16.7	20.1	23.0	24.3	24.3	24.3	24.3	24.3	24.3	24.3
u245	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u246	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u247	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u248	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u250	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u251	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u257	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u260	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u261	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u266	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
u271	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u272	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u273	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u274	9.1	11.6	15.5	18.9	21.8	23.1	23.1	23.1	23.1	23.1	23.1	23.1
u275	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u276	10.5	13.0	16.9	20.3	23.2	24.5	24.5	24.5	24.5	24.5	24.5	24.5
u278	10.4	12.9	16.8	20.2	23.1	24.4	24.4	24.4	24.4	24.4	24.4	24.4
u295	16.4	18.9	22.8	26.2	29.1	30.4	30.4	30.4	30.4	30.4	30.4	30.4
u296	11.3	13.8	17.7	21.1	24.0	25.3	25.3	25.3	25.3	25.3	25.3	25.3
u297	11.5	14.0	17.9	21.3	24.2	25.5	25.5	25.5	25.5	25.5	25.5	25.5
u298	18.3	20.8	24.7	28.1	31.0	32.3	32.3	32.3	32.3	32.3	32.3	32.3
u299	11.8	14.3	18.2	21.6	24.5	25.8	25.8	25.8	25.8	25.8	25.8	25.8
u300	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
u301	10.7	13.2	17.1	20.5	23.4	24.7	24.7	24.7	24.7	24.7	24.7	24.7
u302	11.7	14.2	18.1	21.5	24.4	25.7	25.7	25.7	25.7	25.7	25.7	25.7
u307	10.6	13.1	17.0	20.4	23.3	24.6	24.6	24.6	24.6	24.6	24.6	24.6
u308	12.9	15.4	19.3	22.7	25.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9

(i) Involved receiver

(u) Non-involved receiver

Table 30: 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
i1	25.6	27.5	31.0	34.3	36.5	38.5	38.8	38.8	38.8	38.8	38.8	38.8
i2	11.9	13.8	17.3	20.6	22.8	24.8	25.1	25.1	25.1	25.1	25.1	25.1
i3	12.6	14.5	18.0	21.3	23.5	25.5	25.8	25.8	25.8	25.8	25.8	25.8
i7	25.6	27.5	31.0	34.3	36.5	38.5	38.8	38.8	38.8	38.8	38.8	38.8
i8	27.3	29.2	32.7	36.0	38.2	40.2	40.5	40.5	40.5	40.5	40.5	40.5
i9	20.7	22.6	26.1	29.4	31.6	33.6	33.9	33.9	33.9	33.9	33.9	33.9
i10	20.4	22.3	25.8	29.1	31.3	33.3	33.6	33.6	33.6	33.6	33.6	33.6
i11	26.2	28.1	31.6	34.9	37.1	39.1	39.4	39.4	39.4	39.4	39.4	39.4
i12	24.6	26.5	30.0	33.3	35.5	37.5	37.8	37.8	37.8	37.8	37.8	37.8
i14	25.2	27.1	30.6	33.9	36.1	38.1	38.4	38.4	38.4	38.4	38.4	38.4
i15	26.2	28.1	31.6	34.9	37.1	39.1	39.4	39.4	39.4	39.4	39.4	39.4
i16	25.4	27.3	30.8	34.1	36.3	38.3	38.6	38.6	38.6	38.6	38.6	38.6
i17	24.1	26.0	29.5	32.8	35.0	37.0	37.3	37.3	37.3	37.3	37.3	37.3
i18	23.1	25.0	28.5	31.8	34.0	36.0	36.3	36.3	36.3	36.3	36.3	36.3
i19	24.4	26.3	29.8	33.1	35.3	37.3	37.6	37.6	37.6	37.6	37.6	37.6
i20	22.3	24.2	27.7	31.0	33.2	35.2	35.5	35.5	35.5	35.5	35.5	35.5
i21	18.7	20.6	24.1	27.4	29.6	31.6	31.9	31.9	31.9	31.9	31.9	31.9
i22	18.0	19.9	23.4	26.7	28.9	30.9	31.2	31.2	31.2	31.2	31.2	31.2
i23	14.5	16.4	19.9	23.2	25.4	27.4	27.7	27.7	27.7	27.7	27.7	27.7
i24	30.5	32.4	35.9	39.2	41.4	43.4	43.7	43.7	43.7	43.7	43.7	43.7
u9	11.4	13.3	16.8	20.1	22.3	24.3	24.6	24.6	24.6	24.6	24.6	24.6
u10	14.9	16.8	20.3	23.6	25.8	27.8	28.1	28.1	28.1	28.1	28.1	28.1
u11	16.7	18.6	22.1	25.4	27.6	29.6	29.9	29.9	29.9	29.9	29.9	29.9
u12	14.6	16.5	20.0	23.3	25.5	27.5	27.8	27.8	27.8	27.8	27.8	27.8
u13	14.4	16.3	19.8	23.1	25.3	27.3	27.6	27.6	27.6	27.6	27.6	27.6
u14	16.9	18.8	22.3	25.6	27.8	29.8	30.1	30.1	30.1	30.1	30.1	30.1
u15	19.3	21.2	24.7	28.0	30.2	32.2	32.5	32.5	32.5	32.5	32.5	32.5
u17	25.4	27.3	30.8	34.1	36.3	38.3	38.6	38.6	38.6	38.6	38.6	38.6
u18	22.4	24.3	27.8	31.1	33.3	35.3	35.6	35.6	35.6	35.6	35.6	35.6
u19	22.3	24.2	27.7	31.0	33.2	35.2	35.5	35.5	35.5	35.5	35.5	35.5
u20	24.3	26.2	29.7	33.0	35.2	37.2	37.5	37.5	37.5	37.5	37.5	37.5

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u21	17.4	19.3	22.8	26.1	28.3	30.3	30.6	30.6	30.6	30.6	30.6	30.6
u22	23.7	25.6	29.1	32.4	34.6	36.6	36.9	36.9	36.9	36.9	36.9	36.9
u23	15.3	17.2	20.7	24.0	26.2	28.2	28.5	28.5	28.5	28.5	28.5	28.5
u24	11.1	13.0	16.5	19.8	22.0	24.0	24.3	24.3	24.3	24.3	24.3	24.3
u25	13.7	15.6	19.1	22.4	24.6	26.6	26.9	26.9	26.9	26.9	26.9	26.9
u26	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u27	13.1	15.0	18.5	21.8	24.0	26.0	26.3	26.3	26.3	26.3	26.3	26.3
u28	18.1	20.0	23.5	26.8	29.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
u29	14.0	15.9	19.4	22.7	24.9	26.9	27.2	27.2	27.2	27.2	27.2	27.2
u30	13.6	15.5	19.0	22.3	24.5	26.5	26.8	26.8	26.8	26.8	26.8	26.8
u31	22.6	24.5	28.0	31.3	33.5	35.5	35.8	35.8	35.8	35.8	35.8	35.8
u36	19.4	21.3	24.8	28.1	30.3	32.3	32.6	32.6	32.6	32.6	32.6	32.6
u37	15.3	17.2	20.7	24.0	26.2	28.2	28.5	28.5	28.5	28.5	28.5	28.5
u38	24.4	26.3	29.8	33.1	35.3	37.3	37.6	37.6	37.6	37.6	37.6	37.6
u40	17.3	19.2	22.7	26.0	28.2	30.2	30.5	30.5	30.5	30.5	30.5	30.5
u41	20.0	21.9	25.4	28.7	30.9	32.9	33.2	33.2	33.2	33.2	33.2	33.2
u42	19.2	21.1	24.6	27.9	30.1	32.1	32.4	32.4	32.4	32.4	32.4	32.4
u43	18.8	20.7	24.2	27.5	29.7	31.7	32.0	32.0	32.0	32.0	32.0	32.0
u44	18.2	20.1	23.6	26.9	29.1	31.1	31.4	31.4	31.4	31.4	31.4	31.4
u45	15.1	17.0	20.5	23.8	26.0	28.0	28.3	28.3	28.3	28.3	28.3	28.3
u47	25.3	27.2	30.7	34.0	36.2	38.2	38.5	38.5	38.5	38.5	38.5	38.5
u49	20.7	22.6	26.1	29.4	31.6	33.6	33.9	33.9	33.9	33.9	33.9	33.9
u50	19.4	21.3	24.8	28.1	30.3	32.3	32.6	32.6	32.6	32.6	32.6	32.6
u51	24.5	26.4	29.9	33.2	35.4	37.4	37.7	37.7	37.7	37.7	37.7	37.7
u52	15.2	17.1	20.6	23.9	26.1	28.1	28.4	28.4	28.4	28.4	28.4	28.4
u53	19.9	21.8	25.3	28.6	30.8	32.8	33.1	33.1	33.1	33.1	33.1	33.1
u57	18.9	20.8	24.3	27.6	29.8	31.8	32.1	32.1	32.1	32.1	32.1	32.1
u58	25.1	27.0	30.5	33.8	36.0	38.0	38.3	38.3	38.3	38.3	38.3	38.3
u59	14.9	16.8	20.3	23.6	25.8	27.8	28.1	28.1	28.1	28.1	28.1	28.1
u60	14.4	16.3	19.8	23.1	25.3	27.3	27.6	27.6	27.6	27.6	27.6	27.6
u61	15.2	17.1	20.6	23.9	26.1	28.1	28.4	28.4	28.4	28.4	28.4	28.4
u62	18.5	20.4	23.9	27.2	29.4	31.4	31.7	31.7	31.7	31.7	31.7	31.7

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u63	18.5	20.4	23.9	27.2	29.4	31.4	31.7	31.7	31.7	31.7	31.7	31.7
u64	18.4	20.3	23.8	27.1	29.3	31.3	31.6	31.6	31.6	31.6	31.6	31.6
u65	18.4	20.3	23.8	27.1	29.3	31.3	31.6	31.6	31.6	31.6	31.6	31.6
u66	20.6	22.5	26.0	29.3	31.5	33.5	33.8	33.8	33.8	33.8	33.8	33.8
u70	18.1	20.0	23.5	26.8	29.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
u71	17.7	19.6	23.1	26.4	28.6	30.6	30.9	30.9	30.9	30.9	30.9	30.9
u80	14.3	16.2	19.7	23.0	25.2	27.2	27.5	27.5	27.5	27.5	27.5	27.5
u81	14.5	16.4	19.9	23.2	25.4	27.4	27.7	27.7	27.7	27.7	27.7	27.7
u84	13.1	15.0	18.5	21.8	24.0	26.0	26.3	26.3	26.3	26.3	26.3	26.3
u90	20.0	21.9	25.4	28.7	30.9	32.9	33.2	33.2	33.2	33.2	33.2	33.2
u91	19.9	21.8	25.3	28.6	30.8	32.8	33.1	33.1	33.1	33.1	33.1	33.1
u122	11.3	13.2	16.7	20.0	22.2	24.2	24.5	24.5	24.5	24.5	24.5	24.5
u137	13.4	15.3	18.8	22.1	24.3	26.3	26.6	26.6	26.6	26.6	26.6	26.6
u139	13.4	15.3	18.8	22.1	24.3	26.3	26.6	26.6	26.6	26.6	26.6	26.6
u140	12.0	13.9	17.4	20.7	22.9	24.9	25.2	25.2	25.2	25.2	25.2	25.2
u157	17.5	19.4	22.9	26.2	28.4	30.4	30.7	30.7	30.7	30.7	30.7	30.7
u158	18.4	20.3	23.8	27.1	29.3	31.3	31.6	31.6	31.6	31.6	31.6	31.6
u159	18.7	20.6	24.1	27.4	29.6	31.6	31.9	31.9	31.9	31.9	31.9	31.9
u160	22.7	24.6	28.1	31.4	33.6	35.6	35.9	35.9	35.9	35.9	35.9	35.9
u161	19.6	21.5	25.0	28.3	30.5	32.5	32.8	32.8	32.8	32.8	32.8	32.8
u162	20.0	21.9	25.4	28.7	30.9	32.9	33.2	33.2	33.2	33.2	33.2	33.2
u163	22.9	24.8	28.3	31.6	33.8	35.8	36.1	36.1	36.1	36.1	36.1	36.1
u164	22.6	24.5	28.0	31.3	33.5	35.5	35.8	35.8	35.8	35.8	35.8	35.8
u169	16.9	18.8	22.3	25.6	27.8	29.8	30.1	30.1	30.1	30.1	30.1	30.1
u170	18.1	20.0	23.5	26.8	29.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
u171	16.0	17.9	21.4	24.7	26.9	28.9	29.2	29.2	29.2	29.2	29.2	29.2
u172	14.4	16.3	19.8	23.1	25.3	27.3	27.6	27.6	27.6	27.6	27.6	27.6
u173	14.8	16.7	20.2	23.5	25.7	27.7	28.0	28.0	28.0	28.0	28.0	28.0
u202	12.6	14.5	18.0	21.3	23.5	25.5	25.8	25.8	25.8	25.8	25.8	25.8
u203	12.5	14.4	17.9	21.2	23.4	25.4	25.7	25.7	25.7	25.7	25.7	25.7
u204	13.2	15.1	18.6	21.9	24.1	26.1	26.4	26.4	26.4	26.4	26.4	26.4
u205	13.1	15.0	18.5	21.8	24.0	26.0	26.3	26.3	26.3	26.3	26.3	26.3

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u208	14.4	16.3	19.8	23.1	25.3	27.3	27.6	27.6	27.6	27.6	27.6	27.6
u216	17.3	19.2	22.7	26.0	28.2	30.2	30.5	30.5	30.5	30.5	30.5	30.5
u219	12.2	14.1	17.6	20.9	23.1	25.1	25.4	25.4	25.4	25.4	25.4	25.4
u221	14.1	16.0	19.5	22.8	25.0	27.0	27.3	27.3	27.3	27.3	27.3	27.3
u222	13.9	15.8	19.3	22.6	24.8	26.8	27.1	27.1	27.1	27.1	27.1	27.1
u223	13.8	15.7	19.2	22.5	24.7	26.7	27.0	27.0	27.0	27.0	27.0	27.0
u224	13.3	15.2	18.7	22.0	24.2	26.2	26.5	26.5	26.5	26.5	26.5	26.5
u225	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u226	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u227	13.3	15.2	18.7	22.0	24.2	26.2	26.5	26.5	26.5	26.5	26.5	26.5
u228	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u229	13.4	15.3	18.8	22.1	24.3	26.3	26.6	26.6	26.6	26.6	26.6	26.6
u230	13.3	15.2	18.7	22.0	24.2	26.2	26.5	26.5	26.5	26.5	26.5	26.5
u231	13.4	15.3	18.8	22.1	24.3	26.3	26.6	26.6	26.6	26.6	26.6	26.6
u232	13.5	15.4	18.9	22.2	24.4	26.4	26.7	26.7	26.7	26.7	26.7	26.7
u233	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u234	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u235	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u236	13.2	15.1	18.6	21.9	24.1	26.1	26.4	26.4	26.4	26.4	26.4	26.4
u237	13.2	15.1	18.6	21.9	24.1	26.1	26.4	26.4	26.4	26.4	26.4	26.4
u238	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u239	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u240	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u241	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u242	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u243	12.7	14.6	18.1	21.4	23.6	25.6	25.9	25.9	25.9	25.9	25.9	25.9
u244	12.7	14.6	18.1	21.4	23.6	25.6	25.9	25.9	25.9	25.9	25.9	25.9
u245	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u246	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u247	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u248	12.8	14.7	18.2	21.5	23.7	25.7	26.0	26.0	26.0	26.0	26.0	26.0
u250	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u251	12.8	14.7	18.2	21.5	23.7	25.7	26.0	26.0	26.0	26.0	26.0	26.0
u257	12.8	14.7	18.2	21.5	23.7	25.7	26.0	26.0	26.0	26.0	26.0	26.0
u260	12.7	14.6	18.1	21.4	23.6	25.6	25.9	25.9	25.9	25.9	25.9	25.9
u261	12.8	14.7	18.2	21.5	23.7	25.7	26.0	26.0	26.0	26.0	26.0	26.0
u266	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u271	12.7	14.6	18.1	21.4	23.6	25.6	25.9	25.9	25.9	25.9	25.9	25.9
u272	12.7	14.6	18.1	21.4	23.6	25.6	25.9	25.9	25.9	25.9	25.9	25.9
u273	12.8	14.7	18.2	21.5	23.7	25.7	26.0	26.0	26.0	26.0	26.0	26.0
u274	11.5	13.4	16.9	20.2	22.4	24.4	24.7	24.7	24.7	24.7	24.7	24.7
u275	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u276	12.9	14.8	18.3	21.6	23.8	25.8	26.1	26.1	26.1	26.1	26.1	26.1
u278	12.8	14.7	18.2	21.5	23.7	25.7	26.0	26.0	26.0	26.0	26.0	26.0
u295	18.8	20.7	24.2	27.5	29.7	31.7	32.0	32.0	32.0	32.0	32.0	32.0
u296	13.7	15.6	19.1	22.4	24.6	26.6	26.9	26.9	26.9	26.9	26.9	26.9
u297	13.9	15.8	19.3	22.6	24.8	26.8	27.1	27.1	27.1	27.1	27.1	27.1
u298	20.7	22.6	26.1	29.4	31.6	33.6	33.9	33.9	33.9	33.9	33.9	33.9
u299	14.1	16.0	19.5	22.8	25.0	27.0	27.3	27.3	27.3	27.3	27.3	27.3
u300	13.1	15.0	18.5	21.8	24.0	26.0	26.3	26.3	26.3	26.3	26.3	26.3
u301	13.1	15.0	18.5	21.8	24.0	26.0	26.3	26.3	26.3	26.3	26.3	26.3
u302	14.1	16.0	19.5	22.8	25.0	27.0	27.3	27.3	27.3	27.3	27.3	27.3
u307	13.0	14.9	18.4	21.7	23.9	25.9	26.2	26.2	26.2	26.2	26.2	26.2
u308	15.3	17.2	20.7	24.0	26.2	28.2	28.5	28.5	28.5	28.5	28.5	28.5

(i) Involved receiver

(u) Non-involved receiver

Table 31: Predicted noise levels, dB L_{A90} – V162-6.8MW

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
i1	26.4	26.4	27.4	30.7	33.9	35.7	35.7	35.8	36.2	36.5	36.7	36.9
i2	12.8	12.8	13.8	17.1	20.3	22.1	22.1	22.2	22.6	22.9	23.1	23.3
i3	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
i7	26.3	26.3	27.3	30.6	33.8	35.6	35.6	35.7	36.1	36.4	36.6	36.8
i8	28.0	28.0	29.0	32.3	35.5	37.3	37.3	37.4	37.8	38.1	38.3	38.5
i9	21.6	21.6	22.6	25.9	29.1	30.9	30.9	31.0	31.4	31.7	31.9	32.1
i10	21.3	21.3	22.3	25.6	28.8	30.6	30.6	30.7	31.1	31.4	31.6	31.8
i11	27.0	27.0	28.0	31.3	34.5	36.3	36.3	36.4	36.8	37.1	37.3	37.5
i12	25.4	25.4	26.4	29.7	32.9	34.7	34.7	34.8	35.2	35.5	35.7	35.9
i14	25.9	25.9	26.9	30.2	33.4	35.2	35.2	35.3	35.7	36.0	36.2	36.4
i15	26.9	26.9	27.9	31.2	34.4	36.2	36.2	36.3	36.7	37.0	37.2	37.4
i16	26.1	26.1	27.1	30.4	33.6	35.4	35.4	35.5	35.9	36.2	36.4	36.6
i17	24.9	24.9	25.9	29.2	32.4	34.2	34.2	34.3	34.7	35.0	35.2	35.4
i18	24.0	24.0	25.0	28.3	31.5	33.3	33.3	33.4	33.8	34.1	34.3	34.5
i19	25.2	25.2	26.2	29.5	32.7	34.5	34.5	34.6	35.0	35.3	35.5	35.7
i20	23.2	23.2	24.2	27.5	30.7	32.5	32.5	32.6	33.0	33.3	33.5	33.7
i21	19.8	19.8	20.8	24.1	27.3	29.1	29.1	29.2	29.6	29.9	30.1	30.3
i22	19.0	19.0	20.0	23.3	26.5	28.3	28.3	28.4	28.8	29.1	29.3	29.5
i23	15.4	15.4	16.4	19.7	22.9	24.7	24.7	24.8	25.2	25.5	25.7	25.9
i24	30.9	30.9	31.9	35.2	38.4	40.2	40.2	40.3	40.7	41.0	41.2	41.4
u9	12.3	12.3	13.3	16.6	19.8	21.6	21.6	21.7	22.1	22.4	22.6	22.8
u10	15.9	15.9	16.9	20.2	23.4	25.2	25.2	25.3	25.7	26.0	26.2	26.4
u11	17.7	17.7	18.7	22.0	25.2	27.0	27.0	27.1	27.5	27.8	28.0	28.2
u12	15.6	15.6	16.6	19.9	23.1	24.9	24.9	25.0	25.4	25.7	25.9	26.1
u13	15.4	15.4	16.4	19.7	22.9	24.7	24.7	24.8	25.2	25.5	25.7	25.9
u14	17.9	17.9	18.9	22.2	25.4	27.2	27.2	27.3	27.7	28.0	28.2	28.4
u15	20.2	20.2	21.2	24.5	27.7	29.5	29.5	29.6	30.0	30.3	30.5	30.7
u17	26.2	26.2	27.2	30.5	33.7	35.5	35.5	35.6	36.0	36.3	36.5	36.7
u18	23.3	23.3	24.3	27.6	30.8	32.6	32.6	32.7	33.1	33.4	33.6	33.8
u19	23.3	23.3	24.3	27.6	30.8	32.6	32.6	32.7	33.1	33.4	33.6	33.8
u20	25.1	25.1	26.1	29.4	32.6	34.4	34.4	34.5	34.9	35.2	35.4	35.6

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u21	18.4	18.4	19.4	22.7	25.9	27.7	27.7	27.8	28.2	28.5	28.7	28.9
u22	24.5	24.5	25.5	28.8	32.0	33.8	33.8	33.9	34.3	34.6	34.8	35.0
u23	16.3	16.3	17.3	20.6	23.8	25.6	25.6	25.7	26.1	26.4	26.6	26.8
u24	11.9	11.9	12.9	16.2	19.4	21.2	21.2	21.3	21.7	22.0	22.2	22.4
u25	14.7	14.7	15.7	19.0	22.2	24.0	24.0	24.1	24.5	24.8	25.0	25.2
u26	13.7	13.7	14.7	18.0	21.2	23.0	23.0	23.1	23.5	23.8	24.0	24.2
u27	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u28	19.1	19.1	20.1	23.4	26.6	28.4	28.4	28.5	28.9	29.2	29.4	29.6
u29	14.9	14.9	15.9	19.2	22.4	24.2	24.2	24.3	24.7	25.0	25.2	25.4
u30	14.5	14.5	15.5	18.8	22.0	23.8	23.8	23.9	24.3	24.6	24.8	25.0
u31	23.4	23.4	24.4	27.7	30.9	32.7	32.7	32.8	33.2	33.5	33.7	33.9
u36	20.3	20.3	21.3	24.6	27.8	29.6	29.6	29.7	30.1	30.4	30.6	30.8
u37	16.3	16.3	17.3	20.6	23.8	25.6	25.6	25.7	26.1	26.4	26.6	26.8
u38	25.2	25.2	26.2	29.5	32.7	34.5	34.5	34.6	35.0	35.3	35.5	35.7
u40	18.3	18.3	19.3	22.6	25.8	27.6	27.6	27.7	28.1	28.4	28.6	28.8
u41	21.0	21.0	22.0	25.3	28.5	30.3	30.3	30.4	30.8	31.1	31.3	31.5
u42	20.2	20.2	21.2	24.5	27.7	29.5	29.5	29.6	30.0	30.3	30.5	30.7
u43	19.8	19.8	20.8	24.1	27.3	29.1	29.1	29.2	29.6	29.9	30.1	30.3
u44	19.2	19.2	20.2	23.5	26.7	28.5	28.5	28.6	29.0	29.3	29.5	29.7
u45	16.1	16.1	17.1	20.4	23.6	25.4	25.4	25.5	25.9	26.2	26.4	26.6
u47	26.1	26.1	27.1	30.4	33.6	35.4	35.4	35.5	35.9	36.2	36.4	36.6
u49	21.6	21.6	22.6	25.9	29.1	30.9	30.9	31.0	31.4	31.7	31.9	32.1
u50	20.5	20.5	21.5	24.8	28.0	29.8	29.8	29.9	30.3	30.6	30.8	31.0
u51	25.2	25.2	26.2	29.5	32.7	34.5	34.5	34.6	35.0	35.3	35.5	35.7
u52	16.2	16.2	17.2	20.5	23.7	25.5	25.5	25.6	26.0	26.3	26.5	26.7
u53	20.8	20.8	21.8	25.1	28.3	30.1	30.1	30.2	30.6	30.9	31.1	31.3
u57	19.8	19.8	20.8	24.1	27.3	29.1	29.1	29.2	29.6	29.9	30.1	30.3
u58	25.9	25.9	26.9	30.2	33.4	35.2	35.2	35.3	35.7	36.0	36.2	36.4
u59	15.8	15.8	16.8	20.1	23.3	25.1	25.1	25.2	25.6	25.9	26.1	26.3
u60	15.4	15.4	16.4	19.7	22.9	24.7	24.7	24.8	25.2	25.5	25.7	25.9
u61	16.2	16.2	17.2	20.5	23.7	25.5	25.5	25.6	26.0	26.3	26.5	26.7
u62	19.4	19.4	20.4	23.7	26.9	28.7	28.7	28.8	29.2	29.5	29.7	29.9

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u63	19.5	19.5	20.5	23.8	27.0	28.8	28.8	28.9	29.3	29.6	29.8	30.0
u64	19.4	19.4	20.4	23.7	26.9	28.7	28.7	28.8	29.2	29.5	29.7	29.9
u65	19.3	19.3	20.3	23.6	26.8	28.6	28.6	28.7	29.1	29.4	29.6	29.8
u66	21.5	21.5	22.5	25.8	29.0	30.8	30.8	30.9	31.3	31.6	31.8	32.0
u70	19.2	19.2	20.2	23.5	26.7	28.5	28.5	28.6	29.0	29.3	29.5	29.7
u71	18.7	18.7	19.7	23.0	26.2	28.0	28.0	28.1	28.5	28.8	29.0	29.2
u80	15.3	15.3	16.3	19.6	22.8	24.6	24.6	24.7	25.1	25.4	25.6	25.8
u81	15.5	15.5	16.5	19.8	23.0	24.8	24.8	24.9	25.3	25.6	25.8	26.0
u84	14.0	14.0	15.0	18.3	21.5	23.3	23.3	23.4	23.8	24.1	24.3	24.5
u90	21.0	21.0	22.0	25.3	28.5	30.3	30.3	30.4	30.8	31.1	31.3	31.5
u91	20.9	20.9	21.9	25.2	28.4	30.2	30.2	30.3	30.7	31.0	31.2	31.4
u122	12.2	12.2	13.2	16.5	19.7	21.5	21.5	21.6	22.0	22.3	22.5	22.7
u137	14.4	14.4	15.4	18.7	21.9	23.7	23.7	23.8	24.2	24.5	24.7	24.9
u139	14.4	14.4	15.4	18.7	21.9	23.7	23.7	23.8	24.2	24.5	24.7	24.9
u140	12.9	12.9	13.9	17.2	20.4	22.2	22.2	22.3	22.7	23.0	23.2	23.4
u157	18.4	18.4	19.4	22.7	25.9	27.7	27.7	27.8	28.2	28.5	28.7	28.9
u158	19.4	19.4	20.4	23.7	26.9	28.7	28.7	28.8	29.2	29.5	29.7	29.9
u159	19.7	19.7	20.7	24.0	27.2	29.0	29.0	29.1	29.5	29.8	30.0	30.2
u160	23.5	23.5	24.5	27.8	31.0	32.8	32.8	32.9	33.3	33.6	33.8	34.0
u161	20.6	20.6	21.6	24.9	28.1	29.9	29.9	30.0	30.4	30.7	30.9	31.1
u162	21.0	21.0	22.0	25.3	28.5	30.3	30.3	30.4	30.8	31.1	31.3	31.5
u163	23.8	23.8	24.8	28.1	31.3	33.1	33.1	33.2	33.6	33.9	34.1	34.3
u164	23.5	23.5	24.5	27.8	31.0	32.8	32.8	32.9	33.3	33.6	33.8	34.0
u169	17.9	17.9	18.9	22.2	25.4	27.2	27.2	27.3	27.7	28.0	28.2	28.4
u170	19.1	19.1	20.1	23.4	26.6	28.4	28.4	28.5	28.9	29.2	29.4	29.6
u171	17.0	17.0	18.0	21.3	24.5	26.3	26.3	26.4	26.8	27.1	27.3	27.5
u172	15.4	15.4	16.4	19.7	22.9	24.7	24.7	24.8	25.2	25.5	25.7	25.9
u173	15.8	15.8	16.8	20.1	23.3	25.1	25.1	25.2	25.6	25.9	26.1	26.3
u202	13.5	13.5	14.5	17.8	21.0	22.8	22.8	22.9	23.3	23.6	23.8	24.0
u203	13.3	13.3	14.3	17.6	20.8	22.6	22.6	22.7	23.1	23.4	23.6	23.8
u204	14.1	14.1	15.1	18.4	21.6	23.4	23.4	23.5	23.9	24.2	24.4	24.6
u205	14.0	14.0	15.0	18.3	21.5	23.3	23.3	23.4	23.8	24.1	24.3	24.5

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u208	15.4	15.4	16.4	19.7	22.9	24.7	24.7	24.8	25.2	25.5	25.7	25.9
u216	18.3	18.3	19.3	22.6	25.8	27.6	27.6	27.7	28.1	28.4	28.6	28.8
u219	13.1	13.1	14.1	17.4	20.6	22.4	22.4	22.5	22.9	23.2	23.4	23.6
u221	15.1	15.1	16.1	19.4	22.6	24.4	24.4	24.5	24.9	25.2	25.4	25.6
u222	14.8	14.8	15.8	19.1	22.3	24.1	24.1	24.2	24.6	24.9	25.1	25.3
u223	14.7	14.7	15.7	19.0	22.2	24.0	24.0	24.1	24.5	24.8	25.0	25.2
u224	14.2	14.2	15.2	18.5	21.7	23.5	23.5	23.6	24.0	24.3	24.5	24.7
u225	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u226	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u227	14.2	14.2	15.2	18.5	21.7	23.5	23.5	23.6	24.0	24.3	24.5	24.7
u228	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u229	14.3	14.3	15.3	18.6	21.8	23.6	23.6	23.7	24.1	24.4	24.6	24.8
u230	14.2	14.2	15.2	18.5	21.7	23.5	23.5	23.6	24.0	24.3	24.5	24.7
u231	14.4	14.4	15.4	18.7	21.9	23.7	23.7	23.8	24.2	24.5	24.7	24.9
u232	14.4	14.4	15.4	18.7	21.9	23.7	23.7	23.8	24.2	24.5	24.7	24.9
u233	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u234	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u235	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u236	14.1	14.1	15.1	18.4	21.6	23.4	23.4	23.5	23.9	24.2	24.4	24.6
u237	14.1	14.1	15.1	18.4	21.6	23.4	23.4	23.5	23.9	24.2	24.4	24.6
u238	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u239	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u240	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u241	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u242	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u243	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u244	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u245	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u246	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u247	13.7	13.7	14.7	18.0	21.2	23.0	23.0	23.1	23.5	23.8	24.0	24.2
u248	13.7	13.7	14.7	18.0	21.2	23.0	23.0	23.1	23.5	23.8	24.0	24.2
u250	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3

Receiver	Hub-height wind speed, m/s											
	4	5	6	7	8	9	10	11	12	13	14	15
u251	13.7	13.7	14.7	18.0	21.2	23.0	23.0	23.1	23.5	23.8	24.0	24.2
u257	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u260	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u261	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u266	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u271	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u272	13.6	13.6	14.6	17.9	21.1	22.9	22.9	23.0	23.4	23.7	23.9	24.1
u273	13.7	13.7	14.7	18.0	21.2	23.0	23.0	23.1	23.5	23.8	24.0	24.2
u274	12.4	12.4	13.4	16.7	19.9	21.7	21.7	21.8	22.2	22.5	22.7	22.9
u275	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u276	13.8	13.8	14.8	18.1	21.3	23.1	23.1	23.2	23.6	23.9	24.1	24.3
u278	13.7	13.7	14.7	18.0	21.2	23.0	23.0	23.1	23.5	23.8	24.0	24.2
u295	19.8	19.8	20.8	24.1	27.3	29.1	29.1	29.2	29.6	29.9	30.1	30.3
u296	14.6	14.6	15.6	18.9	22.1	23.9	23.9	24.0	24.4	24.7	24.9	25.1
u297	14.8	14.8	15.8	19.1	22.3	24.1	24.1	24.2	24.6	24.9	25.1	25.3
u298	21.6	21.6	22.6	25.9	29.1	30.9	30.9	31.0	31.4	31.7	31.9	32.1
u299	15.1	15.1	16.1	19.4	22.6	24.4	24.4	24.5	24.9	25.2	25.4	25.6
u300	14.1	14.1	15.1	18.4	21.6	23.4	23.4	23.5	23.9	24.2	24.4	24.6
u301	14.0	14.0	15.0	18.3	21.5	23.3	23.3	23.4	23.8	24.1	24.3	24.5
u302	15.0	15.0	16.0	19.3	22.5	24.3	24.3	24.4	24.8	25.1	25.3	25.5
u307	13.9	13.9	14.9	18.2	21.4	23.2	23.2	23.3	23.7	24.0	24.2	24.4
u308	16.3	16.3	17.3	20.6	23.8	25.6	25.6	25.7	26.1	26.4	26.6	26.8

(i) Involved receiver

(u) Non-involved receiver

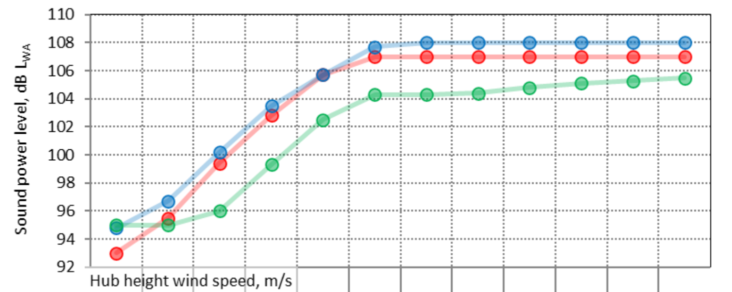
APPENDIX K NZS 6808 DOCUMENTATION

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

(b) Noise sensitive locations: See Section 2.0 and Appendix D

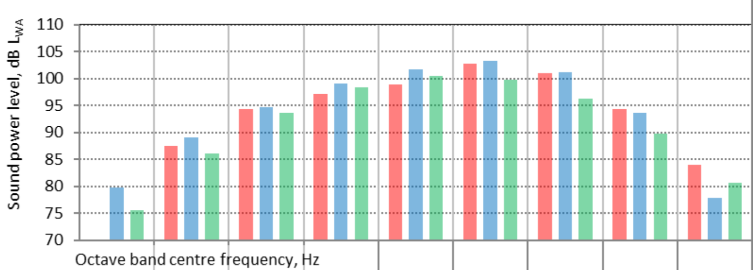
(c) Wind turbine sound power levels, L_{WA} dB (refer to Section 6.3.1)

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
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
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
V162-6.8MW	95.0	95.0	96.0	99.3	102.5	104.3	104.3	104.4	104.8	105.1	105.3	105.5

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
SG 6.6-170		87.5	94.4	97.1	98.9	102.8	100.9	94.3	84.0
GE 6.0-164	79.8	89.1	94.6	99.1	101.7	103.3	101.1	93.6	77.8
V162-6.8MW	75.6	86.0	93.6	98.4	100.5	99.7	96.2	89.8	80.7

(d) Wind turbine model: See Table 7 of Section 6.2

(e) Wind turbine hub height: See Table 7 of Section 6.2

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

(g) Calculation procedure used: ISO 9613-2 prediction algorithm as implemented in SoundPLAN v8.2 (See Section 4.3 and Appendix H)

(h) Meteorological conditions assumed: See Table 5 of Section 4.3

(i) Air absorption parameters:

	Octave band mid frequency, Hz							
Description	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
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 F

(k) Predicted far-field wind farm sound levels: See Section 6.4 and Appendix J.

APPENDIX L CONSTRUCTION EQUIPMENT DATA

A variety of construction equipment would be used for this project.

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

Table 32 summarises the noise emissions used to represent key items of plant associated with construction.

Table 32: Construction noise sources sound power data, dB L_{WA}

Noise source	Sound power level
Batching Plant	110
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 (100 to 200 kW)	107
Excavator fitted with pneumatic breaker	118
Generator	99
Grader	110
Tracked loader	115

Overall aggregated total sound power levels for key construction tasks have been determined on the basis of a typical 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 presented solely as an indication of construction noise levels.

The overall total aggregated sound power levels for each of the key construction tasks are detailed in Table 33, and assume that each item of plant associated with a task operates simultaneously for the entire duration of an assessment period.

MARSHALL DAY Acoustics

Table 33: Overall sound power levels of key construction tasks

Construction task	Plant/Equipment	Approximate overall sound power level, dB L_{WA}
Access road construction	2 x Excavator (100 to 200 kW), 1 x Tracked loader, 2 x Dump truck, 1 x Grader, 1 x Bulldozer	120
Cable trench digging	1 x Excavator (100 to 200 kW), 1 x Dump truck, 1 x Generator, 1 x Bulldozer	120
Concrete batching plant	1 x Concrete truck, 1 x Concrete pump, 1 x Batching plant	115
Site compound construction	1 x Excavator (100 to 200 kW), 1 x Crane (200 t), 1 x Delivery truck, 1 x Concrete truck, 1 x Concrete pump, 1 x Generator, 1 x Bulldozer	115
Substation construction	1 x Excavator (100 to 200 kW), 1 x Crane (500 t), 1 x Delivery truck, 1 x Concrete truck, 1 x Concrete pump, 1 x Generator, 1 x Bulldozer	115
Temporary site compound construction	1 x Excavator (100 to 200 kW), 1 x Crane (200 t), 1 x Delivery truck, 1 x Concrete truck, 1 x Concrete pump, 1 x Generator, 1 x Bulldozer	115
Turbine assembly	2 x Crane (200 t), 2 x Crane (500 t), 1 x Crane (1,200 t), 1 x Generator	120
Turbine foundations	1 x Excavator fitted with pneumatic breaker, 1 x Excavator (100 to 200 kW), 1 x Crane (200 t), 1 x Delivery truck, 1 x Concrete truck, 1 x Concrete pump, 1 x Generator, 1 x Bulldozer	120