PLANNING REPORT

Muskerry Solar Power Station

December 2022

Project Number: 19-941

Document Verification

Project Title:	Muskerry Solar Power Station
Project Number:	19-941
Project File Name:	\\10.0.11.1\Active\Projects\2019\19-941 - Muskerry

Revision	Date	Prepared by	Reviewed by	Approved by
Draft V1.0	7/11/2022	Johanna Duck	Tim Doolan	Johanna Duck
Final V1.0	16/12/2022	Johanna Duck	Tim Doolan	Tim Doolan

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BRISBANE
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Spring Hill QLD 4000 **T.** (07) 3129 7633

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E. ngh@nghconsulting.com.au

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Spectrum Acoustics Pty Limited
ABN: 40 106 435 554
30 Veronica Street, Cardiff NSW 2285
Phone: (02) 4954 2276

Noise Impact and Constraint Assessment
Proposed Solar Power Station
Muskerry, VIC

Prepared for:

Edify Energy
Level 3, 201 Charlotte Street
Brisbane QLD 4000

Document No: 212173-9473-Final-R2

January 2022

Project name:	Muskerry Solar Power Station Noise Impact Assessment
Prepared for:	Edify Energy
Client representative(s):	Patrick Dale, Claire Driessen
Document control number:	212173-9473
Approved for release by:	N. Pennington

DOCUMENT CONTROL

Doc. No. / Version	Date Issued	Prepared by	Reviewed by	Issued to
212173-9473-Final-R2	14 Jan 2022	NP	PD	PD
212173-9473-Draft-R1	13 Jan 2022	NP	PD, CD	PD
212173-9473-Draft-R0	20 Dec 2021	NP	--	PD

PROJECT PERSONNEL

Name	Qualifications	Associations*	Position	Signature
Neil Pennington	B.Sc.(Phys.), B.Math. (Hons)	MAIP, MAAS, MASA	Principal/Director	

*MAIP: Member, Australian Institute of Physics
MAAS: Member, Australian Acoustical Society
MASA: Member, Acoustical Society of America

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EXECUTIVE SUMMARY

A Noise Impact and Constraints Assessment has been conducted for a proposed solar power station at Muskerry, Victoria, referred to herein as the Muskerry Solar Power Station (MSPS). This Noise Impact and Constraints Assessment has been prepared to assist with future design planning to establish noise mitigation and plant setback zones to ensure the project will comply with noise criteria at off-site residential receiver as would be contained in a project approval.

The site is located in farming land approximately 28 km east of Bendigo town centre in central Victoria. The proposed development footprint covers an area of 496 Ha, divided between a northern section of 203.85 Ha which will also host the project's substation and a southern section of 292.36 Ha.

The proposal comprised the following components:

- Up to 250MW solar plant capacity and a battery energy storage system (BESS) of up to 200 MW / 800 MWh (4-hr duration).
- The 200MW / 800 MWh battery may be either:
  a) Centralised, located adjacent to project substation; or
  b) Decentralised, with the battery enclosures distributed throughout the project's footprint (co-located with the PV inverters)
- A new 220/33kV substation will be established to enable connection to the overhead 220kV transmission line.
- Design and final location of the substation will not be confirmed until late-stage development, however this will be located within the northern parcel, proximate to the overhead 220kV transmission line.

The EPA publication 1413 *Noise from Industry in Regional Victoria* (NIRV) was applied to establish a governing night time noise criterion of **32 dB(A), Leq(15min)** at surrounding residential receivers. Edify and Spectrum Acoustics collectively identified 51 receivers located within approximately 3.5km of the development area, which forms the basis of this acoustic modelling investigation.

Noise modelling was conducted using the Environmental Noise Model (ENM, v3.06) software produced by Renzo Tonin Associates (RTA). This software allows for numerical input of wind speed and direction and vertical temperature gradient (inversions) in any combination of values. Worst case modelling was based on an equivalent temperature inversion to give an omni-directional noise increase, relative to calm neutral conditions, equivalent to a 3 m/s wind from any compass direction.

Noise source sound power levels were derived from noise emission data from Tier 1 Original Equipment Manufacturers (OEMs) to provide an indicative noise profile of the project. As the proponent has not finalised the OEM procurement for the Power Conversion Units (PCUs), this assessment has adopted the highest noise emission profile from the OEM data received. In doing so, this assessment methodology aims to conservatively predict the highest potential noise impact for various Tier 1 OEM suppliers.

Modelled noise contours shown in Appendix B were used to establish distances at which battery/PV inverter sets should be set back from potentially impacted off-site residential receivers in order for the criterion to not be exceeded under adverse temperature inversion and wind conditions. The setback distances, also shown in Appendix B, will inform the further design development of the project.

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1.0 INTRODUCTION

1.1 The Proposal

Edify Energy has commissioned Spectrum Acoustics Pty Limited to prepare a Noise Impact and Constraints Assessment for a proposed solar power station at Muskerry, Victoria, referred to herein as the Muskerry Solar Power Station (MSPS). This Noise Impact and Constraints Assessment has been prepared to assist with future design planning to establish noise mitigation and plant setback zones to ensure the project will comply with noise criteria at off-site residential receiver as would be contained in a project approval.

1.2 Project Description

The following preliminary project details have been provided to inform this assessment:

- The capacity of the project is up to 250MW solar plant and a battery energy storage system (BESS) of up to 200 MW / 800 MWh (4-hr duration).
- The project's design and quantity of infrastructure are not confirmed at this stage.
- The 200MW / 800 MWh battery may be either:
  c) Centralised, located adjacent to project substation; or
  d) Decentralised, with the battery enclosures distributed throughout the project's footprint (co-located with the PV inverters)
- A new 220/33kV substation will be established to enable connection to the overhead 220kV transmission line.
- Design and final location of the substation will not be confirmed until late-stage development, however this will be located within the northern parcel, proximate to the overhead 220kV transmission line.

1.3 Project Location

The site is located approximately 28 km east of Bendigo town centre in central Victoria as shown in **Figure 1**.

Figure 1: Local area and project site

1.4 Surrounding Land Uses and Receivers

The project site is within and surrounded by lands zoned for farming use (FZ). The site and surrounding residences are illustrated in **Figure 2**.

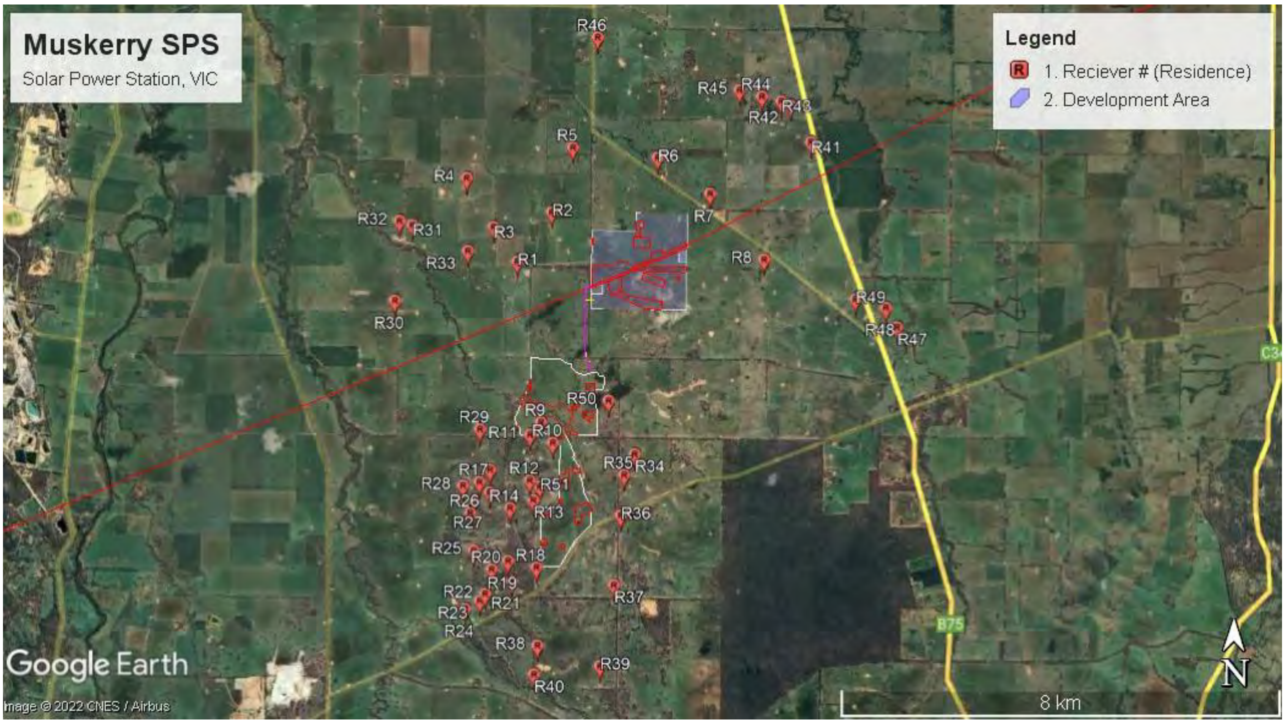


Figure 2: Identified receivers surrounding the site

2.0 NOISE CRITERIA

The noise environment in Victoria is protected by the *Environmental Protection Act* (1970) and State Environment Protection Policy *(Control of Noise from Commerce, Industry and Trade)*. The SEPP aims to protect people from the effects of noise in noise-sensitive areas (residential zones).

The SEPP document N-1 sets noise limits in Metropolitan Melbourne. The EPA publication 1413 *Noise from Industry in Regional Victoria* (NIRV) explains how to set recommended levels for a regional site. The NIRV adopts the SEPP N-1's procedures for measurement of noise and recommends noise levels in urban areas. VIC EPA publication 1413 explains how to apply the NIRV top existing or proposed sites.

In a situation where background noise may be higher than usual for a rural area due to traffic noise, background noise monitoring may be undertaken and an adjustment of the Zone Noise Levels may be made accordingly to determine the maximum allowable noise levels. Given the absence of any appreciable industrial or traffic noise sources near the project site, noise monitoring was not conducted for this assessment.

The applicable noise criteria are derived as follows:

Step 1. Identification of Zones

FZ generating zone and FZ receiver zone

Step 2. Distance adjustment levels

No distance adjustment as generating and receiver zones the same

Step 3. Base noise level check

Check distance adjusted levels from Step 2 against the following base noise levels for each period

- Day 45 dB(A)
- Evening 37 dB(A)
- Night 32 dB(A)

Step 4. Background level check and adjustment

Background monitoring was not required.

Step 5. High traffic noise areas.

Traffic noise levels in the area are not classified as "high".

Derived NIRV criteria:

- **Day 45 dB(A), Leq**
- **Evening 37 dB(A),Leq**
- **Night 32 dB(A),Leq**

The MSPS solar array will operate from 7am – 7pm which overlaps the evening period commencing at 6pm. The BESS will have ability to run at any time including during the night and the governing design noise criterion is therefore **32 dB(A),Leq**.

3.0 NOISE MODELLING

3.1 Noise Sources

The proponent has provided noise emission data from Tier 1 Original Equipment Manufacturers (OEMs) to provide an indicative noise profile of the project. As the proponent has not finalised the OEM procurement for the Power Conversion Units (PCUs), this assessment has adopted the highest noise emission profile from the OEM data received. In doing so, this assessment methodology aims to conservatively predict the highest potential noise impact for various Tier 1 OEM suppliers.

3.2 Modelled Scenarios

Noise modelling was conducted using the Environmental Noise Model (ENM, v3.06) software produced by Renzo Tonin Associates (RTA). This software allows for numerical input of wind speed and direction and vertical temperature gradient (inversions) in any combination of values that provides more flexibility than some modelling packages based on the ISO 6319 series of standards.

The mathematical basis of the ENM meteorological effects is such that the noise increase due to 3m/s source to receiver winds in the rural environment is equal to the omni-directional noise increase from a modelled temperature inversion of +7.5^{0}C/100m. Modelling this inversion strength is therefore the same as modelling a 3m/s wind from all directions simultaneously. This conservative approach was adopted so that noise increases due to winds from any direction, whether a prevailing feature of the area or not, could be considered in establishing a worst-case noise setback zone.

Edify and Spectrum Acoustics collectively identified 51 receivers located within approximately 3.5km of the development area, which forms the basis of this acoustic modelling investigation.

Preliminary noise modelling predicted off-site noise levels well below 20 dB(A) for either substation location option. Modelling also confirmed levels well below the criterion for the centralised BESS option, which models the BESS to be located adjacent to either substation location option (Option A and Option B). Acoustic data provided by the proponent confirmed that the battery packs are louder than the transformers when operating at 90% fan speed in temperatures above 40^{0}C. Consequently, the substation location, centralised BESS location and distributed transformers/PV inverters do not present a potential for the requirement of noise management/mitigation or setback zones.

The decentralised battery pack option could potentially place these units in close proximity to receivers near the proposed southern section of the site, Muskerry South.

Two scenarios were considered for the decentralised BESS option:

Scenario 1. No wind, average 70% relative humidity.
Scenario 2. 8^0/100m temperature inversion, 85% relative humidity.

Noise sources representing four containerised battery packs and associated transformer were evenly distributed throughout both the northern and southern areas in a grid pattern with 200m spacing.

4.0 NOISE PREDICTION RESULTS AND RECOMMENDATIONS

Results of the noise modelling are shown as noise contour plots in **Appendix B**.

Centralised BESS Option

Preliminary noise modelling predicted off-site noise levels well below 20 dB(A) for either substation location option. Modelling also confirmed levels well below the criterion for the centralised BESS option, which models the BESS to be located adjacent to either substation location option (Option A and Option B).

Decentralised BESS Option

The design noise criterion is not exceeded for the decentralised BESS option under calm atmospheric conditions. The noise contours expand under adverse (wind) conditions to produce levels exceeding the criterion at receivers R9 and R10 and approaching the criterion at R12 and R51 near the proposed southern section.

The final figure in Appendix B shows recommended hatched noise source exclusion zones (setback areas) in which battery system enclosures should not be located, to ensure the noise criteria are not exceeded. These setback zones (approximately 240 m for R51 and R12 and 325m for R9 and R10) are a worst case based on the assumption that every receiver is directly down-wind from every noise source. These setback zones may be open to refinement (reduction) in future design stages of the project.

5.0 CONCLUSION

A Noise Impact and Constraints Assessment has been conducted for a proposed solar power station at Muskerry, Victoria, referred to herein as the Muskerry Solar Power Station (MSPS).

Noise modelling conducted using the ENM (v3.06) software has established noise source setback zones around potentially impacted off-site receivers based on worst case adverse meteorological conditions and noise source sound power levels.

The results of this study should be used to inform the future detailed design of the project to ensure compliance with noise criteria that would be contained in a project approval.

APPENDIX A

DESCRIPTION OF ACOUSTICAL TERMS

This section of the report aims to convey an understanding of several commonly used acoustical terms. Various terms are explained in plain language and the effects of certain atmospheric conditions on noise propagation are discussed. Noise level percentiles are explained with the aid of a diagram of a hypothetical noise signal.

The descriptions in this section are not formal definitions of the terms. Formal definitions may be found in AS1633-1985 “Acoustics – Glossary of terms and related symbols”.

GENERAL TERMS

Sound Power Level

The amount of acoustic energy (per second) emitted by a noise source. Usually written as “L_w” or “SWL”, the Sound Power Level is expressed in decibels (dB) and cannot be directly measured. L_w is usually calculated from a measured sound pressure level.

Sound Pressure Level

The “noise level”, in decibels (dB), heard by our ears and/or measured with a sound level meter. Written as “SPL”, the sound pressure level generally decreases with increasing distance from a source. Noise levels are often written as dB(A) rather than dB. The “A-weighting” is a correction applied to the measured noise signal to account for the ear’s ability to hear sound differently at different frequencies. The A-weighted sound pressure level therefore represents the measured (or predicted) noise level as it would be heard by the typical human ear.

Temperature Inversion

An atmospheric state in which the air temperature increases with altitude. Sound travels faster in warmer air than in cold air, so that during an inversion the top of a “sound wave” will move faster than the bottom. This bends (refracts) sound back towards the ground. The result is a “trapping” of sound energy near the ground and an increase in noise levels. Similarly, daytime air temperatures typically reduce with altitude (approximately 1-2 ^{0}C/100m called the adiabatic lapse rate) and sound refracts upward slightly. The result is slightly reduced noise levels compared with a uniform or ‘neutral’ atmosphere.

Wind Shear

A moving air mass will experience a “friction drag” at the ground in much the same way as a lava flow will flow quickly on top and “roll over” the lava beneath which must drag along the ground. This increasing wind speed with altitude is called “wind shear”.

For a sound wave travelling down wind, the top of the wave moves faster than the bottom and the wave bends towards the ground. However, for a wave travelling into the wind the top of the wave is slowed down more than the bottom is and the wave bends upwards. **Figure A1** shows several examples of how atmospheric effects can bend sound waves.

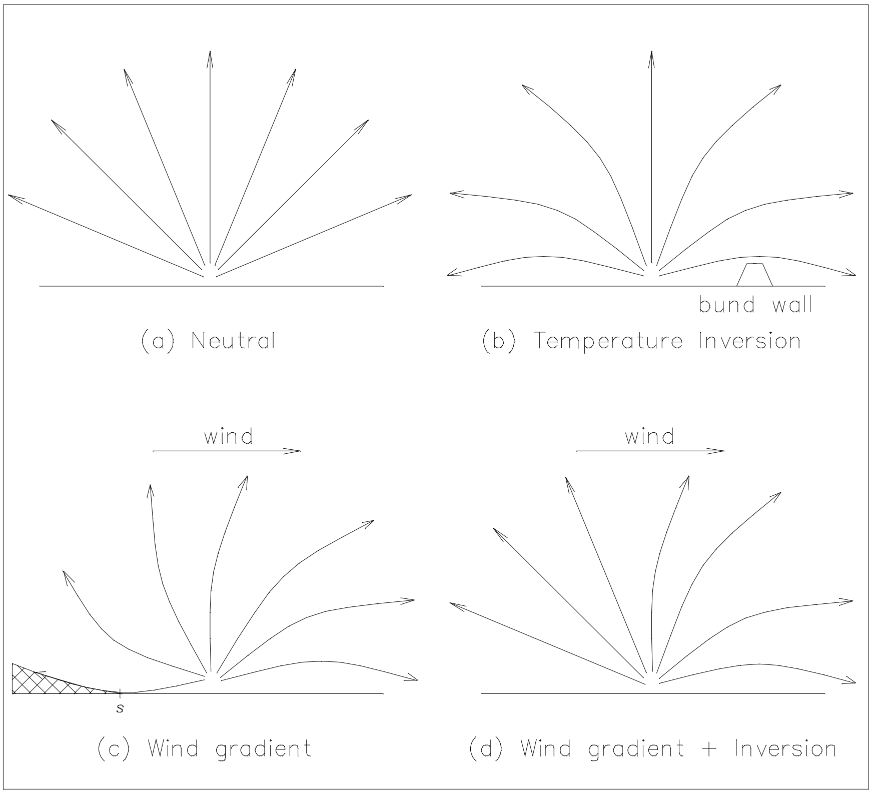


Figure A1. Sound refraction under temperature inversions and wind gradients.

Figure A1 shows that sound rays can be refracted over a barrier (usually a bund wall or small hill) during a temperature inversion, increasing noise levels in the 'shadow zone'.

Neutral Atmospheric Conditions

An atmosphere that is at a temperature of approximately 23^{0}C from ground level to an altitude of 200m or more. There are no fluctuations in density or humidity and no wind. Such conditions rarely occur, as temperature will usually vary with altitude and there is always movement in various directions in different layers of the atmosphere.

Prevailing Atmospheric Conditions

Atmospheric conditions (with regards to potential effects on noise propagation) which are characteristic of the study area. These will typically include seasonal wind directions and velocities. Temperature inversions will be included as prevailing if they occur, on average, for more than 2 nights per week in winter.

Adverse Atmospheric Conditions

Adverse conditions will include simultaneous winds and temperature inversions, even if the inversions occur for less than 2 nights per week in winter. This represents the worst case scenario for potential noise enhancement due to atmospheric effects.

NOISE LEVEL PERCENTILES

A noise level percentile (L_n) is the noise level (SPL) in decibels which is exceeded for "n" % of a given monitoring period. Several important L_n percentiles will be explained by considering the hypothetical time signal in **Figure A2**.

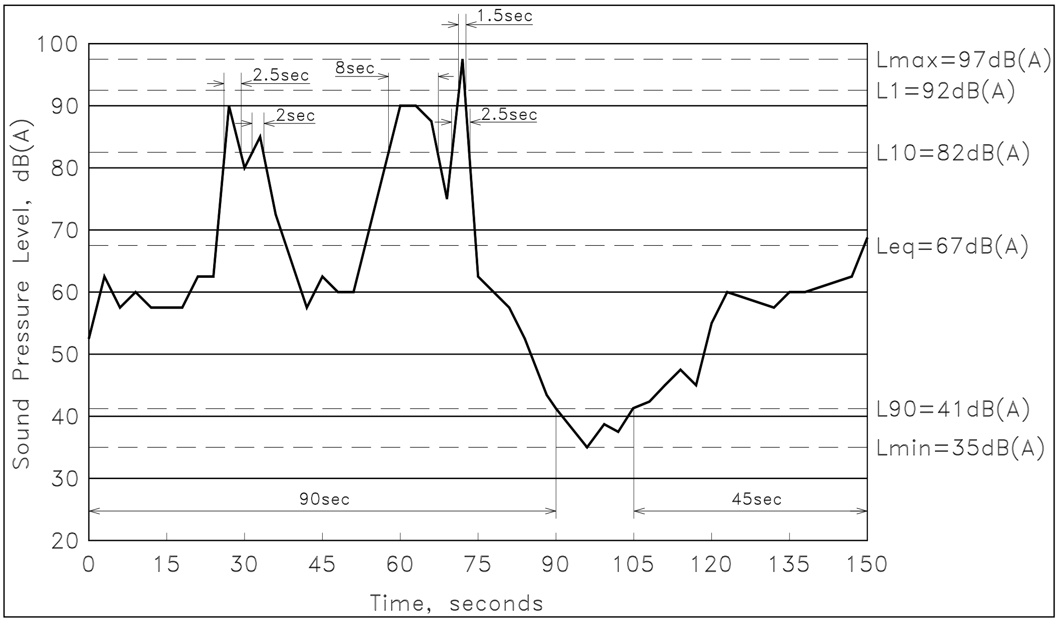


Figure A2. Hypothetical time signal to illustrate noise level percentiles.

The signal in Figure A2 has a duration of 2.5 minutes (ie 150 seconds) with noises occurring as follows:

- The instrument is located beside a road and records crickets in nearby grass at a level of around 60 dB (A);
- At about the 30 second mark a motorcycle passes on the road, followed by a car;
- At 60 seconds a truck passes;
- After the truck passes it sounds its air horn at the 73 second mark;
- The crickets are startled into silence as the truck fades into the distance;
- All is quiet until 105 seconds when the crickets slowly start to make noise, reaching full pitch by 120 seconds;
- The measurement stops at 150 seconds, just when an approaching car starts to become audible.

L_{A1} Noise Level

Near the top of Figure A2, there is a dashed line at 92 dB(A). A small spike of 1.5 sec duration extends above this line at around 73 seconds. Since 1.5 sec is 1% of the signal duration (150 seconds), the L_1 (or L_{A1} to signify A-weighting) noise level of this sample is 92 dB(A) and is from the truck's air horn. The L_1 percentile is often called the *average peak noise level* and is used as a measure of potential disturbance to sleep.

L_{A10} Noise Level

The dashed line at 82 dB(A) is exceeded for four periods of duration 2.5 sec, 2 sec, 8 sec and 2.5 sec, respectively. The total of these is 15 sec, which is 10% of the total sample period. Therefore, the L_{A10} noise level of this sample is 82 dB(A). The L_{A10} percentile is called the *average maximum noise level* and has been widely used as an indicator of annoyance caused by noise.

L_{A90} Noise Level

In similar fashion to L_{A1} and L_{A10}, Figure A2 shows that the noise level of 41 dB(A) is exceeded for 135 seconds (90 + 45 =135). As this is 90% of the total sample period, the L_{A90} noise level of this sample is 41 dB(A). The L_{A90} percentile is called the *background noise level*.

L_{Aeq} Noise Level

Equivalent continuous noise level. As the name suggests, the L_{Aeq} of a fluctuating signal is the continuous noise level which, if occurring for the duration of the signal, would deliver equivalent acoustic energy to the actual signal. L_{Aeq} can be thought of as a kind of 'average' noise level. Recent research suggests that L_{Aeq} is the best indicator of annoyance caused by industrial noise and industrial noise policies and guidelines in most states take this into consideration.

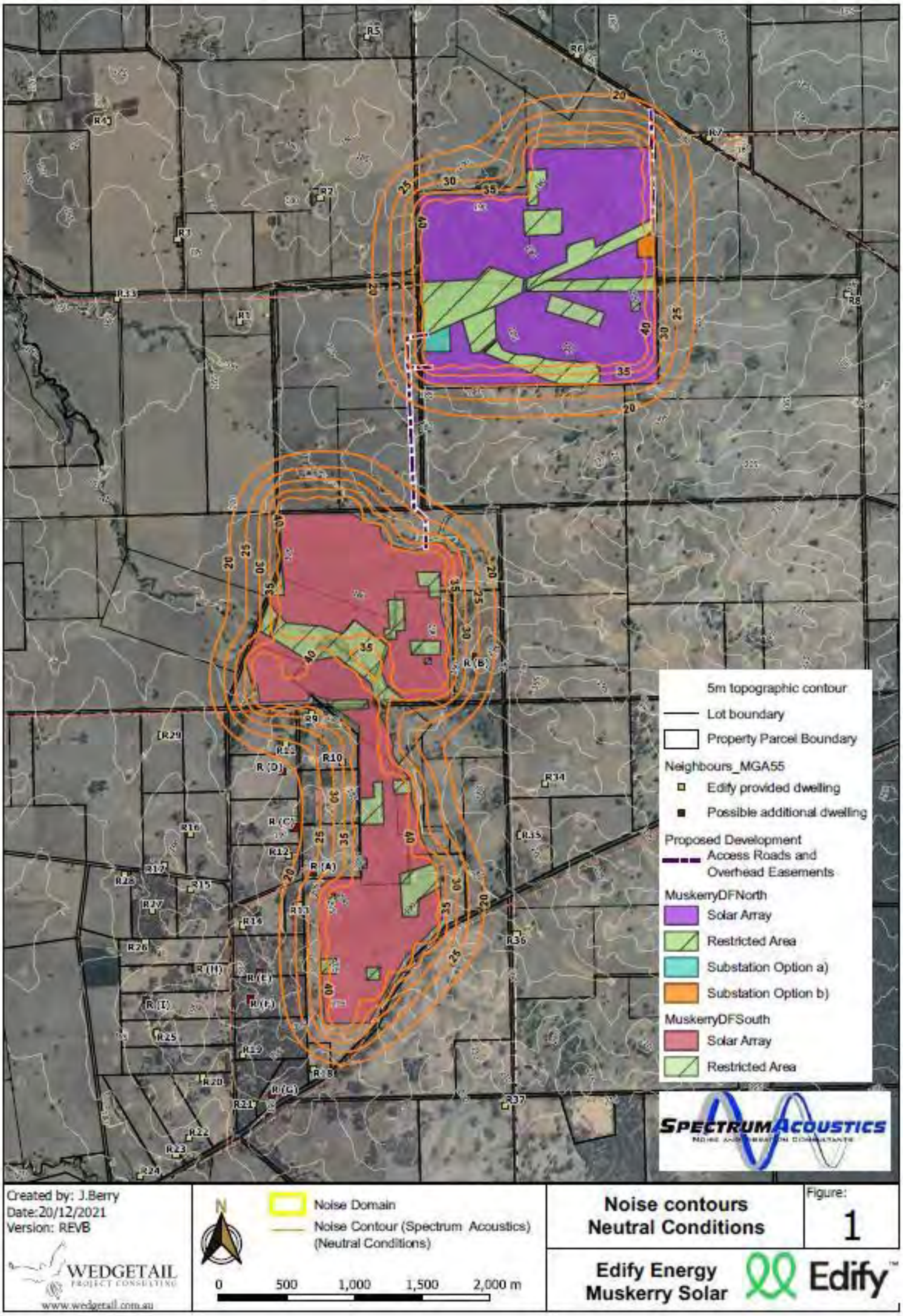
L_{Amax} and L_{Amin} Noise Levels

These are the maximum and minimum SPL values occurring during the sample. Reference to Figure A2 shows these values to be 97 dB(A) and 35 dB(A), respectively.

APPENDIX B

NOISE LEVEL CONTOURS AND

NOISE EXCLUSION SETBACK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Lot boundary
Property Parcel Boundary
Neighbours_MGA55
Edify provided dwelling
Possible additional dwelling
Proposed Development
Access Roads and Overhead Easements
MuskerryDFNorth
Solar Array
Restricted Area
Substation Option a)
Substation Option b)
MuskerryDFSouth
Solar Array
Restricted Area
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Version: REVB
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Noise Domain
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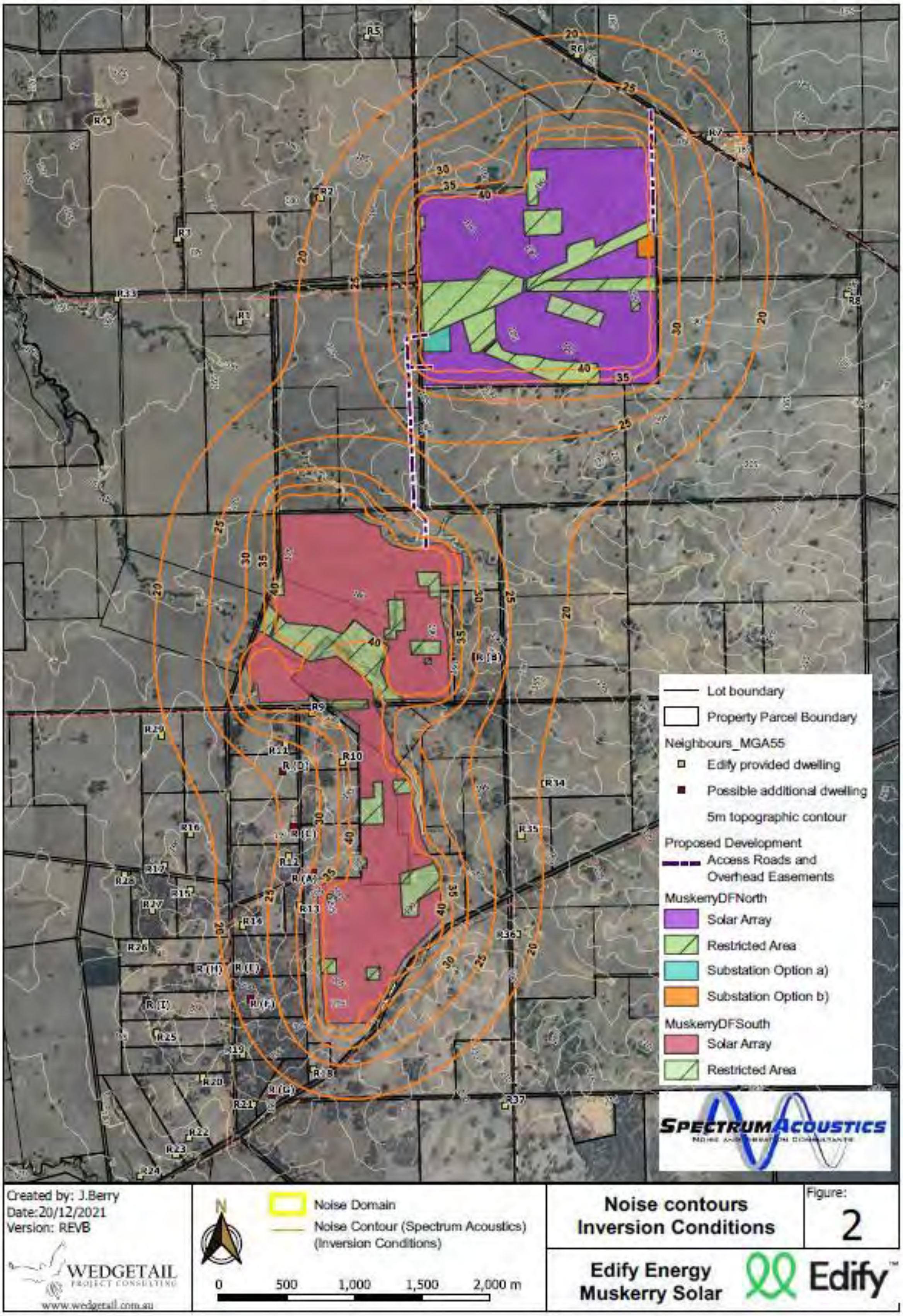

Lot boundary
Property Parcel Boundary
Neighbours_MGA55
Edify provided dwelling
Possible additional dwelling
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Access Roads and Overhead Easements
MuskerryDFNorth
Solar Array
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MuskerryDFSouth
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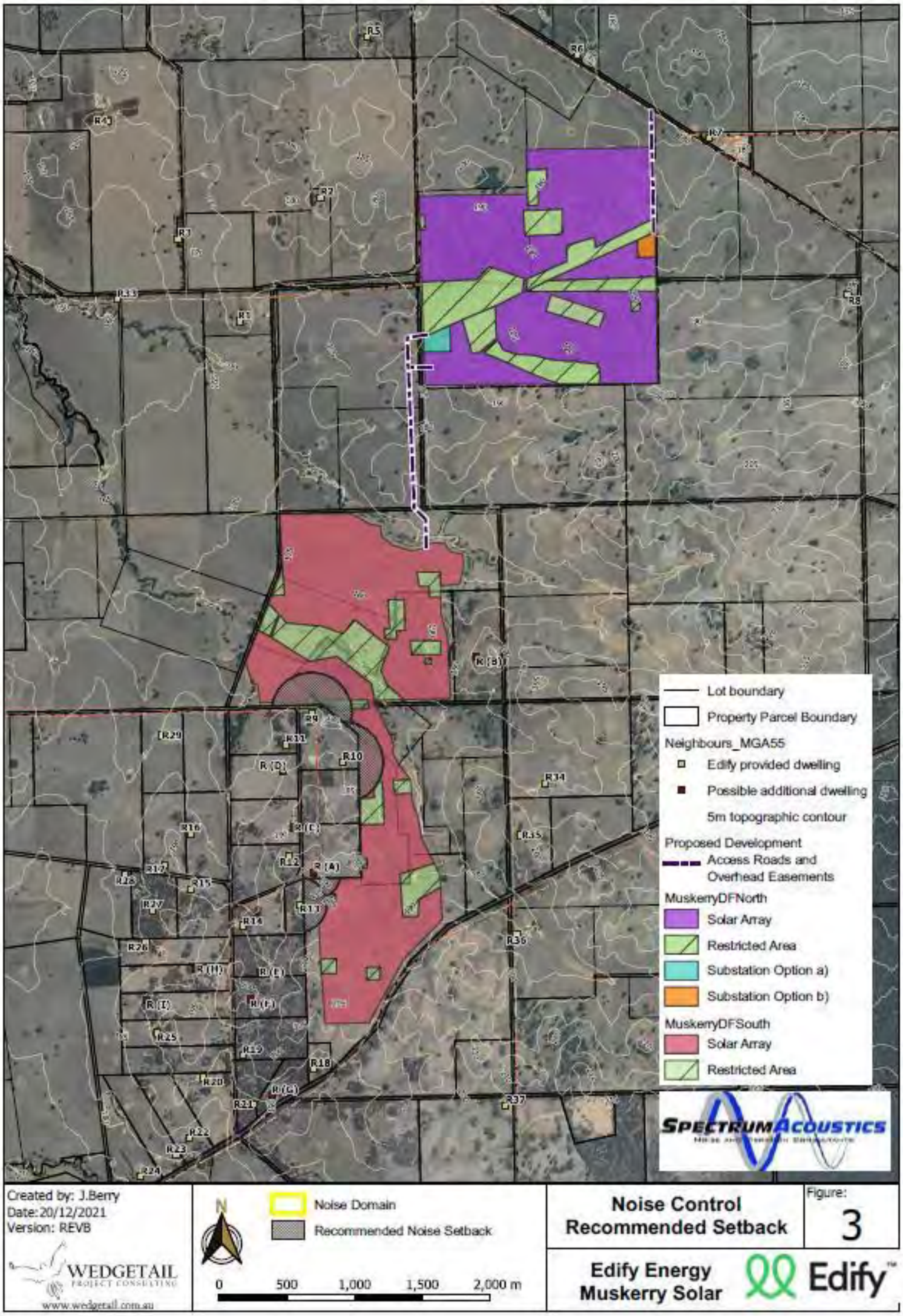

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