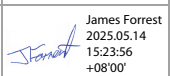
Proposed Wind Farm at Scott River

Noise Impact Assessment

Synergy Renewable Energy Developments Pty Ltd

12 May 2025

→ **The Power of Commitment**

Project name		Proposed Wind Farm at Scott River- Noise Impact Assessment					
Document title		Proposed Wind Farm at Scott River | Noise Impact Assessment					
Project number		12623449					
File name		12623449- Proposed Wind Farm at Scott River- Noise Impact Assessment					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S3	A	H Satari	V Lenchine B Hillion		J Forrest		12/11/2024
S3	B	H Satari	V Lenchine B Hillion		J Forrest		19/12/2024
S4	0	H Satari	B Hillion		J Forrest		24/02/2025
S4	1	H Satari / R Febriyandi	B Hillion		J Forrest		12/05/2025

GHD Pty Ltd | ABN 39 008 488 373

999 Hay Street, Level 10

Perth, Western Australia 6000, Australia

T +61 8 6222 8222 | **F** +61 8 6222 8555 | **E** permail@ghd.com | **ghd.com**

Executive summary

Synergy Renewable Energy Developments Pty Ltd (SynergyRED) is proposing to develop a wind farm at Scott River in southwest WA (the Project). A noise impact assessment (NIA) for the operation of wind turbine generators (WTGs) has been conducted to support the relevant environmental and planning approvals for the Project.

A dual criteria approach was adopted for this NIA which involved deriving the criteria based on both the WA *Environmental Protection (Noise) Regulations* 1997 and SA *Wind Farm Environmental Noise Guidelines, 2021* using the background noise monitoring data collected at seven locations around the Development Envelope.

A 3D environmental noise model of the Project was created to predict noise levels at the adjacent noise sensitive receptors, using the ISO9613-2:2024 calculation algorithm implemented in SoundPLAN (v 8.2) software. A proposed 20 WTG layout with a hub height of 164 metres was considered in the 3D noise model. The turbine source noise input data was based on the overall sound power level and the 1/3 octave source spectra data provided by SynergyRED.

Noise modelling results show that predicted noise levels from turbine operation at adjacent noise sensitive receptors are expected to comply with the noise criteria in accordance with both WA Noise Regulations (1997) and the SA Guidelines (2021).

This report summarises the results of the NIA. This report is subject to and must be read in conjunction with the limitations set out in Section 1.4 and the assumptions and qualifications contained throughout this report.

Glossary

Term	Description
Background noise level	The measured background noise level at a noise receptor location as per the SA Guidelines.
dB	Decibel, which is 20 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	A-weighted decibel measurement to represent the sound frequency sensitivity of the human ear.
Downwind direction	Wind direction for which a noise receptor location is downwind of the nearest WTG as per the SA Guidelines.
Downwind background noise level	Measured background noise level at a noise receptor location for winds within ±45° of the downwind direction as per the SA Guidelines.
Dwelling	Building used for a noise sensitive purpose,
DWER	WA Department of Water and Environmental Regulation
EPA	Environmental Protection Authority of Western Australia
Cut-in wind speed	Wind speed at which the turbine starts power production
GHD	GHD Pty Ltd
IEC 61400-11:2012	International Standard published by the International Electrotechnical Commission regarding wind turbines.
IF	Influencing Factor which is calculated to determine the noise criteria at a specific noise receptor location and depends on the ratio of commercial and industrial land zoning and the presence of major and secondary roads within 100 metres and 450 metres of the point under consideration.
ISO 9613-2: 2024	Recent version of international standard *ISO9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO9613-2), used for noise propagation modelling by considering the distance between source and noise sensitive receptor topography, ground attenuation, atmospheric absorption at different frequencies and meteorological conditions favourable to noise propagation.
L_{A1}	A-weighted sound pressure level that is exceeded for 1 percent of the measurement period.
L_{A10}	A-weighted sound pressure level that is exceeded for 10 percent of the measurement period.
L_{Amax}	Maximum A-weighted sound pressure level recorded during a specified time period.
$L_{Aeq,10\text{-}min}$	The predicted equivalent noise level adjusted for tonality over a 10-minute period.
$L_{A90,10\text{-}min}$	Measured ambient background noise in the absence of the noise under investigation that is equalled or exceeded for 90 percent of the measurement time interval.
$L_{Aeq\ (time)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
L_{Afast}	A-weighted sound level measured with a fast time constant of 125 milliseconds.
L_{Aslow}	A-weighted sound level measured with a slow time constant of 1 second

Term	Description
L_{Apeak}	A-weighted peak sound level. It represents the highest instantaneous sound pressure level measured.
Mitigation	Reduction in severity.
NIA	Noise impact assessment
NMP	Noise monitoring point
Premises	Residential, industrial or other premises of any kind whatsoever and includes land, water and equipment
Project	Proposed wind farm at Scott River in southwest WA
Rated power wind speed	Lowest hub height wind speed at which the WTG reaches its rated power
SA Guidelines	*SA Wind Farm Environmental Noise Guidelines, 2021*
Noise receptor	A noise modelling term used to describe a location/premises used for different purposes where the noise by a specific source is received, measured, predicted or mitigated. The noise receptor types vary depending on the usage of the premises e.g. sensitive, non-sensitive, involved, or not-involved.
Noise sensitive receptor	A noise modelling term used to describe a building or dwelling used for residential or accommodation purposes.
Non-sensitive noise receptor	A noise modelling term used to describe a building not used for residential or accommodation purposes e.g. a shed.
Involved noise sensitive receptor	A noise sensitive receptor in a parcel of land that accommodate part of a wind farm development.
Not-involved noise sensitive receptor	A noise sensitive receptor in a parcel of land that do not accommodate any part of a wind farm development.
Position statement	The Position Statement: Renewable Energy Facilities (WAPC, March 2020) outlines the Western Australian Planning Commission's guidelines for the development and assessment of renewable energy facilities**.**
pW	Picowatt, which is a unit of power equal to one trillionth of a watt
Sound pressure level (SPL)	The change in air pressure above and below the average atmospheric pressure caused by a passing pressure wave; this is then converted to decibels and can be abbreviated as SPL or L_p.
Sound power level (SWL)	Represents the total noise output of the plant or equipment. Also presented as L_{wA} or SPW.
SynergyRED	Synergy Renewable Energy Developments Pty Ltd
The Regulations	*Environmental Protection (Noise) Regulations, 1997*
Tonal noise	Noise with perceptible and definite pitch or tone.
TF	Transport Factor
Wind speed bin	±0.5 m/s at each integer of wind speed from cut-in to cut-out.
WAPC	Western Australian Planning Commission
WHO	World Health Organization
WTG	Wind turbine generator

Contents

Table index

Figure index

Appendices

1. Introduction

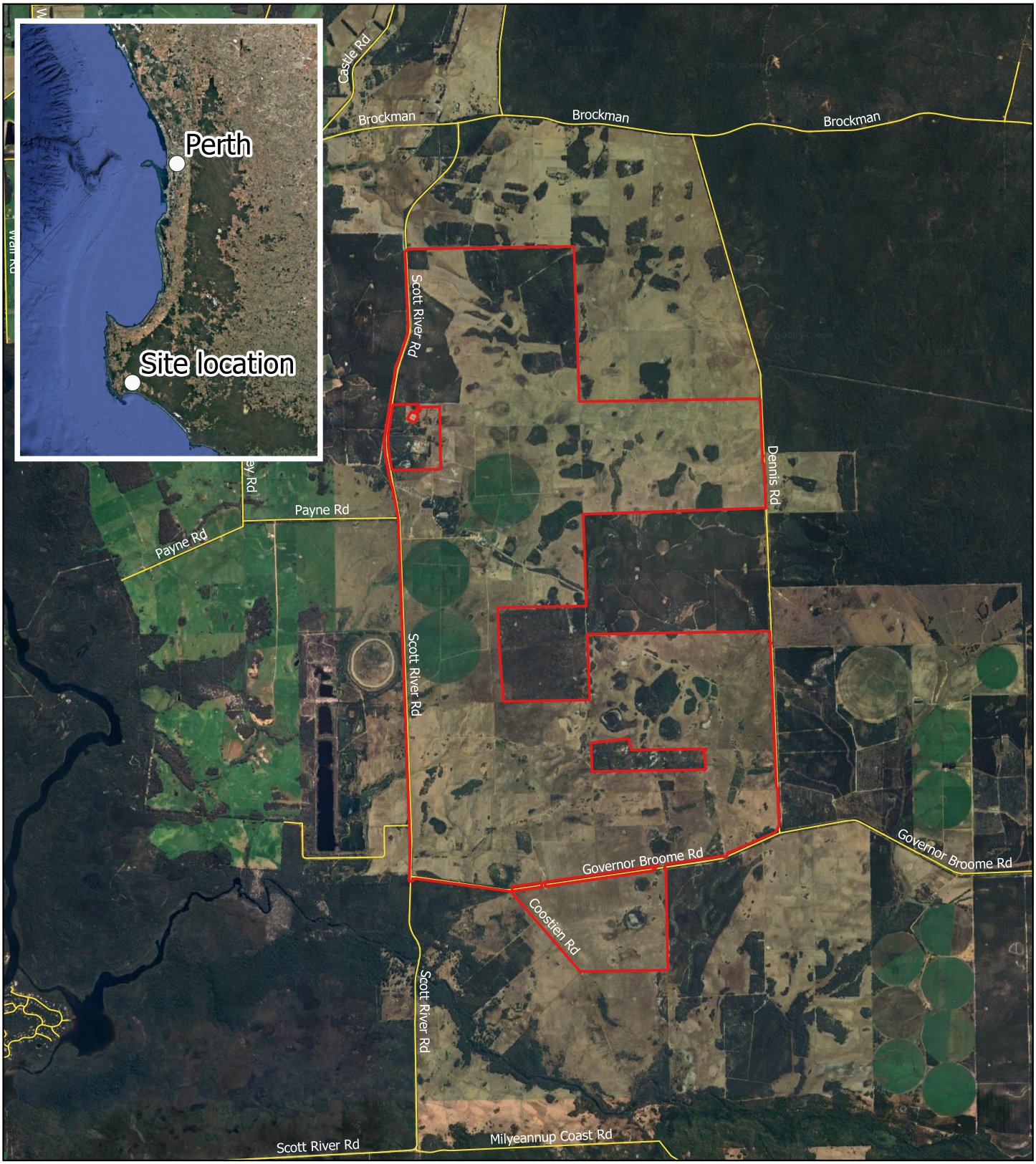
1.1 Background

Synergy Renewable Energy Developments Pty Ltd (SynergyRED) is currently investigating development of a new wind energy project at Scott River in southwest WA (the Project). The Project has the potential to connect to the Southwest Interconnected System.

The Project Development Envelope is located at Scott River in southwest WA, predominantly surrounded by rural lands developed for agricultural purposes with small areas of remnant and regenerated vegetation (Figure 1.1). The development Envelope is generally bound by the following roads:

– Brockman Highway
– Dennis Road
– Milyeannup Coast Road
– Scott River Road

SynergyRED engaged GHD Pty Ltd (GHD) to undertake an environmental noise impact assessment (NIA) for the Project.



Legend

Development Envelope

Local road

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Project Development Envelope

Project No. **12623449**

Version **1**

Date. **09/05/2025**

FIGURE 1.1

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi

1.2 Purpose of this report

This report summarises the results of an operational NIA for the Project, including background noise monitoring, noise modelling and impact assessment in accordance with applicable regulatory requirements.

1.3 Scope of works

The scope of works for this assessment is as follows:

– Background noise monitoring:
  - Review of adjacent noise receptor locations to identify representative noise receptor locations to conduct noise monitoring.
  - Five months of unattended background noise monitoring at seven representative noise receptor locations, with one local weather monitoring station (wind speed, wind direction and rainfall) deployed at one of the seven representative noise receptor locations.
  - NIA based on dual criteria. The criteria were derived primarily based on the *Environmental Protection (Noise) Regulations 1997* (the Regulations). The baseline noise monitoring results were used to determine criteria in accordance with the SA Environment Protection Authority's (SA EPA) *Wind Farms Environmental Noise Guidelines* (SA Guidelines, 2021). The criteria derived based on the SA Guidelines were used as secondary noise criteria for NIA and details of the background noise data processing are provided in Appendix B.

– Noise modelling of the Project:
  - Development of 3D noise model of the Project and surrounding area, incorporating topographic data and all identified noise receptors.
  - Review noise emission data for the candidate turbines being considered for the Project.
  - Conduct noise impact modelling of the Project site according to the prediction procedures as specified in SA Guidelines using ISO9613-2:2024 modelling algorithm.
  - Assess the compliance margin for the proposed layout at noise receptors based on the modelling results. In the case that potential non-compliance is predicted at any noise sensitive receptor, liaise with Project team to discuss mitigation strategies (e.g. changes to turbine layout) to ensure compliance can be achieved. If non-compliance with relevant criteria is still predicted, explore further mitigation measures such as turbine noise curtailment, to achieve the noise criteria
  - Assess operational noise for the substations in accordance with the Regulations.

– Provide a NIA report, summarising the findings relevant to the agreed layout within the scope components above.

1.4 Limitations

This report has been prepared by GHD for SynergyRED and may only be used and relied on by SynergyRED for the purpose agreed between GHD and SynergyRED as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than SynergyRED arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer to Section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.5 Assumptions

This report is subject to the following general assumptions at the time of writing this report:

– All information provided by SynergyRED, including relevant Project location and noise receptor information, wind turbine generator (WTG) layout and specification, wind data from the Project's meteorological mast, and relevant noise data are deemed correct.
– All parameters used in the assessment and other relevant data are based on best estimates using information provided by SynergyRED and other relevant sources.
– Operating hours for the wind farm would be 24 hours a day, seven days a week.
– It is assumed that noise emission from WTGs for the development do not exhibit tonal character that evokes noise level adjustment in accordance with SA Guidelines.
– Hub heights for the layouts of proposed WTGs used in the current assessment were assumed to be 164 metres above ground level.
– Due to the substantial separation distance to the nearest noise receptors (the nearest noise receptor to the substation is located more than 1700 metres away) it is not expected that vibration impacts would be relevant during the operation of the Project.

2. Assessment criteria

2.1 Operation of wind turbines

Specific noise guidelines are applicable to assessment of noise from wind farms due to their unique noise generating characteristics in conjunction with typically low ambient noise surroundings.

Following advice from the Department of Water and Environmental Regulation (DWER), the *Environmental Protection (Noise) Regulations 1997* (the Regulations) will be used as the primary noise criteria for the NIA.

In addition, the SA Guidelines will be also used to derive the secondary noise criteria based on the background noise monitoring data.

2.1.1 Environmental Protection (Noise) Regulations 1997

Noise emissions from the operation of WTG and associated substation will be assessed against criteria according to the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 8 sets out the maximum allowable noise levels (assigned noise levels) based on different time of day and land use (i.e. noise sensitive premises, commercial and industrial type premises), applicable at the premises receiving the noise. Various parameters of the assigned noise levels (L_{A10}, L_{A1} and L_{Amax}) also depend on influencing factor (IF) which are calculated in accordance with Schedule 3 of the Regulations, taking into account the area of industrial and commercial land and the presence of major and secondary roads within a 100 m and 450 m radius around the noise receptor.

A summary of the assigned noise levels from Regulation 8 is presented in Table 2.1.

Table 2.1 Assigned noise levels based on the Environmental Protection (Noise) Regulations 1997

Type of premises receiving noise	Time of day	Assigned noise level. dB(A)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: Highly sensitive area (i.e. noise sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use)	7:00 am to 7:00 pm Monday to Saturday (Day)	45 + IF	55 + IF	65 + IF
	9:00 am to 7:00 pm Sunday and public holidays	40 + IF	50 + IF	65 + IF
	7:00 pm to 10:00 pm all days (Evening)	40 + IF	50 + IF	55 + IF
	10:00 pm on any day to 7:00 am Monday to Saturday and 9:00 am Sunday and public holidays (Night)	35 + IF	45 + IF	55 + IF
Noise sensitive premises: Any area other than highly sensitive area (i.e. Noise Sensitive premises at locations further than 15 metres from a building directly associated with a noise sensitive use)	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90

2.1.1.1 Influencing factor

Influencing factors (IFs) have been calculated and used to determine assigned noise level criteria as presented in Table 2.2 for nearest noise receptors (refer to Figure 3.5).

Schedule 3 of the Regulations details the process to determine the IF for noise sensitive premises, which can be summarised as the following steps:

1. Obtain a Council zoning map covering an area up to 500 m from the receiving location.
2. Draw two circles around the receiving point, of 100 m radius and 450 m radius.
3. Determine the percentage of each circle that is taken up with industrial and commercial zonings. Note that the industrial and commercial areas in the inner circle are also counted in the outer circle.
4. Add the percentages up as follows:
   - (Percent industrial in small circle + percent industrial in a large circle) x 1/10 = I
   - (Percent commercial in small circle + percent commercial in large circle) x 1/20 = C
5. Determine the transport factor (TF) as follows (Note – TF cannot be more than 6):
   - Major road (more than 15,000 vehicles/day) in small circle, TF = 6
   - A major road in a large circle, TF = 2
   - For each secondary road (6,000 - 15,000 vehicles/day) in small circle, TF = 2
6. Add I, C and TF from steps 4 and 5 above to obtain the IF (i.e., IF = I + C + TF), and
7. Fill in the table of assigned levels by adding in the IF to obtain the L_{A10}, L_{A1} and L_{Amax} assigned levels.

Table 2.2 summarises the list of noise receptors, their coordinates and calculated IFs surrounding the Development Envelope.

Table 2.2 Influencing factor (IF) calculated for noise receptors

ID	Noise Receptor Type	Coordinates, GDA2020 / MGA Zone 50		IF
		Easting, metres	Northing, metres	
R01	Not-involved noise sensitive receptor	339933	6218605	0
R02	Not-involved noise sensitive receptor	340681	6218532	0
R03	Not-involved noise sensitive receptor	340852	6218785	0
R04	Not-involved noise sensitive receptor	341008	6219011	0
R05	Not-involved noise sensitive receptor	341249	6219088	0
R06	Not-involved noise sensitive receptor	341069	6218419	0
R07	Not-involved noise sensitive receptor	341535	6217905	0
R08	Not-involved noise sensitive receptor	342043	6218890	0
R09	Not-involved noise sensitive receptor	342690	6218163	0
R10	Not-involved noise sensitive receptor	343549	6218312	0
R11[1]	Non-sensitive noise receptor	343548	6214495	NA
R12[1]	Non-sensitive noise receptor	340638	6214626	NA
R13	Not-involved noise sensitive receptor	338412	6215131	0
R14	Not-involved noise sensitive receptor	338464	6214395	0
R15	Not-involved noise sensitive receptor	338587	6213882	0
R16	Not-involved noise sensitive receptor	338768	6213383	0
R17 [2]	Involved noise sensitive receptor	340924	6213832	0
R18 [2]	Involved noise sensitive receptor	341392	6213419	0
R19	Not-involved noise sensitive receptor	338804	6211691	0

ID	Noise Receptor Type	Coordinates, GDA2020 / MGA Zone 50		IF
		Easting, metres	Northing, metres	
R20	Not-involved noise sensitive receptor	340492	6207596	0
R21	Not-involved noise sensitive receptor	340852	6207358	0
R22	Not-involved noise sensitive receptor	341310	6207260	0
R23	Not-involved noise sensitive receptor	341585	6206886	0
R24	Not-involved noise sensitive receptor	341494	6206613	0
R25[1]	Non-sensitive noise receptor	342437	6208749	NA
R26[1]	Non-sensitive noise receptor	344716	6209189	NA
R27[1]	Non-sensitive noise receptor	345036	6210136	NA
R28	Not-involved noise sensitive receptor	347575	6209225	0
R29	Not-involved noise sensitive receptor	347645	6208472	0
R30	Not-involved noise sensitive receptor	346773	6204588	0
R31	Not-involved noise sensitive receptor	347732	6203961	0
R32	Not-involved noise sensitive receptor	341223	6207695	0
R33	Not-involved noise sensitive receptor	341234	6207287	0
R34	Not-involved noise sensitive receptor	339819	6217839	0

[1] R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be "Non-sensitive" and are not considered within the NIA.

[2] R17 and R18 are involved noise sensitive receptors (participating landowners).

2.1.1.2 Annoying noise characteristics

Regulation 7 requires that the noise character received at noise sensitive receptors must be free from annoying characteristics of tonality, modulation, and impulsiveness. If these characteristics cannot reasonably and practicably be removed, then a series of adjustments to the measured or calculated received levels are set out, and the adjusted level must comply with the assigned level. The adjustments are set out in Table 2.3 and are further defined in Regulation 9(1). These adjustments are cumulative up to a maximum of 15 dB.

Table 2.3 Table of adjustments

Adjustment where noise emission is not music (Adjustments are cumulative to a maximum of 15 dB)		
Where tonality is present	**Where modulation is present**	**Where impulsiveness is present**
+5 dB	+5 dB	+10 dB

– Tonality is defined in Regulation 9(1) as being present where the difference between the A- weighted sound pressure level in any one third octave band and the arithmetic average of the A weighted sound pressure levels in the two adjacent one third octave bands is greater than 3 dB in terms of $L_{Aeq, T}$ where the time period T is greater than 10 percent of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A, Slow}$ levels.

– Modulation is defined as a variation in the emission of noise that:

- Is more than 3 dB $L_{A, Fast}$ or is more than 3 dB $L_{A, Fast}$ in any one third octave band

- Is present for at least 10 percent of the representative assessment period, and
- Is regular, cyclic and audible

– Impulsiveness is defined as present where the difference between $L_{A,\,peak}$ and $L_{Amax,\,S}$ is more than 15 dB when determined for a single representative event.

2.1.2 SA Guidelines

The *Position Statement: Renewable energy facilities (WAPC, March 2020) (Position Statement)* has been used by the Western Australian Planning Commission (WAPC) for wind farm development. For assessment purposes, the Position Statement endorses the use of the SA Guidelines. As a result, the criteria derived based on the SA Guidelines will be used as an additional criterion (secondary criterion) for the NIA presented in this study.

To prevent adverse impacts from the WTG noise, the SA Guidelines require that the received noise levels at the relevant noise sensitive receptors be compared to the corresponding background noise.

The predicted equivalent noise level ($L_{Aeq,10\text{-}min}$) adjusted for tonality in accordance with these guidelines, should not exceed:

– 35 dB(A) at relevant noise sensitive receptors in localities which are primarily intended for rural living (equivalent to noise sensitive receptors in accordance with the WA Regulations), or

– 40 dB(A) at relevant noise sensitive receptors in localities in other zones (equivalent to other types of premises apart from noise sensitive premises in accordance with the WA Regulations), or

– Background noise ($L_{A90,10\text{-}min}$) by more than 5 dB(A)

whichever is the greater, at all relevant noise sensitive receptors for wind speed from cut-in to rated power of the WTG and each integer wind speed in between. These criteria apply for both daytime and nighttime hours.

The proposed project site is located within a rural area. Therefore, the 35 dB(A) baseline criterion or the adjusted “background + 5” dB(A) criteria apply to all relevant noise sensitive receptors.

2.1.2.1 Participating landowners

It should be noted the criteria based on SA Guidelines have been developed to minimise the impact on the amenity of premises that do not have an agreement with wind farm developers (i.e. Not-involved noise sensitive receptors).

Wind farm developers commonly enter into agreements with the owners of private land suitable for a wind farm site (participating landowners). The agreement provides the developer with the appropriate siting and generally rewards the landowner with a level of compensation and diversity in their income stream. Notwithstanding this, the Environmental Protection Authority (EPA) cannot ignore noise impacts on the basis that an agreement has been made between the developer and the landowner. Developers cannot absolve themselves of their obligations under the *Environmental Protection Act 1986* (EP Act) by entering into an agreement with a landowner, i.e., the development should not have an adverse effect on the amenity of the area which unreasonably interferes with the enjoyment of the area. In terms of health impacts in particular, the likely exposure level should not result in sleep disturbance.

The World Health Organization (WHO) *Guidelines for Community Noise* (1999) recommend a 30 dB(A) indoor limit to prevent negative effects on sleep. *The Working Group on Noise from Wind Turbines* (Final Report, ETSU for DTI, 1996) recommends the outdoor noise limit of 45 dB(A) after any adjustment for tonality for landowners having financial involvement in the wind farm. As such, if the received noise level from a wind farm does not exceed 30 dB(A) indoor and 45 dB(A) outdoor at an involved noise sensitive receptor having financial involvement with the developers, then it is considered that the development is not having adverse effect on the amenity of the involved noise sensitive receptor.

2.1.2.2 Background noise monitoring

Long term (unattended) noise measurements were conducted at seven noise logger locations in the area within and adjacent to the Development Envelope. The details of the background noise monitoring and data processing are provided in Appendix B.

As can be seen on appended Figures B.2 to B.8 the measured noise levels generally:

– range approximately from 20 dB to 50 dB L_{A90} at NMP02 (at 4 m/s and 15 m/s wind speed respectively), with averaged values ranging from 30 to 45 dB L_{A90}.
– range approximately from 20 dB to 50 dB L_{A90} at NMP03 (at 4 m/s and 15 m/s wind speed respectively) with averaged values ranging from 30 to 44 dB L_{A90}.
– range approximately from 20 dB to 50 dB L_{A90} at NMP04 (at 4 m/s and 15 m/s wind speed respectively) with averaged values ranging from 30 to 39 dB L_{A90}.
– range approximately from 20 dB to 50 dB L_{A90} at NMP05 (at 4 m/s and 15 m/s wind speed respectively) with averaged values ranging from 28 to 38 dB L_{A90}.
– range approximately from 20 dB to 50 dB L_{A90} at NMP06 (at 4 m/s and 15 m/s wind speed respectively) with averaged values ranging from 28 to 42 dB L_{A90}.

Appended Figure B.2 to Figure B.6 show results of postprocessed data and relevant noise criteria calculated in accordance with SA Guidelines 2021. Data postprocessing is performed for arithmetic averages of measured noise levels in integer wind speed bins as per Section 3.4 of the SA Guidelines.

Relevant SA guidelines noise criteria are derived for each of the monitoring locations for wind speeds referenced to hub height of 164 m.

The resulting SA guidelines criteria are summarised in Table 2.4, along with other criteria.

2.1.3 Summary of wind farm noise criteria

Table 2.4 summarises the criteria derived from both the state Regulations and the SA Guidelines. The full list of noise receptors and their types are provided in Table 2.2.

For the NIA of the WTGs operation, the most stringent criteria i.e. 35 + IF, L_{A10} during nighttime will be adopted for the criteria based on the Regulations. Advice provided by DWER is that the assigned levels in the Regulations are unlikely to apply to involved noise sensitive receptors. DWER recommended that 40 dB L_{A10} be used as the criteria for the involved noise sensitive receptors.

The details of the noise monitoring including the representative monitoring locations and the calculations to derive the noise criteria according to the SA Guidelines are provided in Appendix B. It should be noted that R17 and R18 are involved noise sensitive receptors (section 2.1.2.1), the SA Guideline criteria of 45 dB(A) for an involved receptor has been used.

Table 2.4 Noise criteria for 164 m hub height – Dual criteria for wind farm NIA

Noise receptor [1]	Reference of noise criteria	Representative monitoring location [2]	Hub height wind speed, m/s							
			4	5	6	7	8	9	10	11
Involved, noise sensitive										
R17, R18	The Regulations [3]	-	40	40	40	40	40	40	40	40
	SA Guidelines [4]	-	45	45	45	45	45	45	45	45
Not-involved noise sensitive										
R01, R02, R03, R04, R05, R06, R07, R08, R09, R10, R34	The Regulations	-	35	35	35	35	35	35	35	35
	SA Guidelines	NMP02	35	36	38	39	40	40	39	41
R20, R21, R22, R23, R24, R32, R33	The Regulations	-	35	35	35	35	35	35	35	35
	SA Guidelines	NMP03	35	35	36	36	37	37	37	39
R28, R29, R30, R31	The Regulations	-	35	35	35	35	35	35	35	35

Noise receptor [1]	Reference of noise criteria	Representative monitoring location [2]	Hub height wind speed, m/s							
			4	5	6	7	8	9	10	11
	SA Guidelines	NMP04	35	36	37	37	37	37	37	38
R14, R15, R16, R19	The Regulations	-	35	35	35	35	35	35	35	35
	SA Guidelines	NMP05	35	35	35	35	35	35	35	36
R13	The Regulations	-	35	35	35	35	35	35	35	35
	SA Guidelines	NMP06	35	35	36	36	37	37	37	38

[1] R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be "Non-sensitive" and are not considered within the NIA.

[2] Background noise monitoring results and representative monitoring locations are not applicable to the criteria based on the Regulations.

[3] R17 and R18 are involved noise sensitive receptors (i.e. participating landowners) for which 40 dB(A) is used upon advice from DWER.

[4] R17 and R18 are involved noise sensitive receptors for which the SA Guideline criteria of 45 dB(A) for an involved receptor is used.

2.2 Operation of the substation

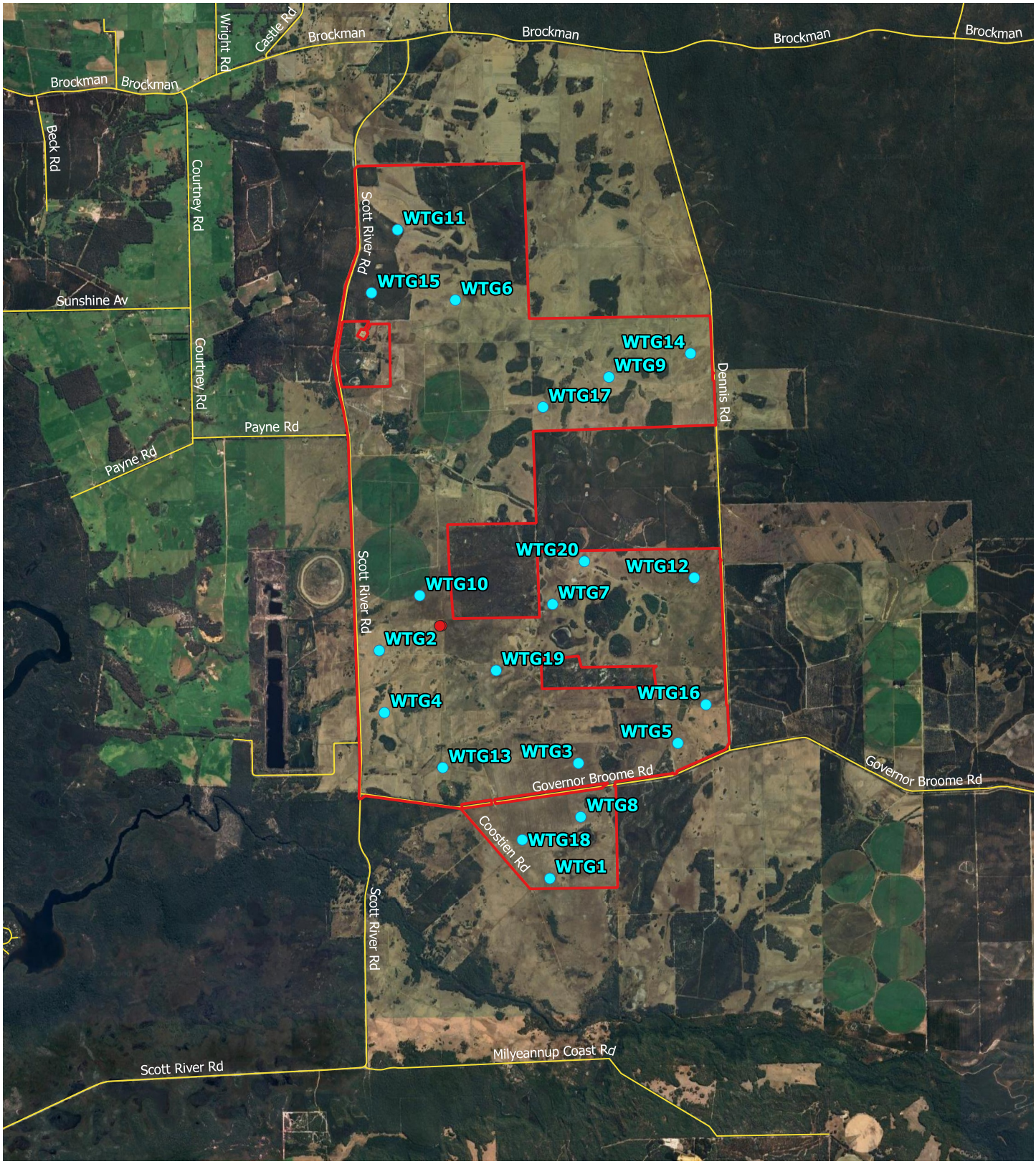
The noise emissions from the substation proposed for the Project are governed by the *Environmental Protection (Noise) Regulations 1997* (Refer to section 2.1.1 above).

3. Project overview

3.1 Wind turbines

3.1.1 Wind turbine locations

A 20-WTG layout has been used for the NIA as presented in Figure 3.1 along with the locations of the transformers. The WTG coordinates are provided in Appendix D.



Legend

Wind turbines | Substation transformer | Development Envelope | Local road

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Wind turbines and transformers locations
20 WTG Layout

Project No. **12623449**

Version **1**

Date. **09/05/2025**

FIGURE 3.1

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi

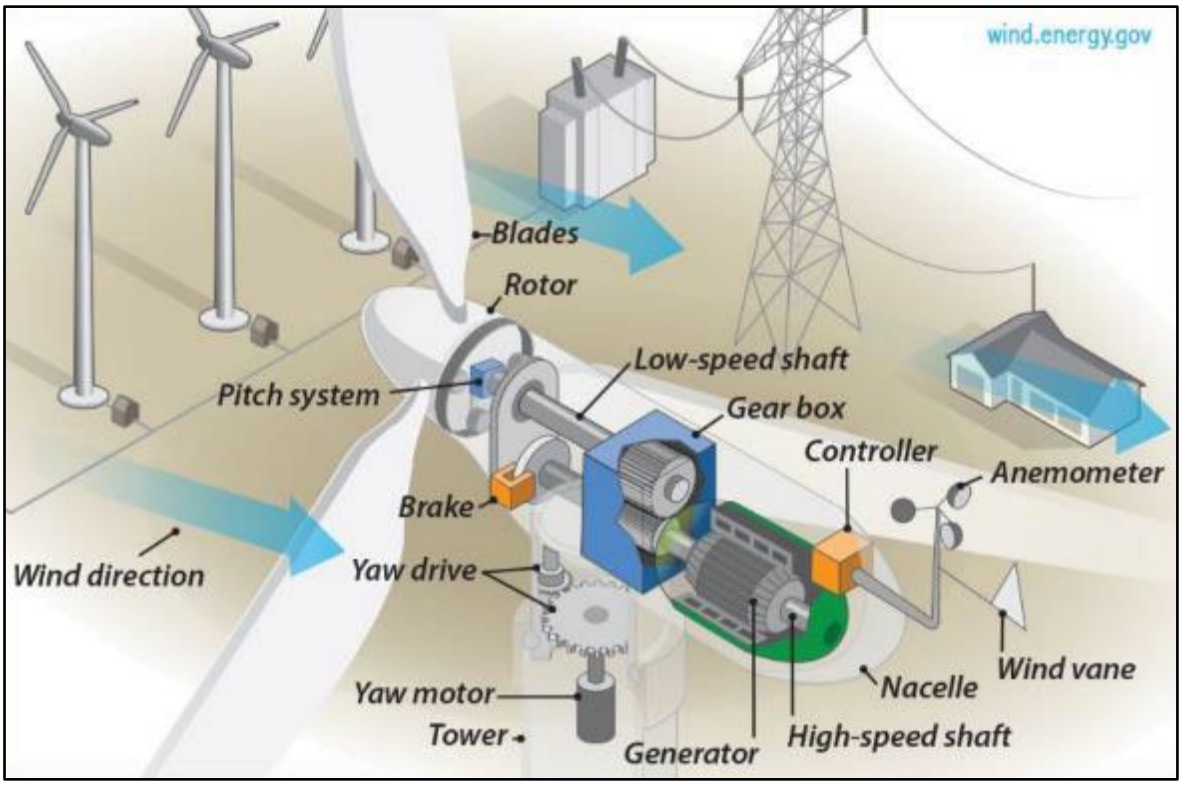
3.1.2 Sources of noise

There are two main groups of noise sources originating from a WTG: mechanical and aerodynamic noise. Sources of mechanical noise include the following (refer to Figure 3.2):

- Gearbox
- Generator
- Yaw drives
- Cooling fans
- Auxiliary equipment
- Brakes (when applied)

Sources of mechanical noise tend to be both tonal and broadband in nature since the emitted sound is associated with the rotation of mechanical and electrical equipment. However, in modern turbines, mechanical noise is not usually audible above aerodynamic noise at greater separation distances. Mechanical noise can be effectively reduced through standard noise control practices such as vibration isolation, damping and noise enclosures.

Aerodynamic noise is associated with the passage of air over the turbine blades and is considered the most dominant source of WTG noise emissions. Aerodynamic noise levels typically increase with rotor speed.



Source: US Office of Energy Efficiency & Renewable Energy

Figure 3.2 WTG components

3.1.3 Sound power levels

The proposed WTG make and model for the Project will be determined through a procurement process prior to commencement of construction. The turbine hub height is not yet finalised and is expected to be a maximum of 164 m.

Among the turbine options considered, the WTG make and model with worst-case noise emissions and their spectral data are used for the noise assessment study. The overall sound power levels (SWLs) are presented in Figure 3.3 with reference to the IEC 61400-11 standard. The SWLs presented are valid for the corresponding wind speeds referenced to the hub height. The prototype cut-in wind speed is 4 m/s and speed of rated power is 11 m/s.

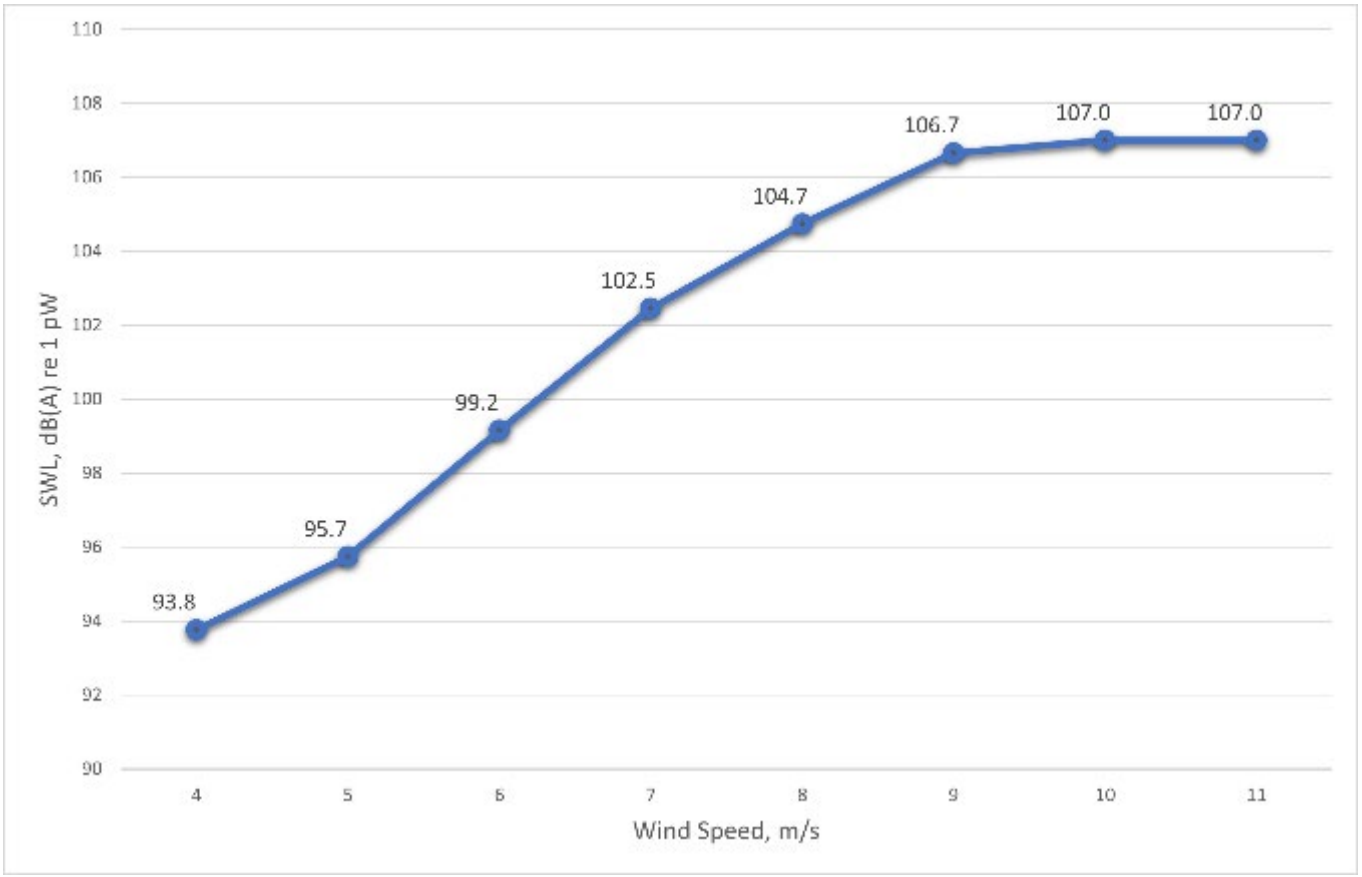


Figure 3.3 WTG SWL vs wind speed

The 1/3 octave source spectra in dB(A) re 1 pW for the corresponding centre frequencies are shown in Figure 3.4 for the wind speed of 8 m/s as an example, referred to the hub height as per IEC 61400-11. Appendix A provides the turbine source spectra for the full range of wind speeds.

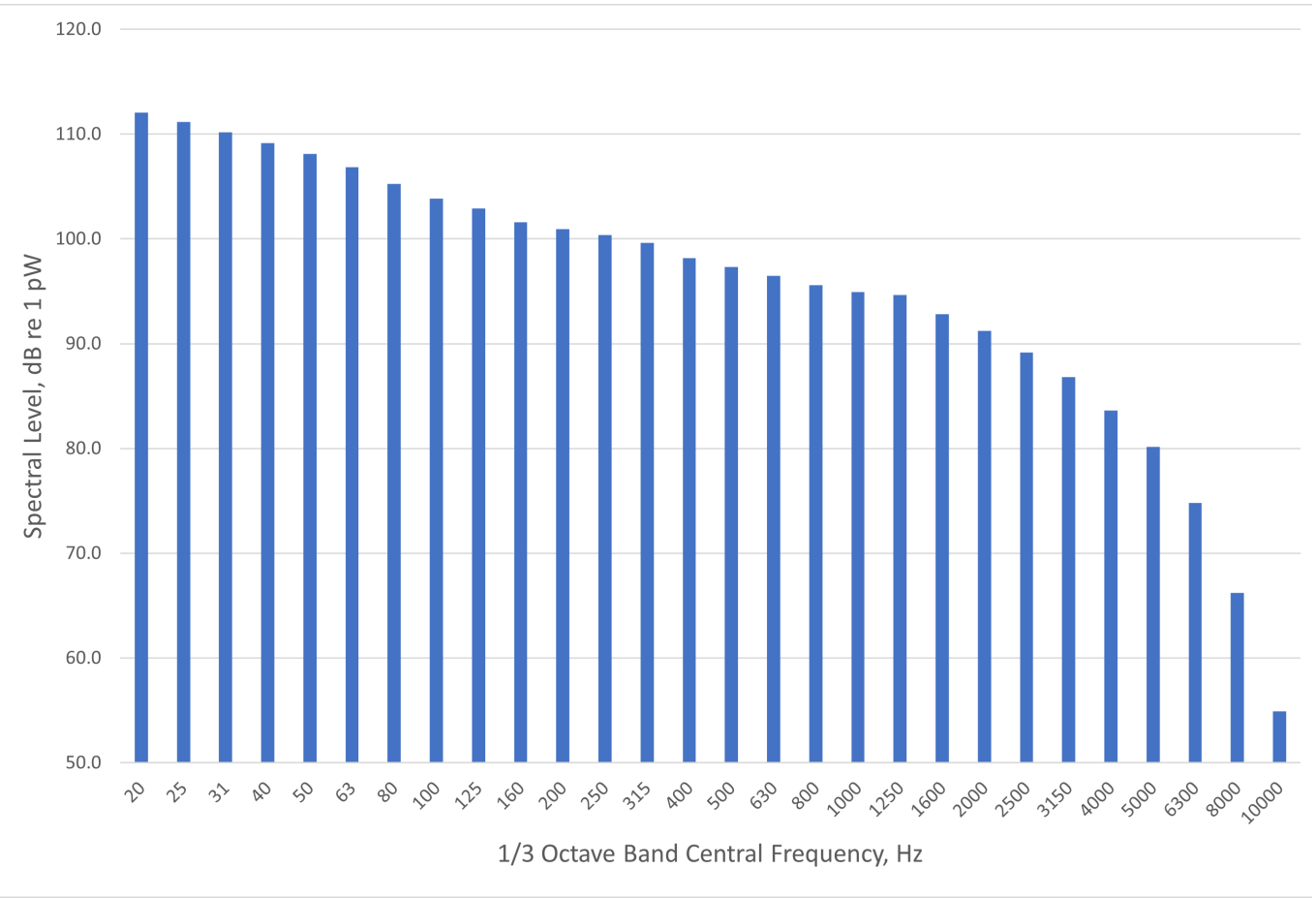


Figure 3.4 *1/3 octave band spectral levels at hub height for wind speed 8 m/s*

3.1.4 Tonality and infrasound

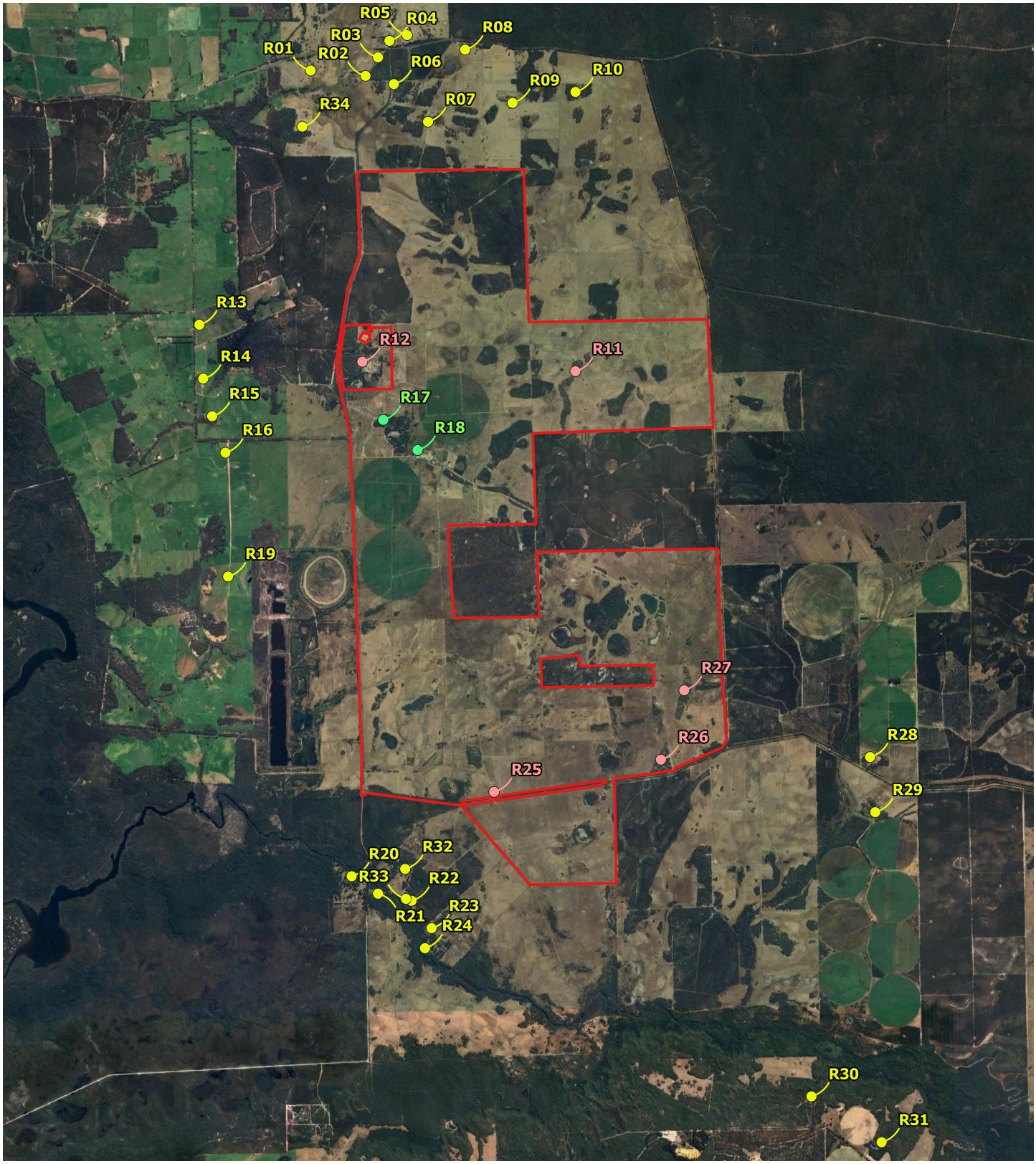
WTG manufacturers are expected to conduct independent acoustic tests in accordance with IEC 61400-11 to assess tonal audibility.

According to both the Regulations and the SA Guidelines, an additional 5 dB should be added to the measured noise level from a wind farm where tonality is shown to be a characteristic and is audible at the relevant noise sensitive receptor. GHD assumes no tonal characteristics associated with the WTG to be used and therefore tonality has been excluded from this assessment.

Infrasound (sound spectral component below 20 Hz) is not tested as an obligatory part of IEC61400-11 or the SA Guidelines. Infrasound was a characteristic attributable to earlier design of WTGs where turbine blades were downwind of the main tower. This generated an infrasound effect as the blades cut through the turbulence generated around the downwind side of the tower. Modern WTG designs typically have the blades upwind of the main tower and combined with improved blade design, infrasound is found not to be one of the major audible characteristics at modern wind farm sites (Wind-watch.org, 2014). SynergyRED is committed to using WTGs of modern design for the Project.

3.1.5 Noise receptors

The noise assessment methodology, as specified in both the Regulations and the SA Guidelines, require all noise receptors within the area surrounding the Development Envelope to be identified. Noise receptors identified within 5 km of the Development Envelope are presented in Figure 3.5.



Legend

- Development Envelope
- Local road
- Not-involved noise sensitive receptor
- Involved noise sensitive receptor
- Non-sensitive noise receptor

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Noise Receptor Locations

Project No. **12623449**

Version **1**

Date. **09/05/2025**

FIGURE 3.5

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi

The coordinates and types of these noise receptors are detailed in Table 2.2. It should be noted that R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be “Non-sensitive” and are not considered within the NIA. Also, receptors R17 and R18 are participating landowners (i.e. involved noise sensitive receptors).

4. Noise modelling and impact assessment

4.1 Noise modelling algorithm and inputs

4.1.1 Modelling algorithm

Both the Regulations and SA Guidelines state that a suitable model must be selected to predict worst-case noise levels at all relevant noise receptors and recommend the use of prediction methods in accordance with ISO9613-2 or CONCAWE.

Noise from the Project has been predicted using the most recent version of international standard *ISO9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO9613-2). The ISO9613-2 noise propagation algorithm is used around the world and is generally accepted as an appropriate model for assessment of wind farms. The model has the ability to take into account the distance between source and noise receptor topography, ground attenuation, atmospheric absorption at different frequencies and meteorological conditions favourable to noise propagation.

In general accordance with the SA Guidelines, noise levels at relevant noise receptor locations were predicted for each reportable wind speed. Appendix D.4 of ISO 9613-2:2024 states that:

When the source is a WTG, attenuation due to ground effect appears lower than considered in the "General method" and selection of the ground factor in a) – c) in 7.3.1 should be modified as follows:

– *Hard ground, which includes paving, water, solid ice, concrete, and all other ground surfaces having a low porosity. Tamped ground, for example, as often occurs around industrial sites, can be considered hard. For hard ground G = 0.*
– *Porous or mixed ground, which includes ground covered by grass, trees or other vegetation, and farming land should be modelled using a maximum of G = 0.5.*
– *When using G = 0.5, a minimum receiver height of 4 m is recommended for the purposes of the predictions, regardless of actual receiver height.*

Because the ground surrounding the Development Envelope comprises mostly of sand, soil and vegetation, ground absorption was set to G=0.5. In order to adhere to ISO 9613-2:2024 for WTG noise prediction as per advice from DWER, noise receptors were set at 4 metres above ground level (instead of typical 1.5 metres above ground level) as this leads to more consistent outcomes for noise prediction of WTGs.

4.1.2 Modelling of wind turbine generators

The noise model was developed based on the following data inputs:

– Topographic elevation contours (5 m resolution) for the Development Envelope and surrounding area, obtained from publicly available data.
– A single scenario for the proposed Project turbine layout (20 WTG layout) (refer to Appendix D for the coordinates) and the hub height (164 m above ground level).
– Noise receptor locations and types, received from SynergyRED.
– The following modelling parameters were used in the model:
  - Atmospheric conditions at 10°C temperature and 80 percent relative humidity.
  - 50 percent acoustically porous or mixed ground (G = 0.5 ground factor).
  - No barriers or intervening structures were included in the model.
  - 4 m noise receptor height.
– Turbine source noise emissions and the 1/3 octave source spectra data, received from SynergyRED.

For modelling purposes, representative WTG type and noise emission data have been used to assess noise compliance. The overall SWLs and 1/3 octave source spectra data (20 Hz to 10 kHz) under integer wind speeds between 4 m/s and 15 m/s are provided in Appendix A. No penalty for tonality was applied to the modelling prediction results.

It should be noted that the following conservative assumptions were implemented in the noise model:

1- Noisiest turbine available at the time was used (i.e. with no mitigation applied).

2- General wind roses available from the BOM website for the area suggest that winds are predominantly south-easterly. However, in the noise model wind has been stipulated to occur in all directions which makes for a conservative assessment (i.e. the noise predicted in the assessment assumes downwind noise conditions have been used for all receptors).

4.1.3 Modelling of substations

The Project proposes a substation comprising two 132 kVA transformers. The overall sound power level of the transformers is 85 dB(A), estimated in accordance with Australian Standard AS 60076 Part 10: 2009 *Power Transformers – Determination of Sound Levels (IEC 60076-10, Ed.1 (2001) MOD)* and the proposed transfer rating (in kVA). The 1/3 octave sound power spectral curve used for the model input, as presented in Appendix A, is based on a reference spectral curve measured for a typical transformer facility.

It should be noted that the equivalent continuous noise parameter L_{Aeq} is used to characterise the noise emissions from the substation transformers. Considering the noise emissions from the transformers are constant in nature, it is expected that the parameter L_{Aeq} will be consistent with the parameter L_{A10} based on which the noise assessment criteria have been specified as in Table 2.1. For this conversion, a 3 dB conversion factor has been used (i.e. $L_{A10} = L_{Aeq} + 3$ dB(A)).

4.2 Impact assessment

4.2.1 WTG noise

Received noise levels have been predicted at all identified noise sensitive receptors with all WTGs (20 WTGs) operating simultaneously, for all source noise emission inputs under relevant individual integer wind speeds as provided in Appendix A.

As explained in Section 1.3, a dual criteria approach has been used for the NIA by assessing the predicted noise levels against the criteria based on the Regulations (Section 2.1.1) and based on the background noise monitoring data processing as indicated by the SA Guidelines (Section 2.1.2). The predicted noise levels for the Project assessed against the criteria derived are provided in Table 4.1 and Table 4.2 based on the Regulations and the SA Guidelines, respectively. As explained in section 2.1.3, the nighttime L_{A10} assigned noise levels for the nighttime (35 + IF) has been used as the most stringent criteria for the NIA at the Not-involved noise sensitive receptors based on the Regulations. Also 40 dB L_{A10} has been used as a conservative criteria for the involved noise sensitive receptors based on DWER advice. All predicted results and criterion values are rounded to the nearest integer for compliance assessment. As can be seen from the tables, the predicted noise levels at all noise sensitive receptors comply with the criteria derived based on both the Regulations and the SA Guidelines.

It should be noted that the criteria derived based on the Regulations, are more stringent which results in smaller safety margines at wind speeds above 10 m/s. The smallest safety margin is less than 1 dB predicted for noise sensitive receptor R32 at wind speeds above 10 m/s (Table 4.1).

Noise contour maps are provided in Figures C1 to C4 in Appendix C for 4 m/s, 6 m/s, 8 m/s and 10-11 m/s which constitute four representative wind speeds from the cut-in to the rated power wind speeds. It should be noted that the turbine source spectra and thus the predicted noise levels are similar for 10 and 11 m/s for the proposed WTG type (Appendix A).

4.2.2 Substation noise

Due to the large distances from the proposed substation to the noise sensitive receptors assessed (i.e. more than 2 km), the predicted noise levels from the substation transformers at all noise sensitive receptors are below 5 dB(A), which is well below the expected ambient noise levels.

Considering the +5 dB adjustment on received levels due to the potential tonal characteristics for transformer noise emissions, the predicted noise levels from the proposed substation are still well below the worst-case 35 dB(A) nighttime assigned level applicable to the fixed equipment under the Regulations.

Table 4.1 Predicted noise levels (dB(A)) assessed against criteria based on the Regulations (Section 2.1.1)

Noise sensitive receptor [1]	Predicted noise level at each wind speed																Compliance
	4 m/s		5 m/s		6 m/s		7 m/s		8 m/s		9 m/s		10 m/s		11 m/s		
	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	
R01	16	35	18	35	21	35	24	35	26	35	27	35	28	35	28	35	Yes
R02	16	35	18	35	21	35	24	35	26	35	28	35	28	35	28	35	Yes
R03	15	35	17	35	20	35	23	35	25	35	27	35	27	35	27	35	Yes
R04	14	35	16	35	19	35	22	35	24	35	26	35	26	35	26	35	Yes
R05	15	35	17	35	20	35	23	35	25	35	27	35	27	35	27	35	Yes
R06	16	35	19	35	22	35	25	35	26	35	28	35	28	35	28	35	Yes
R07	19	35	21	35	25	35	28	35	30	35	31	35	32	35	32	35	Yes
R08	15	35	17	35	21	35	24	35	25	35	27	35	27	35	27	35	Yes
R09	17	35	19	35	22	35	25	35	27	35	28	35	29	35	29	35	Yes
R10	15	35	17	35	21	35	23	35	25	35	27	35	27	35	27	35	Yes
R13	16	35	19	35	22	35	25	35	27	35	29	35	29	35	29	35	Yes
R14	16	35	19	35	22	35	25	35	27	35	28	35	29	35	29	35	Yes
R15	16	35	18	35	21	35	24	35	26	35	28	35	28	35	28	35	Yes
R16	16	35	19	35	22	35	25	35	26	35	28	35	28	35	28	35	Yes
R17 [2]	21	40	24	40	27	40	30	40	32	40	34	40	34	40	34	40	Yes
R18 [2]	22	40	24	40	27	40	30	40	32	40	34	40	34	40	34	40	Yes
R19	18	35	21	35	24	35	27	35	29	35	30	35	31	35	30	35	Yes
R20	20	35	23	35	26	35	29	35	31	35	33	35	33	35	33	35	Yes
R21	21	35	23	35	27	35	30	35	31	35	33	35	33	35	33	35	Yes
R22	21	35	23	35	27	35	30	35	31	35	33	35	33	35	33	35	Yes
R23	21	35	23	35	27	35	29	35	31	35	33	35	33	35	33	35	Yes
R24	19	35	22	35	25	35	28	35	30	35	31	35	32	35	32	35	Yes
R28	18	35	20	35	23	35	26	35	28	35	29	35	30	35	30	35	Yes
R29	17	35	19	35	22	35	25	35	27	35	28	35	29	35	29	35	Yes
R30	11	35	13	35	16	35	19	35	21	35	22	35	23	35	23	35	Yes
R31	9	35	12	35	14	35	17	35	19	35	20	35	21	35	21	35	Yes
R32	22	35	25	35	28	35	31	35	33	35	34	35	35	35	35	35	Yes
R33	21	35	23	35	26	35	29	35	31	35	33	35	33	35	33	35	Yes
R34	17	35	19	35	22	35	25	35	27	35	29	35	29	35	29	35	Yes

[1] R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be “Non-sensitive” and are not considered within the NIA.*[2] R17 and R18 are involved noise sensitive receptors (i.e. participating landowners) for which 40 dB(A) is used upon advice from DWER (Section 2.1.3).*

Table 4.2 Predicted noise levels (dB(A)) assessed against the criteria based on SA Guidelines (Section 2.1.2)

Noise sensitive receptor [1]	Predicted noise level at each wind speed																Compliance
	4 m/s		5 m/s		6 m/s		7 m/s		8 m/s		9 m/s		10 m/s		11 m/s		
	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	L_{Aeq} 10 min	Criteria	
R01	16	35	18	36	21	38	24	39	26	40	27	40	28	39	28	41	Yes
R02	16	35	18	36	21	38	24	39	26	40	28	40	28	39	28	41	Yes
R03	15	35	17	36	20	38	23	39	25	40	27	40	27	39	27	41	Yes
R04	14	35	16	36	19	38	22	39	24	40	26	40	26	39	26	41	Yes
R05	15	35	17	36	20	38	23	39	25	40	27	40	27	39	27	41	Yes
R06	16	35	19	36	22	38	25	39	26	40	28	40	28	39	28	41	Yes
R07	19	35	21	36	25	38	28	39	30	40	31	40	32	39	32	41	Yes
R08	15	35	17	36	21	38	24	39	25	40	27	40	27	39	27	41	Yes
R09	17	35	19	36	22	38	25	39	27	40	28	40	29	39	29	41	Yes
R10	15	35	17	36	21	38	23	39	25	40	27	40	27	39	27	41	Yes
R13	16	35	19	35	22	36	25	36	27	37	29	37	29	37	29	38	Yes
R14	16	35	19	35	22	35	25	35	27	35	28	35	29	35	29	36	Yes
R15	16	35	18	35	21	35	24	35	26	35	28	35	28	35	28	36	Yes
R16	16	35	19	35	22	35	25	35	26	35	28	35	28	35	28	36	Yes
R17 [2]	21	45	24	45	27	45	30	45	32	45	34	45	34	45	34	45	Yes
R18 [2]	22	45	24	45	27	45	30	45	32	45	34	45	34	45	34	45	Yes
R19	18	35	21	35	24	35	27	35	29	35	30	35	31	35	30	36	Yes
R20	20	35	23	35	26	36	29	36	31	37	33	37	33	37	33	39	Yes
R21	21	35	23	35	27	36	30	36	31	37	33	37	33	37	33	39	Yes
R22	21	35	23	35	27	36	30	36	31	37	33	37	33	37	33	39	Yes
R23	21	35	23	35	27	36	29	36	31	37	33	37	33	37	33	39	Yes
R24	19	35	22	35	25	36	28	36	30	37	31	37	32	37	32	39	Yes
R28	18	35	20	36	23	37	26	37	28	37	29	37	30	37	30	38	Yes
R29	17	35	19	36	22	37	25	37	27	37	28	37	29	37	29	38	Yes
R30	11	35	13	36	16	37	19	37	21	37	22	37	23	37	23	38	Yes
R31	9	35	12	36	14	37	17	37	19	37	20	37	21	37	21	38	Yes
R32	22	35	25	35	28	36	31	36	33	37	34	37	35	37	35	39	Yes
R33	21	35	23	35	26	36	29	36	31	37	33	37	33	37	33	39	Yes
R34	17	35	19	36	22	38	25	39	27	40	29	40	29	39	29	41	Yes

[1] R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be "Non-sensitive" and are not considered within the NIA.

[2] R17 and R18 are involved noise sensitive receptors for which the SA Guideline criteria of 45 dB(A) for a not-involved receptor is used (Section 2.1.3).

4.2.3 Noise from substation vs noise from WTGs

Currently there are no known significant sources of noise in the area adjacent to the Development Envelope which is predominantly rural in nature. The noise modelling results for both WTG and substation demonstrate that the received noise levels at assessed noise sensitive receptors from the proposed substation are more than 20 dB lower than the noise levels received from the proposed WTGs. Therefore, the combined noise impact from the Project is dominated by the WTG noise emissions, and the proposed substation is unlikely to result in any noticeable increases in received noise levels at the assessed noise sensitive receptors.

5. Conclusion

A NIA has been conducted for the operation of the Project in general accordance with the requirements of the Regulations and the SA Guidelines (2021) for the operation of the WTGs.

A dual criteria approach was adopted for this NIA: 1- the criteria was derived based on the Regulations, and 2- baseline noise monitoring was conducted at seven monitoring locations around the Development Envelope, and the baseline noise criteria were derived in accordance with the SA Guidelines.

A 3D environmental noise model of the Development Envelope was created using the SoundPLAN software to predict noise levels at the adjacent noise sensitive receptors, using the ISO9613-2:2024 calculation algorithm. A 20 WTG layout with hub height of 164 metres was considered in the 3D noise model. The turbine source noise input data is based on the 1/3 octave source spectra data provided by SynergyRED.

The noise modelling results show that the predicted noise levels from the Project received at the adjacent noise sensitive receptors comply with the noise criteria in accordance with both the Regulations and the SA Guidelines. The smallest safety margin is less than 1 dB predicted for noise sensitive receptor R32 at wind speed 10 m/s and above when assessed against the criteria based on the Regulations which are more stringent especially at high wind speeds.

It should be noted that the following conservative assumptions were implemented in the noise model:

1- Noisiest turbine available at the time was used (i.e. with no mitigation applied).

2- General wind roses available from the BOM website for the area suggest that winds are predominantly south-easterly. However, in the noise model wind has been stipulated to occur in all directions which makes for a conservative assessment (i.e. the noise predicted in the assessment assumes downwind noise conditions have been used for all receptors).

It is recommended that the turbines are properly maintained to ensure the noise emissions of the turbines are not adversely affected by the turbine wear, which could potentially result in audible tonality.

Once the wind farm is operating, in accordance with the Regulations and SA Guidelines, it is recommended that compliance monitoring be undertaken at the noise sensitive receptors with the highest predicted noise levels (i.e. R32).

6. References

Australian Standard AS 60076 Part 10: 2009 *Power Transformers – Determination of Sound Levels (IEC 60076-10, Ed.1 (2001) MOD)*

Berglund, Birgitta, Lindvall, Thomas, Schwela, Dietrich H & World Health Organization, Occupational and Environmental Health Team, (1999), *Guidelines for community noise*, World Health Organization, https://apps.who.int/iris/handle/10665/66217

Environment Protection Authority, *South Australia - Wind farms environmental noise guidelines*, EPA South Australia (2021)

International Electrotechnical Commission 2012, *Wind turbine generator systems – Part 11: Acoustic emission measurement techniques*, IEC Wind Energy Standard 61400-11

ISO9613-2 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO9613-2)

New Zealand Standards NZS 6808:2010 *Acoustics – Wind farm noise, New Zealand Standard* (2010)

The Working Group on Noise from Wind Turbines, *The assessment and rating of noise from wind farms*, Final Report, September 1996, ETSU-R-97

The Western Australian Planning Commission (WAPC), *Guidelines for Wind Farm Development*, Planning Bulletin, Number 67

The Western Australian Planning Commission (WAPC), *Position Statement: Renewable energy facilities*, March 2020

Western Australia Environmental Protection Act 1986 (EP Act) *Environmental Protection (Noise) Regulations 1997*, Government of Western Australia

Waubra Foundation, Wind Turbine Noise: a simple statement of facts, August 2014, Wind Turbine Noise: a simple statement of facts | Wind Energy Impacts and Issues (wind-watch.org)

Appendices

Appendix A

Sound power levels for WTGs and substation transformers

Table A.1 Sound power levels (dB) for the proposed WTG type

Unweighted 1/3 octave band centre frequency	Hub height wind speed – 164 m											
	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s
20 Hz	103	104	107	110	112	114	114	114	114	114	114	114
25 Hz	102	103	106	109	111	113	113	113	113	113	113	113
31.5 Hz	101	102	105	108	110	112	112	112	112	112	112	112
40 Hz	100	101	104	107	109	111	111	111	111	111	111	111
50 Hz	99	100	103	106	108	110	110	110	110	110	110	110
63 Hz	97	99	102	104	107	109	109	109	109	109	109	109
80 Hz	96	98	100	103	105	107	108	108	108	108	108	108
100 Hz	95	97	99	102	104	106	106	106	106	106	106	106
125 Hz	94	97	99	101	103	105	105	105	105	105	105	105
160 Hz	93	96	98	100	102	103	103	103	103	103	103	103
200 Hz	92	95	98	100	101	102	103	103	103	103	103	103
250 Hz	91	94	97	99	100	102	102	102	102	102	102	102
315 Hz	89	92	96	98	100	101	101	101	101	101	101	101
400 Hz	87	90	94	97	98	100	100	100	100	100	100	100
500 Hz	86	88	92	95	97	99	99	99	99	99	99	99
630 Hz	84	86	90	94	96	98	98	98	98	98	98	98
800 Hz	83	85	89	93	96	97	98	98	98	98	98	98
1 kHz	83	84	88	92	95	97	97	97	97	97	97	97
1.25 kHz	83	83	87	92	95	97	97	97	97	97	97	97
1.6 kHz	81	82	86	90	93	95	96	96	96	96	96	96
2 kHz	81	81	84	88	91	94	94	94	94	94	94	94
2.5 kHz	79	81	83	86	89	92	92	92	92	92	92	92
3.15 kHz	77	79	82	84	87	89	89	89	89	89	89	89
4 kHz	75	77	79	82	84	86	86	86	86	86	86	86
5 kHz	71	73	76	78	80	82	82	82	82	82	82	82

Unweighted 1/3 octave band centre frequency	Hub height wind speed – 164 m											
	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s
6.3 kHz	65	68	71	73	75	76	76	76	76	76	76	76
8 kHz	55	59	62	65	66	67	68	68	68	68	68	68
10 kHz	43	46	50	53	55	56	56	56	56	56	56	56
Overall A-Weighted dB(A)	94	96	99	102	105	107	107	107	107	107	107	107

Table A.2 Sound power overall and 1/3 octave spectral levels – Substation transformer

Overall, dB(A)	1/3 octave band central frequency (Hz) and noise level, in dB (linear)													
	20	25	31	40	50	63	80	100	125	160	200	250	315	400
85	71	73	75	73	68	71	71	91	71	67	87	72	83	85
	500	630	800	1 K	1.25 K	1.6 K	2 K	2.5 K	3.15 K	4 K	5 K	6.3 K	8 k	
	80	75	69	70	68	62	60	54	53	52	53	54	53	

Appendix B

Background noise monitoring

B. Background noise monitoring

Long term (unattended) noise measurements were conducted at seven monitoring locations in the area adjacent to the Development Envelope. Loggers at locations NMP01 and NMP05 were deployed on 8 December 2023 and loggers at locations NMP02, NMP03, NMP04, NMP06 and NMP07 on 7 December 2023. Loggers at locations NMP01, NMP02, NMP03 and NMP04 were retrieved on 14 May 2024 and loggers at locations NMP05, NMP06 and NMP07 on 13 May 2024.

For measurement of local ground level meteorology and rainfall, one ultrasonic automatic weather mast was co-located at the NMP01 logger location during the deployment period (from 8 December 2023 to 14 May 2024). Wind data at greater heights was taken from the existing meteorological mast near the Development Envelope provided by the client.

The data across all noise loggers, local weather masts, and existing site meteorological masts was date and time synchronised over 10-minute data intervals.

B-1 Instrumentation

Ambient noise levels were monitored using SVAN 977 environmental noise loggers. Details of the noise measurement instrumentation used are presented in Table B.1.

All noise monitoring instrumentation was in current National Association of Testing Authorities (NATA) calibration at the time of use. All instrumentation was field-checked and calibrated both before and after noise measurements using a Svantek SV-36 calibrator. No discrepancies equal to or greater than 1 dB were noted throughout the measurement exercise as is required under Section 5.6 of Australian Standard AS 1055:2018 *Acoustics – Description and Measurement of Environmental Noise* (Standards Australia, 2018).

Table B.1 Unattended noise monitor equipment details

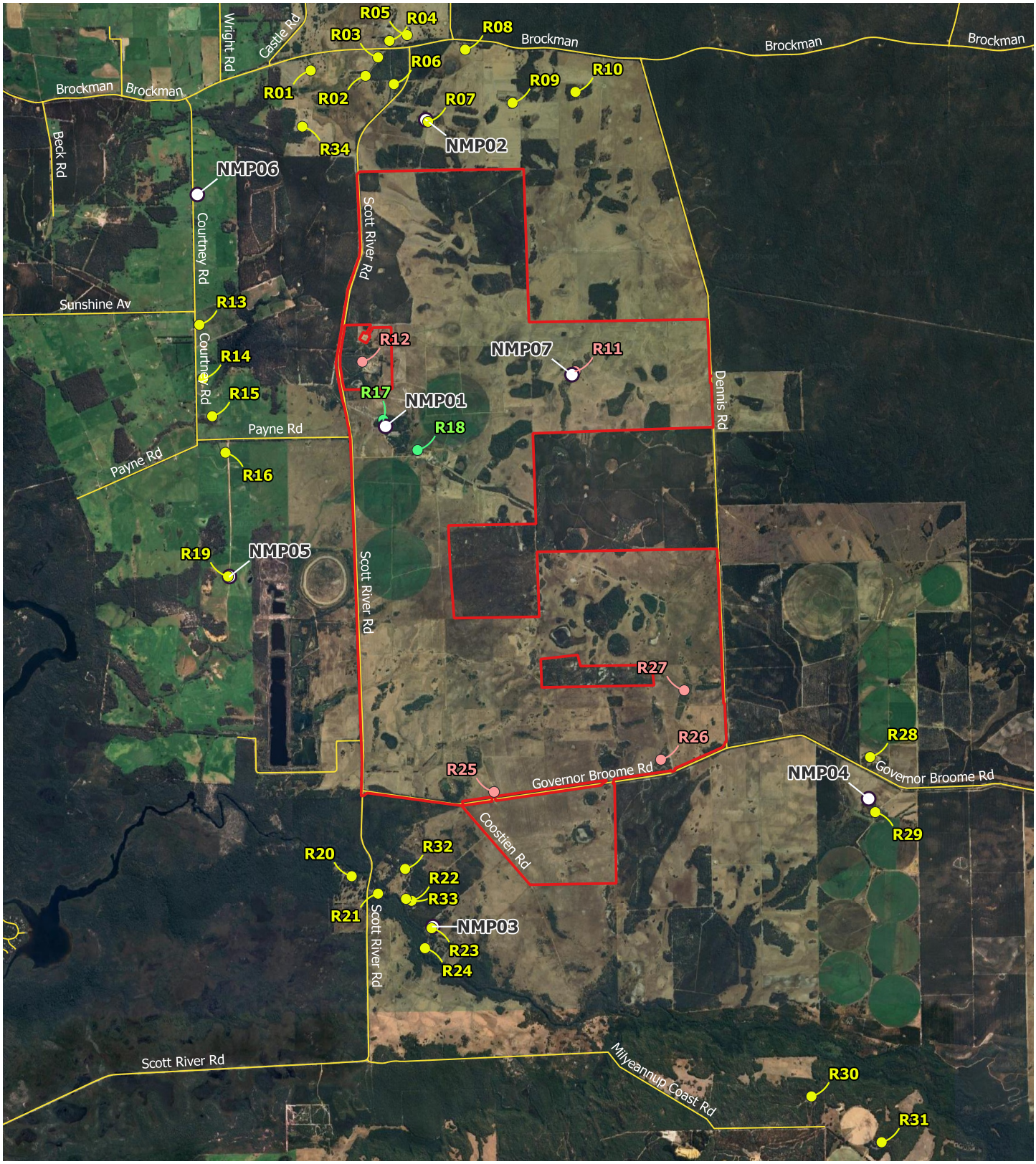
Instrumentation details	NMP01	NMP02	NMP03	NMP04	NMP05	NMP06	NMP07
Model and class	SVAN 977 Type A	SVAN 977 Type C	SVAN 977 Type D	SVAN 977 Type D	SVAN 977 Type C	SVAN 977 Type D	SVAN 977 Type D
Serial No.	69721	98077	99011	99009	92622	99010	99261
Deployment date	08 Dec 2023	07 Dec 2023	07 Dec 2023	07 Dec 2023	08 Dec 2023	07 Dec 2023	07 Dec 2023
Collection Date	14 May 2024	14 May 2024	14 May 2024	14 May 2024	13 May 2024	13 May 2024	13 May 2024

B-2 Noise measurement locations

Long term monitoring was performed at locations close to residences. Coordinates of the monitoring locations details are summarised in Table B.2. Figure B.1 shows the location of monitoring locations in relation to the noise receptors. As can be seen from Figure B.1, the monitoring locations were selected to cover a reasonable range of wind directions and to represent several NSRs by designating similar criteria to a number of noise receptors based on similarity of acoustic environment.

Table B.2 Noise logger coordinates

Logger location	Coordinates, GDA2020 / MGA Zone 50	
	Easting, metres	Northing, metres
NMP01	340955	6213742
NMP02	341506	6217931
NMP03	341602	6206907
NMP04	347555	6208654
NMP05	338823	6211690
NMP06	338384	6216910
NMP07	343502	6214448



Legend

- Not-involved noise sensitive receptor
- Involved noise sensitive receptor
- Non-sensitive noise receptor
- Development Envelope
- Noise monitoring points
- Local road

Paper Size ISO A4

0 0.5 1 1.5 2 km

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

N

GHD

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Noise monitoring locations

Project No. **12623449**

Version **1**

Date. **09/05/2025**

FIGURE B.1

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi

B-3 Meteorology

B-3-1 Hub height wind speed

Data from a meteorological mast provided by SynergyRED was used for collecting wind data at various hub heights (from 60 m to 150 m with 30 m steps). Wind speeds were calculated at the proposed 164 m hub height and then used to calculate the noise criteria (refer to Section B-4-1).

B-3-2 Rainfall and local wind speed

SA Guidelines state: As part of the development application, developers should confirm that the reported noise levels are not influenced by high wind speed across the microphone.

Hence, in the case of wind farm noise monitoring, it is a requirement to undertake measurements in a manner that allows collection of noise measurements in situations where the wind speed exceeds the 5 m/s at the microphone position normally provided as the upper limit for environmental noise monitoring. The limit is a guide to reduce air pressure fluctuations across the microphone artificially increasing the measured noise level. Standard 90 mm wind shield was used during noise monitoring.

According to the SA Guidelines, sound level measurements should be made during a representative range of wind speeds and directions generally expected at the wind farm, and include the normal operating range of the turbines, that is from cut-in to rated power. Extraneous sound levels caused by events, including precipitation, insects, fauna, and so on, as far as is practical for an unattended monitoring exercise, be identified and removed from the data set.

Rain data collected by the co-located weather station placed at the logger location NMP01 was utilised to confirm rain events during the monitoring period. This data has been used to exclude periods where rain events were recorded.

Average 10-minute noise measurements where rainfall, high local wind speeds or irrelevant noise occurred were defined as ‘extraneous events’ and were excluded from the background noise assessment. Data acquired during local wind speeds (microphone height) exceeding 5 m/s was excluded from further analysis.

B-4 Results of noise monitoring and derived noise criteria

Applicable noise criteria were calculated for the proposed 20 WTG layout with 164 m hub height.

Background noise was processed and analysed in accordance with procedures in the SA Guidelines. The number of valid monitoring points is summarised in Table B.3. The total number of valid data points is well above 2000 which gives sufficient basis to derive applicable noise criteria.

Table B.3 Number of valid background noise monitoring data

Monitoring location			Valid data points- Guidelines 2021
Logger location	**Start time**	**End time**	**Hub height 164 m**
NMP01	7/12/2023	14/05/2024	22699
NMP02	7/12/2023	14/05/2024	22853
NMP03	7/12/2023	14/05/2024	22862
NMP04	7/12/2023	14/05/2024	22858
NMP05	8/12/2023	13/05/2024	22632
NMP06	7/12/2023	13/05/2024	22753
NMP07	7/12/2023	13/05/2024	22748

The SA Guidelines also recommend that no less than 500 data points are to be collected for downwind conditions. Wind direction for downwind conditions is defined as ±45° from line connecting the noise receptor and the nearest turbine. If there are more than one turbine at similar distances from the noise receptor, SA Guidelines recommend identification of more than one downwind angle. The resulted downwind angles and the number of downwind data points for each monitoring location is presented are presented in Table B.4.

Table B.4 Background noise data points - Downwind direction

Monitoring location			Nearest turbine ID	Downwind direction, degree	Valid downwind data points at hub height 164 m
Logger location	Start time	End time			
NMP01	3/08/2023	27/09/2023	WTG 15	356	1269
NMP02	3/08/2023	27/09/2023	WTG 11	196	2068
NMP03	16/08/2023	27/09/2023	WTG 1	101	10993
NMP04	3/08/2023	27/09/2023	WTG 5	300	794
NMP05	3/08/2023	27/09/2023	WTG 2	113	10974
NMP06	17/10/2023	22/11/2023	WTG 11	103	11021
NMP07	17/10/2023	22/11/2023	WTG 9	99	8773

Table B.3 and Table B.4 show that the background noise monitoring program allowed to collect a suitable number of downwind data points in accordance with the requirements of the SA Guidelines.

It is understood that relevant noise sensitive receptors around the Development Envelope are situated in zones classified as rural living. As such, Project specific noise criteria based on the SA Guidelines are derived as:

– 35 dB(A) at affected noise sensitive receptors, or
– Background noise ($L_{A90,10\text{-}min}$) plus 5 dB(A)

whichever is greater for wind speed from cut-in to rated power of the WTG.

The Project Development Envelope is located within a rural area. It should be noted that R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be “Non-sensitive” and are not considered within the NIA. Therefore, the 35 dB(A) baseline criterion or the adjusted “background + 5” dB(A) criterion apply to all Not-involved noise sensitive receptors identified in Table 2.2. R17 and R18 are involved noise sensitive receptors (section 2.1.2.1) for which the SA guidelines criteria of 45 dB(A) is used.

B-4-1 Background noise monitoring data and noise criteria for hub height 164m

Results of background noise monitoring were processed in accordance with SA Guidelines 2021 and relevant noise criteria are derived for each of the monitoring locations for wind speeds referenced to hub height of 164 m.

Figure B.2 to Figure B.6 show results of postprocessed data and relevant noise criteria calculated in accordance with SA Guidelines 2021. Data postprocessing is performed for arithmetic averages of measured noise levels in integer wind speed bins as per Section 3.4 of the SA Guidelines.

One can see that applicable noise criteria correspond to the baseline limit of 35 dB(A) where the background noise is equal or smaller than 30 dB and based on background plus 5 dB(A) where the background noise exceeds 30 dB (at higher wind speeds). The maximum applicable noise criterion used for the compliance assessment reaches approximately 41 dB(A) at monitoring location NMP02.

B-4-2 Summary of wind farm noise criteria based on SA guidelines

There are 35 noise receptors in the area within and adjacent to the Development Envelope. SA Guidelines recognise that it is not always practicable to perform background noise measurements at each of affected noise receptor. Noise monitoring has been undertaken at representative locations and used to derive the criteria at a number of adjacent noise receptors. Table 2.2 contains the list of noise receptors in the area surrounding the Development Envelope. Results of the background noise monitoring survey are used to assign criteria to relevant noise receptors with expected similar background. It should be noted that compliance with noise criteria at the nearest noise receptor typically ensures that noise from the wind farm will meet similar criteria at greater separation distances from a wind farm. Table B.5 presents noise limits for each integer wind speed from cut-in to the speed of the rated power as referenced to 164 m hub height. Results are presented for procedures included in the SA Guidelines.

Table B.5 Noise criteria for 164 m hub height - SA Guidelines

Noise receptor	Representative monitoring location	Hub height wind speed, m/s							
		4	5	6	7	8	9	10	11
R12[1]	NMP01	38	38	39	39	39	39	38	39
R17[2], R18[2]	-	45	45	45	45	45	45	45	45
R01, R02, R03, R04, R05, R06, R07, R08, R09, R10, R34	NMP02	35	36	38	39	40	40	39	41
R20, R21, R22, R23, R24, R25[1], R32, R33	NMP03	35	35	36	36	37	37	37	39
R26[1], R27[1], R28, R29, R30, R31	NMP04	35	36	37	37	37	37	37	38
R14, R15, R16, R19	NMP05	35	35	35	35	35	35	35	36
R13	NMP06	35	35	36	36	37	37	37	38
R11[1]	NMP07	35	35	35	35	35	35	35	36

[1] R12 is a commercial building, and in agreement with the landowner, R11, R25, R26 and R27 will not be used for residential, or accommodation purposes when the wind farm is built. For these reasons, these premises are considered to be "Non-sensitive" and are not considered within the NIA.

[2] R17 and R18 are involved noise sensitive receptors, the SA Guideline criteria of 45 dB(A) for a not-involved receptor will be used for the NIA.

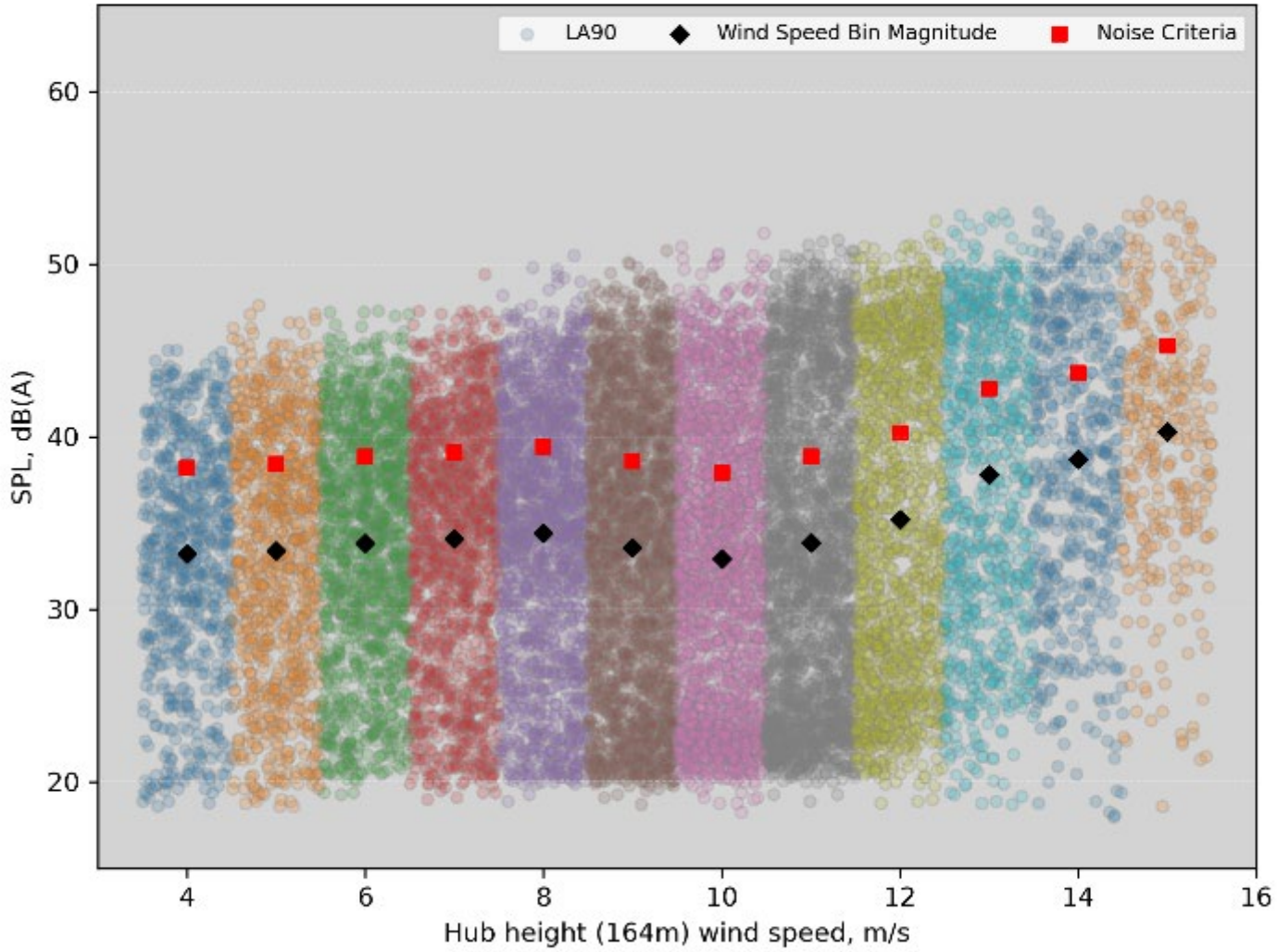


Figure B.2 Background noise monitoring data and applicable noise criteria at logger location NMP01, 164 m hub height - SA Guidelines, 2021

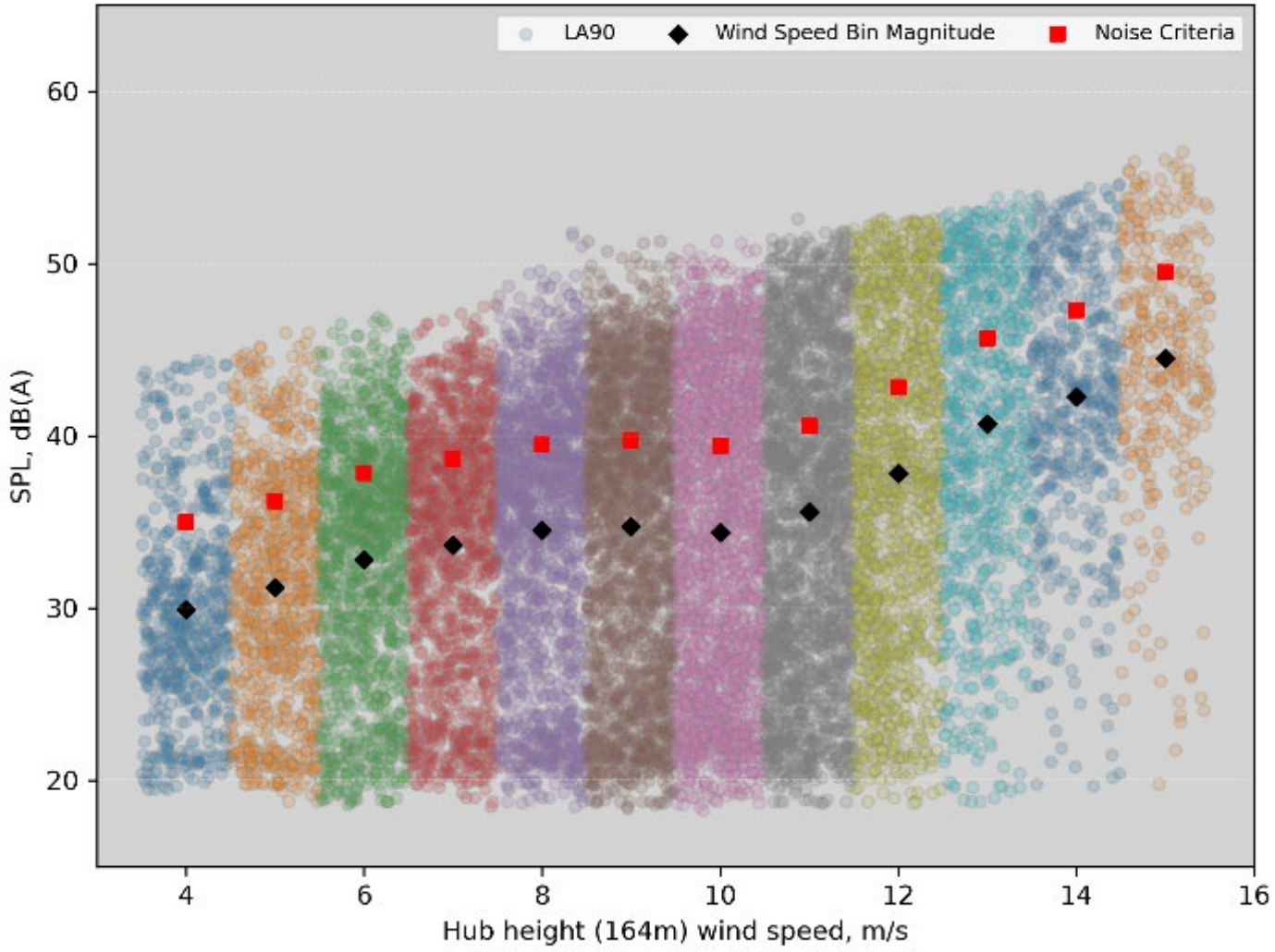


Figure B.3 Background noise monitoring data and applicable noise criteria at logger location NMP02, 164 m hub height - SA Guidelines, 2021

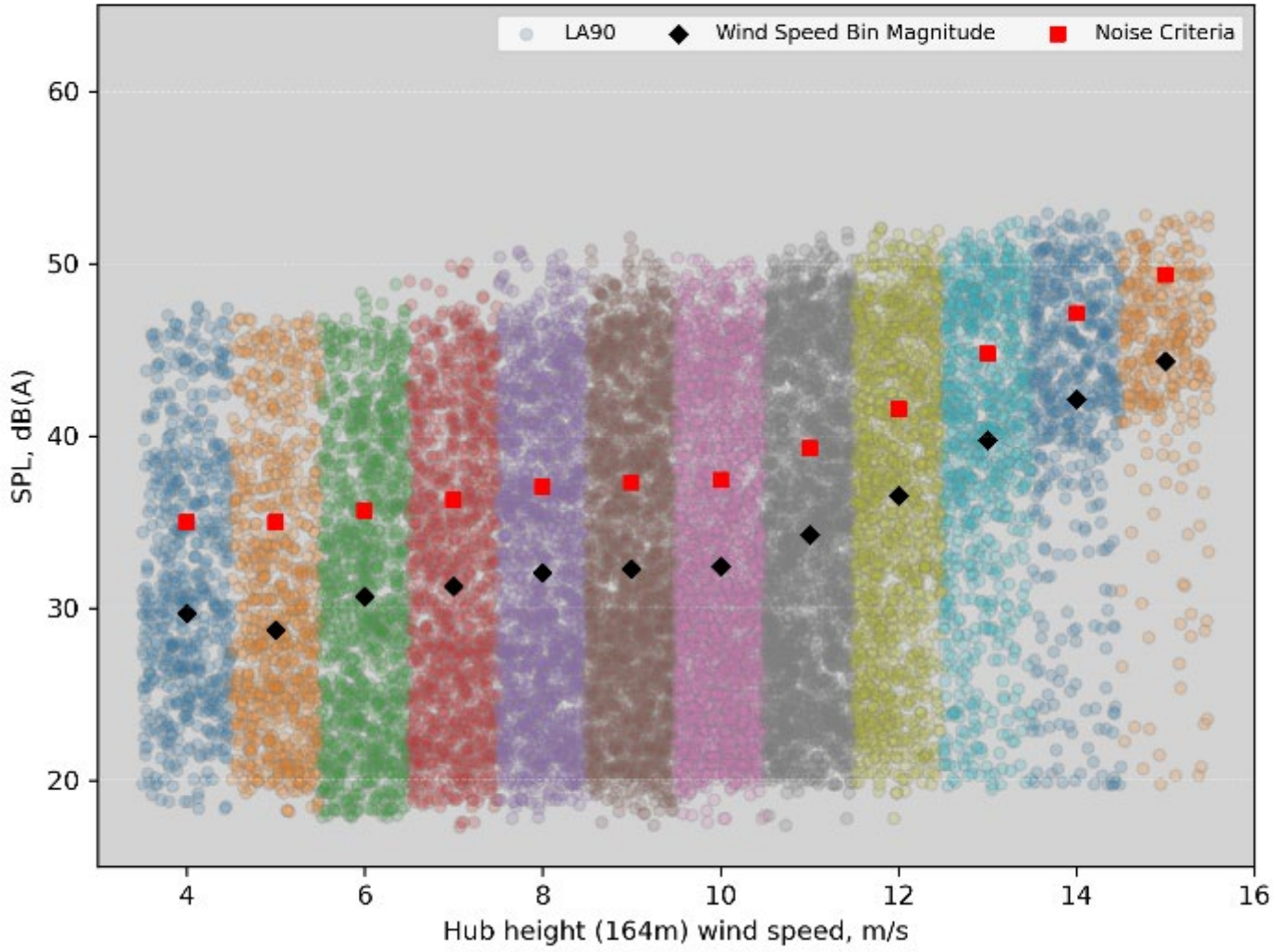


Figure B.4 ***Background noise monitoring data and applicable noise criteria at logger location NMP03, 164 m hub height - SA Guidelines, 2021***

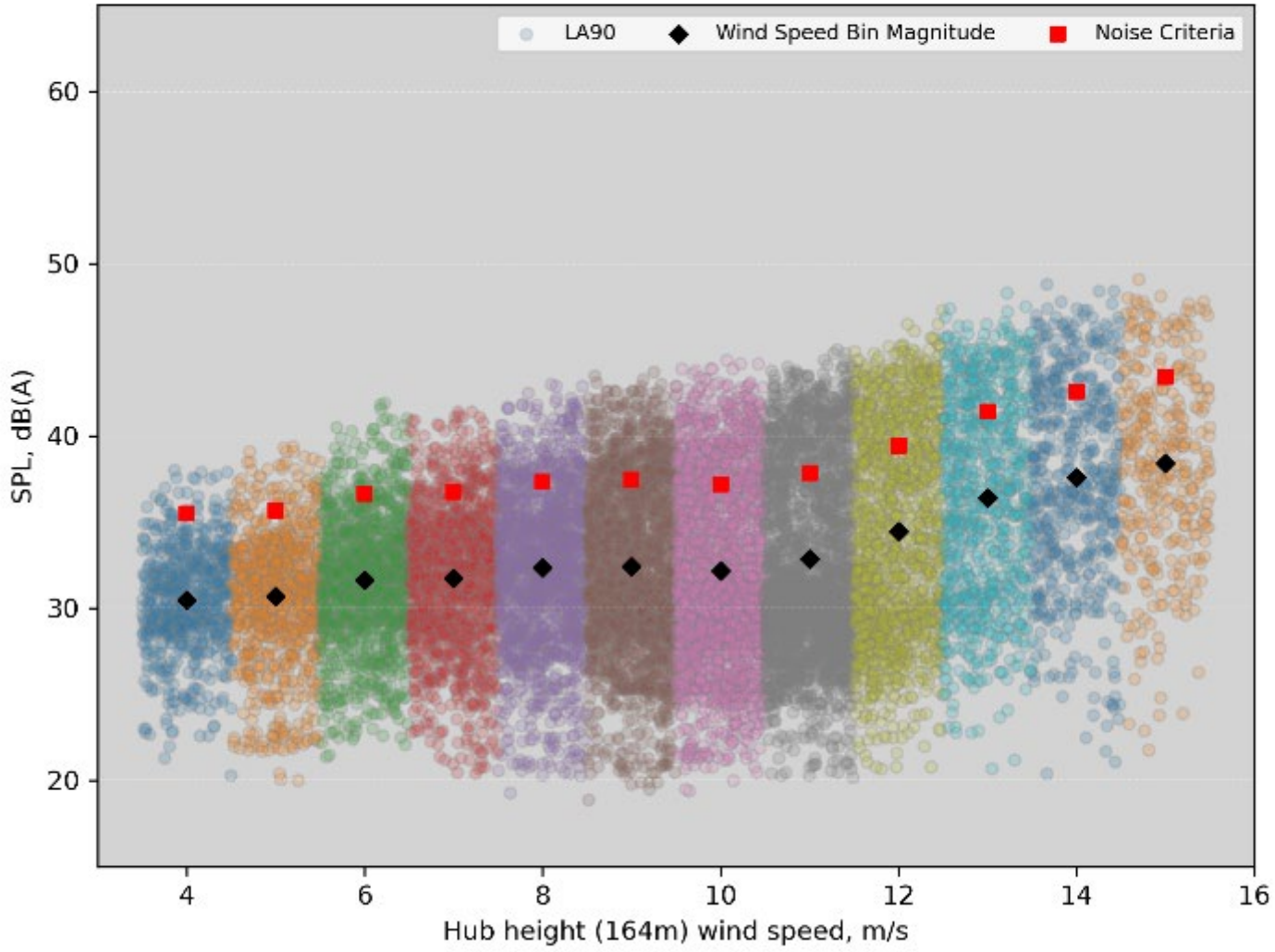


Figure B.5 Background noise monitoring data and applicable noise criteria at logger location NMP04, 164 m hub height - SA Guidelines, 2021

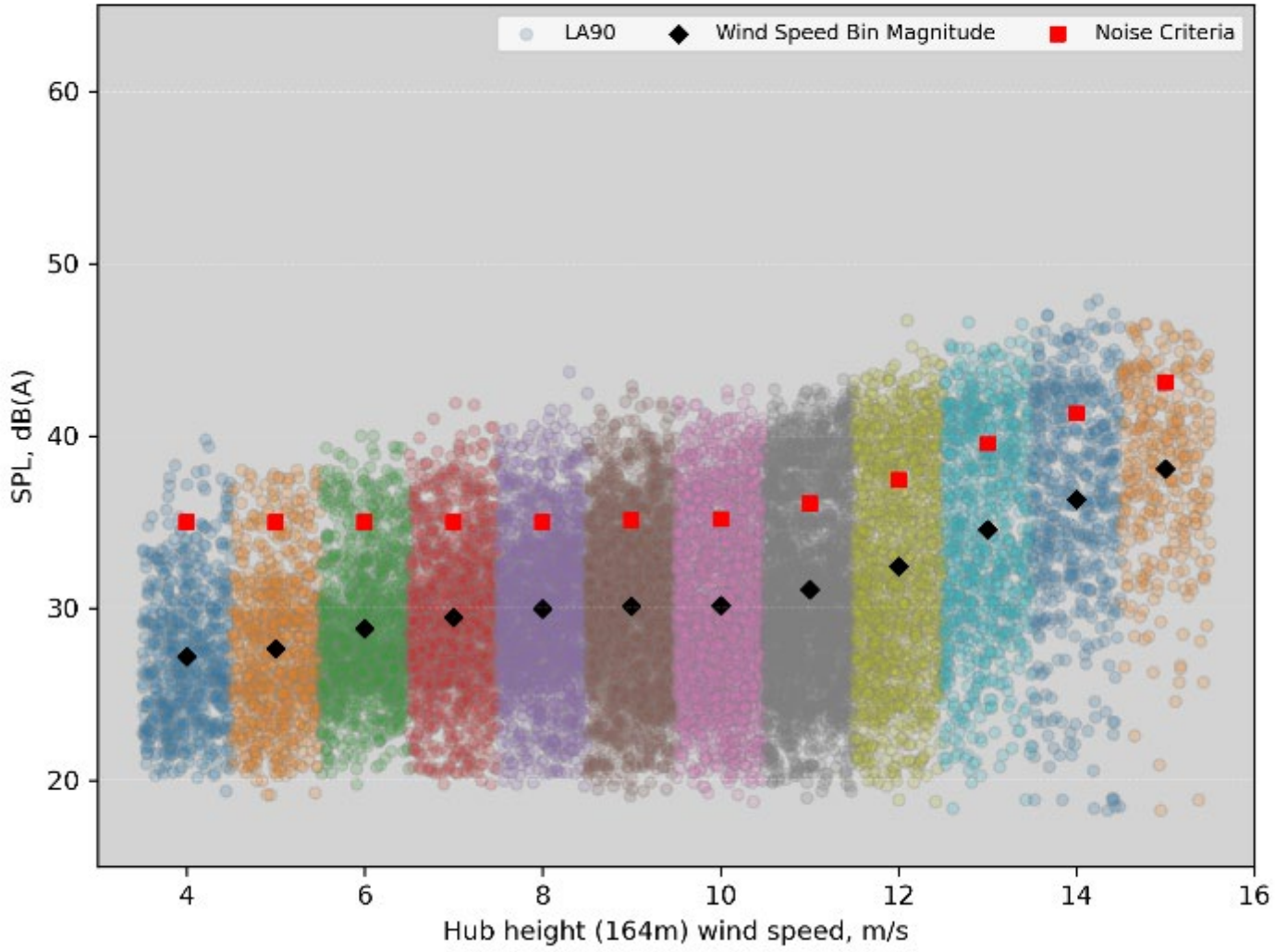


Figure B.6 ***Background noise monitoring data and applicable noise criteria at logger location NMP05, 164 m hub height - SA Guidelines, 2021***

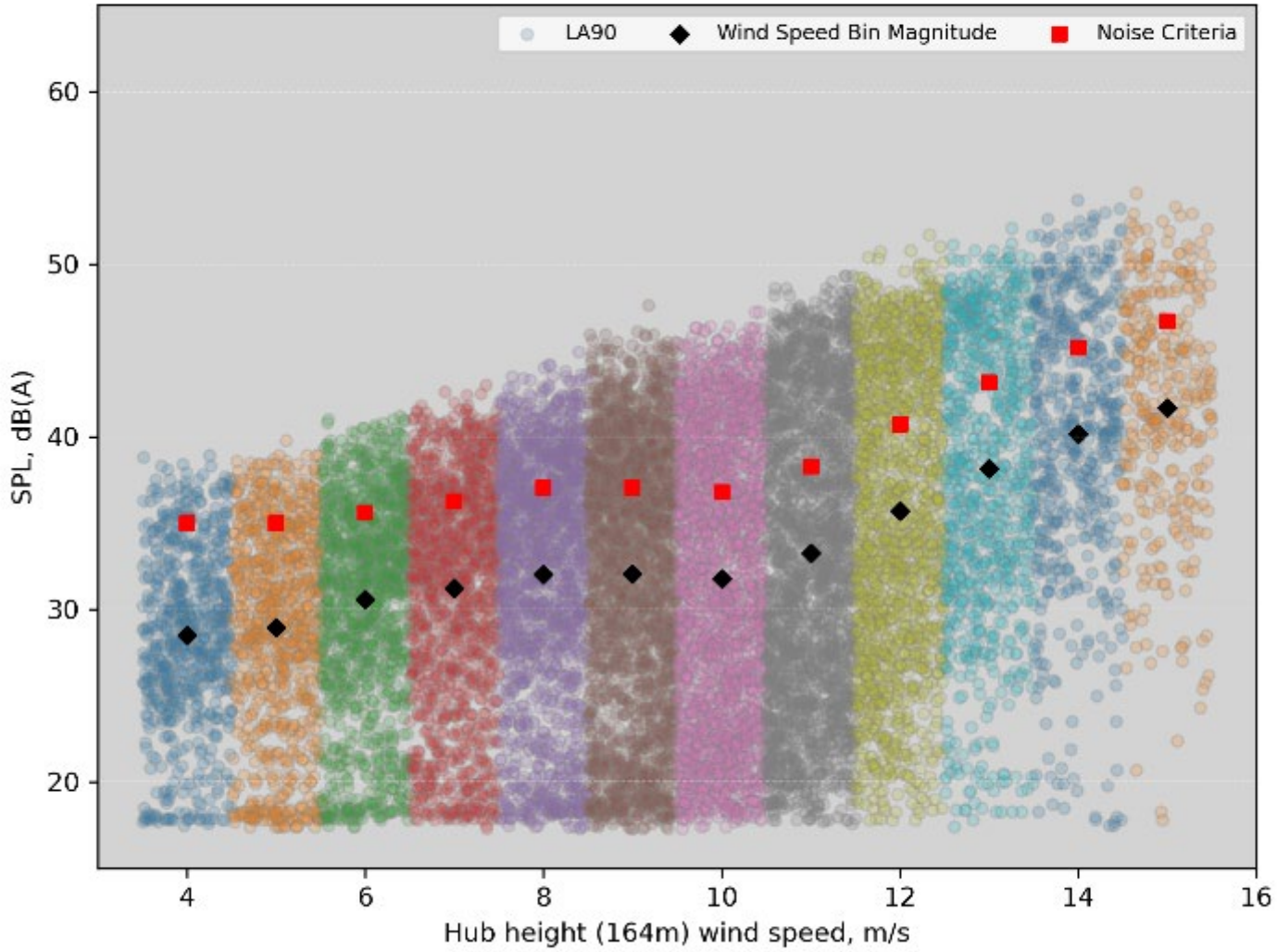


Figure B.7 ***Background noise monitoring data and applicable noise criteria at logger location NMP06, 164 m hub height - SA Guidelines, 2021***

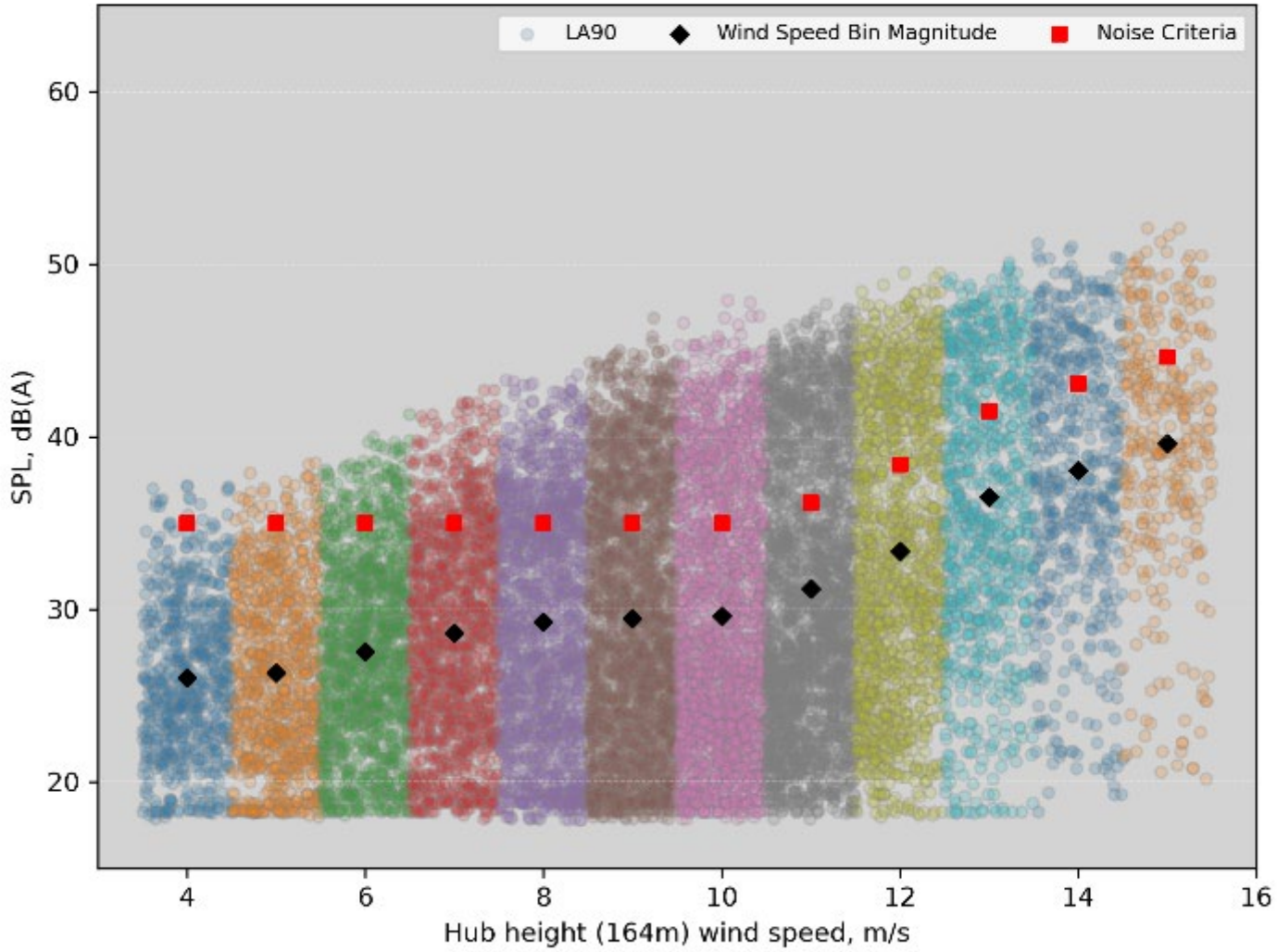


Figure B.8 ***Background noise monitoring data and applicable noise criteria at logger location NMP07, 164 m hub height - SA Guidelines, 2021***

Site photographs of the monitoring instrumentation are provided below.

Description	Site photo
Logger location NMP01 and local weather station	

Description	Site photo
Logger location NMP02	

Description	Site photo
Logger location NMP03	

Description	Site photo
Logger location NMP04	

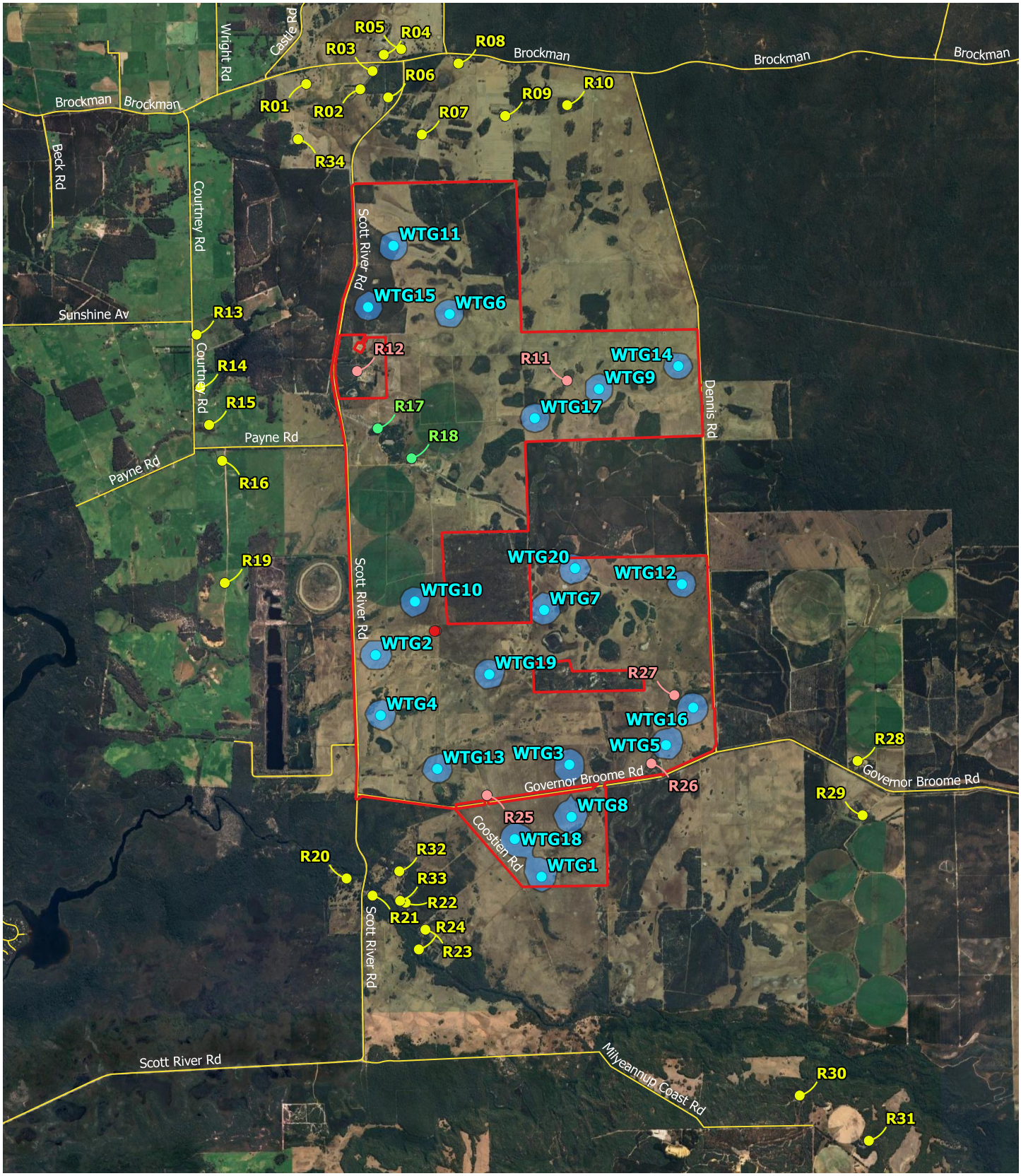
Description	Site photo
Logger location NM05	

Description	Site photo
Logger location NM06	

Description	Site photo
Logger location NM07	

Appendix C

Noise contour maps



Legend

- Not-involved noise sensitive receptor
- Involved noise sensitive receptor
- Non-sensitive noise receptor
- Substation transformer
- Development Envelope
- Noise Contours dB, LAeq, 10-min
  - 35 - 40
- Local road
- Wind turbines

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

GHD

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Noise Contours (dB, $L_{Aeq, 10\ min}$), 20 WTG Layout, 4 m/s

Project No. **12623449**

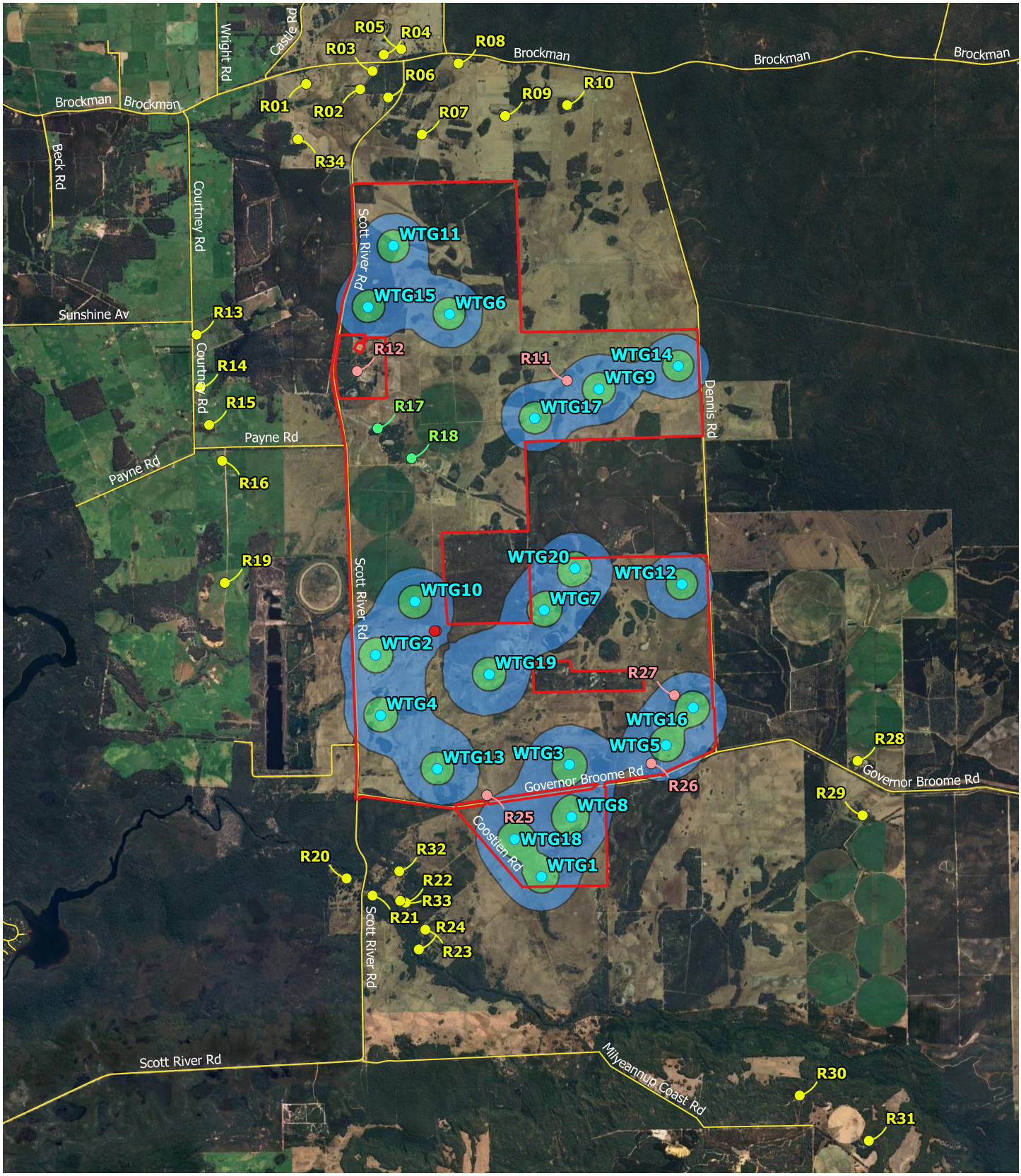
Version **1**

Date. **09/05/2025**

FIGURE C.1

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi



Legend

- Not-involved noise sensitive receptor
- Involved noise sensitive receptor
- Non-sensitive noise receptor
- Substation transformer
- Development Envelope

Noise Contours dB, LAeq, 10-min

- 35 - 40
- 40 - 45

- Local road
- Wind turbines

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

GHD

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Noise Contours (dB, $L_{Aeq, 10\ min}$), 20 WTG Layout, 6 m/s

Project No. **12623449**

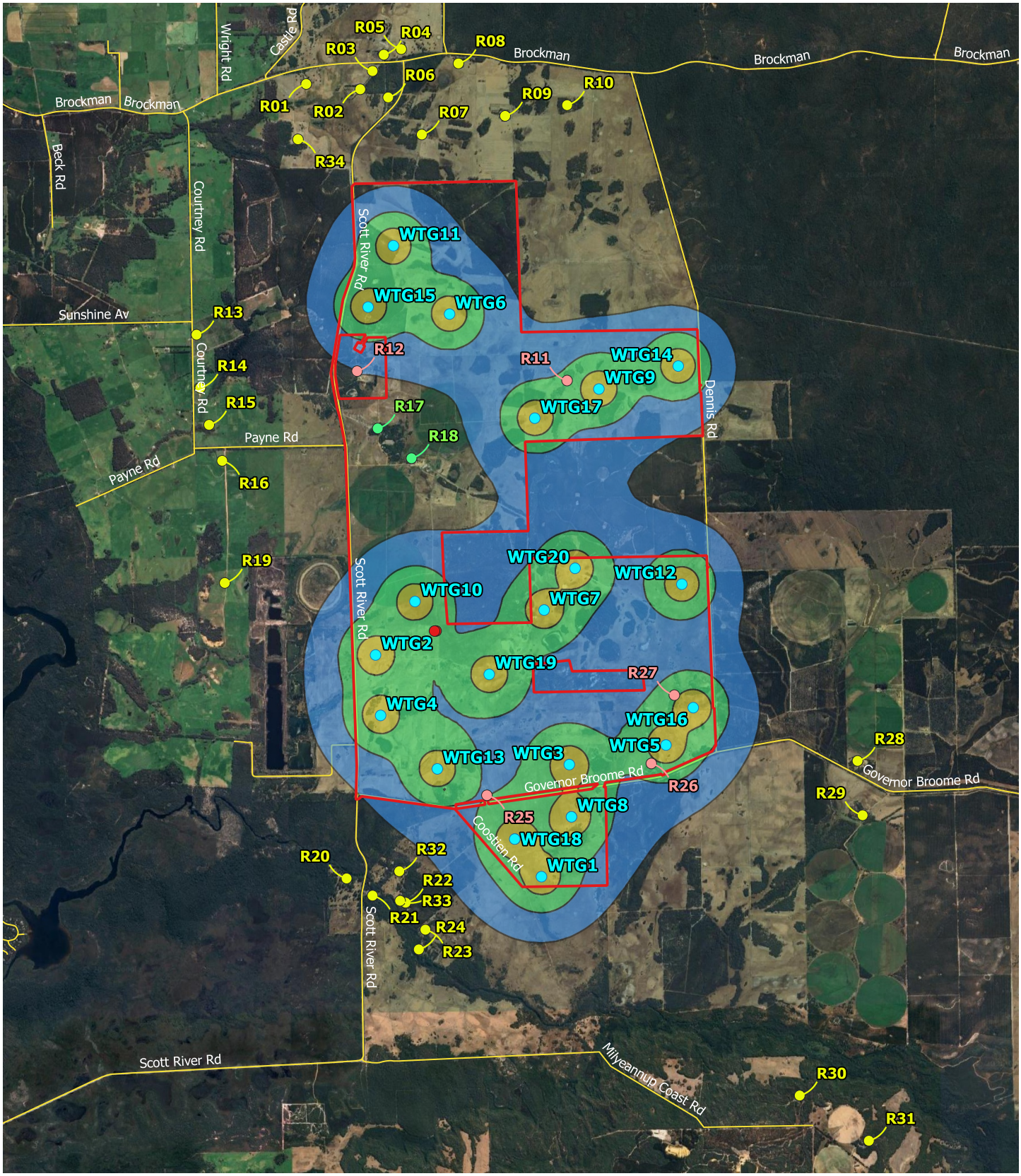
Version **1**

Date. **09/05/2025**

FIGURE C.2

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi



Legend

- Not-involved noise sensitive receptor
- Involved noise sensitive receptor
- Non-sensitive noise receptor
- Substation transformer
- Development Envelope

Noise Contours dB, LAeq, 10-min

- 35 - 40
- 40 - 45
- 45 - 50
- Local road
- Wind turbines

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

GHD

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Noise Contours (dB, $L_{Aeq, 10\ min}$), 20 WTG Layout, 8 m/s

Project No. **12623449**

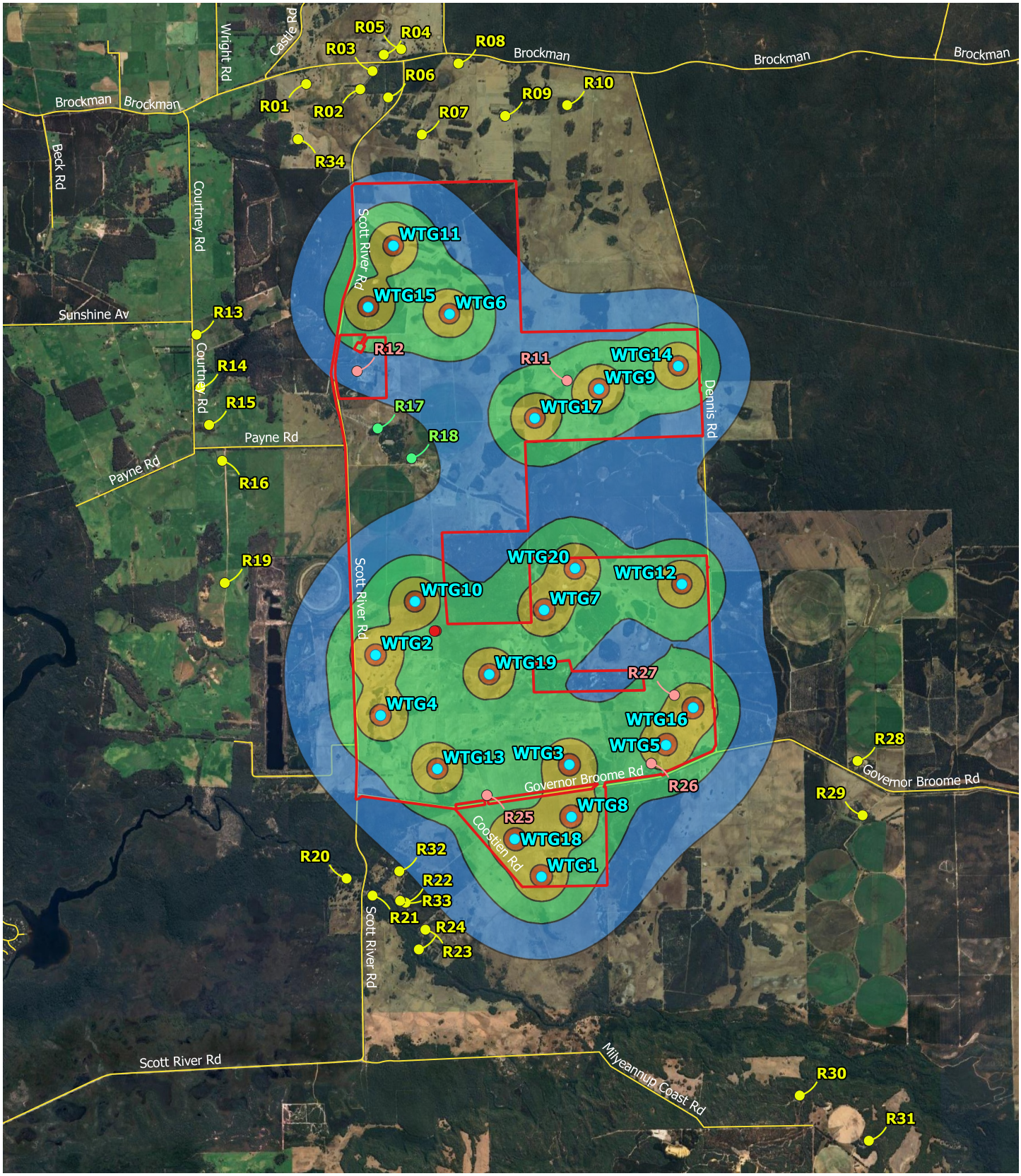
Version **1**

Date. **09/05/2025**

FIGURE C.3

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi



Legend

- Not-involved noise sensitive receptor
- Involved noise sensitive receptor
- Non-sensitive noise receptor
- Substation transformer
- Development Envelope

Noise Contours dB, LAeq, 10-min
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- Local road
- Wind turbines

Paper Size ISO A4

0 0.5 1 1.5 2 km

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 / MGA zone 50

GHD

SynergyRED

Proposed Wind Farm at Scott River
Noise impact assessment

Noise Contours (dB, $L_{Aeq, 10\ min}$), 20 WTG Layout, 10 -11 m/s

Project No. **12623449**

Version **1**

Date. **09/05/2025**

FIGURE C.4

Document Path: \\ghdnet\ghd\AU\Perth\Projects\61\12623449\Tech\Noise\03_GIS\QGIS\Beenup_WindFarm.qgz
Print Date: 09/05/2025

Data Source:Google Earth Imagery 2025.
Created By: dfebriyandi

Appendix D

WTG coordinates

Table D.1 Wind turbine coordinates

Location	Coordinates, GDA2020 / MGA Zone 50	
	Easting, metres	Northing, metres
WTG 1	343194	6207620
WTG 2	340894	6210692
WTG 3	343580	6209174
WTG 4	340964	6209855
WTG 5	344919	6209444
WTG 6	341920	6215417
WTG 7	343230	6211316
WTG 8	343610	6208450
WTG 9	343990	6214378
WTG 10	341440	6211434
WTG 11	341141	6216364
WTG 12	345140	6211673
WTG 13	341750	6209114
WTG 14	345090	6214696
WTG 15	340790	6215514
WTG 16	345297	6209963
WTG 17	343101	6213974
WTG 18	342823	6208141
WTG 19	342469	6210424
WTG 20	343659	6211894

ghd.com

→ The Power of Commitment