JEREMIAH WIND FARM

Scoping Report - Appendices

16 July 2021

Appendix A – Scoping Worksheet

Appendix B – Preliminary Noise Assessment

Appendix A - Scoping Worksheet

Scoping Worksheet for Proposal:		Jeremiah Wind Farm						Stage of Proposal:				Date:	11-Jun-21
What matters might be impacted?		What activities might cause an impact?		What are the characteristics of the impact?						How will the impact be managed?	What are the community & other stakeholders views?	What type of assessment and engagement is required in the EIS stage?	
Environmental and social matters these are natural or human assets or values aggregated at the level most appropriate for informing management and assessment requirements *for more information about the matters click the link above*		Without any mitigation, will the proposal impact on the matter?	If there is a "likely" impact: 1. list the activities likely to cause the impact; and 2. if applicable, list the receptor being impacted and its status. *E.g. clearing 100ha EEC, or construction noise nearby school* If "unlikely", why? has the impact been actively avoided through project design or site location?	Is the impact, without mitigation, likely to cause a material effect with regard to its ...				Does the impact need assessment in the EIS? *(auto fills)*	Is the impact, without mitigation, likely to have a material cumulative effect with other impacts from emerging projects?	What safeguards and management measures are likely to be required to address the impact?	Are there community & other stakeholder concerns regarding the impact or activity? *(requires consultation)*	Likely level of assessment and/or engagement required *(auto fills)*	Relevant Section in Scoping Report
				Extent	Duration	Severity	Sensitivity						
AMENITY	acoustic	Likely	Construction - nuisance noise levels during construction, road traffic noise, vibration. Operation - nuisance noise levels from operation of wind turbines. Receptors - nearby residences, community (road noise), fauna.	Y	Y	N	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Noise & Vibration
	visual	Likely	Construction - Reduction in visual amenity associated with construction equipment and machinery and ground disturbance/vegetation removal; lighting impacts. Operational - Location of wind turbines and impact on visual amenity and scenic landscape character; shadow flicker disturbance at each turbine. Potential cumulative impacts. Receptors - nearby residences, adjoining landscapes, community.	Y	Y	Y	Y		Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Landscape and Visual Amenity
	odour	Likely	Construction - potential odour impacts from vehicle and machinery exhausts and any chemicals used in construction. Receptor - nearby residences	N	N	N	Y	No	No	Standard	No	Other Issue	Other Issues
	microclimate	Likely	Operational - configuration and siting of turbines creates micro climate changes in wind speed and turbulent mixing, potentially affecting local temperatures, CO_2 levels and moisture levels. Potential impacts on agricultural uses. Receptor - land users, flora, fauna, community.	Y	Y	?	?	Yes	Unknown	Standard	Unknown	Other Issue	Unsure which technical report addresses microclimate impacts of the wind farm - is this usually picked up in SEARs?
	other - please specify												
ACCESS	access to property	Likely	Construction - Blocking of residential access during construction and delivery of WT; Increased traffic volumes . Receptors - general public, road users, residences.	Y	N	N	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Traffic & Transport
	access to services	Likely	Construction - potential disruption of services during construction, increased demand on existing services including power, water, telecommunications	Y	N	N	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Traffic & Transport
	road and rail network	Likely	Construction - Traffic impacts from transportation of oversize wind turbines to the project site for construction; increase in traffic volumes. Operational - maintenane vehicles, truck movements. Receptors - general public, drivers, cyclists, pedestrians (existing road network)	Y	Y	N	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Traffic & Transport
	offsite parking	Likely	Construction - potential for parking on site, off site and surrounding areas during construction by staff, contractors. Receptors - Community, nearby residences	Y	N	N	Y	Yes	No	Project Specific	Unknown	Key Issue	Traffic & Transport
	other - please specify												
BUILT ENVIRONMENT	public domain	Likely	Operational - WT are large structures and likely to affect the aesthetic appeal of the rural and natural environment. Receptors - Community / general public, residences	Y	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Visual Amenity
	public infrastructure	Likely	Construction - potential impacts to local roads, any local bridges due to construction, vibration activities. Receptor - Residences, community.	Y	N	N	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Noise & Vibration
	other built assets	Likely	Construction - potential impacts to private built assets including houses, sheds, private roads and bridges etc due to construction vibration. Receptor - nearby residences.	Y	N	N	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Noise & Vibration
	other - please specify												

What does the proposal mean for people?	HERITAGE	natural	Likely	There are National Parks and State Forests adjacent to the project site boundary and in proximity to some proposed WTGs. Whilst direct impacts are not expected to the Reserves, indirect impacts are likely including microclimate, noise, erosion and sedimetation, dust deposition.	Y	N	N	Y	Yes	No	Standard	Yes	Other Issue + Focussed Engagement	Other Issue
		cultural	Likely	Contruction - excavation, access road construction, construction of WT potential to impact on known and unknown artefacts/values. May include natural heritage items or places listed on LEP schedules, State Heritage Register, Aboriginal Heritage Information Management System (AHIMS), National Heritage List, World Heritage List, or objects and places not listed of heritage value likely to be on impacted. Operational - permanent change to potentially sacred and cultural landscapes and places for Aboriginal people. Receptor - Aboriginal people, community	N	Y	Y	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Historic Heritage
		Aboriginal cultural	Likely	As above.	N	Y	Y	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Aboriginal Cultural
		built	Likely	No registered historical hertiage sites have been recorded in the vicnitiy of the proposed area for the JWF. Despite this, there remains the potential for presence of remains from mid and late nineteenth century mining and settlement, or listings to occur in the meantime. Receptor - community	N	Y	Y	Y	Yes	No	Project Specific	Unknown	Key Issue	Historic Heritage
		other - please specify												
	SOCIAL	health	Likely	Construction - potential for localised impacts to physical health from air pollution, water pollution, odour. Operational - impacts to physical and mental health, including from electromagnetic fields, low frequency noise and infrasound, shadow flicker and blade glint. Receptors - general public / community, nearby residences.	Y	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Hazards and Risks / Social and Economic
		safety	Likely	Construction - safety of public on road network relating to transportation of WT and potential for incidents. Operational - infrastructure design and potential for bushfire, blade throw, and including impacts addressed above in health. Receptors - Community, residences	Y	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Hazards and Risks / Social and Economic
		community services and facilities	Unlikely	The proposal is unlikely to impact on the availability of or access to education, healthcare, open space and recreation facilities for the affected community.								Unknown	Scoping Report	Scoping Only Issues
		housing availability	Unlikely	the proposal is unlikely to impact on housing availability. Land is in rural zones unlikely to provide future potential subdivision potential.								Unknown	Scoping Report	Scoping Only Issues
		social cohesion	Likely	Construction and operation - Potential conflict created in the community; opposition to the project; conflict between affected landowners. Receptor - nearby properties, community, general public.	Y	Y	N	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Social & Economic
		other - please specify												
	ECONOMIC	natural resource use	Likely	Construction - use of local natural resources i.e. from local quarries or through the creation of quarries may have a positive economic effect. Operational change in land use inlocations of WT unlikely to affect availability of and access to natural resources.	Y	Y	N	N	Yes	Unknown	Standard	Unknown	Other Issue	Other Issue
		livelihood	Likely	Operational - Decreased land value may affect the livelihood of some landowners. Receptor - landowners and nearby landowners.	N	Y	Y	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Social & Economic
		opportunity cost	Unknown	It is unlikely that there will be any predicted loss of business opportunity.	Y	Y	N	Y	Yes	Unknown	Project Specific	No	Key Issue	Social & Economic
		other - please specify												
		particulate matter	Likely	Construction - Air quality impacts from construction dust. Receptor - construction staff, nearby residences, flora and fauna	Y	N	N	Y	Yes	No	Standard	No	Other Issue	Other Issues
		gases	Likely	Emissions are associated with conventional energy sources used in the construction and maintenance of the WF facilities.	Y	N	N	Y	Yes	No	Standard	No	Other Issue	Other Issues

What does the proposal mean for the natural environment?	AIR	atmospheric emissions	Unlikely	Long term positive. There will be no long term change in the pattern of the weather; the wind farm aims to reduce atmospheric emissions attributed to other forms of energy production i.e. fossil fuel burning.								No	Scoping Report	Scoping Only Issues
		other - please specify												
	BIODIVERSITY	native vegetation	Likely	Construction - Disturbance/loss of vegetation during construction, including potential direct and indirect impacts to Threatened Ecological Communities and threatened flora species. Impacts inlucde clearing, sedimentation, dust deposition, erosion, weed introduction and/or spread, soil and/or water pollution. Operational - potential indirect impacts associated with weed spread, erosion. Receptor - vegetation communities, plants.	N	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Biodiversity
		native fauna	Likely	Construction - disturbance / loss of habitat, injury and mortality from vehicle strike, indirect construction related impacts including light, noise, dust. Operational - injury and mortality (i.e. bird and bat strike) through direct collision or barotrauma. Potential continuation of indirect impacts, introduction of weeds and competitive pests. Receptor - fauna	N	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Biodiversity
		other - please specify	Likely	Construction and operational - impacts on terrestrial and aquatic ecosystems including loss or modification of habitat for aquatic species. Introduction / spread of weeds. Introduction/spread of pests. Sedimentation and erosion. Soil and water pollution. Indirect impacts of proposal e.g. light, noise, dust. Receptor - ecosystems, flora, fauna.	Y	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Biodiversity
	LAND	stability / structure	Likely	Construction - excavation, disturbance and erosion of soils and productive topsoil, exposure of soils to wind and/or water erosion, compaction of soils leading to concentrated run off. Receptors - general public, infrastructure, watercourses.	Y	N	Y	Y	Yes	No	Project Specific	No	Key Issue	Geology & Soils
		soil chemistry	Likely	Construction - soil contamination from spills, introduction and spread of weeds. Receptors - general public, watercourse, flora and fauna.	Y	N	N	Y	Yes	No	Project Specific	No	Key Issue	Geology & Soils
		capability	Likely	Construction - excavation and clearing of productive soils and potential for reduced agricultural viability. Operational - use of and removal of rural land. Weed incursion and spread into nearby properties. Receptors - Nearby properties and residents.	Y	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Social and Economic
		topography	Likely	Construction - excavation and stockpiling associated with access roads, WTs affecting high elevations, steep slopes and waterways. Receptor - watercourses.	N	N	Y	Y	Yes	No	Project Specific	No	Key Issue	Geology & Soils
		other - please specify												
	WATER	water quality	Likely	Construction - degradation of surface water quality related to construction sediment and erosion, dust deposition, construction pollution from spills, contamination from construction waste., potential degradation of groundwater quality. Receptor - watercourses, groundwater, fauna, community.	Y	N	Y	Y	Yes	Unknown	Project Specific	Unknown	Key Issue	Water
		water availability	Likely	Construction - Availability of water for construction, potential reduction in groundwater quantity if drawdowns required for project. Receptor - groundwater aquifer or surface water, licenced users, aquatic fauna, vegetation.	Y	N	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Water
		hydrological flows	Likely	Construction - concentrated / increased run off. Receptor - general public, residences, flora and fauna.	Y	N	N	Y	Yes	Unknown	Project Specific	Unknown	Key Issue	Water
		other - please specify												
		coastal hazards	n/a										No assessment necessary - Worksheet only	
		flood waters	Unknown	Construction and operational - Potential impact to access ways resulting from local flooding of watercourses, or flooding external to the site affecting transportation of WT, site personnel access. Receptor - community, staff	Y	N	N	Y	Yes	Unknown	Project Specific	Unknown	Key Issue	Water

What risks does the proposal face?	RISKS	bushfire	Likely	Construction - potential for bushfire starting from construction activities. potential for construction to be affected by a bushfire. Operational - Potential for bushfire starting from electrical malfunction. These potential impacts are exacerbated by location of project within bushland/ rural environments. Receptors - general public, built environment, infrastructure, fauna, vegetation	Y	Y	Y	Y	Yes	Unknown	Project Specific	Yes	Key Issue + Focussed Engagement	Hazards and Risks
		undermining	Likely	Construction - Project area has potential to contain archaeological evidence of mid and late nineteenth century mining activities. Receptor - community	N	N	Y	Y	Yes	No	Project Specific	Unknown	Key Issue	Historic Heritage
		steep slopes	Likely	Construction and operation - project area is in areas of steep to rolling hills. Steep slopes may be impacted by construction impact resulting in impact to environment from landslip, erosion, sedimentation. Potential impacts may extend to built infrastructure in the case of erosion/collapse. Receptor - vegetation, fauna, infrastructure	N	Y	Y	Y	Yes	No	Project Specific	Yes	Key Issue + Focussed Engagement	Geology & Soils
		other - please specify	Likely	Operational - potential impact to aviation safety. Potential effects on telecommunications distributors and systems. Receptors - aviation industry, community/public, service providers.	Y	Y	Y	Y	Yes	Unknown	Project Specific	Unknown	Key Issue	Hazards and Risks

Appendix B - Preliminary Noise Assessment

MARSHALL DAY Acoustics

JEREMIAH WIND FARM
PRELIMINARY NOISE ASSESSMENT

Rp 001 R01 20200782 | 9 July 2021

Marshall Day Acoustics Pty Ltd
ABN: 53 470 077 191
4/46 Balfour St
Chippendale NSW 2008
Australia
T: +612 9282 9422
www.marshallday.com

Project: **JEREMIAH WIND FARM**

Prepared for: **Eco Logical Australia**
GPO BOX 1558
Level 2, 11 London Circuit
Canberra
ACT 2601

Attention: **Skye O'Brien**

Report No.: **Rp 001 R01 20200782**

Document Control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Superseded	--	For issue to client	12 May 2021	A. Stoker	C. Delaire
Complete	R01	Includes conceptual 300 m tip height turbine	9 July 2021	A. Stoker	J. Adcock

EXECUTIVE SUMMARY

A preliminary assessment of operational noise for the proposed Jeremiah Wind Farm has been carried out in accordance with the NSW Department of Planning and Environment's *Wind Energy: Noise Assessment Bulletin - For State significant wind energy development*, dated December 2016 (the NSW Noise Assessment Bulletin).

This noise assessment has been prepared based on the current project design comprising sixty-five (65) multi-megawatt wind turbine generators and associated ancillary infrastructure within the wind farm site. Noise modelling was undertaken based on three (3) candidate turbine models as nominated by the proponent. The candidate models are in the generation capacity range of 5.5 MW to 6.0 MW and are typical of the type of turbines which are being considered for the site, and are representative of the tallest turbines presently available on the market.

Noise levels have also been predicted for one (1) conceptual turbine model with a tip height of 300 m, corresponding to the maximum tip height that the proponent is understood to be seeking consent for. As 300 m tip height turbines are not currently available on the market, a conceptual turbine has been modelled by adjusting the hub height of one of the candidate turbines to provide a tip height of 300 m.

The results of the modelling demonstrate that the project can be designed and operated to comply with the operational noise requirements of the NSW Noise Assessment Bulletin.

Once the Secretary's Environmental Assessment Requirements (SEARs) are released for this project, further detailed assessment will be undertaken to support a subsequent development application. This would include background noise monitoring at selected receivers around the site, revised modelling and assessment of other noise considerations including special noise characteristics, construction and ancillary infrastructure to demonstrate how compliance with the specific noise matters defined by the SEARs for the project would be achieved.

TABLE OF CONTENTS

1.0 INTRODUCTION

Jeremiah Wind farm Pty Ltd (JWF), on behalf of CWP Renewables (CWPR), is proposing to develop a wind farm known as Jeremiah Wind Farm located in NSW, approximately 95 kilometres northwest of Canberra.

This report presents the results of a preliminary noise assessment prepared for submission with a Scoping Report and a Secretary's Environmental Assessment Requirements (SEARs) request.

The preliminary noise assessment has been prepared in accordance with the NSW Department of Planning and Environment's *Wind Energy: Noise Assessment Bulletin - For State significant wind energy development*, dated December 2016 (the NSW Noise Assessment Bulletin) and based on:

- The minimum (base) operational noise limit determined in accordance the NSW Noise Assessment Bulletin;
- Preliminary noise modelling for the project based on the current proposed site layout, three (3) candidate turbine models and one (1) conceptual turbine model, representative of the size and type of turbine being considered for the site; and
- A comparison of the predicted noise levels with the base noise limit.

At this stage, Marshall Day Acoustics Pty Ltd (MDA) has not been advised of existing or approved wind farms within 10 km of the proposed subject site. Therefore, potential cumulative noise considerations have not been assessed for the project at this stage.

Other noise considerations relating to the project would be assessed during the development application stage of the project. This would include the noise of construction and ancillary infrastructure associated with the project, along with any other specific noise matters defined by the SEARs when issued.

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

2.0 PROJECT DESCRIPTION

2.1 Overview

The proposed Jeremiah Wind Farm is located in the Southern Tablelands region of NSW, approximately 95 km northwest of Canberra. The project comprises a wind farm component and associated infrastructure such as substations, overhead and underground electrical cable routes, and access tracks.

The current project design comprises a total of sixty-five (65) wind turbines. The coordinates of the wind turbines are presented in tabular format in Appendix B.

A total of ninety-four (94) noise sensitive receivers are located within 8 km from the proposed wind turbine locations. This includes twelve (12) receivers associated with the project. The remainder of the receivers are referred to as non-associated receivers.

Typically, MDA would assess noise to receivers within 3 km, a nominal distance commonly referenced on account of being significantly greater than the separation distance required to achieve compliance with the lowest possible noise limit of 35 dB L_{Aeq}. For the purposes of this assessment CWPR has requested that MDA assess noise at all receivers within 8 km from the project.

The coordinates of the receivers are tabulated in Appendix C.

A site layout plan illustrating the turbine layout and receiver locations is provided in Appendix D.

2.2 Wind turbines

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

The turbine model(s) to be assessed in detail as part of the development application will be determined from ongoing project design development. Further, if the project were ultimately approved, the final wind turbine model would only be selected after a tender process to procure the supply of turbines. The final selection would be made on account of a range of design requirements including achieving compliance with relevant noise limits at surrounding noise sensitive receiver.

2.2.1 Candidate wind turbine models

To assess the proposed development at this stage in the project, it is necessary to consider representative candidate turbine models for the size and type of turbines being considered. The purpose of using candidate turbines in this assessment is to inform a preliminary assessment of operational noise, accounting for the base noise limit and noise emission levels that are typical of the size of turbines being considered for the development. While three (3) leading turbine manufacturer’s data has been relied on for the assessment, the turbine make and model has not been specified at this stage for commercial reasons, at the request of CWPR.

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

2.2.2 Conceptual wind turbine model

In addition to the three (3) candidate turbines, one (1) conceptual turbine model with a tip height of 300 m has been modelled to account for the envelope of turbine tip heights being considered by the proponent.

It is understood that 300 m tip height turbines are anticipated by the industry, but are not currently available on the market, meaning manufacturer's noise data is not available. To approximate a 300 m tip height turbine model, the hub height of Candidate Turbine 3 has been adjusted such that the rotor tip height corresponds with 300 m. The noise data associated with Candidate Turbine 3 is also used for predictions.

The above approach represents the most reasonable approximation that MDA can provide given the limitations imposed by lack of manufacturers data or specific 300 m tip height specifications. We note that this arrangement has been developed solely to approximate the potential noise emissions from a conceptual 300 m tip height turbine.

Details of the candidate and conceptual wind turbine models are provided in Table 1.

Table 1: Candidate wind turbine model details

Item	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
Rated power	5.6 MW	5.5 MW	6.0 MW	6.0 MW
Rotor diameter	162 m	158 m	170 m	170 m
Modelled hub height	166 m	161 m	165 m	215 m
Modelled tip height	247 m	240 m	250 m	300 m
Operating mode	Standard	Standard	Standard	Standard
Serrated trailing edge	Yes	Yes	Yes	Yes

A wind turbine model (or models) with suitable specifications will be used in the Environmental Impact Statement (EIS), to reflect the candidate wind turbine models under consideration at the time. Accordingly, the noise assessment undertaken for the EIS would reflect those wind turbine models.

2.3 Wind turbine noise emissions

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

Sound power level data for the candidate turbine models were sourced from the respective manufacturer's specification document supplied by CWPR at the time of reporting. The provided 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.

The sound power levels referenced in this assessment, including the +1.0 dB adjustment, are illustrated in Table 2. The overall level represents the total noise emission of the turbines, including the secondary contribution of ancillary plant associated with the turbines (e.g. cooling fans and internal transformer).

The sound power levels in Table 2 are considered typical of the range of noise emissions associated with comparable multi-megawatt wind turbines and therefore considered appropriate to reference in this preliminary assessment.

The sound frequency characteristics of the turbines were also sourced from the respective manufacturer's specification document supplied by CWPR at the time of reporting. The reference spectra used as the basis for this assessment are illustrated Table 3 and corresponds to the highest overall sound power level detailed in Table 2.

Table 2: Turbine assessment sound power levels (including +1 dB for test uncertainty), dB L_{WA}

	Hub height wind speed m/s								
Turbine	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**≥12**
Candidate Model 1	94.7	95.3	98.3	101.2	103.9	105.0	105.0	105.0	105.0
Candidate Model 2	94.8	95.5	98.6	102.0	104.9	107.0	107.0	107.0	107.0
Candidate Model 3	93.0	95.5	99.4	102.8	105.7	107.0	107.0	107.0	107.0

Table 3: Turbine assessment sound power level spectrum (including +1 dB for test uncertainty), dB L_{WA}

	Octave band centre frequency (Hz)									
Turbine	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**Total**
Candidate Model 1[1]	76.0	86.4	93.8	98.3	100.1	99.0	94.9	88.2	78.5	105.0
Candidate Model 2[2]	79.0	88.2	93.6	98.2	100.6	102.3	100.1	92.7	77.0	107.0
Candidate Model 3[3]	74.7	88.5	95.3	97.5	98.5	101.7	101.4	96.9	85.1	107.0

[1] Based on one-third octave band levels at 12 m/s
[2] Based on octave band levels at 9 m/s
[3] Based on octave band sound power levels at 9 m/s adjusted to the highest overall sound power level

Neither of the manufacturer specification document for the candidate turbine models provide information about tonality.

The occurrence of tonality in the noise of contemporary multi-megawatt turbine designs is generally limited. This is supported by evidence of operational wind farms in Australia which indicates that the occurrence of tonality at receiver locations is atypical. On this basis, adjustments for tonality have not been applied to the predicted noise levels presented in this preliminary assessment. Notwithstanding this, the subject of tonality would be addressed in subsequent assessment stages for the project. As part of this, further information will need to be obtained from the manufacturer(s) concerning tonality.

As described in Section 2.2, manufacturer's noise data associated with Candidate Turbine 3 has been used for the approximation of Conceptual Turbine 1. This includes assessment sound power levels and the associated sound power level spectrum.

2.4 Low frequency noise

The other special noise characteristic which is assessable in accordance with the NSW Noise Assessment Bulletin is low frequency noise. While there is a prescribed criterion for the application of low frequency noise penalty adjustments in the NSW Noise Assessment Bulletin (based on C-weighted noise levels), there is no established or verified engineering prediction method of C-weighted noise levels associated with the operation of wind turbines.

For the purposes of this report, a risk assessment approach has been adopted using a simplified prediction method to estimate the C-weighted noise levels. Details of the study have been provided in Appendix H.

3.0 ASSESSMENT CRITERIA

3.1 Operational wind farm noise criteria

3.1.1 Non-associated receivers

The NSW Department of Planning and Environment publication *Wind Energy: Noise Assessment Bulletin* dated December 2016 (the NSW Noise Assessment Bulletin) provides guidance on how noise impacts are to be assessed for large-scale wind energy development projects that are State Significant Development.

The NSW Noise Assessment Bulletin states that the South Australian EPA publication *Wind farms environmental noise guidelines* dated July 2009 (the SA EPA Guideline) is to be used as the relevant assessment standard, subject to a set of variations that apply to the assessment of NSW projects. The variations are defined for:

- noise limits;
- special noise characteristics; and
- noise monitoring.

In relation to noise limits, the variation defined in the NSW Noise Assessment Bulletin sets the base criterion at a value of 35 dB L_{Aeq} for all projects, in lieu of the 35 to 40 dB base criterion range defined in the SA EPA Guideline. The criteria in the NSW Noise Assessment Bulletin are defined as follows:

> *The predicted equivalent noise level ($L_{Aeq,10\ minute}$)*, adjusted for tonality and low frequency noise in accordance with these guidelines, should not exceed 35 dB(A) or the background noise ($L_{A90(10\ minute)}$) by more than 5 dB(A), whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the wind turbine generator and each integer wind speed in between.*
>
> ** Determined in accordance with SA 2009, Section 4.*

Variations are also defined in the NSW Noise Assessment Bulletin for the assessment of special noise characteristics. These procedures will be referenced in subsequent detailed assessment phases for the project.

The NSW Noise Assessment Bulletin notes the following in relation to the types of receivers where the noise limits apply:

> *The criteria in this Bulletin have been developed to address potential noise impacts on the amenity of residents and other relevant receivers in the vicinity of a proposed wind energy project. Wind energy proponents commonly negotiate agreements with private land owners where applicable noise limits may not be achievable at relevant receiver locations. A negotiated agreement will be considered as part of the assessment of a wind energy project, as will the requirements of SA 2009 and this Bulletin. The proponent's EIS should clearly identify the expected noise levels at all receiver locations including host properties to ensure that affected persons are appropriately informed regarding the development proposal.*

3.1.2 Associated receivers

The assessment criteria detailed in the previous section apply to all noise sensitive receivers that are not associated with the proposed project (e.g. by way of land ownership or a negotiated agreement). However, in accordance with the requirements of the NSW Noise Assessment Bulletin, predicted noise levels are also presented for participating receivers, comprising host properties and receivers where a noise agreement is in place.

Notwithstanding the above, a reference level of 45 dB L_{Aeq} is presented for participating receivers in order to provide context to the predicted noise levels for these locations. This is consistent with the SA EPA Guideline which recommends a level of 45 dB for *financial stakeholders*. Comparisons between the predicted noise levels and the 45 dB reference level are provided for informative purposes only. Noise levels at these receivers will ultimately need to be managed in accordance with the commercial agreements established between the proponent and the landowners.

4.0 ASSESSMENT METHOD

Operational wind farm noise levels are predicted using:

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

At this preliminary stage of assessment, the primary consideration is potential A-weighted noise levels associated with operation of the wind turbines.

The method selected to predict A-weighted 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 the SA EPA Guideline and has been shown to provide a reliable method of predicting the typical upper A-weighted levels of the noise expected to occur in practice from wind farm developments.

The ISO 9613-2 method is used in conjunction with a set of input choices and procedural modifications that are specific to wind farm noise assessment, based on international research and guidance.

The noise prediction method is summarised in Table 4 with further discussion of the method and the calculation choices is provided in Appendix E.

Table 4: Downwind prediction methodology

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 noise modelling software and relate to the influence of terrain screening and ground effects on sound propagation. Specific details of adjustments are noted below and are discussed in Appendix E.
Source characterisation	Each wind turbine is modelled as a point source of sound. The total sound of the wind farm is then calculated based on simultaneous operation of all wind turbines and summing the contribution of each. Calculations of turbine to receiver distances and average sound propagation heights are made based on the point source being located at the position of the hub of the turbine. Calculations of terrain related screening are made based on the point source being located at the maximum tip height of each turbine. Further discussion of terrain screening effects is provided below.
Terrain data	Elevation contours in 5 m resolution provided by CWPR

Detail	Description
Terrain effects	Adjustments for the effect of terrain are determined and applied based on the UK Institute of Acoustics guidance and research outlined in Appendix E. • Valley effects: +3 dB is applied to the calculated noise level of a wind turbine when a significant valley exists between the wind turbine and calculation point. A significant valley is determined to exist when the actual mean sound propagation height between the turbine and calculation point is 50 % greater than would occur if the ground were flat. • Terrain screening effects: only calculated if the terrain blocks line of sight between the maximum tip height of the turbine and the calculation point. The value of the screening effect is limited to a maximum value of 2 dB. The project is located within a hilly area characterised by variations in ground elevation between the turbines and surrounding receivers. These terrain characteristics were sufficient to trigger the application of adjustments to the predicted noise levels for some turbine/receiver combinations, equated in overall adjustments of up to +2.5 dB. For reference purposes, the ground elevations at the turbine and receiver locations are tabled in Appendix B and Appendix C respectively. The topography of the site is depicted in the elevation map provided in Appendix F.
Ground conditions	Ground factor of G = 0.5 based on the UK good practice guide and research outlined in Appendix E. The ground around the site corresponds to acoustically soft conditions (G = 1) according to ISO 9613-2. The adopted value of G = 0.5 assumes that 50 % of the ground cover is acoustically hard (G = 0) to account for variations in ground porosity and provide a cautious representation of ground effects.
Atmospheric conditions	Temperature 10 °C and relative humidity 80 % These represent conditions which result in relatively low levels of atmospheric sound absorption and are chosen based on the UK Institute of Acoustics guidance and the SA EPA Guideline. The calculations are based on sound speed profiles[1] which increase the propagation of sound from each turbine to each receiver location, whether as a result of thermal inversions or wind directed toward each calculation point. The primary consideration for wind farm noise assessment is wind speed and direction. The noise level at each calculation point is assessed based on being simultaneously downwind of every wind turbine at the site. Other wind directions in which part or the entire wind farm is upwind of the receiver will result in lower noise levels. In some cases, it is not physically possible for a receiver to be simultaneously downwind of each turbine and the approach is therefore conservative in these instances.
Receiver heights	1.5 m above ground level This is a deviation from UK Institute of Acoustics guidance. However, the modelling also does not include the 2 dB subtraction recommended by the UK Institute of Acoustics guidance. This approach has been shown to be valid for predicting noise level of wind farms expected to be measured using the L_{A90} parameter (as per the NSW Noise Assessment Bulletin).

[1] The sound speed profile defines the rate of change in the speed of sound with increasing height above ground

5.0 WIND TURBINE NOISE ASSESSMENT

5.1 Preliminary predicted noise levels

This section of the report presents the preliminary predicted A-weighted noise levels for the Jeremiah Wind Farm at surrounding receivers, together with an assessment of compliance with the base noise limit.

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

The receivers where operational wind farm noise levels are predicted to be higher than 30 dB L_{Aeq} are listed in Table 5 and Table 6 for non-associated and associated receivers, respectively. The value of 30 dB is referenced here for informative purposes. The minimum noise limit applicable to the wind farm at non-associated receivers is 35 dB L_{Aeq}.

Wind farm noise levels have been predicted using the sound power level data detailed in Section 2.3 for the three (3) candidate turbine models and one (1) conceptual turbine model. The predicted noise levels are summarised in Table 5 and Table 6 for wind speeds which result in the highest predicted noise levels (hub height wind speed of 12 m/s for Candidate Turbine 1 and 9 m/s for Candidate Turbines 2 and 3 and Conceptual Turbine 1).

Table 5: Highest predicted noise level at non-associated receivers with predicted levels over 30 dB L_{Aeq}, dB L_{Aeq}

Receiver	Distance to the nearest turbine, m	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
MR001	2,140	30.9	31.8	31.5	31.4
NRS005	1,889	32.1	33.0	32.7	32.5

It can be seen from Table 5 that the predicted noise levels from the proposed Jeremiah Wind Farm comply with the NSW Noise Assessment Bulletin base criterion of 35 dB L_{Aeq} at all of the assessed non-associated receivers.

Table 6: Highest predicted noise level at associated receivers with predicted levels over 30 dB L_{Aeq}, dB L_{Aeq}

Receiver	Distance to the nearest turbine, m	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
NRS006	1,095	38.0	39.2	38.7	38.6
NRS007	1,869	34.9	35.8	35.4	34.8
PCR005	1,034	36.5	37.9	37.4	37.3
PCR006	3,588	29.4	30.1	30.0	29.8
PCR007	3,710	30.1	30.9	30.8	30.2
PCR008	2,496	32.7	33.5	33.3	32.8

It can be seen from Table 6 that the predicted noise levels from the proposed Jeremiah Wind Farm are below the 45 dB L_{Aeq} reference level for all associated receivers.

Predicted noise levels for each integer wind speed are tabulated in Appendix G for all considered receivers, including those where the highest predicted noise level is below 30 dB L_{Aeq}.

The above findings support that the project can be designed and operated to comply with the operational noise requirements of the NSW Noise Assessment Bulletin.

The location of the total predicted 30, 35, 40, and 45 dB L_{Aeq} noise contours is illustrated in Figure 1, Figure 2, Figure 3 and Figure 4 for each of the candidate and conceptual turbine models.

5.2 Low-frequency noise

5.2.1 Non-associated receivers

The risk assessment provided in Appendix H indicates calculated low frequency noise levels below the applicable thresholds described in Section 2.4 for non-associated receivers. It is noted that the margin between the predicted levels and the most stringent threshold is of a comparable magnitude to the uncertainty associated with C-weighted predictions.

On the basis of the above, adjustments for special noise characteristics referred to in the NSW Noise Assessment Bulletin have not been applied to the predicted noise levels for non-associated receivers presented in this assessment. However, assessment of these special noise characteristics would need to be carried out as part of the post-construction compliance assessment.

5.2.2 Associated receivers

The risk assessment provided in Appendix H indicates that for a small number of associated receivers, the calculated low frequency noise levels are marginally below or above the applicable thresholds. This applies in particular for NRS006 and PCR005, with Candidate Turbine 2 resulting in the worst case noise levels.

Unlike the application of A-weighted noise limits, the NSW Noise Assessment Bulletin does not specifically allow for relaxed C-weighted thresholds for receivers associated with the wind farm development. However, given the expectation that associated receivers are typically subject to land use and/or noise agreements, consideration for low frequency noise may be required to be addressed as part of these agreements, with noise levels at these locations ultimately managed in accordance with the commercial agreements established between the proponent and the landowners.

Notwithstanding the above, low frequency noise should also be considered as part of the final turbine selection and during the post-construction compliance assessment.

Figure 1: Highest predicted noise level contours (corresponding to hub height wind speeds of 12 m/s or greater) - Candidate Turbine 1

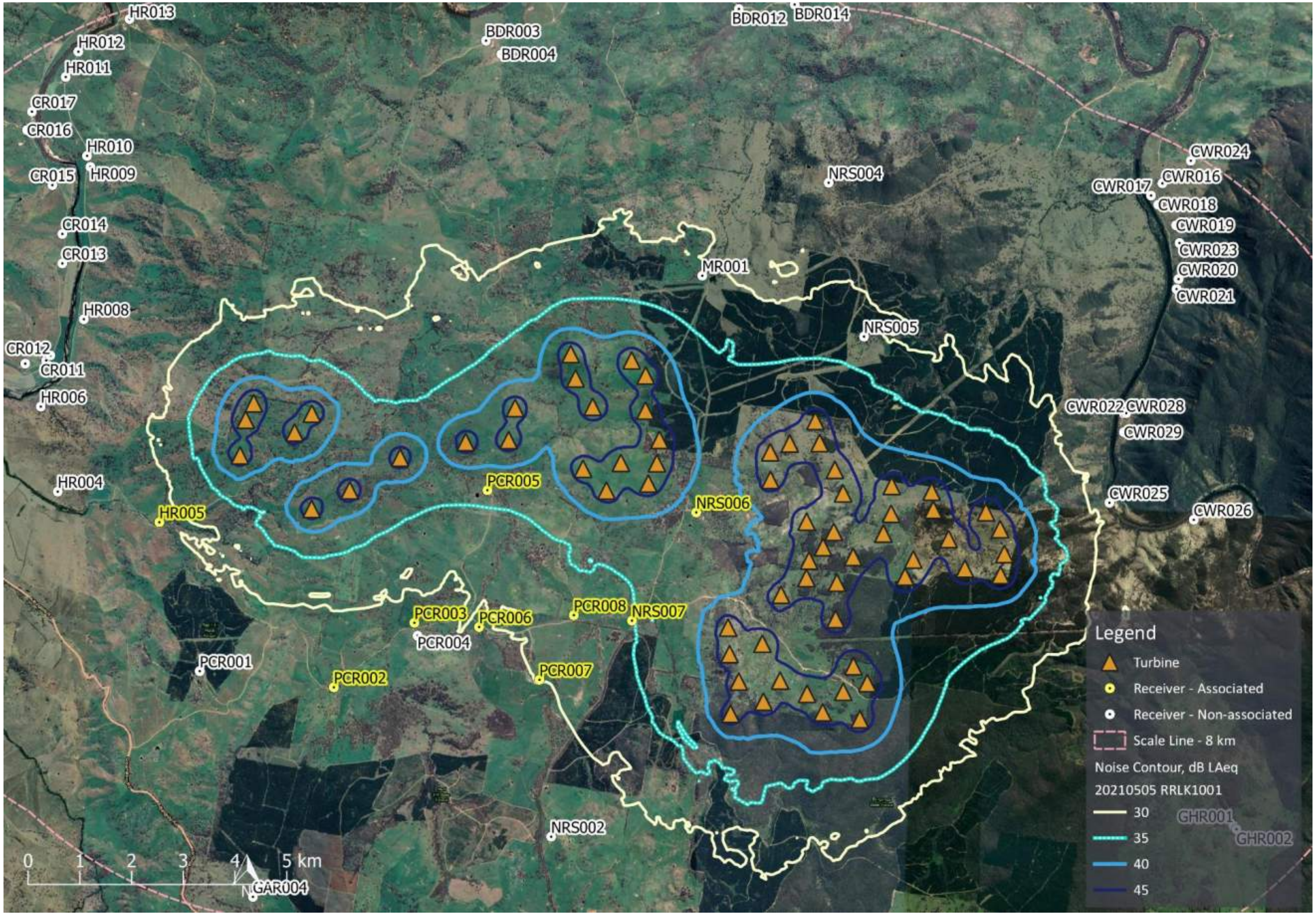


Figure 2: Highest predicted noise level contours (corresponding to hub height wind speeds of 9 m/s or greater) - Candidate Turbine 2

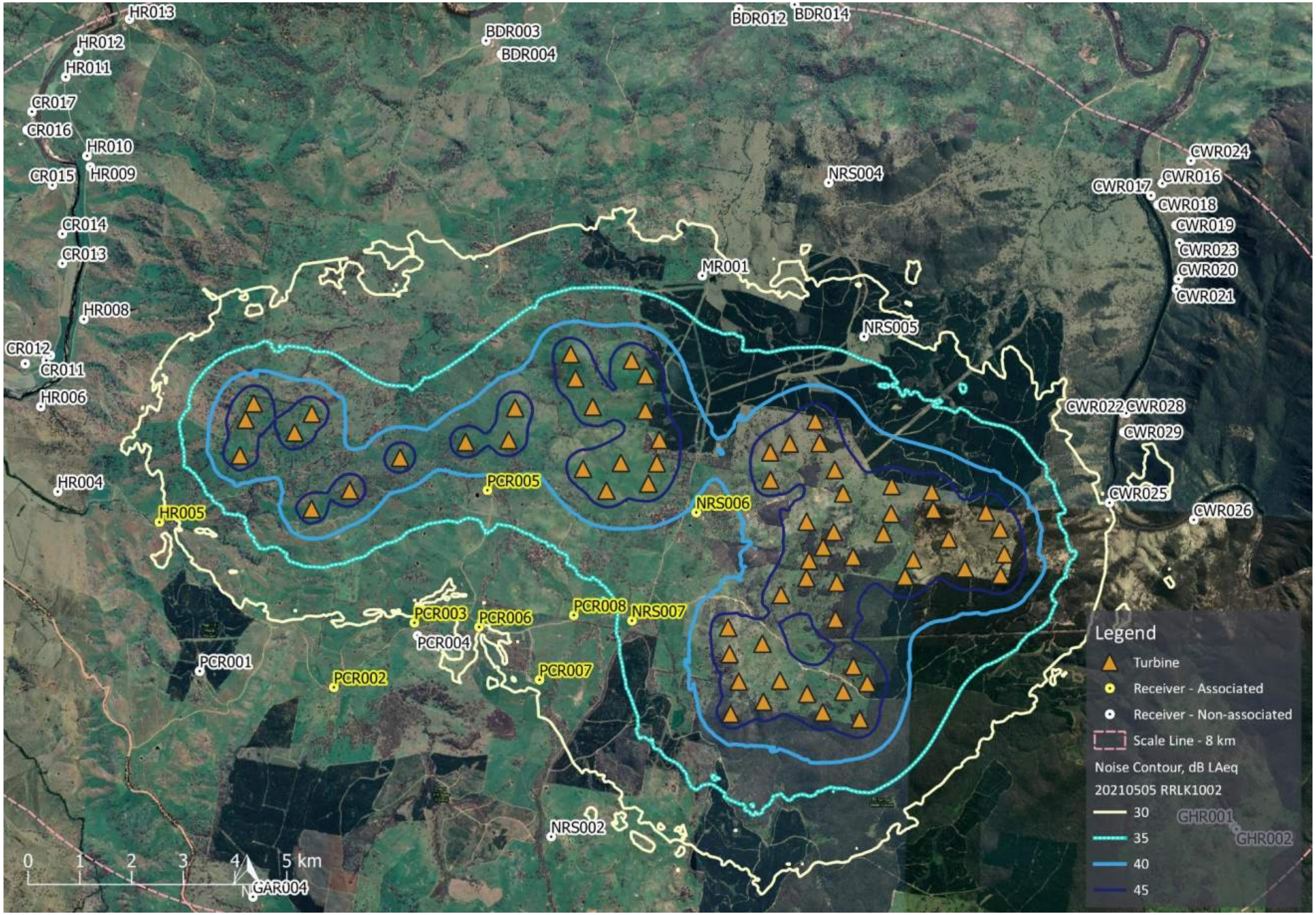
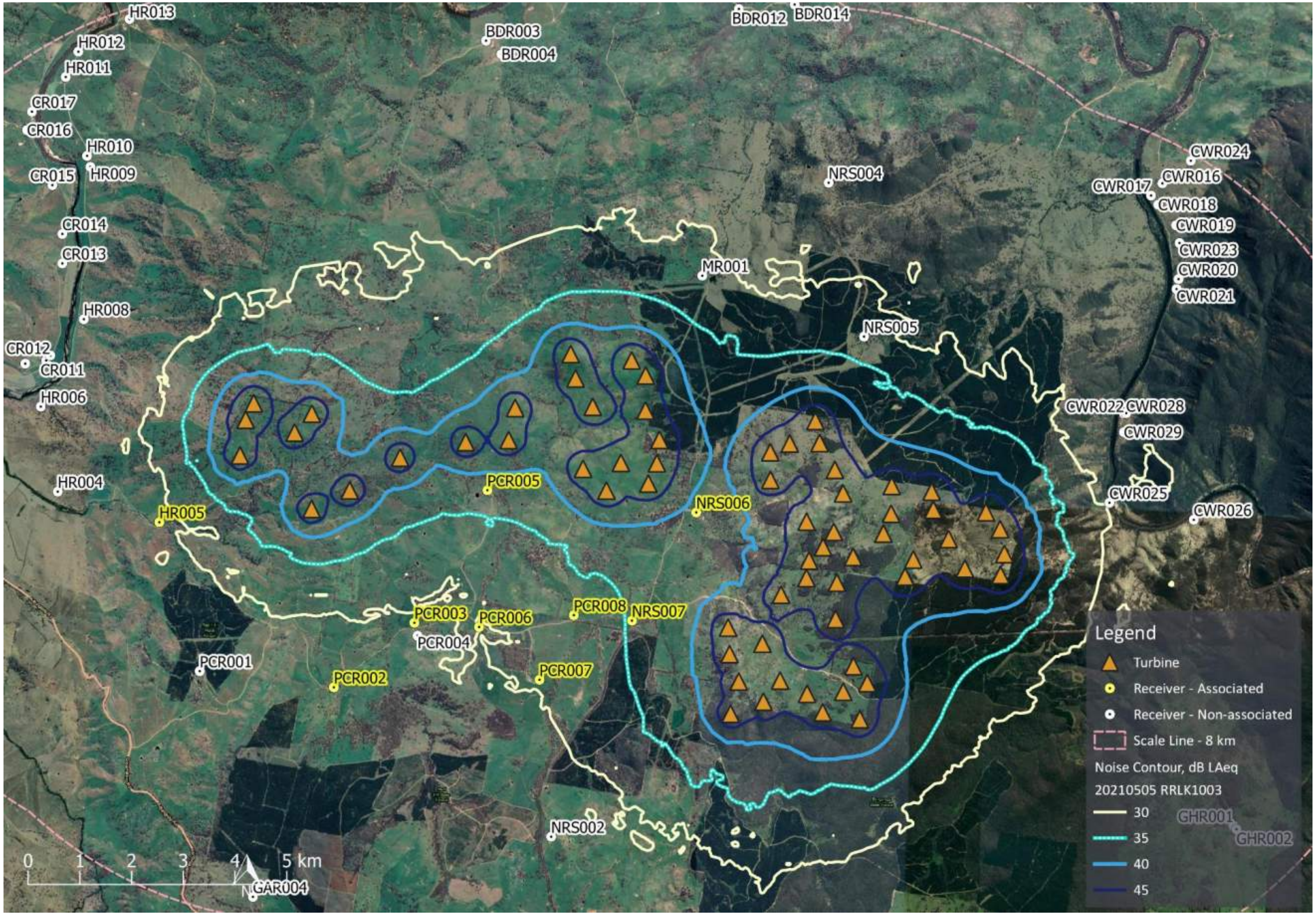
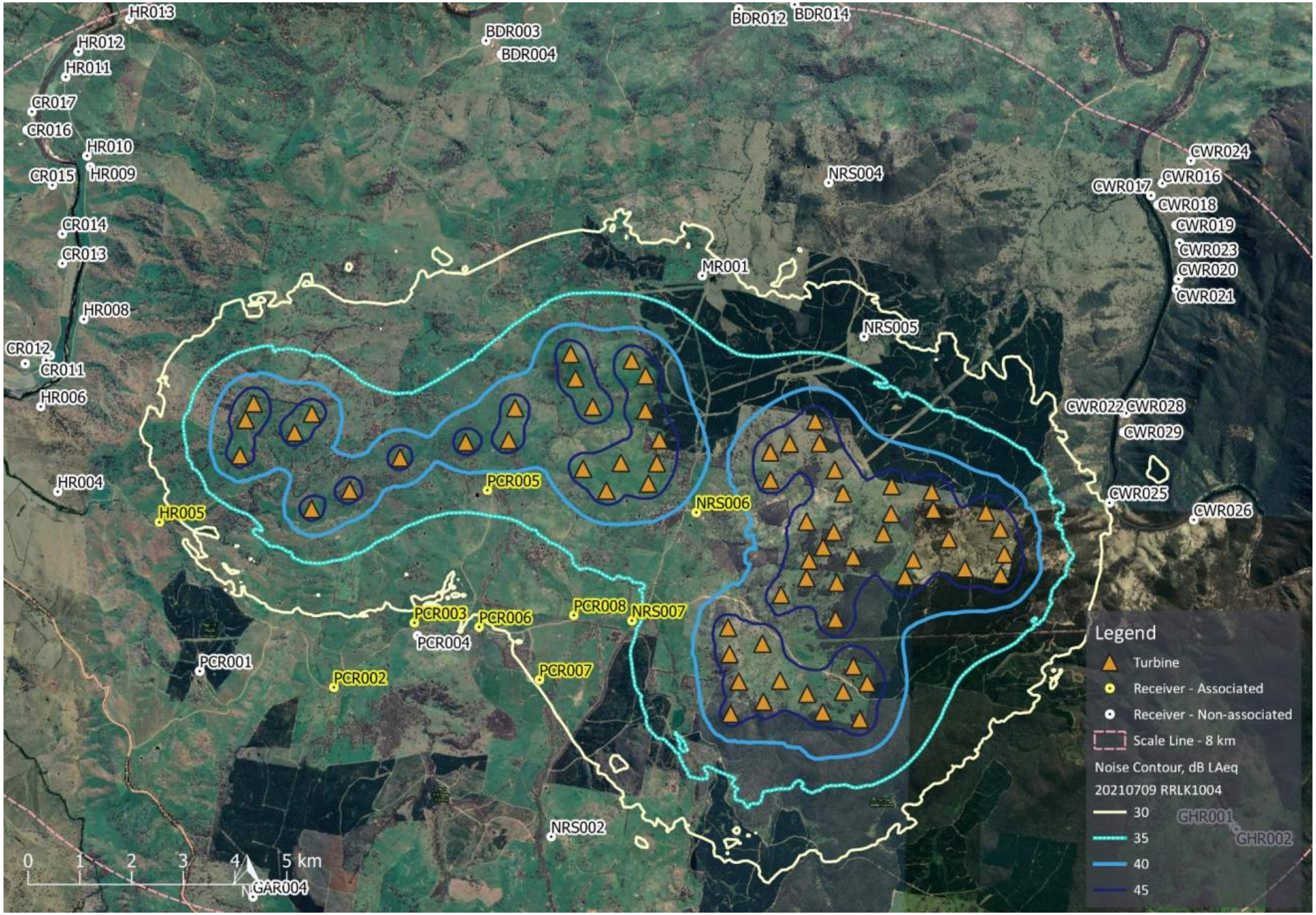


Figure 3: Highest predicted noise level contours (corresponding to hub height wind speeds of 9 m/s or greater) - Candidate Turbine 3



MARSHALL DAY Acoustics

Figure 4: Highest predicted noise level contours (corresponding to hub height wind speeds of 9 m/s or greater) - Conceptual Turbine 1



6.0 DETAILED ASSESSMENT PHASE

A detailed assessment of a NSW wind farm development involves addressing several environmental noise considerations detailed in the project specific SEARs. Whilst project specific SEARs are yet to be issued, typical SEARs requirements include assessment of:

- Operational wind turbine noise;
- Ancillary infrastructure noise;
- Construction noise;
- Construction traffic noise; and
- Construction vibration.

Environmental noise considerations relating to construction and ancillary infrastructure would be addressed at the development application phase of the assessment, once the project specific SEARs have been released.

Further detailed assessment work may involve background noise monitoring at selected receivers to determine the applicable criteria in accordance with the NSW Noise Assessment Bulletin. The results of any background noise monitoring would be documented in the noise assessment report prepared to accompany the development application for the Jeremiah Wind Farm.

The NSW Noise Assessment Bulletin specifies additional criteria relating to special characteristics, defined as tonality and low frequency. While tonality cannot be readily predicted, in relation to low frequency noise, the bulletin states that:

> *Noise assessments for proposed wind energy projects shall assess the potential for non-associated residential receiver locations to experience low frequency noise levels exceeding 60 dB(C).*

Low frequency noise characteristics are highly specific to the turbine being considered, and its assessment can involve detailed modelling using alternative procedures to those used for A-weighted noise levels. In accordance with the NSW Noise Assessment Bulletin, this modelling data is to be provided as part of an application to develop a wind farm. Accordingly, this modelling is to be undertaken and reported at the development application phase of the assessment.

7.0 SUMMARY

A preliminary assessment of operational noise for the proposed Jeremiah Wind Farm has been carried out. The preliminary noise assessment has been prepared in accordance with the NSW Department of Planning and Environment's *Wind Energy: Noise Assessment Bulletin - For State significant wind energy development*, dated December 2016 (the NSW Noise Assessment Bulletin).

The preliminary noise assessment has been carried out based on the current project design comprising sixty-five (65) multi-megawatt turbines within the wind farm site.

Noise modelling was carried out based on three (3) candidate turbine models as nominated by CWPR, and one (1) conceptual 300 m tip height turbine. The candidate models are in the generation capacity range of 5.5 MW to 6.0 MW and are typical of the type of turbines which are being considered for the site, and are representative of the tallest turbines presently available on the market. Turbine manufacturer's data has been relied on for the assessment of the candidate turbines, however the turbine make and model has not been specified at this stage for commercial reasons, as requested by CWPR.

Noise levels have also been predicted for one (1) conceptual turbine model with a tip height of 300 m, corresponding to the maximum tip height that the proponent is understood to be seeking consent for. As 300 m tip height turbines are not currently available on the market, a conceptual turbine has been modelled by adjusting the hub height of one of the candidate turbines to provide a tip height of 300 m. Further details on the method are provided in Section 2.2.2.

The results of the modelling demonstrate that the project can be designed and operated to comply with the operational noise requirements of the NSW Noise Assessment Bulletin.

Once the Secretary's Environmental Assessment Requirements (SEARs) are released for this project, further detailed assessment will be undertaken to support a subsequent development application. This would include background noise monitoring at selected receivers around the site, revised modelling and assessment of other noise considerations including special noise characteristics, construction and ancillary infrastructure to demonstrate how compliance with the specific noise matters defined by the SEARs for the project would be achieved.

APPENDIX A GLOSSARY OF TERMINOLOGY

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 L_A dB. Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report.

Term	Definition	Abbreviation
A-weighting	A method of adjusting sound levels to reflect the human ear's varied sensitivity to different frequencies of sound.	See discussion above this table.
C- weighting	A method of adjusting sound levels to account for non-linear frequency response of the human ear at high noise levels (typically greater than 100 decibels).	-
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 equivalent level	The A-weighted equivalent continuous pressure level.	L_{Aeq}
C-weighted equivalent level	The C-weighted equivalent continuous pressure level.	L_{Ceq}
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
Low frequency	A sound with perceptible content in the audible frequency range typically below 200 Hz	-
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 characteristics	A term used by the NSW Noise Assessment Bulletin to define sound characteristics that increase the likelihood of adverse reaction to the sound. The characteristics are tonality and low frequency.	-
Tonality	A characteristic to describe sounds which are composed of distinct and narrow groups of audible sound frequencies (e.g. whistling or humming sounds).	-

APPENDIX B TURBINE COORDINATES

The following table sets out the coordinates of the current proposed turbine layout supplied by CWPR.

Table 7: Turbine coordinates – GDA2020 / MGA Zone 55

Turbine	Easting (m)	Northing (m)	Terrain elevation (m)
1	634,201	6,126,075	779
2	633,557	6,128,079	705
3	633,931	6,125,817	775
4	633,181	6,127,910	710
5	634,788	6,123,774	723
6	634,913	6,122,748	752
7	635,517	6,126,723	754
8	635,529	6,127,260	684
9	632,414	6,122,855	808
10	637,632	6,125,536	740
11	634,054	6,128,517	663
12	635,056	6,123,447	734
13	633,881	6,125,479	745
14	635,947	6,125,837	693
15	634,469	6,125,390	725
16	633,184	6,127,377	715
17	632,572	6,123,478	730
18	635,368	6,126,338	728
19	634,444	6,124,684	750
20	633,883	6,126,569	765
21	637,350	6,126,751	670
22	632,365	6,124,522	695
23	632,394	6,124,007	716
24	633,389	6,125,156	727
25	635,787	6,125,506	710
26	634,135	6,128,090	643
27	633,048	6,123,088	703
28	634,589	6,127,117	680
29	636,942	6,125,661	703
30	630,502	6,129,687	525

Turbine	Easting (m)	Northing (m)	Terrain elevation (m)
31	630,294	6,127,707	570
32	634,194	6,122,880	728
33	636,300	6,127,149	650
34	630,014	6,127,170	560
35	629,324	6,129,809	524
36	630,773	6,129,397	547
37	637,624	6,126,424	678
38	630,769	6,128,718	545
39	629,418	6,129,338	526
40	629,749	6,128,789	534
41	634,592	6,123,280	750
42	636,333	6,126,798	655
43	631,039	6,128,151	529
44	636,628	6,126,232	680
45	630,990	6,127,698	533
46	628,125	6,128,146	495
47	633,029	6,124,209	634
48	633,371	6,123,495	695
49	628,251	6,128,767	475
50	629,562	6,127,591	545
51	627,294	6,128,107	455
52	630,824	6,127,306	567
53	634,430	6,127,570	623
54	634,409	6,126,373	762
55	637,706	6,125,943	702
56	622,933	6,127,849	525
57	623,988	6,128,291	554
58	624,321	6,128,658	554
59	623,198	6,128,858	537
60	623,042	6,128,539	517
61	634,783	6,125,887	795
62	633,892	6,123,240	676
63	625,053	6,127,174	410

Turbine	Easting (m)	Northing (m)	Terrain elevation (m)
64	626,027	6,127,806	435
65	624,316	6,126,814	405

APPENDIX C RECEIVER LOCATIONS

The following table sets out the ninety-four (94) noise sensitive receivers located within 8 km of the proposed project and considered in the preliminary noise assessment, together with their respective distance to the nearest turbine.

Table 8: Receiver locations – GDA2020 / MGA Zone 55

Receiver ID	Easting (m)	Northing (m)	Terrain elevation (m)	Distance to the nearest turbine (m)
Associated receivers				
GAR003	618,317	6,125,580	318	5,157
HR002	617,633	6,128,751	240	5,394
HR003	617,925	6,128,682	235	5,096
HR005	621,374	6,126,558	260	2,069
NRS006	631,751	6,126,747	520	1,103
NRS007	630,508	6,124,655	496	1,897
PCR002	624,746	6,123,365	457	3,478
PCR003	626,303	6,124,614	446	2,851
PCR005	627,715	6,127,177	434	1,038
PCR006	627,554	6,124,532	478	3,587
PCR007	628,721	6,123,512	527	3,723
PCR008	629,384	6,124,760	520	2,499
Non-associated receivers				
AVR001	627,987	6,116,305	517	7,919
AVR002	628,041	6,116,225	517	7,955
BDR002	626,212	6,137,107	296	7,944
BDR003	627,686	6,135,871	270	6,293
BDR004	627,984	6,135,608	285	5,966
BDR005	628,482	6,136,664	265	6,920
BDR006	628,538	6,136,714	265	6,963
BDR007	628,570	6,136,752	265	6,997
BDR008	628,637	6,136,780	266	7,018
BDR009	628,746	6,136,782	267	7,009
BDR010	628,809	6,136,688	270	6,911
BDR011	631,306	6,136,972	283	7,340
BDR012	632,574	6,136,484	281	7,118
BDR014	633,653	6,136,570	282	7,581

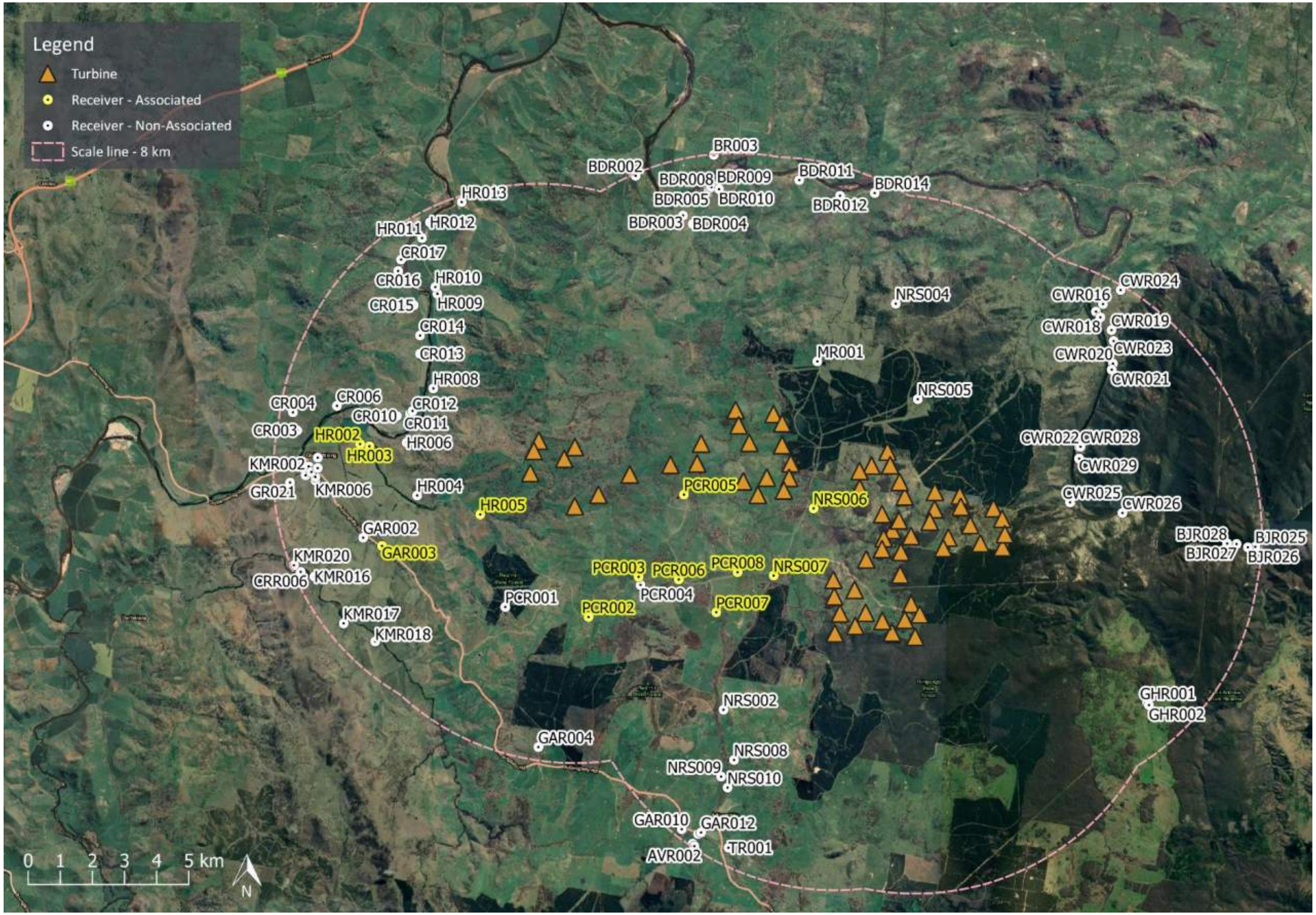
Receiver ID	Easting (m)	Northing (m)	Terrain elevation (m)	Distance to the nearest turbine (m)
BJR025	645,502	6,125,551	444	7,818
BJR026	645,272	6,125,534	417	7,590
BJR027	644,919	6,125,637	413	7,233
BJR028	644,626	6,125,654	402	6,941
BR003	628,644	6,137,757	340	7,984
CR003	615,680	6,129,176	242	7,386
CR004	615,542	6,129,739	280	7,605
CR006	616,912	6,129,942	272	6,301
CR010	618,782	6,129,625	256	4,417
CR011	619,186	6,129,685	243	4,046
CR012	619,267	6,129,784	242	3,999
CR013	619,499	6,131,563	248	4,605
CR014	619,499	6,132,132	250	4,960
CR015	619,306	6,133,078	248	5,758
CR016	618,818	6,134,141	261	6,877
CR017	618,911	6,134,497	241	7,099
CRR006	615,783	6,124,771	266	7,795
CWR016	640,760	6,133,112	317	7,235
CWR017	640,541	6,132,876	283	6,928
CWR018	640,680	6,132,699	290	6,838
CWR019	641,024	6,132,301	303	6,677
CWR020	641,071	6,131,260	300	5,870
CWR021	641,034	6,131,067	291	5,700
CWR022	640,021	6,128,660	298	3,323
CWR023	641,092	6,131,958	304	6,434
CWR024	641,309	6,133,548	329	7,882
CWR025	639,737	6,126,935	292	2,243
CWR026	641,367	6,126,605	293	3,764
CWR028	640,060	6,128,668	304	3,356
CWR029	640,017	6,128,299	308	3,087
GAR001	616,313	6,128,004	240	6,636
GAR002	617,730	6,125,835	295	5,593
GAR004	623,182	6,119,313	585	7,587

Receiver ID	Easting (m)	Northing (m)	Terrain elevation (m)	Distance to the nearest turbine (m)
GAR010	627,647	6,116,755	518	7,755
GAR011	628,157	6,116,605	505	7,577
GAR012	628,249	6,116,653	505	7,485
GHR001	642,135	6,120,687	765	6,619
GHR002	642,192	6,120,622	766	6,706
GR021	615,454	6,127,553	244	7,498
HR001	616,316	6,128,327	240	6,649
HR004	619,410	6,127,150	256	3,617
HR006	619,081	6,128,794	274	3,988
HR008	619,914	6,130,484	248	3,693
HR009	620,041	6,133,431	257	5,574
HR010	619,976	6,133,643	259	5,785
HR011	619,563	6,135,168	245	7,296
HR012	619,808	6,135,657	240	7,611
HR013	620,796	6,136,289	256	7,822
KMR001	616,033	6,128,055	235	6,918
KMR002	615,926	6,127,909	247	7,021
KMR003	616,115	6,127,881	240	6,832
KMR004	615,936	6,127,776	250	7,010
KMR005	616,240	6,127,726	243	6,708
KMR006	616,240	6,127,616	246	6,711
KMR016	616,208	6,124,623	270	7,470
KMR017	617,122	6,123,165	298	7,473
KMR018	618,105	6,122,603	303	7,139
KMR020	615,576	6,124,977	282	7,907
MR001	631,868	6,131,326	511	2,141
NRS002	628,947	6,120,476	566	4,224
NRS004	634,309	6,133,123	562	4,621
NRS005	634,993	6,130,148	583	1,898
NRS008	629,274	6,118,912	571	5,056
NRS009	628,873	6,118,393	546	5,712
NRS010	629,073	6,118,051	538	5,867
PCR001	622,154	6,123,678	454	3,811

Receiver ID	Easting (m)	Northing (m)	Terrain elevation (m)	Distance to the nearest turbine (m)
PCR004	626,364	6,124,362	460	3,104
TR001	629,102	6,116,180	516	7,465

APPENDIX D SITE LAYOUT PLAN

Figure 5: Proposed turbine locations and sensitive receiver locations



APPENDIX E NOISE PREDICTION MODEL

Environmental noise levels associated with wind farms are predicted using engineering methods.

The international standard ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation* (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 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 the South Australian EPA publication *Wind farms environmental noise guidelines*, NZS 6808:2010 *Acoustics – Wind farm noise* and AS 4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators.*

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 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; and
- 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 receiver locations.

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 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
- 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 standards such as CONCAWE and ENM. Specifically, the report indicated the ISO 9613 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 Institute of Acoustics guidance). 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 methodologies.

A range of measurement and prediction studies[2, 3, 4] 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 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.

[2] 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.

[3] 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.

[4] 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.

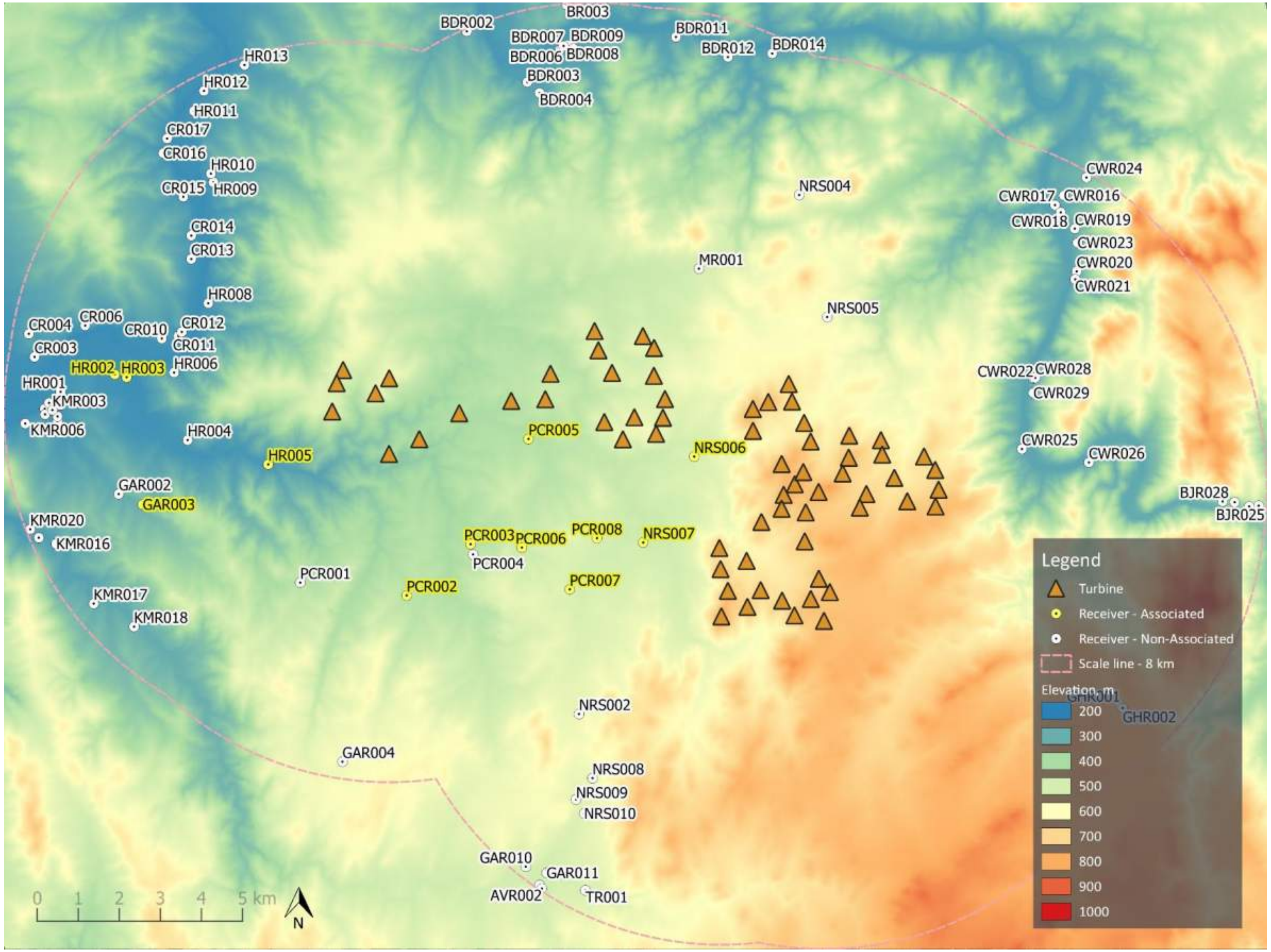
In addition to the choice of ground factor referred to above, adjustments to the ISO 9613-2 standard for screening and valleys effects are applied based on recommendations of the Joule Report, UK IOA 2009 joint agreement and the UK IOA Good Practice Guide. The following adjustments are applied to the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

- screening effects as a result of terrain are limited to 2 dB
- screening effects are assessed based on each turbine being represented by a single noise source located at the maximum tip height of the turbine rotor
- an adjustment of 3 dB is added to the predicted noise contribution of a turbine if the terrain between the 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 turbine and receiver pairing and then subsequently applies the adjustments to each turbine’s predicted noise contribution where appropriate.

APPENDIX F SITE TOPOGRAPHY

Figure 6: Terrain elevation map for the Jeremiah Wind Farm project and surrounding area



APPENDIX G TABULATED PREDICTED NOISE LEVEL DATA

Table 9: Predicted noise levels, dB L_{Aeq} - Candidate Turbine 1

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
Associated receivers						
GAR003	10.8	13.8	16.7	19.4	20.5	20.5
HR002	9.4	12.4	15.3	18.0	19.1	19.1
HR003	9.8	12.8	15.7	18.4	19.5	19.5
HR005	18.3	21.3	24.2	26.9	28.0	28.0
NRS006	28.3	31.3	34.2	36.9	38.0	38.0
NRS007	25.2	28.2	31.1	33.8	34.9	34.9
PCR002	17.2	20.2	23.1	25.8	26.9	26.9
PCR003	19.3	22.3	25.2	27.9	29.0	29.0
PCR005	26.8	29.8	32.7	35.4	36.5	36.5
PCR006	19.7	22.7	25.6	28.3	29.4	29.4
PCR007	20.4	23.4	26.3	29.0	30.1	30.1
PCR008	23.0	26.0	28.9	31.6	32.7	32.7
Non-associated receivers						
AVR001	9.3	12.3	15.2	17.9	19.0	19.0
AVR002	9.2	12.2	15.1	17.8	18.9	18.9
BDR002	8.3	11.3	14.2	16.9	18.0	18.0
BDR003	9.7	12.7	15.6	18.3	19.4	19.4
BDR004	10.1	13.1	16.0	18.7	19.8	19.8
BDR005	8.9	11.9	14.8	17.5	18.6	18.6
BDR006	8.9	11.9	14.8	17.5	18.6	18.6
BDR007	8.8	11.8	14.7	17.4	18.5	18.5
BDR008	8.8	11.8	14.7	17.4	18.5	18.5
BDR009	8.9	11.9	14.8	17.5	18.6	18.6
BDR010	9.0	12.0	14.9	17.6	18.7	18.7
BDR011	8.9	11.9	14.8	17.5	18.6	18.6
BDR012	9.4	12.4	15.3	18.0	19.1	19.1

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
BDR014	9.1	12.1	15.0	17.7	18.8	18.8
BJR025	9.8	12.8	15.7	18.4	19.5	19.5
BJR026	10.7	13.7	16.6	19.3	20.4	20.4
BJR027	10.4	13.4	16.3	19.0	20.1	20.1
BJR028	11.9	14.9	17.8	20.5	21.6	21.6
BR003	9.9	12.9	15.8	18.5	19.6	19.6
CR003	7.5	10.5	13.4	16.1	17.2	17.2
CR004	8.3	11.3	14.2	16.9	18.0	18.0
CR006	10.0	13.0	15.9	18.6	19.7	19.7
CR010	11.2	14.2	17.1	19.8	20.9	20.9
CR011	12.0	15.0	17.9	20.6	21.7	21.7
CR012	12.1	15.1	18.0	20.7	21.8	21.8
CR013	10.7	13.7	16.6	19.3	20.4	20.4
CR014	10.0	13.0	15.9	18.6	19.7	19.7
CR015	8.8	11.8	14.7	17.4	18.5	18.5
CR016	8.6	11.6	14.5	17.2	18.3	18.3
CR017	7.4	10.4	13.3	16.0	17.1	17.1
CRR006	6.8	9.8	12.7	15.4	16.5	16.5
CWR016	10.1	13.1	16.0	18.7	19.8	19.8
CWR017	9.8	12.8	15.7	18.4	19.5	19.5
CWR018	10.0	13.0	15.9	18.6	19.7	19.7
CWR019	10.7	13.7	16.6	19.3	20.4	20.4
CWR020	11.8	14.8	17.7	20.4	21.5	21.5
CWR021	12.1	15.1	18.0	20.7	21.8	21.8
CWR022	16.3	19.3	22.2	24.9	26.0	26.0
CWR023	11.1	14.1	17.0	19.7	20.8	20.8
CWR024	10.5	13.5	16.4	19.1	20.2	20.2
CWR025	18.6	21.6	24.5	27.2	28.3	28.3
CWR026	15.9	18.9	21.8	24.5	25.6	25.6

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
CWR028	16.2	19.2	22.1	24.8	25.9	25.9
CWR029	16.9	19.9	22.8	25.5	26.6	26.6
GAR001	8.1	11.1	14.0	16.7	17.8	17.8
GAR002	10.0	13.0	15.9	18.6	19.7	19.7
GAR004	11.2	14.2	17.1	19.8	20.9	20.9
GAR010	9.1	12.1	15.0	17.7	18.8	18.8
GAR011	9.5	12.5	15.4	18.1	19.2	19.2
GAR012	9.4	12.4	15.3	18.0	19.1	19.1
GHR001	12.4	15.4	18.3	21.0	22.1	22.1
GHR002	12.2	15.2	18.1	20.8	21.9	21.9
GR021	6.2	9.2	12.1	14.8	15.9	15.9
HR001	8.1	11.1	14.0	16.7	17.8	17.8
HR004	12.2	15.2	18.1	20.8	21.9	21.9
HR006	11.7	14.7	17.6	20.3	21.4	21.4
HR008	12.8	15.8	18.7	21.4	22.5	22.5
HR009	8.9	11.9	14.8	17.5	18.6	18.6
HR010	8.7	11.7	14.6	17.3	18.4	18.4
HR011	7.0	10.0	12.9	15.6	16.7	16.7
HR012	6.4	9.4	12.3	15.0	16.1	16.1
HR013	6.1	9.1	12.0	14.7	15.8	15.8
KMR001	8.0	11.0	13.9	16.6	17.7	17.7
KMR002	7.9	10.9	13.8	16.5	17.6	17.6
KMR003	7.7	10.7	13.6	16.3	17.4	17.4
KMR004	8.5	11.5	14.4	17.1	18.2	18.2
KMR005	7.7	10.7	13.6	16.3	17.4	17.4
KMR006	8.4	11.4	14.3	17.0	18.1	18.1
KMR016	7.1	10.1	13.0	15.7	16.8	16.8
KMR017	6.9	9.9	12.8	15.5	16.6	16.6
KMR018	7.3	10.3	13.2	15.9	17.0	17.0

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
KMR020	7.0	10.0	12.9	15.6	16.7	16.7
MR001	21.2	24.2	27.1	29.8	30.9	30.9
NRS002	16.6	19.6	22.5	25.2	26.3	26.3
NRS004	15.2	18.2	21.1	23.8	24.9	24.9
NRS005	22.4	25.4	28.3	31.0	32.1	32.1
NRS008	12.7	15.7	18.6	21.3	22.4	22.4
NRS009	11.7	14.7	17.6	20.3	21.4	21.4
NRS010	10.8	13.8	16.7	19.4	20.5	20.5
PCR001	16.2	19.2	22.1	24.8	25.9	25.9
PCR004	19.2	22.2	25.1	27.8	28.9	28.9
TR001	8.6	11.6	14.5	17.2	18.3	18.3

Table 10: Predicted noise levels, dB L_{Aeq} - Candidate Turbine 2

Receiver	Hub-height wind speed (m/s)					
	5	**6**	**7**	**8**	**9**	**≥10**
Associated receivers						
GAR003	9.9	13.0	16.4	19.3	21.4	21.4
HR002	8.5	11.6	15.0	17.9	20.0	20.0
HR003	8.8	11.9	15.3	18.2	20.3	20.3
HR005	17.4	20.5	23.9	26.8	28.9	28.9
NRS006	27.7	30.8	34.2	37.1	39.2	39.2
NRS007	24.3	27.4	30.8	33.7	35.8	35.8
PCR002	16.2	19.3	22.7	25.6	27.7	27.7
PCR003	18.3	21.4	24.8	27.7	29.8	29.8
PCR005	26.4	29.5	32.9	35.8	37.9	37.9
PCR006	18.6	21.7	25.1	28.0	30.1	30.1
PCR007	19.4	22.5	25.9	28.8	30.9	30.9
PCR008	22.0	25.1	28.5	31.4	33.5	33.5
Non-associated receivers						
AVR001	8.4	11.5	14.9	17.8	19.9	19.9
AVR002	8.3	11.4	14.8	17.7	19.8	19.8
BDR002	7.4	10.5	13.9	16.8	18.9	18.9
BDR003	8.8	11.9	15.3	18.2	20.3	20.3
BDR004	9.2	12.3	15.7	18.6	20.7	20.7
BDR005	8.0	11.1	14.5	17.4	19.5	19.5
BDR006	8.0	11.1	14.5	17.4	19.5	19.5
BDR007	8.0	11.1	14.5	17.4	19.5	19.5
BDR008	7.9	11.0	14.4	17.3	19.4	19.4
BDR009	8.0	11.1	14.5	17.4	19.5	19.5
BDR010	8.1	11.2	14.6	17.5	19.6	19.6
BDR011	8.0	11.1	14.5	17.4	19.5	19.5
BDR012	8.5	11.6	15.0	17.9	20.0	20.0
BDR014	8.2	11.3	14.7	17.6	19.7	19.7
BJR025	9.0	12.1	15.5	18.4	20.5	20.5

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
BJR026	9.9	13.0	16.4	19.3	21.4	21.4
BJR027	9.4	12.5	15.9	18.8	20.9	20.9
BJR028	11.0	14.1	17.5	20.4	22.5	22.5
BR003	9.0	12.1	15.5	18.4	20.5	20.5
CR003	6.7	9.8	13.2	16.1	18.2	18.2
CR004	7.4	10.5	13.9	16.8	18.9	18.9
CR006	9.0	12.1	15.5	18.4	20.5	20.5
CR010	10.2	13.3	16.7	19.6	21.7	21.7
CR011	11.0	14.1	17.5	20.4	22.5	22.5
CR012	11.1	14.2	17.6	20.5	22.6	22.6
CR013	10.9	14.0	17.4	20.3	22.4	22.4
CR014	9.0	12.1	15.5	18.4	20.5	20.5
CR015	7.9	11.0	14.4	17.3	19.4	19.4
CR016	7.7	10.8	14.2	17.1	19.2	19.2
CR017	6.6	9.7	13.1	16.0	18.1	18.1
CRR006	6.0	9.1	12.5	15.4	17.5	17.5
CWR016	9.1	12.2	15.6	18.5	20.6	20.6
CWR017	8.8	11.9	15.3	18.2	20.3	20.3
CWR018	9.0	12.1	15.5	18.4	20.5	20.5
CWR019	9.7	12.8	16.2	19.1	21.2	21.2
CWR020	10.8	13.9	17.3	20.2	22.3	22.3
CWR021	11.1	14.2	17.6	20.5	22.6	22.6
CWR022	15.2	18.3	21.7	24.6	26.7	26.7
CWR023	10.0	13.1	16.5	19.4	21.5	21.5
CWR024	9.4	12.5	15.9	18.8	20.9	20.9
CWR025	17.7	20.8	24.2	27.1	29.2	29.2
CWR026	14.9	18.0	21.4	24.3	26.4	26.4
CWR028	15.1	18.2	21.6	24.5	26.6	26.6
CWR029	15.8	18.9	22.3	25.2	27.3	27.3

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
GAR001	7.3	10.4	13.8	16.7	18.8	18.8
GAR002	9.1	12.2	15.6	18.5	20.6	20.6
GAR004	10.3	13.4	16.8	19.7	21.8	21.8
GAR010	8.2	11.3	14.7	17.6	19.7	19.7
GAR011	8.6	11.7	15.1	18.0	20.1	20.1
GAR012	8.6	11.7	15.1	18.0	20.1	20.1
GHR001	11.5	14.6	18.0	20.9	23.0	23.0
GHR002	11.4	14.5	17.9	20.8	22.9	22.9
GR021	5.4	8.5	11.9	14.8	16.9	16.9
HR001	7.3	10.4	13.8	16.7	18.8	18.8
HR004	11.2	14.3	17.7	20.6	22.7	22.7
HR006	10.7	13.8	17.2	20.1	22.2	22.2
HR008	11.7	14.8	18.2	21.1	23.2	23.2
HR009	7.9	11.0	14.4	17.3	19.4	19.4
HR010	7.8	10.9	14.3	17.2	19.3	19.3
HR011	6.0	9.1	12.5	15.4	17.5	17.5
HR012	5.6	8.7	12.1	15.0	17.1	17.1
HR013	5.4	8.5	11.9	14.8	16.9	16.9
KMR001	7.1	10.2	13.6	16.5	18.6	18.6
KMR002	7.4	10.5	13.9	16.8	18.9	18.9
KMR003	6.7	9.8	13.2	16.1	18.2	18.2
KMR004	7.7	10.8	14.2	17.1	19.2	19.2
KMR005	6.9	10.0	13.4	16.3	18.4	18.4
KMR006	7.5	10.6	14.0	16.9	19.0	19.0
KMR016	6.3	9.4	12.8	15.7	17.8	17.8
KMR017	6.1	9.2	12.6	15.5	17.6	17.6
KMR018	6.5	9.6	13.0	15.9	18.0	18.0
KMR020	6.3	9.4	12.8	15.7	17.8	17.8
MR001	20.3	23.4	26.8	29.7	31.8	31.8

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
NRS002	15.5	18.6	22.0	24.9	27.0	27.0
NRS004	14.1	17.2	20.6	23.5	25.6	25.6
NRS005	21.5	24.6	28.0	30.9	33.0	33.0
NRS008	11.7	14.8	18.2	21.1	23.2	23.2
NRS009	10.7	13.8	17.2	20.1	22.2	22.2
NRS010	9.8	12.9	16.3	19.2	21.3	21.3
PCR001	15.2	18.3	21.7	24.6	26.7	26.7
PCR004	18.2	21.3	24.7	27.6	29.7	29.7
TR001	7.7	10.8	14.2	17.1	19.2	19.2

Table 11: Predicted noise levels, dB L_{Aeq} - Candidate Turbine 3

Receiver	Hub-height wind speed (m/s)					
	5	**6**	**7**	**8**	**9**	**≥10**
Associated receivers						
GAR003	10.1	13.2	16.6	19.5	21.6	21.6
HR002	8.6	11.7	15.1	18.0	20.1	20.1
HR003	9.0	12.1	15.5	18.4	20.5	20.5
HR005	17.1	20.2	23.6	26.5	28.6	28.6
NRS006	27.2	30.3	33.7	36.6	38.7	38.7
NRS007	23.9	27.0	30.4	33.3	35.4	35.4
PCR002	16.2	19.3	22.7	25.6	27.7	27.7
PCR003	18.2	21.3	24.7	27.6	29.7	29.7
PCR005	25.9	29.0	32.4	35.3	37.4	37.4
PCR006	18.5	21.6	25.0	27.9	30.0	30.0
PCR007	19.3	22.4	25.8	28.7	30.8	30.8
PCR008	21.8	24.9	28.3	31.2	33.3	33.3
Non-associated receivers						
AVR001	8.8	11.9	15.3	18.2	20.3	20.3
AVR002	8.6	11.7	15.1	18.0	20.1	20.1
BDR002	7.8	10.9	14.3	17.2	19.3	19.3
BDR003	9.0	12.1	15.5	18.4	20.5	20.5
BDR004	9.4	12.5	15.9	18.8	20.9	20.9
BDR005	8.3	11.4	14.8	17.7	19.8	19.8
BDR006	8.3	11.4	14.8	17.7	19.8	19.8
BDR007	8.3	11.4	14.8	17.7	19.8	19.8
BDR008	8.2	11.3	14.7	17.6	19.7	19.7
BDR009	8.3	11.4	14.8	17.7	19.8	19.8
BDR010	8.4	11.5	14.9	17.8	19.9	19.9
BDR011	8.3	11.4	14.8	17.7	19.8	19.8
BDR012	8.8	11.9	15.3	18.2	20.3	20.3
BDR014	8.5	11.6	15.0	17.9	20.0	20.0
BJR025	9.3	12.4	15.8	18.7	20.8	20.8

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
BJR026	10.1	13.2	16.6	19.5	21.6	21.6
BJR027	9.7	12.8	16.2	19.1	21.2	21.2
BJR028	11.2	14.3	17.7	20.6	22.7	22.7
BR003	9.4	12.5	15.9	18.8	20.9	20.9
CR003	7.0	10.1	13.5	16.4	18.5	18.5
CR004	7.7	10.8	14.2	17.1	19.2	19.2
CR006	9.2	12.3	15.7	18.6	20.7	20.7
CR010	10.2	13.3	16.7	19.6	21.7	21.7
CR011	10.9	14.0	17.4	20.3	22.4	22.4
CR012	11.0	14.1	17.5	20.4	22.5	22.5
CR013	10.3	13.4	16.8	19.7	21.8	21.8
CR014	9.1	12.2	15.6	18.5	20.6	20.6
CR015	8.0	11.1	14.5	17.4	19.5	19.5
CR016	8.0	11.1	14.5	17.4	19.5	19.5
CR017	6.8	9.9	13.3	16.2	18.3	18.3
CRR006	6.3	9.4	12.8	15.7	17.8	17.8
CWR016	9.5	12.6	16.0	18.9	21.0	21.0
CWR017	9.1	12.2	15.6	18.5	20.6	20.6
CWR018	9.3	12.4	15.8	18.7	20.8	20.8
CWR019	10.0	13.1	16.5	19.4	21.5	21.5
CWR020	11.0	14.1	17.5	20.4	22.5	22.5
CWR021	11.2	14.3	17.7	20.6	22.7	22.7
CWR022	15.1	18.2	21.6	24.5	26.6	26.6
CWR023	10.3	13.4	16.8	19.7	21.8	21.8
CWR024	9.9	13.0	16.4	19.3	21.4	21.4
CWR025	17.4	20.5	23.9	26.8	28.9	28.9
CWR026	14.8	17.9	21.3	24.2	26.3	26.3
CWR028	15.0	18.1	21.5	24.4	26.5	26.5
CWR029	15.7	18.8	22.2	25.1	27.2	27.2

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
GAR001	7.6	10.7	14.1	17.0	19.1	19.1
GAR002	9.3	12.4	15.8	18.7	20.8	20.8
GAR004	10.7	13.8	17.2	20.1	22.2	22.2
GAR010	8.6	11.7	15.1	18.0	20.1	20.1
GAR011	8.9	12.0	15.4	18.3	20.4	20.4
GAR012	8.9	12.0	15.4	18.3	20.4	20.4
GHR001	11.7	14.8	18.2	21.1	23.2	23.2
GHR002	11.5	14.6	18.0	20.9	23.0	23.0
GR021	5.7	8.8	12.2	15.1	17.2	17.2
HR001	7.5	10.6	14.0	16.9	19.0	19.0
HR004	11.2	14.3	17.7	20.6	22.7	22.7
HR006	10.7	13.8	17.2	20.1	22.2	22.2
HR008	11.7	14.8	18.2	21.1	23.2	23.2
HR009	8.1	11.2	14.6	17.5	19.6	19.6
HR010	8.0	11.1	14.5	17.4	19.5	19.5
HR011	6.4	9.5	12.9	15.8	17.9	17.9
HR012	5.9	9.0	12.4	15.3	17.4	17.4
HR013	5.7	8.8	12.2	15.1	17.2	17.2
KMR001	7.4	10.5	13.9	16.8	18.9	18.9
KMR002	7.7	10.8	14.2	17.1	19.2	19.2
KMR003	7.1	10.2	13.6	16.5	18.6	18.6
KMR004	8.0	11.1	14.5	17.4	19.5	19.5
KMR005	7.1	10.2	13.6	16.5	18.6	18.6
KMR006	7.8	10.9	14.3	17.2	19.3	19.3
KMR016	6.6	9.7	13.1	16.0	18.1	18.1
KMR017	6.4	9.5	12.9	15.8	17.9	17.9
KMR018	6.8	9.9	13.3	16.2	18.3	18.3
KMR020	6.6	9.7	13.1	16.0	18.1	18.1
MR001	20.0	23.1	26.5	29.4	31.5	31.5

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
NRS002	15.6	18.7	22.1	25.0	27.1	27.1
NRS004	14.2	17.3	20.7	23.6	25.7	25.7
NRS005	21.2	24.3	27.7	30.6	32.7	32.7
NRS008	11.9	15.0	18.4	21.3	23.4	23.4
NRS009	11.0	14.1	17.5	20.4	22.5	22.5
NRS010	10.1	13.2	16.6	19.5	21.6	21.6
PCR001	15.3	18.4	21.8	24.7	26.8	26.8
PCR004	18.0	21.1	24.5	27.4	29.5	29.5
TR001	8.1	11.2	14.6	17.5	19.6	19.6

Table 12: Predicted noise levels, dB L_{Aeq} - Conceptual Turbine 1

Receiver	Hub-height wind speed (m/s)					
	5	**6**	**7**	**8**	**9**	**≥10**
Associated receivers						
GAR003	9.4	12.5	15.9	18.8	20.9	20.9
HR002	8.2	11.3	14.7	17.6	19.7	19.7
HR003	8.7	11.8	15.2	18.1	20.2	20.2
HR005	17.0	20.1	23.5	26.4	28.5	28.5
NRS006	27.1	30.2	33.6	36.5	38.6	38.6
NRS007	23.3	26.4	29.8	32.7	34.8	34.8
PCR002	15.4	18.5	21.9	24.8	26.9	26.9
PCR003	18.0	21.1	24.5	27.4	29.5	29.5
PCR005	25.8	28.9	32.3	35.2	37.3	37.3
PCR006	18.3	21.4	24.8	27.7	29.8	29.8
PCR007	18.7	21.8	25.2	28.1	30.2	30.2
PCR008	21.3	24.4	27.8	30.7	32.8	32.8
Non-associated receivers						
AVR001	8.5	11.6	15.0	17.9	20.0	20.0
AVR002	8.4	11.5	14.9	17.8	19.9	19.9
BDR002	7.4	10.5	13.9	16.8	18.9	18.9
BDR003	8.8	11.9	15.3	18.2	20.3	20.3
BDR004	9.0	12.1	15.5	18.4	20.5	20.5
BDR005	8.0	11.1	14.5	17.4	19.5	19.5
BDR006	8.0	11.1	14.5	17.4	19.5	19.5
BDR007	7.9	11.0	14.4	17.3	19.4	19.4
BDR008	8.0	11.1	14.5	17.4	19.5	19.5
BDR009	8.0	11.1	14.5	17.4	19.5	19.5
BDR010	8.1	11.2	14.6	17.5	19.6	19.6
BDR011	8.0	11.1	14.5	17.4	19.5	19.5
BDR012	8.4	11.5	14.9	17.8	19.9	19.9
BDR014	8.2	11.3	14.7	17.6	19.7	19.7
BJR025	8.9	12.0	15.4	18.3	20.4	20.4

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
BJR026	9.9	13.0	16.4	19.3	21.4	21.4
BJR027	9.2	12.3	15.7	18.6	20.7	20.7
BJR028	10.7	13.8	17.2	20.1	22.2	22.2
BR003	8.8	11.9	15.3	18.2	20.3	20.3
CR003	6.5	9.6	13.0	15.9	18.0	18.0
CR004	7.8	10.9	14.3	17.2	19.3	19.3
CR006	8.5	11.6	15.0	17.9	20.0	20.0
CR010	10.0	13.1	16.5	19.4	21.5	21.5
CR011	10.8	13.9	17.3	20.2	22.3	22.3
CR012	10.9	14.0	17.4	20.3	22.4	22.4
CR013	9.7	12.8	16.2	19.1	21.2	21.2
CR014	9.0	12.1	15.5	18.4	20.5	20.5
CR015	7.8	10.9	14.3	17.2	19.3	19.3
CR016	6.9	10.0	13.4	16.3	18.4	18.4
CR017	6.2	9.3	12.7	15.6	17.7	17.7
CRR006	6.0	9.1	12.5	15.4	17.5	17.5
CWR016	9.3	12.4	15.8	18.7	20.8	20.8
CWR017	8.8	11.9	15.3	18.2	20.3	20.3
CWR018	9.0	12.1	15.5	18.4	20.5	20.5
CWR019	9.6	12.7	16.1	19.0	21.1	21.1
CWR020	10.7	13.8	17.2	20.1	22.2	22.2
CWR021	10.9	14.0	17.4	20.3	22.4	22.4
CWR022	15.0	18.1	21.5	24.4	26.5	26.5
CWR023	10.0	13.1	16.5	19.4	21.5	21.5
CWR024	9.5	12.6	16.0	18.9	21.0	21.0
CWR025	17.3	20.4	23.8	26.7	28.8	28.8
CWR026	14.4	17.5	20.9	23.8	25.9	25.9
CWR028	14.9	18.0	21.4	24.3	26.4	26.4
CWR029	15.6	18.7	22.1	25.0	27.1	27.1
GAR001	7.3	10.4	13.8	16.7	18.8	18.8

Receiver	Hub-height wind speed (m/s)					
	5	6	7	8	9	≥10
GAR002	8.8	11.9	15.3	18.2	20.3	20.3
GAR004	10.7	13.8	17.2	20.1	22.2	22.2
GAR010	8.3	11.4	14.8	17.7	19.8	19.8
GAR011	8.4	11.5	14.9	17.8	19.9	19.9
GAR012	8.5	11.6	15.0	17.9	20.0	20.0
GHR001	10.9	14.0	17.4	20.3	22.4	22.4
GHR002	10.7	13.8	17.2	20.1	22.2	22.2
GR021	5.0	8.1	11.5	14.4	16.5	16.5
HR001	7.2	10.3	13.7	16.6	18.7	18.7
HR004	10.9	14.0	17.4	20.3	22.4	22.4
HR006	10.6	13.7	17.1	20.0	22.1	22.1
HR008	11.7	14.8	18.2	21.1	23.2	23.2
HR009	8.0	11.1	14.5	17.4	19.5	19.5
HR010	7.8	10.9	14.3	17.2	19.3	19.3
HR011	6.1	9.2	12.6	15.5	17.6	17.6
HR012	5.7	8.8	12.2	15.1	17.2	17.2
HR013	5.4	8.5	11.9	14.8	16.9	16.9
KMR001	7.1	10.2	13.6	16.5	18.6	18.6
KMR002	7.2	10.3	13.7	16.6	18.7	18.7
KMR003	6.8	9.9	13.3	16.2	18.3	18.3
KMR004	7.3	10.4	13.8	16.7	18.8	18.8
KMR005	6.7	9.8	13.2	16.1	18.2	18.2
KMR006	7.2	10.3	13.7	16.6	18.7	18.7
KMR016	5.8	8.9	12.3	15.2	17.3	17.3
KMR017	5.8	8.9	12.3	15.2	17.3	17.3
KMR018	5.8	8.9	12.3	15.2	17.3	17.3
KMR020	6.1	9.2	12.6	15.5	17.6	17.6
MR001	19.9	23.0	26.4	29.3	31.4	31.4
NRS002	15.0	18.1	21.5	24.4	26.5	26.5
NRS004	13.7	16.8	20.2	23.1	25.2	25.2

Receiver	Hub-height wind speed (m/s)					
	5	**6**	**7**	**8**	**9**	**≥10**
NRS005	21.0	24.1	27.5	30.4	32.5	32.5
NRS008	11.3	14.4	17.8	20.7	22.8	22.8
NRS009	10.5	13.6	17.0	19.9	22.0	22.0
NRS010	9.9	13.0	16.4	19.3	21.4	21.4
PCR001	14.8	17.9	21.3	24.2	26.3	26.3
PCR004	17.6	20.7	24.1	27.0	29.1	29.1
TR001	7.6	10.7	14.1	17.0	19.1	19.1

APPENDIX H C-WEIGHTING ASSESSMENT RESULTS

H1 Introduction

Presented below are details of the risk assessment carried out for the purpose of gauging whether penalties for low frequency, as detailed in the NSW Noise Assessment Bulletin, may be applicable.

H2 Assessment requirement

The following excerpt concerning C-weighted wind turbine noise have been reproduced from NSW Noise Assessment Bulletin.

> ***Low Frequency Noise***
>
> *The presence of excessive low frequency noise (a special noise characteristic) [ie noise from the wind farm that is repeatedly greater than 65 dBC during day time or 60 dBC during the night-time at any relevant receiver] will incur a 5 dB(A) penalty, to be added to the measured noise level for the wind farm, unless a detailed internal low frequency noise assessment demonstrates compliance with the proposed criteria for the assessment of low frequency noise disturbance (UK Department for Environment, Food and Rural Affairs (DEFRA, 2005) for a steady noise source.*

H3 Prediction method

As stated in Section 2.4, there are no commonly used, practical methods to accurately predict the wind turbine low frequency noise levels at receptor locations.

In this case, the C-weighted noise levels at receivers have been estimated using a simplified approach based on the same noise modelling methods as described above for A-weighted levels, but with the following modifications:

- The range of band frequencies has been expanded to include bands down to the 12.5 Hz frequency band
- The ground absorption parameter has been set to G = 0 (hard ground) to account for the increased influence of ground reflections at low frequencies.

C-weighted noise levels have been predicted for the worst-case wind speed in terms of C-weighted levels (12 m/s for Candidate Turbine 1 and 9 m/s for Candidate Turbines 2 and 3).

H4 Results

Table 13 presents the results of the preliminary C-weighted noise predictions.

Table 13: Predicted C-weighted noise levels, dB L_{Ceq}

Receiver ID	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
Associated receivers				
GAR003	45.7	48.1	46.4	45.7
HR002	45.1	47.6	45.8	45.3
HR003	45.3	47.7	46.0	45.6
HR005	50.3	52.5	51.0	50.9
NRS006	58.4	60.6	59.1	59.1
NRS007	55.9	58.1	56.7	56.4
PCR002	50.9	53.4	51.6	51.0
PCR003	52.2	54.6	53.0	52.7
PCR005	56.9	59.1	57.6	57.5
PCR006	52.5	54.9	53.3	53.1
PCR007	53.1	55.5	53.8	53.4
PCR008	54.7	57.0	55.5	55.2
Non-associated receivers				
AVR001	45.9	48.3	46.6	46.3
AVR002	45.8	48.3	46.5	46.2
BDR002	45.1	47.5	45.7	45.5
BDR003	46.0	48.4	46.6	46.2
BDR004	46.2	48.7	46.9	46.4
BDR005	45.5	48.0	46.2	45.7
BDR006	45.5	47.9	46.2	45.7
BDR007	45.5	47.9	46.1	45.7
BDR008	45.5	47.9	46.1	45.7
BDR009	45.5	47.9	46.1	45.8
BDR010	45.5	48.0	46.2	45.8
BDR011	45.5	48.0	46.2	45.8
BDR012	45.9	48.3	46.6	46.1
BDR014	45.7	48.2	46.4	46.0
BJR025	45.5	47.9	46.1	45.7
BJR026	46.2	48.7	46.9	46.6

Receiver ID	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
BJR027	45.8	48.3	46.5	46
BJR028	47.0	49.5	47.7	47.2
BR003	46.4	48.9	47.1	46.7
CR003	43.8	46.3	44.4	44.2
CR004	44.0	46.5	44.7	44.9
CR006	45.0	47.5	45.7	45.3
CR010	46.1	48.5	46.7	46.4
CR011	46.5	48.8	47.1	46.9
CR012	46.5	48.9	47.2	47.0
CR013	45.8	48.6	46.7	46.3
CR014	45.5	47.9	46.2	45.9
CR015	44.9	47.3	45.6	45.2
CR016	44.5	47.0	45.2	44.5
CR017	44.0	46.5	44.6	44.1
CRR006	43.1	45.6	43.8	43.5
CWR016	46.4	48.8	47.1	46.9
CWR017	46.0	48.5	46.7	46.3
CWR018	46.2	48.6	46.9	46.5
CWR019	46.6	49.0	47.3	46.8
CWR020	47.2	49.6	47.9	47.5
CWR021	47.4	49.8	48.1	47.5
CWR022	49.8	52.1	50.5	50.2
CWR023	46.8	49.2	47.5	47.0
CWR024	46.7	49.0	47.4	47.1
CWR025	51.0	53.2	51.7	51.5
CWR026	49.3	51.7	50.1	49.8
CWR028	49.7	52.0	50.4	50.2
CWR029	50.1	52.4	50.8	50.6
GAR001	44.6	47.1	45.2	44.9
GAR002	45.2	47.7	45.9	45.3
GAR004	46.8	49.2	47.5	47.5

Receiver ID	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
GAR010	45.7	48.1	46.3	46
GAR011	46.0	48.4	46.7	46.3
GAR012	45.9	48.4	46.6	46.3
GHR001	47.8	50.3	48.5	48.0
GHR002	47.7	50.2	48.4	47.8
GR021	42.8	45.3	43.5	42.9
HR001	44.6	47.0	45.2	44.8
HR004	46.6	49.0	47.2	46.9
HR006	46.2	48.6	46.9	46.7
HR008	46.9	49.2	47.6	47.5
HR009	44.9	47.4	45.6	45.3
HR010	44.9	47.3	45.6	45.2
HR011	43.9	46.3	44.5	44.1
HR012	43.6	46.0	44.2	43.9
HR013	43.4	45.9	44.1	43.7
KMR001	44.5	47.0	45.2	44.8
KMR002	44.5	47.1	45.3	44.9
KMR003	44.1	46.5	44.8	44.5
KMR004	44.9	47.4	45.6	45.1
KMR005	44.1	46.6	44.8	44.3
KMR006	44.5	46.9	45.1	44.8
KMR016	43.4	45.9	44.0	43.5
KMR017	43.5	46.0	44.1	43.6
KMR018	43.9	46.4	44.6	43.9
KMR020	43.3	45.8	43.9	43.6
MR001	53.5	55.8	54.2	54.0
NRS002	50.5	52.9	51.2	50.6
NRS004	49.6	52.1	50.4	49.9
NRS005	54.2	56.4	54.9	54.9
NRS008	47.8	50.2	48.5	48.1
NRS009	47.3	49.6	47.9	47.6

Receiver ID	Candidate Turbine 1	Candidate Turbine 2	Candidate Turbine 3	Conceptual Turbine 1
NRS010	46.7	49.2	47.4	47.1
PCR001	50.0	52.4	50.7	50.2
PCR004	52.2	54.5	52.9	52.5
TR001	45.3	47.8	46.0	45.5