APPENDIX E NOISE IMPACT ASSESSMENT

E.1 NOISE IMPACT ASSESSMENT

Hills of Gold Wind Farm

Noise and Vibration Assessment

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S6400C14

sonus.

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GLOSSARY

A-weighting	Frequency adjustment applied to measured noise levels to replicate the frequency response of the human ear.
AGL	Above Ground Level.
Ambient noise level	The noise level of all existing noise sources in the environment (in the absence of the wind farm).
Associated Dwelling	Any dwelling where the landowner has reached a financial or in kind agreement in relation to the wind farm (except where the agreement excludes noise impacts).
Background noise level	The ambient noise level which excludes intermittent noise sources.
C-weighting	Frequency adjustment applied to measured noise levels to indicate low frequency content.
CONCAWE	The oil companies' international study group for conservation of clean air and water - Europe, *The propagation of noise from petrochemical complexes to neighbouring communities* (May 1981).
dB(A)	A-weighted noise in decibels.
dB(C)	C-weighted noise in decibels.
DEC 2006	New South Wales Department of Environment and Conservation *Assessing Vibration: a technical guideline* (2006).
Construction Noise Guideline	New South Wales Department of Environment and Climate Change *Interim Construction Noise Guideline* (2009).
NSW Road Noise Policy	Department of Environment, Climate Change and Water *NSW Road Noise Policy* (2011).
EPA	Environment Protection Authority.
Equivalent noise level	Energy averaged noise level over a period of time.
Intermittent noise sources	noise caused by infrequently occurring events such as from aircraft , dogs barking, mobile farm machinery and the occasional vehicle movements.
$L_{A90, \text{ time period}}$	A-weighted noise level exceeded for 90% of defined time period. Represents the background noise level for the defined time period.
$L_{Aeq, \text{ time period}}$	A-weighted equivalent noise level over a defined time period.
RBL	The Rating Background Level is an overall, single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period
SA Noise Guidelines	South Australian Environment Protection Authority *Wind Farms Environmental Noise Guidelines* (2009).
SEARs	Secretary's Environmental Assessment Requirements.
Sound power level	A measure of the sound energy emitted from a source of noise.
NPI	New South Wales Environment Protection Authority *Noise Policy for Industry* (2017).
The Project	Hills of Gold Wind Farm
The Bulletin	New South Wales Planning and Environment *Wind Energy: Noise Assessment Bulletin* (2016).
Non-Associated Dwelling	Not an Associated Dwelling.
Weather category 6	The CONCAWE weather conditions which is most conducive for the propagation of noise, resulting in highest predicted noise levels.
WHO Guidelines	*World Health Organisation Guidelines for Community Noise.*
Worst-case	Operational and weather conditions which result in the highest noise level at dwelling
WTG	Wind turbine generator.

1 INTRODUCTION

A noise and vibration assessment has been made of the construction and operation of the proposed Hills of Gold Wind Farm (the **Project**). The Project is located approximately 50km south of Tamworth, New South Wales (NSW).

The proposed wind farm consists of up to 70 wind turbine generators (WTGs) and ancillary infrastructure, including a switching station, a substation, transmission line and two batching plants to operate during construction.

The NSW Department of Planning and Environment has provided *Secretary's Environmental Assessment Requirements* (SEARS) for the assessment of noise and vibration from the Project. The NSW EPA has also provided *Environmental Assessment Requirements* (EARS) in a separate letter which are mostly addressed by the SEARs, with the exception of an additional requirement for the assessment of blasting impacts. The noise and vibration related sections of the SEARS and EARs are provided in Appendix A of this report.

The noise and vibration assessment addresses the requirements of the SEARS and EARs. The assessment provides conservative predictions of the noise and vibration as a result of the construction and operation of the wind farm and compares the predicted levels at surrounding dwellings with relevant criteria under the applicable noise and vibration policies and standards.

2 PROJECT LAYOUT

2.1 Wind Turbines

The coordinates of the up to 70 WTG layout are provided in Table 1 and the locations of the infrastructure are provided in Table 2.

Table 1: Coordinates of wind turbine layout.

Turbine ID	Coordinates (UTM WGS84 J56)	
	Easting	Northing
WP1	316191	6502649
WP2	316660	6502870
WP3	317062	6502923
WP4	317449	6502903
WP5	317647	6503321
WP6	317818	6503696
WP7	317184	6502322
WP8	317589	6502127
WP9	317453	6501426
WP10	317732	6501347
WP11	318251	6501256
WP12	319102	6501480
WP13	318924	6501259
WP14	318778	6501033
WP15	319341	6500599
WP16	320042	6500329
WP17	320736	6500326
WP18	321007	6499685
WP19	321513	6498816
WP20	323083	6499077
WP21	323138	6499551
WP22	323096	6499977
WP23	323199	6497538
WP24	323308	6498134
WP25	323581	6498726
WP26	323546	6499107
WP27	324704	6497556
WP28	324613	6498100
WP29	324632	6498515
WP30	324229	6498998
WP31	325873	6498218
WP32	325819	6498682
WP33	325258	6499019
WP34	323773	6499406
WP35	324342	6499322
WP36	324635	6499495
WP37	324928	6499683
WP38	325217	6499831
WP39	325543	6499949
WP40	325908	6500089
WP41	326394	6500562
WP42	326467	6500881

Turbine ID	Coordinates (UTM WGS84 J56)	
	Easting	Northing
WP43	326624	6501222
WP44	326930	6501400
WP45	327249	6501520
WP46	327153	6502077
WP47	326890	6502554
WP48	326439	6502906
WP49	326079	6503434
WP50	325789	6503902
WP51	325975	6504360
WP52	326002	6504778
WP53	325888	6505289
WP54	325995	6505707
WP55	326064	6506092
WP56	325597	6506290
WP57	325618	6506645
WP58	325469	6507177
WP59	325633	6507483
WP60	325827	6507814
WP61	326056	6508202
WP62	326036	6508551
WP63	325788	6508927
WP64	326519	6508699
WP65	327050	6508701
WP66	327215	6508969
WP67	327185	6509403
WP68	327367	6509623
WP69	327737	6509901
WP70	327922	6509331

Table 2: Coordinates of Ancillary Infrastructure.

ID	Approximate Coordinates (UTM WGS84 J56)	
	Easting	Northing
Sub-Station		
1	*323393*	*6499304*
Switching Station		
1	303376	6510523
Temporary Batching Plants		
1	320554	6502827
2	327197	6508737

2.2 Dwellings in the Vicinity of the Wind Farm

The dwellings located in the vicinity of the wind farm site are listed in Table 3, as well as their status as either associated (having an agreement with the developer) or non-associated.

Table 3: Dwelling Locations and Status

Dwelling ID	Coordinates (UTM WGS84 J56)	
	Easting	Northing
Non-Associated Dwellings		
NAD_1	320992	6496158
NAD_3	329854	6506558
NAD_4a	329397	6507209
NAD_4b	329534	6507212
NAD_4c	329350	6507326
NAD_5	324003	6508235
NAD_7	329663	6509501
NAD_8	328903	6509784
NAD_10	323436	6510321
NAD_10a	324750	6510549
NAD_11	327761	6510966
NAD_12	328054	6511244
NAD_13	328155	6511648
NAD_14	328483	6511690
NAD_15	328490	6511836
NAD_16	328430	6512004
NAD_17	325779	6512114
NAD_18	329077	6512215
NAD_19	329299	6512385
NAD_20	329450	6512433
NAD_21	314719	6505531
NAD_22	315473	6507424
NAD_23	328943	6512128
NAD_24	327870	6511947
NAD_25	328919	6513366
NAD_26	328442	6513705
NAD_30	330239	6512943
NAD_32	330182	6512615
NAD_33	320291	6509321
NAD_34	316860	6509584
NAD_35	328329	6513939
NAD_36	328474	6513861
NAD_37	328334	6514024
NAD_38	329106	6513475
NAD_39	330544	6512768
NAD_40	328495	6513789
NAD_41	316108	6496893
NAD_44	331096	6512617
NAD_45	320278	6514434
NAD_47	321049	6514768
NAD_48	331392	6505905
NAD_49	316386	6509799
NAD_50	320353	6495383
NAD_51	307480	6511211
NAD_52	307953	6511904
NAD_53	307917	6512259
NAD_54	312970	6508604
NAD_55	314743	6509871
NAD_56	316134	6510901
NAD_57	328393	6514480
NAD_58	328559	6514581
NAD_59	328502	6514660
NAD_60	328503	6514683
NAD_61	328334	6514826
NAD_62	328300	6514859
NAD_63	328292	6515063
NAD_64	328657	6515117
NAD_65	328296	6515187
NAD_66	323698	6511863
NAD_67	327486	6506061
NAD_68	322643	6515070
NAD_69	320456	6495895
NAD_70	318539	6494620
NAD_71	308435	6513767
NAD_72	314889	6499214
NAD_73	315882	6498385
NAD_74	315171	6507263
NAD_75	321384	6515431
NAD_76	320925	6515433
NAD_77	321125	6515811
Nundle Township	321826	6516740
Development Approved Dwelling[1]		
DAD_10	323119	6513312
Associated Dwellings		
AD_2	328733	6505963
AD_3	323978	6502750
AD_5	326945	6507944
AD_6	324410	6508941
AD_7	315761	6499069
AD_8	324949	6501859
AD_10	317746	6496505
AD_11	328384	6508125
AD_13	324403	6509959

[1] A dwelling location understood to not yet be constructed , but approved and therefore considered to be a noise sensitive location.

3 SEARS and EARs

The noise related SEARs for the Project specify that the following must be considered:

- *assess wind turbine noise in accordance with the NSW Wind Energy: Noise Assessment Bulletin (EPA/DPE, 2016);*
- *assess noise generated by ancillary infrastructure in accordance with the NSW Noise Policy for Industry (EPA, 2017);*
- *assess construction noise under the Interim Construction Noise Guideline (DECC, 2009);*
- *assess traffic noise under the NSW Road Noise Policy (DECCW, 2011); and*
- *assess vibration under the Assessing Vibration: A Technical Guideline (DEC, 2006);*

In response to consultation regarding the content of the SEARs, the NSW EPA provided its Environmental Assessment Requirements (EARs). The EARs are generally addressed by the requirements under the SEARs, with the exception of the following regarding potential blasting;

- If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in *Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990).*

Each of the above SEARS and the EAR relating to blasting are described below, as they relate to each the Project components.

3.1 Wind Turbines

The SEARs reference the New South Wales Planning and Environment *Wind Energy: Noise Assessment Bulletin* (**the Bulletin**) for the assessment of operational noise from the wind turbine generators.

The Bulletin adopts the South Australian Environment Protection Authority *Wind Farms – Environmental Noise Guidelines* (**SA Noise Guidelines**) as the basis of the regulatory noise standard and assessment methodology in NSW.

The SA Noise Guidelines was developed with the "*core objective……to balance the advantage of developing wind energy projects ... with protecting the amenity of the surrounding community from adverse noise impacts"*.

The Bulletin states that:

> [The] *NSW Government recognises that rural land use zones in NSW are often more densely settled than those of South Australia and that there is a relatively high density of rural residential living in parts of regional NSW with reliable wind resources.*
>
> *Therefore only the lower base noise criteria in [the SA Noise Guidelines] will be applied in NSW. This Criteria is defined as:*
>
> > *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."*

3.1.1 Special Noise Characteristics

The Bulletin prescribes a 5 dB(A) penalty adjustment (added to the measured or predicted noise level) for the presence of repeated and excessive tonality and/or low frequency which occurs for more than 10 percent of an assessment period. Excessive tonality and low frequency are determined as follows:

Tonality

The Bulletin references the methodology described in *ISO 1996.2: 2007 Acoustics - Description, measurement and assessment of environmental noise – Determination of environmental noise levels (Annex D – Objective method for assessing the audibility of tones in noise – Simplified method)*. Excessive tonality is present at a particular one-third octave band level if the band level exceeds the adjacent bands on both sides by at least:

- 5 dB , if the centre frequency of the band is in the range 500 Hz to 10,000 Hz;
- 8 dB, if the centre frequency of the band is in the range 160 Hz to 400 Hz; and/or
- 15 dB, if the centre frequency of the band is in the range 25 Hz to 125 Hz.

The penalty for tonality only applies if the tone from the wind farm is audible at the receiver location. The absence of a tone at an intermediate location will be sufficient to demonstrate that the wind farm noise at the relevant receiver location is non-tonal.

Low Frequency Noise

Excessive low frequency noise is present if the low frequency noise levels at non-associated dwellings exceed 60 dB(C).

3.2 Ancillary Infrastructure

The SEARs reference the New South Wales Environment Protection Authority's *Noise Policy for Industry* (**the NPI**) for the assessment of noise from ancillary infrastructure such as substations.

The NPI establishes *noise trigger levels* based on either the;

- existing background noise environment (intrusiveness noise levels); or,
- the amenity for particular land uses (amenity noise levels).

The *noise trigger levels* are the lower of the values provided by the two methods, which in a rural environment will generally be the *intrusiveness noise levels.*

In accordance with the NPI, the Rating Background Level (**RBL**) is used to determine the *intrusiveness noise levels* for each of the day, evening and night periods. The RBL is determined from the lower tenth percentile of the measured background noise level ($L_{A90,\ 15\ minute}$) in the environment, effectively representing the quietest periods of the noise monitoring.

Further detail is provided regarding the existing background noise environment and resulting criteria in the Ancillary Infrastructure Section of this report.

3.3 Construction

The SEARs reference the New South Wales Department of Environment & Climate Change *Interim Construction Noise Guideline* (**Construction Noise Guideline**) for the assessment of construction noise.

The construction of a wind farm comprises activities such as road construction, civil works, excavation, foundation construction, electrical infrastructure works and turbine erection. These construction activities

require processes such as heavy vehicle movements, crushing and screening, concrete batching and use of mobile plant and equipment (such as loaders, excavators, generators, cranes).

The Construction Noise Guideline provides an emphasis on implementing "feasible" and "reasonable" noise reduction measures and does not set mandatory objective criteria. However, the Construction Noise Guideline does establish a quantitative approach, whereby "management levels" are defined based on the existing RBL.

3.4 Traffic

The SEARs reference the New South Wales Department of Environment, Climate Change and Water *NSW Road Noise Policy* (**NSW Road Noise Policy**) for the assessment of traffic noise.

The NSW Road Noise Policy applies traffic noise criteria to particular types of project, road category and land use. The most appropriate classification for the traffic associated with the wind farm is considered to be "*Local Roads - Existing residences affected by additional traffic on existing local roads generated by land use developments*".

The traffic associated with the wind farm will predominantly occur during construction. However, it should be noted that the NSW Road Noise Policy criterion applies to an ongoing operation, as distinct to a temporary process and as such provides a conservative assessment approach.

3.5 Vibration

The SEARs reference the New South Wales Department of Environment and Conservation *Assessing Vibration: a technical guideline* (**DEC 2006**) for the assessment of vibration.

DEC 2006 provides an emphasis on construction activity implementing feasible and practicable vibration reduction measures and establishes goal vibration levels for continuous, intermittent and impulsive vibration based on human response.

For construction activity occurring during the day time, the DEC 2006 can be interpreted to provide goal vibration levels criteria at the dwellings based on the British Standard *BS 6472-1992 "Evaluation of human exposure to vibration in buildings (1-80Hz)".*

3.6 Blasting

The EARs reference the *Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (**ANZEC 1990**) for the assessment of blasting impacts.

ANZEC 1990 applies airblast noise and ground vibration criteria to minimise the annoyance and discomfort to dwellings. The criteria apply to the peak airblast noise level and the peak particle velocity for ground vibration.

4 WIND TURBINE OPERATION

4.1 Criteria

The operational noise criteria for the Project are presented in Sonus report "S6400C10" (the **Background Noise Report**). The Background Noise Report provides Project specific noise criteria for each of the dwellings in the vicinity of the wind farm based on the noise criteria contained in the Bulletin, the SA Noise Guidelines and the outcomes of background noise monitoring at reference locations in the vicinity of the wind farm. The Project specific operational noise criteria for each location are repeated below:

Table 4: Project Noise Criteria – Wind Turbine Noise

Dwelling ID	Wind Speed (m/s) at 150m									
	3	4	5	6	7	8	9	10	11	12
Associated Dwellings										
AD 2, AD 5, AD 11, AD 7, AD 10, AD 3, AD 6, AD 8, AD 13	45	45	45	45	45	45	45	45	45	45
Non-Associated Dwellings										
NAD 3, NAD 4a, NAD 4b, NAD 4c, NAD 48, NAD 67, NAD 33, NAD 45, NAD 47, NAD 68, NAD 1, NAD 21, NAD 22, NAD 34, NAD 41, NAD 49, NAD 50, NAD 51, NAD 52, NAD 53, NAD 54, NAD 55, NAD 56, NAD 69, NAD 70, NAD 71, NAD 72, NAD 73, NAD 74, NAD 75, NAD 76, NAD 77, Nundle Township	35	35	35	35	35	35	35	35	35	35
NAD 5, NAD 10, NAD 10a, NAD 17, NAD 66	35	35	35	35	35	35	35	35	35	36
NAD 7, NAD 8, NAD 11, NAD 12, NAD 13, NAD 14, NAD 15, NAD 16, NAD 18, NAD 19, NAD 20, NAD 23, NAD 24, NAD 25, NAD 26, NAD 30, NAD 32, NAD 38, NAD 39, NAD 40, NAD 44, NAD 35, NAD 36, NAD 37, NAD 57, NAD 58, NAD 59, NAD 60, NAD 61, NAD 62, NAD 63, NAD 64, NAD 65	35	35	35	35	35	35	35	36	38	40
Development Application Dwelling										
DAD 10	35	35	35	35	35	35	35	35	35	35

4.2 Assessment

Noise Sources

The assessment of WTG noise has been made based on the following:

- A candidate wind turbine for the project, with a hub height of 150m;[3]
- Sound Power Levels for the representative wind turbine, as provided in the following table for the "Normal" operating mode.

[3] The assessment is based on the highest hub height being considered and is a conservative approach. For lower hub heights, the noise criteria which are adjusted for background noise would be less onerous.

Table 5: *WTG Sound Power Level – "Normal" Operating Mode.*

Hub Height Wind Speed (m/s)	Sound Power Level (dB(A) re 1 pW)
3	93.5
4	93.7
5	94.3
6	97.3
7	100.2
8	102.9
9 and above	104

The Bulletin requires that the WTG noise level be adjusted where excessive levels of tonality and/or low frequency noise is identified to a maximum adjustment of 5 dB(A). This assessment has been made based on the assumption that the turbine model selected for the project will be free of any excessive levels of tonality or any other special noise characteristics.

The assumption has been confirmed for the representative wind turbine model by reviewing the1/3 octave band data. This confirms that the noise from the operation of this turbine model would not incur a penalty for the characteristic of tonality. The application of a penalty for the noise character of low frequency is discussed further below.

NOISE PROPAGATION MODEL

The predictions of environmental noise from the Project utilise the CONCAWE noise propagation model and SoundPLAN noise modelling software. The sound propagation model considers the following influences:

- sound power levels of each individual noise source;
- the locations of noise sources;
- separation distances between noise sources and dwellings;
- local topography;
- influence of the ground;
- air absorption; and,
- meteorological conditions.

The CONCAWE system divides meteorological conditions into six separate "weather categories", depending on wind speed, wind direction, time of day and level of cloud cover. Weather Category 1 provides the weather conditions associated with the "lowest" propagation of noise, whilst Weather Category 6 provides "worst-case" (i.e. highest noise level) conditions. Weather Category 4 provides "neutral" weather conditions

for noise propagation (that is, conditions which do not account for the effects of temperature inversion or wind on propagation).

The assessment has been based on the following input conditions, which have been widely accepted for the assessment of wind turbine noise:

- weather category 6 (representing a temperature inversion and wind conditions that assist with the propagation of noise);
- atmospheric conditions at 10°C and 80% relative humidity (representing conditions that result in low levels of noise absorption from the atmosphere);
- wind direction from all noise sources to the particular dwelling under consideration, even in circumstances where sources are located in opposite directions from the dwelling (representing the absolute worst-case noise propagation from the wind). This will overestimate the predicted noise level where receptors have WTGs located around them in more than a singular direction or quadrant as wind is not able to blow in more than one directional quadrant simultaneously;
- acoustically soft ground (representing the pastoral nature of the land); and,
- maximum barrier attenuation from topography of 2 dB(A) (representing a conservative assessment of any shielding provided by topography).

Noise Predictions

The operational noise level from the Project outside each dwelling has been predicted for all integer wind speeds from cut in to rated power and compared with the relevant criterion at each dwelling as outlined in Table 7. Where the predicted noise levels exceed the operational noise criteria, it is shown in **RED**.

Table 6: *Wind Farm Noise Predictions at dwellings.*

Dwelling ID	Noise Level at Hub Height integer wind speeds, 150m AGL (dB(A))																			
	3 m/s		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	
	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction
Associated Dwellings																				
AD_2	45	<25	45	<25	45	<25	45	25	45	28	45	31	45	32	45	32	45	32	45	32
AD_3	45	<25	45	<25	45	<25	45	27	45	30	45	33	45	34	45	34	45	34	45	34
AD_5	45	33	45	33	45	34	45	37	45	39	45	42	45	43	45	43	45	43	45	43
AD_6	45	26	45	26	45	27	45	30	45	33	45	36	45	37	45	37	45	37	45	37
AD_7	45	<25	45	<25	45	<25	45	<25	45	<25	45	27	45	28	45	28	45	29	45	29
AD_8	45	28	45	28	45	29	45	32	45	34	45	37	45	38	45	38	45	38	45	38
AD_10	45	<25	45	<25	45	<25	45	<25	45	<25	45	<25	45	<25	45	<25	45	<25	45	<25

Dwelling ID	Noise Level at Hub Height integer wind speeds, 150m AGL (dB(A))																			
	3 m/s		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	
	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction
AD_11	45	28	45	28	45	29	45	32	45	34	45	37	45	38	45	38	45	38	45	38
AD_13	45	<25	45	<25	45	<25	45	27	45	30	45	33	45	34	45	34	45	34	45	34
AD_27	45	<25	45	<25	45	<25	45	26	45	29	45	32	45	33	45	33	45	33	45	33
Development Application Dwelling																				
DAD_10	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
Non Associated Dwellings																				
NAD_1	35	<25	35	<25	35	<25	35	<25	35	25	35	28	35	29	35	29	35	29	35	29
NAD_3	35	<25	35	<25	35	<25	35	<25	35	<25	35	27	35	28	35	28	35	28	35	28
NAD_4a	35	<25	35	<25	35	<25	35	<25	35	26	35	29	35	30	35	30	35	30	35	30
NAD_4b	35	<25	35	<25	35	<25	35	<25	35	26	35	29	35	30	35	30	35	30	35	30
NAD_4c	35	<25	35	<25	35	<25	35	<25	35	26	35	29	35	30	35	30	35	30	35	30
NAD_5	35	25	35	25	35	26	35	29	35	32	35	35	35	36	35	36	35	36	36	36
NAD_7	35	<25	35	<25	35	<25	35	27	35	29	35	32	35	33	36	33	38	33	40	33
NAD_8	35	27	35	27	35	28	35	31	35	34	35	36	35	38	36	38	38	38	40	38
NAD_10	35	<25	35	<25	35	<25	35	<25	35	<25	35	27	35	28	35	28	35	29	36	29
NAD_10a	35	<25	35	<25	35	<25	35	26	35	29	35	32	35	33	35	33	35	33	36	33
NAD_11	35	27	35	27	35	28	35	31	35	34	35	36	35	37	36	38	38	38	40	38
NAD_12	35	<25	35	<25	35	26	35	29	35	31	35	34	35	35	36	35	38	35	40	35
NAD_13	35	<25	35	<25	35	<25	35	26	35	29	35	31	35	33	36	33	38	33	40	33
NAD_14	35	<25	35	<25	35	<25	35	<25	35	28	35	31	35	32	36	32	38	32	40	32
NAD_15	35	<25	35	<25	35	<25	35	<25	35	27	35	30	35	31	36	31	38	31	40	31
NAD_16	35	<25	35	<25	35	<25	35	<25	35	26	35	29	35	30	36	30	38	30	40	30
NAD_17	35	<25	35	<25	35	<25	35	<25	35	<25	35	28	35	29	35	29	35	29	36	29
NAD_18	35	<25	35	<25	35	<25	35	<25	35	<25	35	26	35	27	36	27	38	28	40	28
NAD_19	35	<25	35	<25	35	<25	35	<25	35	<25	35	25	35	26	36	26	38	26	40	26
NAD_20	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	26	36	26	38	26	40	26
NAD_21	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	26	35	26	35	26	35	26
NAD_22	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_23	35	<25	35	<25	35	<25	35	<25	35	<25	35	27	35	28	36	28	38	28	40	28
NAD_24	35	<25	35	<25	35	<25	35	<25	35	25	35	28	35	29	36	29	38	29	40	29
NAD_25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_26	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_30	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_32	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_33	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_34	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_35	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_36	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_37	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_38	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_39	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_40	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_41	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_44	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_45	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_47	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_48	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_49	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25

Dwelling ID	Noise Level at Hub Height integer wind speeds, 150m AGL (dB(A))																			
	3 m/s		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	
	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction
NAD_50	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_51	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_52	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_53	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_54	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_55	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_56	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_57	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_58	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_59	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_60	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_61	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_62	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_63	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_64	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_65	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25	38	<25	40	<25
NAD_66	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	36	<25
NAD_67	35	26	35	27	35	27	35	30	35	33	35	36	35	37	35	37	35	37	35	37
NAD_68	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_69	35	<25	35	<25	35	<25	35	<25	35	<25	35	26	35	27	35	27	35	27	35	27
NAD_70	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_71	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_72	35	<25	35	<25	35	<25	35	<25	35	<25	35	25	35	26	35	26	35	26	35	26
NAD_73	35	<25	35	<25	35	<25	35	<25	35	<25	35	25	35	26	35	26	35	27	35	27
NAD_74	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_75	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_76	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
NAD_77	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25
Nundle Township	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25	35	<25

The highest predicted low frequency noise level at non-associated dwellings is 52 dB(C) at NAD_11, which is less than the 60 dB(C) criterion. Therefore, a penalty for excessive low frequency noise is not applicable and no adjustment has been made to the predictions provided above.

Based on the predictions above, without any noise mitigation measures the noise from the 70 WTGs will achieve the operational noise criteria at all dwellings in the vicinity of the wind farm, with the exception of NAD_5, NAD_8, NAD_11 and NAD_67.

The predicted noise level contours at the wind speed corresponding to the WTG maximum sound power levels (10m/s) are provided in Appendix B.

Curtailment

While the noise modelling carried out is conservative and the actual operational noise impacts from the Project may be less, a curtailment regime has been determined in order to ensure the noise from the wind farm can practically achieve the criteria at all dwellings and under all wind speeds. The curtailment regime involves operating selected turbines in a noise reduced mode at the wind speeds where the model predicts that the criteria would otherwise be exceeded.

The following table summarises the noise criteria and the predicted noise level for the wind speeds which require selected turbines to be curtailed.

Table 7: Predicted noise level exceeds criteria.

Dwelling ID	Noise Level at Hub Height integer wind speeds, 150m AGL (dB(A))									
	8 m/s		9 m/s		10 m/s		11 m/s		12 m/s (and above)	
	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction
NAD_5	35	35	35	36	35	36	35	36	36	36
NAD_8	35	36	35	38	36	38	38	38	40	38
NAD_11	35	36	35	37	36	38	38	38	40	38
NAD_67	35	36	35	37	35	37	35	37	35	37

Based on the above, the curtailment strategy has been determined using the reduced noise modes of the representative turbine. The sound power level for the reduced noise modes of the representative turbine are provided below.

Table 8: *WTG Reduced Noise Mode Sound Power Levels.*

Hub Height Wind Speed (m/s)	Normal Operating Mode (dB(A))	Operating Mode A (dB(A))	Operating Mode B (dB(A))	Operating Mode C (dB(A))	Operating Mode D (dB(A))	Operating Mode E (dB(A))
3	93.5	93.5	93.5	93.5	93.5	93.5
4	93.7	93.7	93.7	93.7	93.7	93.7
5	94.3	94.3	94.3	94.3	94.3	94.3
6	97.3	97.3	97.3	97.3	97.2	97.1
7	100.2	100.2	100.2	99.7	99	98
8	102.9	102	101	100	99	98
9 and above	104	102	101	100	99	98

The table below outlines a curtailment strategy, including the specific noise modes and applicable turbines which are required to operate in the relevant modes in order to ensure the criteria are achieved. This curtailment strategy has been developed based on the maximum 70 turbine layout proposed and the

reference turbine model assessed. The curtailment strategy will be finalised post approval when the final layout and turbine model is confirmed so as to ensure the operational noise from the project complies with the noise criteria.

Table 9: *Curtailed operating strategy.*

	Noise Reduced Mode Operation @ Hub Height (m) Integer Wind Speeds				
Turbine	**8 m/s**	**9m/s**	**10 m/s**	**11 m/s**	**12 m/s (and above)**
WP55	E				
WP54	B	C			
WP57	A	C			
WP53	*N/A*	B			
WP52, WP56, WP58	*N/A*	A			
WP69	B	D	C	*N/A*	
WP70	D	E	C	*N/A*	
WP68	B	B	*N/A*		

The following table provides the revised predicted noise levels at the specific dwellings where the criteria were previously predicted to be exceeded when the wind farm operates under the noise curtailment strategy outlined above. The predicted noise level contours for the operating strategy at 10m/s are provided in Appendix B.

Table 10: *Predicted noise level for curtailed operating strategy.*

Dwelling ID	Noise Level at Hub Height integer wind speeds, 150m AGL (dB(A))									
	8 m/s		9 m/s		10 m/s		11 m/s		12 m/s and above	
	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction	Criterion	Prediction
NAD_5	35	35	35	35	35	35	35	35	36	35
NAD_8	35	35	35	35	36	36	38	38	40	38
NAD_11	35	35	35	35	36	36	38	38	40	38
NAD_67	35	35	35	35	35	35	35	35	35	35

Accordingly, the revised modelling confirms that if the curtailment strategy is implemented for wind speeds of 8m/s and above, the noise levels from the wind farm are predicted to fully comply with the noise criteria at all dwellings in the vicinity.

Given that the noise assessment has been made based on the currently proposed turbine layout, an assessed representative WTG and that both the project layout and WTG model selection may change during the detailed design of the Project, the need for curtailment and the final operating strategy will be determined during a pre-construction noise assessment. This assessment will consider the final turbine selection, layout

and guaranteed sound power levels. Operational noise monitoring will also be carried out following commissioning of the Project to verify compliance with the noise criteria.

Re-Classified Dwellings

It is noted that since the assessment of noise impacts, the owners of a number of dwellings have entered into commercial agreements with the wind farm developer and these dwellings should now be considered as Associated Dwellings. Based on the assessment, these locations are predicted to achieve the noise criteria assigned to non-associated dwellings and therefore will easily achieve the criteria for an associated dwelling.

The locations which have been re-classified are provided in the following table;

Table 11: Re Classified Dwelling Locations

Dwelling ID	Coordinates (UTM WGS84 J56)	
	Easting	Northing
New Associated Dwellings		
NAD_13	328155	6511648
NAD_14	328483	6511690
NAD_23	328943	6512128
NAD_26	328442	6513705
NAD_37	328334	6514024
NAD_40	328495	6513789
NAD_50	320353	6495383
NAD_74	315171	6507263

5 ANCILLARY INFRASTRUCTURE - SUBSTATIONS

5.1 Criteria

The NPI establishes *noise trigger levels* based on the existing background noise environment (intrusiveness noise levels) and the amenity for particular land uses (amenity noise levels). The *noise trigger levels* are the lower values provided by the two methods.

In order to determine construction noise criteria, reference is made to the Background Noise Report. The background noise environment was monitored at a number of dwellings in the vicinity of the wind farm and was often below 30 dB(A). Therefore, in accordance with the NPI, the minimum RBL becomes 30dB(A) during the evening and night and 35dB(A) during the day.

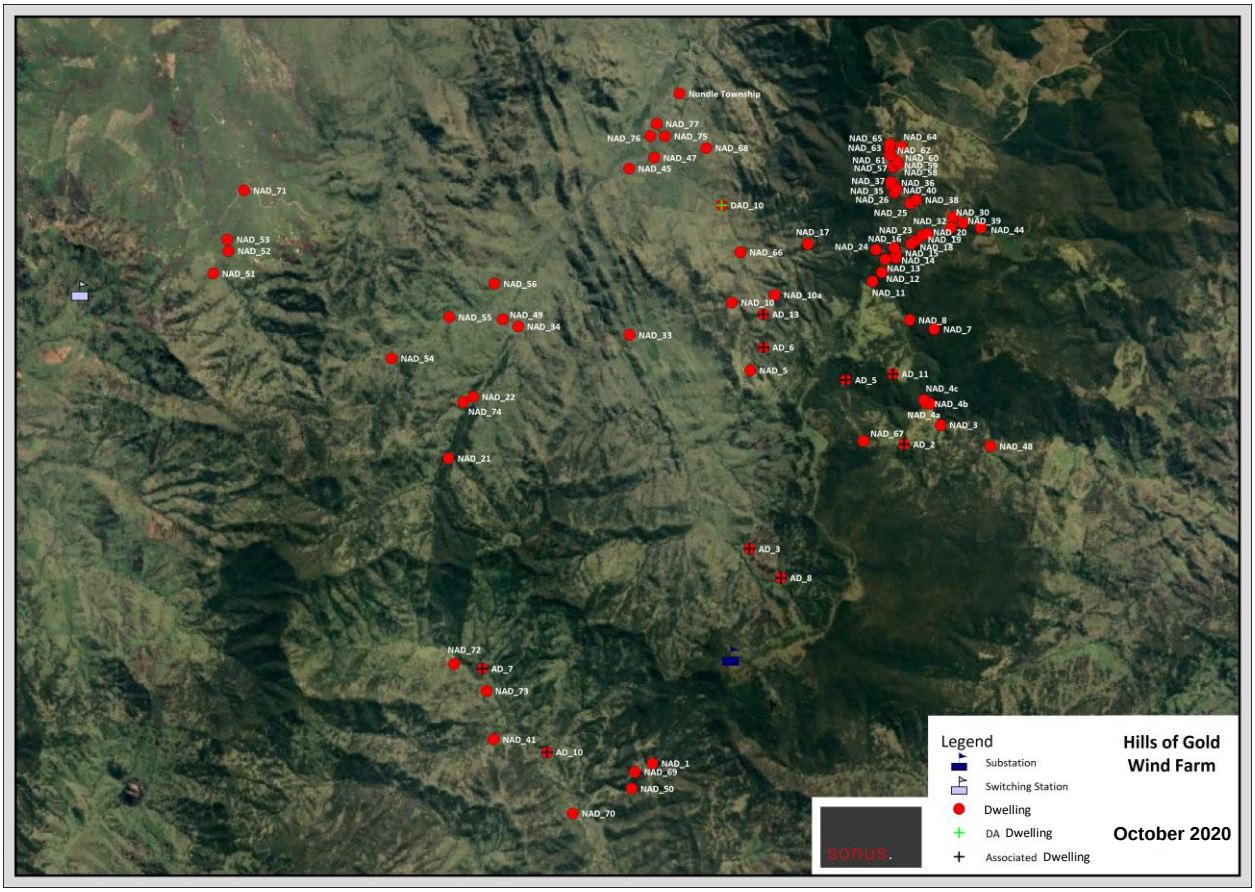
As such, for activity occurring during the day, evening and night, the noise trigger level is based on the *project intrusiveness noise level* of 35 dB(A), which is lower than the *project amenity noise level* of 40 dB(A) that applies in a rural area during the night.

If noise assessed under the NPI is found to have a character that has the potential to be annoying, such as tonality, modulation or dominant low-frequency content, a modifying correction factor is to be applied to the predicted noise levels at the dwelling before comparison with the project *noise trigger levels*.

5.2 Assessment

Noise Sources

The Project will comprise of a single substation and one switching station, in the locations shown in the image below:



There is not proposed to be any significant noise sources at the switching station and therefore the assessment does not consider the location as a noise source.

The proposed substation will include transformers which have been assessed against the objective noise criteria.

The predictions have been made based on a high-voltage transformer(s) with an overall capacity of 500MVA. The sound power level for the prediction has been determined derived from the Australian/New Zealand Standard AS/NZS60076.10:2009, *Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD)* and is summarised in the following table.

Table 12: *500 MVA substation transformer sound power levels.*

Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 ρW)
63 Hz	83
125 Hz	91
250 Hz	98
500 Hz	101
1,000 Hz	93
2,000 Hz	90
4,000 Hz	83
Total	**104**

Noise Predictions

Based on the preliminary predictions and the assumed size of the Substation, a noise level of less than 20 dB(A) is predicted for the closest non-associated dwelling, therefore easily achieving the criteria.

Transformers will often have audible tonality in close proximity, although the potential for it to be a dominant characteristic is diminished at the separation distances to the dwellings. Notwithstanding, the preliminary predictions have been based on the inclusion of a penalty.

In order to demonstrate compliance with the SEARS, the assessment of noise from the substation will be updated should the size of the transformer(s) or sound power level change from that assumed in this report.

Any updates to the predictions should ensure that the highest equivalent noise level at a non-associated dwelling from operation of the substation transformers will comply with the criteria established by the SEARs, under conditions most conducive to noise propagation (such as temperature inversions).

6 ANCILLARY INFRASTRUCTURE – TRANSMISSION LINE

Corona and Aeolian noise can be generated from the transmission lines of a wind farm. Corona noise is electrically-induced and occurs under specific conditions when the transmission lines are operational, whereas Aeolian noise is wind-induced and occurs under specific conditions regardless of the transmission lines are operational or not.

Corona noise is infrequent and typically occurs in specific conditions of rain or high humidity when the air adjacent to a conductor of high voltage lines is ionised and becomes a conductor of electricity. The noise that is produced is typically a low level of hissing that is rarely a problem at distances greater than 50 to 100m from the transmission lines.

Aeolian noise is infrequent and only occurs at times when there is a specific wind speed and direction to generate the mechanism of air passing over thin structures. The Aeolian noise generally only occurs on rare occasions and at times when there are high wind speeds and high background noise levels. As such, the distances of influence are often similar to that for Corona noise. There are however mitigation measures available to reduce Aeolian noise if necessary.

Based on the above, the noise impact of transmission lines is generally dealt with by maintaining the separation distances required in the consideration of other factors related to the lines. It is understood that the proposed transmission lines will be more than 500m from the closest dwellings. That is, the separation distance will be significantly greater than that generally considered necessary to address Corona and Aeolian noise.

7 CONSTRUCTION

7.1 Criteria

The Construction Noise Guideline provides an emphasis on implementing "feasible" and "reasonable" noise reduction measures and does not set mandatory objective criteria. The Construction Noise Guideline does establish a quantitative approach, whereby "management levels" are defined based on the existing RBL.

As noted in Section 5.1 the minimum RBL is 30dB(A) for the evening and night and 35dB(A) for the day. The time of day under the Construction Noise Guideline is defined as follows:

- day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays
- evening – the period from 6 pm to 10 pm
- night – the remaining periods

Based on the above, the construction noise *Management levels* and the requirement for "feasible" and "reasonable" noise reduction measures are summarised in the following table:

Table 13: Construction Noise Guideline Requirements.

Time of Day	**Management level** $L_{Aeq\ (15\ min)}$	**How to apply**
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected **RBL + 10 dB = <u>45dB(A)</u>**	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected **75 dB(A)**	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of Day	Management level $L_{Aeq\ (15\ min)}$	How to apply
Outside recommended standard hours	Noise affected **RBL + 5 dB = 35dB(A)**	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

7.2 Assessment

Noise Predictions

The equipment and activities on site will vary throughout the project, depending on various stages of construction, required processes and specific equipment used. The predicted noise from construction activity is presented as a typical worst case (highest noise level) scenario for the various stages of construction.

The predictions are based on weather conditions that are the most conducive for the propagation of noise, being CONCAWE Category 6 conditions (receivers being down wind of noise sources and light to no cloud cover). Other weather conditions would result in lower noise levels than those predicted for day-time construction.

All non-associated dwellings are separated by 1050m or more from the closest proposed WTG location (with NAD_11 being 1065m from WP69), and 2000m or more from the closest proposed temporary concrete batching plants (with NAD_8 being 2000m to the closest batching plant location).

The predicted noise level from the closest activity at the WTG location sites (at a separation distance of 1050m) is provided in the table below. The required separation distance in order to achieve the *noise affected level* of 45 dB(A) during standard hours is also provided. The predictions for each “Phase” are based on the assumption that all equipment stated is being operated.

Table 14: Predicted construction noise levels during standard hours.

Phase	Main Plant and Equipment	**Predicted Noise Level at Closest Dwelling** (1050m to activity)	Outcome/Action
Site Set-Up and Civil Works	Generator Transport truck Excavator Low loader	44 dB(A)	Achieves criterion at all non-associated dwellings.
Road Construction	Mobile crushing and screening plant Dozer Roller Low loader Tipper truck Excavator Scraper Transport truck	50 dB(A)	Predicted to exceed criterion at dwellings within 1,800m of the construction activity. Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
Excavation and foundation construction	Excavator Front end loader Mobile crushing and screening plant Truck-mounted concrete pump Concrete mixer truck Mobile crane Transport truck Tipper truck	49 dB(A)	Predicted to exceed criterion at dwellings within 1,700m of the construction activity. Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
Electrical Installation	Rock trencher Concrete mixer truck Low loader Tipper truck Mobile crane	50 dB(A)	Predicted to exceed criterion at dwellings within 1,800m of the construction activity. Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
Turbine Delivery and Erection (at the turbine locations)	Extendable trailer truck Low loader Mobile crane Support crane Grinder Rattle Gun	44 dB(A)	Achieves criterion at all non-associated dwellings.

The predicted noise level from the closest activity that could occur outside of standard construction hours, such as the operation of a batching plant and concrete pouring at WTG sites early in the morning, is provided below. The required separation distance as modelled in order to achieve the *noise affected level* of 35 dB(A) for activity outside of standard hours is also provided.

Table 15: Predicted construction noise levels outside of standard hours.

Phase	Main Plant and Equipment	Predicted Noise Level at Closest Dwelling	Outcome/Action
Batching	Front end loader Truck	38 dB(A) (2000m from Dwelling)	Predicted to exceed criterion at dwellings within 2,400m of the construction activity (NAD_8 and NAD_11). Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.
Concrete Pour	Generator Truck Concrete pump	39 dB(A) (1050m from Dwelling)	Predicted to exceed criterion at dwellings within 1,900m of the construction activity (NAD_5, NAD_7, NAD_8, NAD_11, NAD_12, NAD_13 and NAD_67). Implement "feasible and reasonable" noise control strategies to minimise noise during construction in accordance with the recommendations below.

In accordance with the Construction Noise Guideline, if the noise is "particularly annoying' to nearby residents, a modifying correction factor is to be applied to the measured level. The noise associated with construction activity can exhibit annoying characteristics on occasion and therefore a 5 dB(A) correction (increase to the predicted level) has been applied to the noise predictions.

It is noted that separation distances greater than the distances presented in the above tables will result in lower noise levels.

Based on the predicted noise levels, it is expected that construction:

- during standard hours will potentially be greater than 45 dB(A) for some activities at a limited number of non-associated dwellings (7 locations). However, the predicted noise levels are significantly less than 75 dB(A), which represent the point where there may be strong community reaction to noise.
- Outside of standard hours will potentially be greater than 35 dB(A) for some activities. That is, the noise from temporary batching may exceed 35 dB(A) at 2 dwellings and concrete pouring at 7 locations.

Recommendations

For construction with noise levels as detailed above, the Construction Noise Guideline requires the developer to apply all feasible and reasonable work practices, and to inform the residents of the proposed construction work.

"Feasible and reasonable" noise control strategies to minimise noise during construction may include engineering measures such as the construction of temporary acoustic barriers, the use of proprietary enclosures around machines, the use of silencers, the substitution of alternative construction processes and the fitting of broadband reversing signals. It may also include administrative measures such as inspections, scheduling and providing training to establish a noise minimisation culture for the works.

The following mitigation measures are recommended to be implemented for the construction works by the construction team once the final construction methods, timing, locations and equipment has been determined.

Scheduling

Construction works, including heavy vehicle movements into and out of the site, will generally restricted to the hours between 7am and 6pm Monday to Friday, and between 8am and 1pm on Saturdays. Works carried out outside of the hours will be limited to:

- works that do not cause noise emissions above 35 dB(A) at any nearby non associated dwellings not located on the site; or,
- the delivery of materials as requested by Police or other authorities for safety reasons; or,
- emergency work to avoid the loss of lives, property, and/or to prevent environmental harm; or
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

If any other works are required outside of the specified hours, they will only be carried out with the prior consent of the relevant authority.

Location of Fixed Noise Sources

Locate fixed noise sources such as crushing and screening plant, concrete batching plant, generators and compressors at the maximum practicable distance to the nearest dwellings, and where possible, use existing topography to block line of sight between the fixed noise source and the dwelling.

Provide Acoustic Screens around Fixed Noise Sources

Provide acoustic screens or mounding for *fixed* crushing and screening plant and concrete batching plant wherever these noise sources are located within 2400m of a non-associated dwelling and do not have direct line of sight blocked by site topography to that dwelling, in accordance with the following requirements:

- Locate the acoustic screens or mounding as close as practicable to the noise source;
- Construct from mounding using excavated soil from the site or a material with a minimum surface density of 10 kg/m^2, such as 1.2mm thick sheet steel or 9mm thick compressed fibre cement sheeting, or use proprietary barriers such as the *FlexShield* "Sonic Quilt";
- Construct to a minimum height that blocks direct line of sight between the noise source and any dwellings within 2400m;
- Construct such that air gaps or openings at joints between sections of the acoustic screens are minimised.

Enclose Generators and Compressors

Provide proprietary acoustic enclosures for site compressors and generators located within 2400m of a non-associated dwelling.

Alternative Processes

Investigate and implement alternative processes where feasible and reasonable, such as hydraulic or chemical splitters as an alternative to impact rock breaking, or the use of broadband reversing alarms in lieu of the high-pitched alarms. A broadband reversing alarm emits a sound which addresses the annoyance from the high-pitched alarms. The fitting of a broadband alarm should be subject to an appropriate risk assessment, with the construction team being responsible for ensuring the alarms are installed and operated in accordance with all relevant occupational, health and safety legislative requirements.

Site Management

- Select and locate centralised site activities and material stores as far from dwellings as practicable;
- Care should be taken not to excessively drop materials such as rock, to cause peak noise events, including materials from a height into a truck. Site personnel should be directed as part of a training regime to consider such practices;

- Plant known to emit noise strongly in one direction, such as the exhaust outlet of generator set, shall be orientated so that the noise is directed away from noise sensitive areas if practicable;
- Machines that are used intermittently shall be shut down in the intervening periods between works or throttled down to a minimum;
- Implement worksite induction training, educating staff.

Equipment and Vehicle Management

- Ensure equipment has Original Equipment Manufacturer (OEM) mufflers (or better) installed;
- Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the OEM design specifications. This inspection should be part of a monitoring regime;
- Ensure silencers and enclosures are intact, rotating parts are balanced, loose bolts are tightened, frictional noise is reduced through lubrication and cutting noise reduced by keeping equipment sharp. These items should be part of a monitoring regime;
- Use only necessary power to complete the task;
- Inspect, as part of a monitoring regime, plant and equipment to determine if it is noisier than other similar machines, and replace or rectify as required.

Community Consultation

Implement the following noise related elements into the overall community consultation process. The aim of the consultation is to ensure adequate community awareness and notice of expected construction noise.

The minimum elements should include:

- Community Information newsletters, providing details of the construction plan and duration of the construction phases;
- A site notice board in a community location providing copies of the newsletters, updated construction program details, and contact details of relevant project team members;
- A feedback mechanism for the community to submit questions to the construction team, and for the construction team to respond;
- Regular updates on the construction activities to local authorities to assist in complaint management if necessary;
- Contact details of the project manager and/or site “Environmental Representative”.

In addition, prior to any construction activity outside of standard work hours occurring within 2400m of a

non-associated dwelling, or significant construction traffic periods or impacts on local road conditions:

- Contact the local community potentially affected by the proposed works and inform them of the proposed work, the location of the work, the day(s) and date(s) of the work and the hours involved;
- This contact should be made a reasonable time before the proposed commencement of the work; and
- Contact details of the project manager and / or site "Environmental Representative" should be provided.

The above measures should be incorporated and implemented through the construction of the site. The mitigation measures should be requirements of the construction team once the actual construction activities and schedule have been determined.

8 TRAFFIC

The traffic associated with the winds farm will predominantly occur during construction and will include semi-trailers, low loaders, trucks, mobile cranes, water tankers, four-wheel-drive vehicles and passenger vehicles.

The preferred access routes include the New England Highway, Lindsays Gap Road, Nundle Road, Morrisons Gap Road, Barry Road and Peel Road. As described in the traffic and transport assessment, that majority of light vehicles are expected to either Nundle Road or a combination of the New England Highway, Garoo Road and Lindsays Gap Road.

Heavy vehicles and materials for construction are expected to use the New England Highway, Lindsays Gap Road and Nundle Road.

Traffic from Nundle will primarily access the site via Morrisons Gap Road and Barry Road. A secondary access rout for some heavy/oversized vehicles will include Crawney Road to Head of Peal Road subject to final design considerations.

8.1 Criteria

The NSW Road Noise Policy criteria for "*Local Roads - Existing residences affected by additional traffic on existing local roads generated by land use developments*" are equivalent ($L_{Aeq,\ 1hour}$) noise levels of no greater than 55 dB(A) during the day-time (7am to 10pm) and 50 dB(A) during the night-time (10pm to 7am). This noise level is to be achieved outside, at a distance of 1m from the facade of a dwelling and at a height of 1.5m.

8.2 Assessment

The traffic noise assessment considers the noise at the closest (worst case) dwelling to any road/track, understood to be a setback distance in the order of 25m from a highway and 10m within the township of Nundle.

It is predicted that for a dwelling set back 25m from a highway, the 55 dB(A) criterion will be achieved in all hours when there are no more than 20 passenger vehicle movements and 6 heavy vehicle movements. For a dwelling within the township of Nundle (10m form the roadside), the criterion will also be achieved in all

hours when there are no more than 20 passenger vehicle movements and 6 heavy vehicle movements in one hour.

The above assessment demonstrates that the NSW Road Noise Policy can be satisfied with relatively large number of vehicle movements. It is also noted that roads such as the highways and Barry Road would already be exposed to levels of traffic which exceed these trip numbers.

Notwithstanding, during the peak of construction (from month 6 to 19) the number of vehicles associated with the wind farm development, using the preferred access route is predicted to exceed the above traffic volumes. During this time, morning traffic levels are expected to reach 109 light vehicle trips and 18 large vehicles within one hour. For this level of activity, a noise level of 58 dB(A) is predicted at 25m from a highway and 60 dB(A) at 10m from the road within a township.

For other roads or tracks where dwellings are located further from the road, the above number of vehicle movements can double for every doubling of the distance between the road and dwelling.

It is noted that care should be taken, particularly around site entry and exit points, to avoid excessive acceleration of trucks and the use of truck engine brakes in close proximity to dwellings.

In accordance with the general principles of dealing with temporary construction noise impacts as compared to permanent operational noise, where the NSW Road Noise Policy criteria are exceeded (during the peak construction period), the following mitigation measures should be employed to reduce construction traffic noise:

- Communicate with the affected community in accordance with the provisions above;
- Establish and maintain a route into the site so that heavy vehicles do not enter noise sensitive areas for access where practicable;
- Incorporate information regarding the route to all drivers prior to accessing the site and the need to minimise impacts through driver operation at certain locations;
- Schedule construction traffic deliveries such that it is as evenly dispersed as practicable;
- Restrict construction to the day-time operating hours for the construction site, subject to the justifications for activity outside of this time as detailed in the Construction Noise Management Plan.

9 CONSTRUCTION VIBRATION

9.1 Criteria

For construction activity occurring during the day time, the DEC 2006 can be interpreted to provide the vibration criteria in the following table at the dwellings, based on the core document used as the technical basis for the Technical Guideline, the British Standard *BS 6472-1992 "Evaluation of human exposure to vibration in buildings (1-80Hz)".*

Table 16: Vibration Criteria

Continuous Vibration Vertical (rms)		**Impulsive Vibration Vertical (rms)**		**Vibration Dose Value for Intermittent Vibration**	
Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
0.01 m/s^2	0.02 m/s^2	0.3 m/s^2	0.6 m/s^2	0.2 $m/s^{1.75}$	0.4 $m/s^{1.75}$

Continuous vibration is uninterrupted for an extended period of time. Intermittent vibration is an interrupted form of continuous vibration, and impulsive vibration is a sudden event or events.

9.2 Assessment

It is expected that the main sources of construction vibration will be the rock trenching equipment and roller operation during the road and hard stand construction. The level of vibration at a distance will be subject to the input of the equipment and the local ground conditions. Typically, the distances required to achieve the construction vibration criteria provided in DEC 2006 are in the order of 20m. At a distance of 100m, vibration from these activities is unlikely to be detectable.

Based on the separation distances between the construction activities and the nearest dwellings being well in excess of 100m, vibration levels are predicted to easily achieve the criteria.

If construction activities producing high levels of vibration occur within 100m of a dwelling, such as upgrading existing roads (which may be within 25m of the closest dwelling), it is recommended that a monitoring regime is implemented during these times to ensure compliance with DEC 2006.

10 BLASTING

10.1 Criteria

Objective criteria for airblast overpressure and ground vibration from blasting are provided by ANZEC 1990.

Airblast Overpressure

To minimise the annoyance and discomfort from airblast overpressure ANZEC 1990 recommends:

- a maximum level for airblast overpressure is 115 dB (Lin, Peak).
- the level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but the level should not exceed 120 dB (Lin, Peak) at any time.

Ground Vibration

To minimise the annoyance and discomfort from ground vibration ANZEC 1990 recommends:

- a maximum level for ground vibration of 5mm/sec (peak particle velocity (ppv)).
- the ppv level of 5mm/sec may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but the level should not exceed 10mm/sec at any time.

In addition to the above, ANZEC 1990 also recommends that blasting be restricted to the hours of 9am to 5pm on Monday to Saturday, with no blasting activity on Sunday or public holidays.

10.2 Assessment

The relationship between the airblast overpressure and ground vibration from blasting for a given site is dependent on a number of variables specific to that site. The magnitude of the airblast overpressure and ground vibration decrease with increasing distance from the blast and increase with increasing charge weight per delay. Other variables such as particular source-receiver geometries, rock type and formation and the local geology of the site also influence the result of blasting. It is therefore common practice for the blasting specialist to design each blast to achieve the project criterion, once the locations and requirement for blasting is known.

The separation distances between any potential blasting activity associated with the wind farm and the nearest dwellings are of the order of magnitude for which ground vibration and airblast levels have been adequately controlled at other sites.

Given the range of factors associated with both the generation and control of blasting, it is recommended that in the event that blasting is necessary, a monitoring regime is implemented to ensure compliance with the blasting criteria provided above.

11 CONCLUSION

A noise and vibration assessment has been made of the construction and operation of the Hills of Gold Wind Farm.

The Project will generally involve up to 70 wind turbine sites and ancillary infrastructure, including electricity substation, access tracks and temporary batching facilities during construction.

The noise and vibration assessment addresses the "Secretary's Environmental Assessment Requirements" issued for the Project (SSD 9679) dated 22 November 18.

Noise predictions have been made of the wind turbine operation, the potential substation, traffic on local roads and construction activities including batching. Vibration predictions have also been made for construction activities.

Based on the predictions, the relevant noise and vibration criteria will be achieved under conditions most conducive to noise propagation at all dwellings on the basis that the turbines will be operated in accordance with a specific operating strategy and construction activities, including traffic, will be managed in accordance with the recommendations within this report.

APPENDIX A: Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs)

Environmental Assessment Requirements

Section 4.12 (8A) of the *Environmental Planning and Assessment Act 1979*
Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*

Application Number	SSD 9679
Development	Hills of Gold Wind Farm which includes: The construction, operation and decommissioning of a wind farm with: • a maximum of 97 turbines, a maximum of 410 megawatts (MW) and maximum height of 220 metres (to blade tip); and • ancillary infrastructure including access tracks, road upgrades, battery storage, underground and overhead electricity cabling, substations and grid connection to the 330 kV Liddell to Tamworth transmission line.
Location	Morrisons Gap Road, Hanging Rock
Proponent	Wind Energy Partners
Date of Issue	22 November 2018

...

	Noise and Vibration – the EIS must: • assess wind turbine noise in accordance with the NSW Wind Energy: Noise Assessment Bulletin (EPA/DPE, 2016); • assess noise generated by ancillary infrastructure in accordance with the NSW Noise Policy for Industry (EPA, 2017); • assess construction noise under the Interim Construction Noise Guideline (DECC, 2009); • assess traffic noise under the NSW Road Noise Policy (DECCW, 2011); and • assess vibration under the Assessing Vibration: A Technical Guideline (DECC, 2006);

...

Noise and Vibration	
	NSW Wind Energy: Noise Assessment Bulletin (EPA/DPE)
	NSW Noise Policy for Industry (EPA)
	Interim Construction Noise Guidelines (EPA)
	NSW Road Noise Policy (EPA)
	Assessing Vibration: A Technical Guideline (EPA)
	Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZEC)

ATTACHMENT A: Environmental Assessment Requirements – EAR (SSD 9679) – 'Hills of Gold' Windfarm.

4. Noise and Vibration

The EA must assess the following noise and vibration aspects of the proposed development

4.1. Construction noise associated with the proposed development should be assessed using the *Interim Construction Noise Guideline* (DECC, 2009). These are available at:https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/interim-construction-noise-guideline

4.2. Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the *Assessing Vibration: a technical guideline* (DEC, 2006). These are available at: https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/assessing-vibration

4.3. If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in *Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZEC, 1990).These are available at: https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/interim-construction-noise-guideline

Industry

4.4. Operational noise from all industrial activities (including private haul roads) to be undertaken on the premises should be assessed using the guidelines contained in the *NSW Noise Policy for Industry* (EPA, 2017). https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/noise-policy-for-industry-(2017)

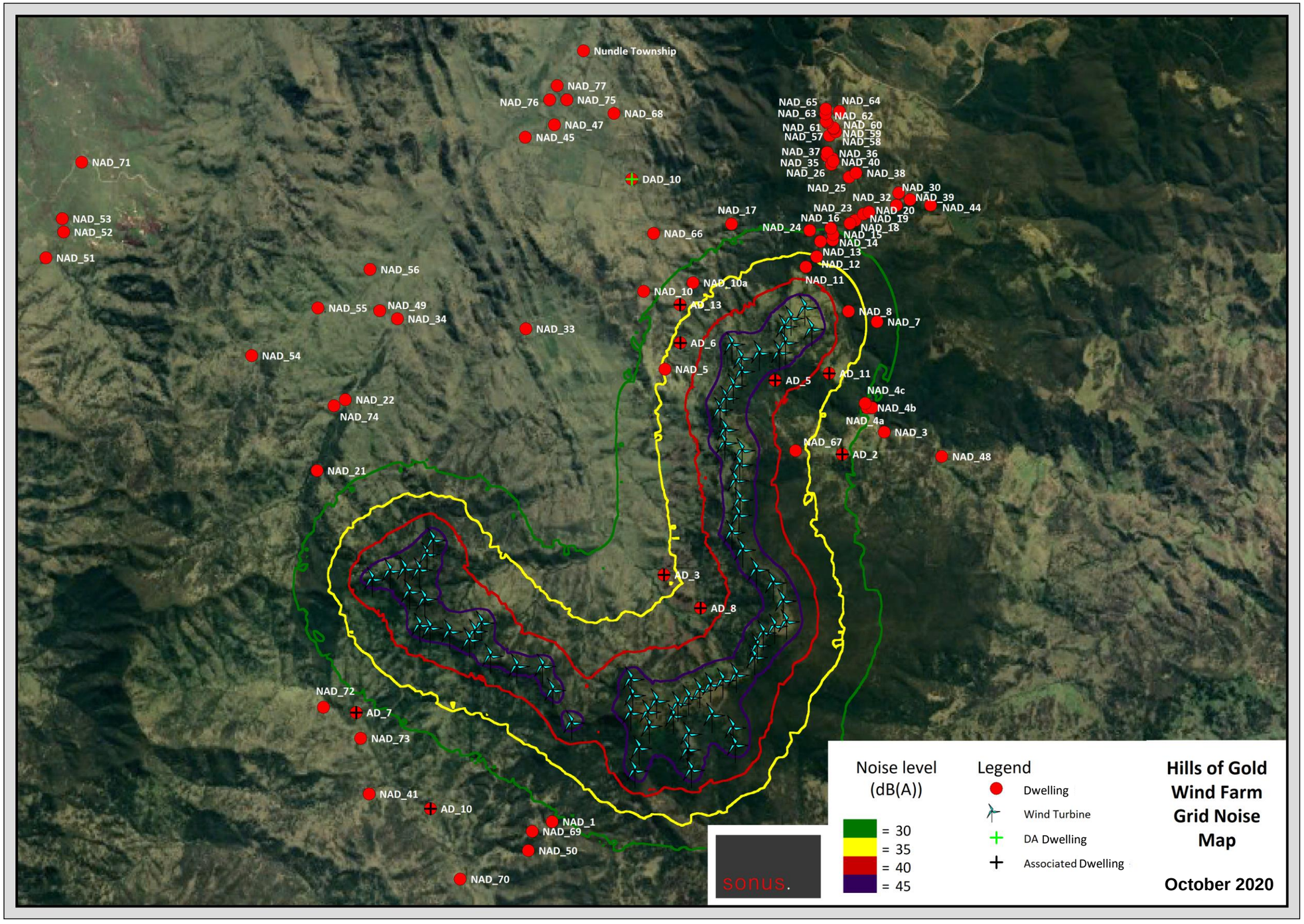
Wind Farms

4.5. Operational noise activities from Wind Farms should be accessed against the South Australian EPA's *Wind Farm- Environmental Noise Guidelines* (2009) and the DPE's *Wind Energy: Noise Assessment Bulletin* (2016), available at: www.planning.nsw.gov.au/~/media/Files/DPE/Bulletins-and-Community-Updates/wind-energy-noise-assessment-bulletin-2016-12.ashx

Roads

4.6. Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the *NSW Road Noise Policy* and associated application notes (EPA, 2011).https://www.epa.nsw.gov.au/your-environment/noise/transport-noise

APPENDIX B: Noise Prediction Contours (Wind Speed of 10m/s at Hub Height)



Operating Strategy Noise Prediction Contours (Wind Speed of 10m/s at Hub Height)