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YANCO SOLAR FARM

Construction & Operational Noise & Vibration Assessment

6 February 2019

NGH Environmental Pty Ltd

TJ856-01F01 Noise & Vibration Assessment (r2)

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Document details

Detail	Reference
Doc reference:	TJ856-01F01 Noise & Vibration Assessment (r2)
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Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Authorised
23.11.2018	Generate report	0	1	D Kim	M Chung	M Chung
23.01.2019	Finalise report	-	2	D Kim	M Chung	M Chung
06.02.2019	Update report	-	3	D Kim	M Chung	M Chung

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1 Introduction

Renzo Tonin & Associates was engaged to conduct an environmental noise and vibration assessment of the proposed Yanco Solar Farm located approximately two kilometres northwest of the town of Yanco in New South Wales, as part of the Environmental Impact Statement (EIS) for the Project. Noise and vibration impacts from the construction and operation phases of the Project have been addressed in this report in accordance with relevant Council and EPA requirements and guidelines.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project Description

2.1 Background Information

The Yanco Solar Farm project includes the construction and operation of a solar photovoltaic (PV) plant and associated infrastructure, with a capacity of approximately 72 MW. The subject site is located approximately two kilometres northwest of the town of Yanco in New South Wales, within the Leeton Shire Council Local Government Area (LGA). A 33kV powerline will connect the solar farm to the grid from the transfer station at the southeast corner of the solar plant to the Yanco Substation at 115 Houghton Road, Yanco. It should be noted that this solar farm will not have a large high voltage transformer as it will connect into the 33kV powerline.

2.2 Regulatory Requirements

Noise and vibration impacts are assessed in accordance with the applicable policies, guidelines and standards, including:

- NSW 'Interim Construction Noise Guideline' (ICNG – DECC 2009);
- NSW 'Noise Policy for Industry' (NPfI – EPA 2017);
- 'Assessing Vibration: A Technical Guideline' (DECC 2006); and
- NSW 'Road Noise Policy' (RNP – DECCW 2011).

2.3 Receiver Locations

The nearest affected receivers were identified through aerial maps as follows:

- **Receiver R01 – 649 Ronfeldt Road, Yanco**
  Residential property located approximately 300m southwest of the project area
- **Receiver R02 – 405 Research Road, Yanco**
  Residential property located approximately 110m southwest of the project area
- **Receiver R03 – 410 Yate Road, Leeton**
  Residential property located approximately 130m southwest of the project area
- **Receiver R04 – 328 Toorak Road, Leeton**
  Residential property located approximately 110m west of the project area
- **Receiver R05 – 284 Toorak Road, Leeton**
  Residential property located approximately 140m west of the project area
- **Receiver R06 – 22 McMaster Road, Leeton**
  Residential property located approximately 250m northwest of the project area
- **Receiver R07 – 191 Toorak Road, Leeton**

Residential property located approximately 30m northwest of the project area

- **Receiver R08 – 165 Toorak Road, Leeton (West)**
  Residential property located approximately 250m north of the project area
- **Receiver R09 – 165 Toorak Road, Leeton (East)**
  Residential property located approximately 300m north of the project area
- **Receiver R10 – 32 Back Yanco Road, Leeton**
  Residential property located approximately 240m northeast of the project area
- **Receiver R11 – 30 Back Yanco Road, Leeton**
  Residential property located approximately 410m northeast of the project area
- **Receiver R12 – 50 Maxwell Road, Leeton (West)**
  Residential property located approximately 390m east of the project area
- **Receiver R13 – 50 Maxwell Road, Leeton (East)**
  Residential property located approximately 420m east of the project area
- **Receiver R14 – 55 Maxwell Road, Leeton**
  Residential property located approximately 420m east of the project area
- **Receiver R15 – 40 Gladman Road, Leeton**
  Residential property located approximately 480m east of the project area
- **Receiver R16 – 49 Gladman Road, Leeton**
  Residential property located approximately 560m east of the project area
- **Receiver R17 – 80 Dempsey Road, Leeton**
  Residential property located approximately 910m east of the project area
- **Receiver R18 – 186 Research Road, Leeton**
  Residential property located approximately 760m southeast of the project area
- **Receiver R19 – 215 Research Road, Yanco**
  Residential property located approximately 450m southeast of the project area
- **Receiver R20 – 235 Research Road, Yanco**
  Residential property located approximately 240m southeast of the project area
- **Receiver R21 – 13 Tecoma Street, Yanco**
  Residential property located approximately 130m northeast of the project area
- **Receiver R22 – 120 Houghton Road, Yanco**
  Residential property located approximately 1,030m southeast of the project area, and approximately 430m south of the powerline easement
- **Receiver R23 – 26 Euroley Road, Yanco**
  Residential property located approximately 1,600m southeast of the project area and approximately 550m southeast of the powerline easement

Figure 1 provides details of the site, surrounds and receiver locations.

2.4 Hours of Operation

2.4.1 Construction

It is proposed that construction of the Project will take approximately ten (10) months. Construction will occur during the following standard hours of construction:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 8:00am to 1:00pm
- No work on Sundays or public holidays

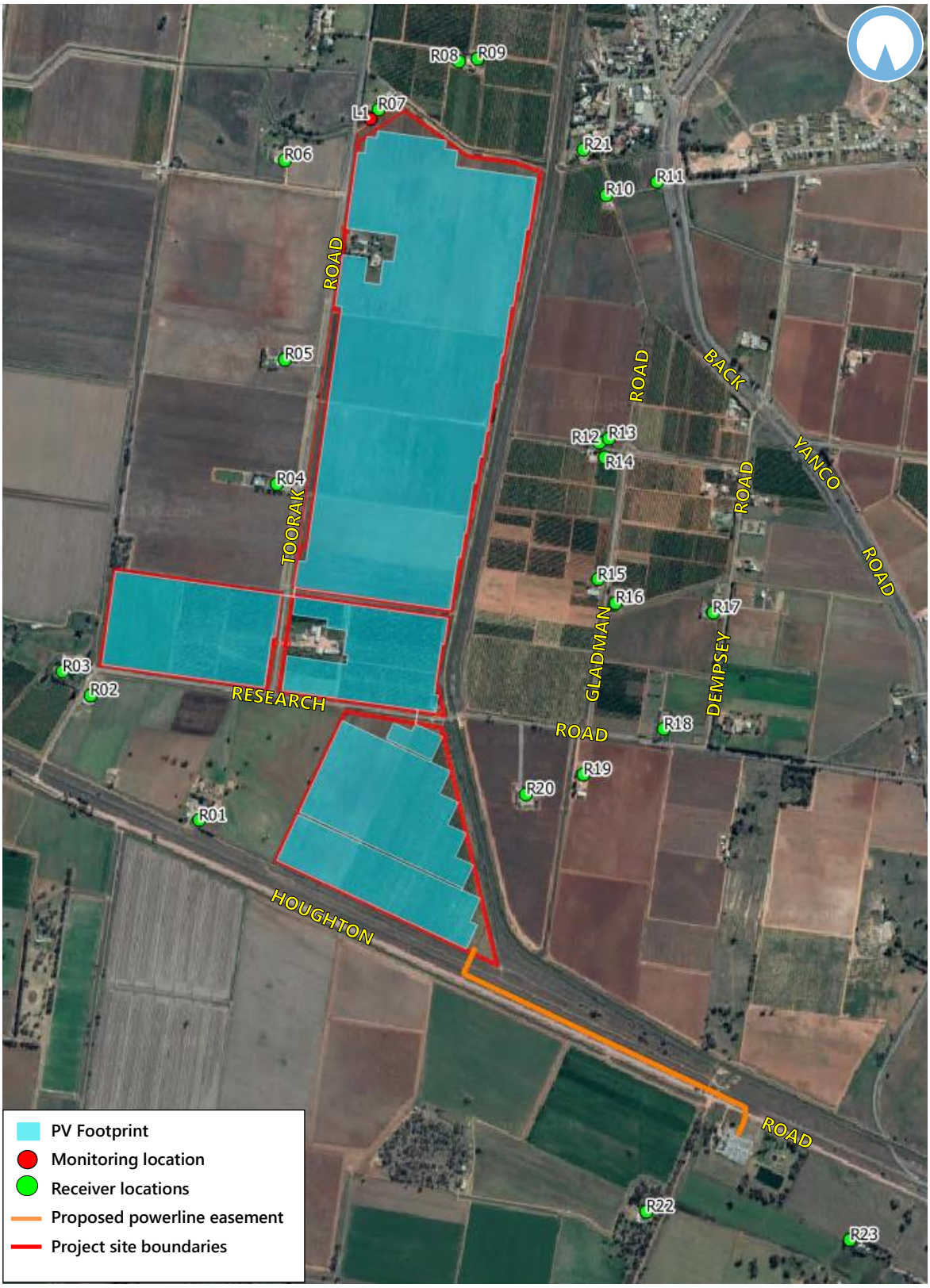
2.4.2 Operation

The solar farm will operate autonomously during times when there is sunlight. This will predominantly be during day and evening periods (7am-6pm and 6pm-10pm, respectively) throughout the year and potentially part of the night time period (prior to 7am) during the summer months.

Furthermore, there will be staff on site during the following standard hours:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 8:00am to 1:00pm

Figure 1 – Site, Surrounds and Receiver, and Noise Monitoring Locations



3 Existing Noise Environment

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW 'Noise Policy for Industry' (NPfI – Environment Protection Authority NSW 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The NSW NPfI defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

3.1 Noise Monitoring Locations

Noise monitoring is to be undertaken where the background and ambient noise environment is representative of the most affected sensitive receivers surrounding the site. The closest identified sensitive receiver is Receiver R07. As such, the monitoring location was established on the property boundary of Receiver R07. Details of the noise monitoring location is described below.

- **Location L1 – 191 Toorak Road, Leeton (Coordinates: -34°34'9.85", 146°22'56.82")**
  The noise monitor was installed on the boundary of Receiver R07, in the 'free field' (ie. noise monitor positioned away from building facades, solid fences or barriers, and other reflecting surfaces). Noise data represents the background and ambient noise environment for residences surrounding the project area.

To quantify the existing ambient noise environment, long term (unattended) noise monitoring was conducted at Location L1 between Tuesday 2nd October and Wednesday 17th October 2018.

Appendix A of this report presents a description of noise terms. Appendix B details the noise monitoring methodology and the graphical recorded outputs from long term noise monitoring are included in Appendix C. The graphs in Appendix C were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24 hour period of noise monitoring and based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NSW NPfI.

3.2 Existing Background & Ambient Noise Levels

Existing background and ambient noise levels are presented in Table 3.1 below. The noise monitor was positioned outdoors in the 'free-field' (ie. away from building facades). Construction and operational

noise from the site should be assessed away from the facade at the potentially most affected residential boundaries and therefore, the representative noise levels listed in Table 3.1 are directly applicable.

Table 3.1 – Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L_{90} Background Noise Levels			L_{eq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
L1 (-34°34'9.85", 146°22'56.82")	33	35	31	50	50	45

The identified receivers surrounding the subject site are all classified as rural under NPfI guidelines. It was found that the background noise levels were close to levels typical for a rural area, with a day RBL less than 40dB(A), an evening RBL of 35 dB(A) and a night RBL of 30 dB(A).

Based on Table 2.1 of the NPfI, where background noise levels are less than the minimum assumed RBLs, the minimum assumed RBL's are adopted instead for all receiver locations nominated in Section 2.3. Furthermore, the NPfI recommends that the project intrusiveness level for evening be set at no greater than the project intrusiveness noise level for daytime. Therefore, the background noise levels have been set at the levels detailed in the fourth column of Table 3.2 below.

Table 3.2 – Rating Background Noise Level, dB(A)

Time of Day	Measured Existing Background (L_{90})	Minimum Assumed RBLs	Rating Background Level (used for assessment)
Day	33	35	**35**
Evening	35	30	**33**
Night	31	30	**31**

4 Construction Noise Assessment

4.1 Construction Noise Management Levels

The NSW 'Interim Construction Noise Guideline' (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- *Use of L_{Aeq} as the descriptor for measuring and assessing construction noise*

  NSW noise policies, including the NPfI, RNP and RING have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- *Application of reasonable and feasible noise mitigation measures*

  As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice and is practical to build given the project constraints.

  Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the length of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

4.1.1 Residential Receivers

Table 4.1 reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

Table 4.1 – Noise Management Levels at Residential Receivers

Time of Day	Management Level $L_{eq\ (15\ min)}$	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 + 10dB(A)	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 75dB(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: • 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) • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(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 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Table 4.2 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring results presented in Table 3.1, the proposed construction hours and the above ICNG requirements. The receiver locations are marked in Figure 1.

Table 4.2 – Construction Noise Management Levels at Residential Receivers, dB(A)

Location Description	Day L_{90} Background Noise Level (RBL)	Day Noise Management Level $L_{eq(15min)}$
All residential receivers (Receivers R01 to R23)	35[1]	45

Notes: 1. Construction works occur during the daytime period only; hence, only the day period assessed

4.2 Construction Noise Sources

Table 4.3 lists typical plant and equipment likely to be used by the contractor to carry out the necessary construction works within the development envelope depicted in Figure 1, while Table 4.4 details the equipment required to construct the powerline easement for the Project.

Table 4.3 – Typical Solar Farm Construction Plant & Equipment & Sound Power Levels, dB(A)

Plant Item	Plant Description	L_{Aeq} Sound Power Levels, dB(A) re. 1pW
1	Small Pile Driver	114
2	Fixed Crane	113
3	Front End Loader	113
4	Backhoe	111
5	Grader	110
6	Vibratory Roller	109
7	Concrete Truck	109
8	Delivery Truck	108
9	Water Cart	107
10	Concrete Pump	105
11	Power Generator	103
12	Concrete Vibrator	103
13	Light Vehicles (eg 4WD)	103

Table 4.4 – Easement Construction Plant & Equipment & Sound Power Levels, dB(A)

Plant Item	Plant Description	L_{Aeq} Sound Power Levels, dB(A) re. 1pW
1	Front End Loader	113
2	Grader	110
3	Vibratory Roller	109
4	Delivery Truck	108
5	Water Cart	107
6	Light Vehicles (eg 4WD)	103

The sound power levels for the majority of activities presented in the above table are provided by the client, based on maximum levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', the ICNG, information from past projects and/or information held in our library files.

4.3 Construction Noise Assessment

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018) noise modelling computer program. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models takes into account:

- Location of noise sources and receiver locations;
- Height of sources and receivers;

- Separation distances between sources and receivers;
- Ground type between sources and receivers (soft); and
- Attenuation from barriers (natural and purpose built).

Noise levels at any receptors resulting from construction would depend on the above and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary substantially over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Table 4.5 presents construction noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant equipment associated with the works conducted within the development envelope. Table 4.6 refers to the noise levels likely to be experienced at the nearby affected receivers due to the construction of the easement. The noise level ranges represent the noise source being located at the furthest to the closest proximity to each receiver location.

Table 4.5 – Predicted $L_{Aeq,15min}$ Solar Farm Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq(15min)}$ Construction Noise Levels																						
		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23
Noise Management Level[1]		*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Small pile driver	<20-44	<20-**54**	<20-**52**	24-**54**	21-**51**	<20-**46**	<20-**63**	<20-**46**	<20-44	<20-**46**	<20-41	23-38	23-38	23-38	25-36	24-36	22-32	20-35	20-40	<20-**47**	<20-**52**	<20-32	<20-26
2	Fixed Crane	<20-43	<20-**53**	<20-**51**	23-**53**	20-**50**	<20-45	<20-**62**	<20-45	<20-43	<20-45	<20-40	22-37	22-37	22-37	24-35	23-35	21-31	<20-34	<20-39	<20-**46**	<20-**51**	<20-31	<20-25
3	Front End Loader	<20-43	<20-**53**	<20-**51**	23-**53**	20-**50**	<20-45	<20-**62**	<20-45	<20-43	<20-45	<20-40	22-37	22-37	22-37	24-35	23-35	21-31	<20-34	<20-39	<20-**46**	<20-**51**	<20-31	<20-25
4	Backhoe	<20-41	<20-**51**	<20-**49**	21-**51**	<20-**48**	<20-43	<20-**60**	<20-43	<20-41	<20-43	<20-38	20-35	20-35	20-35	22-33	21-33	<20-29	<20-32	<20-37	<20-44	<20-**49**	<20-29	<20-23
5	Grader	<20-40	<20-**50**	<20-**48**	<20-**50**	<20-**47**	<20-42	<20-**59**	<20-42	<20-40	<20-42	<20-37	<20-34	<20-34	<20-34	21-32	<20-32	<20-28	<20-31	<20-36	<20-43	<20-**48**	<20-28	<20-22
6	Vibratory Roller	<20-39	<20-**49**	<20-**47**	<20-**49**	<20-**46**	<20-41	<20-**58**	<20-41	<20-39	<20-41	<20-36	<20-33	<20-33	<20-33	<20-31	<20-31	<20-27	<20-30	<20-35	<20-42	<20-**47**	<20-27	<20-21
7	Concrete Truck	<20-39	<20-**49**	<20-**47**	<20-**49**	<20-**46**	<20-41	<20-**58**	<20-41	<20-39	<20-41	<20-36	<20-33	<20-33	<20-33	<20-31	<20-31	<20-27	<20-30	<20-35	<20-42	<20-**47**	<20-27	<20-21
8	Delivery Truck	<20-38	<20-**48**	<20-**46**	<20-**48**	<20-45	<20-40	<20-**57**	<20-40	<20-38	<20-40	<20-35	<20-32	<20-32	<20-32	<20-30	<20-30	<20-26	<20-29	<20-34	<20-41	<20-**46**	<20-26	<20-20
9	Water Cart	<20-37	<20-**47**	<20-45	<20-**47**	<20-44	<20-39	<20-**56**	<20-39	<20-37	<20-39	<20-34	<20-31	<20-31	<20-31	<20-29	<20-29	<20-25	<20-28	<20-33	<20-40	<20-45	<20-25	<20
10	Concrete Pump	<20-35	<20-45	<20-43	<20-45	<20-42	<20-37	<20-**54**	<20-37	<20-35	<20-37	<20-32	<20-29	<20-29	<20-29	<20-27	<20-27	<20-23	<20-26	<20-31	<20-38	<20-43	<20-23	<20
11	Power Generator	<20-33	<20-43	<20-41	<20-43	<20-40	<20-35	<20-**52**	<20-35	<20-33	<20-35	<20-30	<20-27	<20-27	<20-27	<20-25	<20-25	<20-21	<20-24	<20-29	<20-36	<20-41	<20-21	<20
12	Concrete Vibrator	<20-33	<20-43	<20-41	<20-43	<20-40	<20-35	<20-**52**	<20-35	<20-33	<20-35	<20-30	<20-27	<20-27	<20-27	<20-25	<20-25	<20-21	<20-24	<20-29	<20-36	<20-41	<20-21	<20
13	Light vehicles (eg 4WD)	<20-33	<20-43	<20-41	<20-43	<20-40	<20-35	<20-**52**	<20-35	<20-33	<20-35	<20-30	<20-27	<20-27	<20-27	<20-25	<20-25	<20-21	<20-24	<20-29	<20-36	<20-41	<20-21	<20
Up to 3 (noisiest) plant operating concurrently		23-**48**	24-**59**	24-**57**	28-**59**	25-**56**	21-**50**	20-**68**	<20-**50**	<20-**48**	22-**50**	22-45	28-42	27-42	28-42	29-40	28-40	26-36	25-39	24-44	24-**51**	21-**56**	<20-36	<20-30

Notes: 1. Noise Management Levels for day period (ie. standard construction hours)

2. **Bold** font represents exceedance of the relevant NML

Table 4.6 – Predicted $L_{Aeq,15min}$ Easement Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq(15min)}$ Construction Noise Levels																						
		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23
Noise Management Level[1]		*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Front End Loader	21-30	<20-25	<20-24	<20-24	<20-21	<20	<20	<20	<20	<20	<20	<20-23	<20-23	<20-23	22-27	23-27	23-26	26-30	27-34	27-37	<20	30-40	24-37
2	Grader	<20-27	<20-22	<20-21	<20-21	<20	<20	<20	<20	<20	<20	<20	<20-20	<20	<20-20	<20-24	<20-24	20-23	23-27	24-31	24-34	<20	27-37	21-34
3	Vibratory Roller	<20-26	<20-21	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20-23	<20-23	<20-22	22-26	23-30	23-33	<20	26-36	20-33
4	Delivery Truck	<20-25	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20-22	<20-22	<20-21	21-25	22-29	22-32	<20	25-35	<20-32
5	Water Cart	<20-24	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20-21	<20-21	<20-20	20-24	21-28	21-31	<20	24-34	<20-31
6	Light vehicles (eg 4WD)	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20-20	<20-24	<20-27	<20	<20-30	<20-27
Up to 3 (noisiest) plant operating concurrently		23-33	<20-28	<20-26	<20-26	<20-23	<20	<20	<20	<20	<20-20	<20	21-26	21-26	22-26	25-30	25-30	26-29	29-33	30-37	29-39	<20	32-42	27-40

Notes: 1. Noise Management Levels for day period (ie. standard construction hours)

Based on the construction noise levels presented in Table 4.5 for the construction of the solar farm, the noise management levels at Receivers R01 to R10 and R20 to R21 may be exceeded when construction works are conducted within close proximity to the receivers (ie. at a location within the site where construction works are closest to the corresponding receiver). For the construction of the easement, Table 4.6 indicates that construction noise levels will comply with the noise management levels at all the identified receivers. It is noted that construction noise levels at all receivers are predicted to be less than the highly noise affected level of 75dB(A) for all construction stages of the solar farm project.

In light of the predicted noise levels above, it is recommended that a feasible and reasonable approach towards noise management measures be applied to reduce noise levels as much as possible to manage the impact from construction noise. Any impacts due to construction works are temporary in nature and would not represent a permanent impact on the community and surrounding environment. The predicted noise levels are generally conservative and would only be experienced for limited periods during construction.

Impacts may be reduced through the introduction of construction noise mitigation and management measures as provided in Section 4.4 below.

4.4 Construction Noise Mitigation and Management Measures

The following recommendations provide in-principle feasible and reasonable noise control solutions to reduce noise impacts to sensitive receivers. Where actual construction activities differ from those assessed in this report, more detailed design of noise control measures may be required once specific items of plant and construction methods have been chosen and assessed on site.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

4.4.1 General Engineering Noise Controls

Implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 "Guide to Noise Control on Construction, Demolition and Maintenance Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C of AS2436 presents typical examples of noise reductions achievable after treatment of various noise sources. Table C3 in Appendix C of AS2436 presents the relative effectiveness of various forms of noise control treatment.

Table 4.7 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 4.7 – Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical Noise Reduction Possible in Practice		Maximum Noise Reduction Possible in Practice	
		AS 2436	Renzo Tonin & Associates	AS 2436	Renzo Tonin & Associates
Distance	Doubling of distance between source and receiver	6	6	6	6
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	5 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

An indicative list of the approximate minimum required distance from each construction equipment / plant to a receiver such that noise levels at the receivers comply with the Noise Management Level (NML) is provided in Table 4.8 below. It should be noted that the distances detailed below are approximate and noise monitoring may be required to confirm noise levels at the receivers.

Table 4.8 – Minimum Required Construction Plant Distance to Receiver for Noise Compliance

Plant Item	Plant Description	Minimum Required Distance for Compliance with NML (m)
1	Small Pile Driver	305
2	Fixed Crane	275
3	Front End Loader	275
4	Backhoe	220
5	Grader	195
6	Vibratory Roller	175
7	Concrete Truck	175
8	Delivery Truck	155
9	Water Cart	140
10	Concrete Pump	100
11	Power Generator	80
12	Concrete Vibrator	80
13	Light Vehicles (eg 4WD)	80

Notes: 1. Minimum construction plant distances to receivers are indicative and approximate only. Noise monitoring required to confirm noise levels at receivers.

Table 4.9 below identifies possible noise control measures, which are applicable on the construction plant likely to be used on site.

Table 4.9 – Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Small pile driver	✔	✖	✔	✔
Fixed Crane	✔	✔	✔	✖
Front End Loader	✔	✖	✔	✖
Backhoe	✔	✖	✔	✖
Grader	✔	✖	✔	✖
Vibratory Roller	✔	✖	✔	✖
Concrete Truck	✔	✖	✔	✖
Delivery Truck	✔	✖	✔	✖
Water Cart	✔	✖	✔	✖
Concrete Pump	✔	✔	✔	✔
Power Generator	✔	✔	✔	✖
Concrete Vibrator	✔	✖	✖	✖
Light vehicles (eg 4WD)	✔	✖	✖	✖

4.4.2 Noise Management Measures

In addition to physical noise controls, the following general noise management measures should be followed.

- Use less noisy plant and equipment, where feasible and reasonable.
- Plant and equipment should be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work should be switched off.
- In addition to the noise mitigation measures outlined above, a management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration

measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.

- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community should be adequately trained and experienced in such matters.

Where noise level exceedances cannot be avoided, then consideration may be given to implementing time restrictions and/or providing periods of repose for residents, where feasible and reasonable. That is, daily periods of respite from noisy activities may also be scheduled for building occupants during construction hours.

Some items of plant may exceed noise limits even after noise treatment is applied. To reduce the overall noise impact, the use of noisy plant may be restricted to within certain time periods, where feasible and reasonable and to be negotiated with Council and the residents. Allowing the construction activities to proceed, despite the noise exceedance may be the preferred method in order to complete the works expeditiously.

5 Operational Noise Assessment

5.1 Operational Noise Criteria

Noise impact from the general operation of the proposed solar farm is assessed against the NSW 'Noise Policy for Industry' (NPfI, 2017). The assessment procedure in terms of the NPfI has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for residences and other land uses.

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

5.1.1 Intrusive Noise Impacts

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15minute}$ Intrusiveness noise level = Rating Background Level (RBL) plus 5dB(A)

Based on the RBLs set in Table 3.2, the intrusiveness noise levels for the residential receivers are determined in Table 5.1.

Table 5.1 – NPfI Intrusive Noise Levels at Residential Receivers, dB(A)

Period	Rating Background Level	Intrusiveness Noise Level, $L_{Aeq,15min}$
Daytime	35	35+5 = **40**
Evening	33	33+5 = **38**
Night-time	31	31+5 = **36**

5.1.2 Protecting Noise Amenity

The project amenity noise levels for different time periods of a day are determined in accordance with Section 2.4 of the NSW NPfI. The NPfI recommends amenity noise levels ($L_{Aeq, period}$) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These "recommended amenity noise levels" represent the objective for **total** industrial noise experienced at a receiver location. However, when assessing a **single** industrial development and its impact on an area, "project amenity noise levels" apply.

To ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$$L_{Aeq,period}\ \textbf{Project amenity noise level} = L_{Aeq,period}\ \textbf{Recommended amenity noise level} - \textbf{5dB(A)}$$

Furthermore, given that the intrusiveness noise level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15min}$ level in order to standardise the time periods.

$$L_{Aeq,15min} = L_{Aeq,period} + 3\text{dB(A)}$$

The policy, in accordance with the NPfI, applies an adjustment of (+3 dB) to the recommended noise levels ($L_{Aeq,\ period}$) in order to standardise the time periods for the intrusiveness and amenity noise levels. The project amenity noise levels ($L_{Aeq,\ 15min}$) applied for this project are reproduced in Table 5.2.

It is noted that the residential receivers in the vicinity of the site have been categorised as being in a 'rural' area in accordance with Table 2.3 of the NPfI.

Table 5.2 – NPfI Project Amenity Noise Levels, dB(A)

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Noise Level	
			$L_{Aeq,\ Period}$	$L_{Aeq,\ 15min}$
Residence	Rural	Day	50 – 5 = 45	45 + 3 = **48**
		Evening	45 – 5 = 40	40 + 3 = **43**
		Night	40 – 5 = 35	35 + 3 = **38**

Notes: 1. Monday to Saturday – Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
2. On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am

5.2 Summary of Project Noise Trigger Levels

In accordance with the NPfI the project noise trigger level, which is the lower (ie. more stringent) value of the project intrusiveness noise level and project amenity noise level, has been determined and reproduced in Table 5.3 below.

Table 5.3 – Project Noise Trigger Levels, dB(A)

Receiver Location	$L_{Aeq,\ 15min}$ Project Noise Trigger Levels		
	Day	Evening	Night
Receiver R01 - 649 Ronfeldt Road, Yanco	40	38	36
Receiver R02 - 405 Research Road, Yanco	40	38	36
Receiver R03 - 410 Yate Road, Leeton	40	38	36
Receiver R04 - 328 Toorak Road, Leeton	40	38	36

Receiver Location	$L_{Aeq, 15min}$ Project Noise Trigger Levels		
	Day	Evening	Night
Receiver R05 - 284 Toorak Road, Leeton	40	38	36
Receiver R06 - 22 McMaster Road, Leeton	40	38	36
Receiver R07 - 191 Toorak Road, Leeton	40	38	36
Receiver R08 - 165 Toorak Road, Leeton (West)	40	38	36
Receiver R09 - 165 Toorak Road, Leeton (East)	40	38	36
Receiver R10 - 32 Back Yanco Road, Leeton	40	38	36
Receiver R11 - 30 Back Yanco Road, Leeton	40	38	36
Receiver R12 - 50 Maxwell Road, Leeton (West)	40	38	36
Receiver R13 - 50 Maxwell Road, Leeton (East)	40	38	36
Receiver R14 - 55 Maxwell Road, Leeton	40	38	36
Receiver R15 - 40 Gladman Road, Leeton	40	38	36
Receiver R16 - 49 Gladman Road, Leeton	40	38	36
Receiver R17 - 80 Dempsey Road, Leeton	40	38	36
Receiver R18 - 186 Research Road, Leeton	40	38	36
Receiver R19 - 215 Research Road, Yanco	40	38	36
Receiver R20 - 235 Research Road, Yanco	40	38	36
Receiver R21 - 13 Tecoma Street, Leeton	40	38	36
Receiver R22 - 120 Houghton Road, Yanco	40	38	36
Receiver R23 - 26 Euroley Road, Yanco	40	38	36

Notes: 1. Monday to Saturday – Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
2. On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am

5.3 Operational Noise Sources

The proposed solar farm will operate solar panels installed on single-axis trackers that are driven by motors that track the arc of the sun to maximise the solar effect. Hence, the tracking motors are a potential source of mechanical noise and therefore, has been included for a more conservative assessment. Up to a total of 4,300 tracking motors (NexTracker or equivalent) will be employed to drive the solar panels and are to be evenly distributed across the PV footprint area depicted in Figure 1. The tracking motors would turn no more than five (5) degrees every 15 minutes and would operate no more than one (1) minute out of every 15 minute period.

In addition to the trackers, the site will require the operation of up to 17 containerised inverter / transformer units (SMA MV PS 5500SC or equivalent) and 18 containerised Energy Storage Systems (ESS) with associated converters which are distributed across the PV footprint. The ESS will also utilise air conditioning units to maintain stable temperatures for the batteries, which have also been identified as a potential noise source. Furthermore, the solar farm will also incorporate a synchronous condenser at the south-eastern corner of the site.

During operations, it is assumed that three (3) staff members will attend site daily during the day time period to inspect the equipment and will travel around the site using light vehicles.

Based on the above, the following table lists associated plant and equipment likely to be used for the operation of the proposed solar farm and their corresponding sound power levels.

Table 5.4 – Typical Operational Plant and Equipment & Sound Power Levels

Plant Item	Plant Description	L_{Aeq} Sound Power Levels, dB(A) re. 1pW
1	Tracker Motor (up to 4,300 in total; model NexTracker or equivalent)	50 (each)
2	Inverter / Transformer[1] (17 in total; model SMA MVPS 5500SC)	88 (each)
3	Energy Storage Facility Converter (18 in total; model Freemaq DC/DC TD0500)	74 (each)
4	Energy Storage Facility Air Conditioning Units (18 in total)	75 (each)
5	Synchronous Condenser (1 in total)	93 (each)
6	Light vehicle (3 in total)	103 (each)

Notes: 1. Sound power level based on similar solar plant inverters (Ingeteam 1640TL B630 Inverter)

The sound power levels for the plant and equipment presented in the above table are provided by the client, manufacturer, information from past projects and/or information held in our library files.

5.4 'Modifying Factor' Adjustments

Further to the above and in accordance with the NPfI, where the character of the noise in question is assessed as particularly annoying (ie. if it has an inherently tonal, low frequency, impulsive or intermittent characteristic), then an adjustment of 5dB(A) for each annoyance aspect, up to a total of 10dB(A), is to be added to the predicted value to penalise the noise for its potential increase in annoyance.

Table C1 in Fact Sheet C of the NSW NPfI provides definitive procedures for determining whether a penalty or adjustment should be applied from increased annoyance. For the assessment of the solar farm, the noise from the condenser, inverters and transformers (storage and substation) are considered to be tonal in nature. Therefore, a 5dB(A) penalty has been applied individually to the predicted noise contributions from the condenser, inverters and transformers.

5.5 Operational Noise Assessment

Noise emissions were predicted by modelling the noise sources, receiver locations, topographical features of the intervening area, and possible noise control treatments using CadnaA (version 2018) noise modelling computer program. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

The noise prediction models takes into account:

- Location of noise sources and receiver locations;
- Height of sources and receivers;
- Separation distances between sources and receivers;
- Ground type between sources and receivers (soft); and
- Attenuation from barriers (natural and purpose built).

Furthermore, in accordance with the NPfI noise predictions were prepared for each of the following meteorological conditions:

1. **Calm & isothermal conditions (acoustically neutral)** – no wind and no temperature inversion
2. **Slight to gentle breeze** – 3m/s wind velocity at 10m from ground level between each noise source and each noise receiver (as per NPfI default wind conditions). Wind direction was based on wind travelling from the source to the receiver.
3. **Moderate temperature inversion** – applicable for noise predictions during night time periods only

Table 5.5 below present the predicted noise levels for the worst case scenario based on concurrent operation of all the plant and equipment shown in Table 5.4. The tracker motors were time corrected based on their operation of one (1) minute out of a 15 minute period.

Table 5.5 – Predicted $L_{Aeq,15min}$ Operational Noise Levels at Residential Receiver Locations, dB(A)

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels, $L_{Aeq, 15min}$			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion[1]	
Receiver R1	*40*	*38*	*36*	25	30	30	Yes
Receiver R2	*40*	*38*	*36*	26	30	30	Yes
Receiver R3	*40*	*38*	*36*	25	29	29	Yes
Receiver R4	*40*	*38*	*36*	30	33	34	Yes
Receiver R5	*40*	*38*	*36*	29	33	33	Yes
Receiver R6	*40*	*38*	*36*	24	29	29	Yes
Receiver R7	*40*	*38*	*36*	24	29	29	Yes
Receiver R8	*40*	*38*	*36*	22	27	27	Yes
Receiver R9	*40*	*38*	*36*	22	27	27	Yes
Receiver R10	*40*	*38*	*36*	25	29	29	Yes
Receiver R11	*40*	*38*	*36*	22	27	27	Yes
Receiver R12	*40*	*38*	*36*	24	29	29	Yes
Receiver R13	*40*	*38*	*36*	24	29	29	Yes
Receiver R14	*40*	*38*	*36*	24	29	29	Yes
Receiver R15	*40*	*38*	*36*	24	29	29	Yes

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels, $L_{Aeq, 15min}$			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion[1]	
Receiver R16	*40*	*38*	*36*	23	29	29	Yes
Receiver R17	*40*	*38*	*36*	21	26	26	Yes
Receiver R18	*40*	*38*	*36*	23	28	28	Yes
Receiver R19	*40*	*38*	*36*	26	31	31	Yes
Receiver R20	*40*	*38*	*36*	29	33	33	Yes
Receiver R21	*40*	*38*	*36*	24	29	29	Yes
Receiver R22	*40*	*38*	*36*	<20	24	24	Yes
Receiver R23	*40*	*38*	*36*	<20	20	20	Yes

Notes: 1. Applicable for the night time period only

Based on the predicted operational noise levels presented in the table above, predicted noise levels at the nearest receivers comply with the nominated criteria under all meteorological conditions.

Therefore, no further reasonable and feasible noise mitigation measures are required to reduce operational noise impacts.

5.6 Sleep Disturbance Assessment

To assess the likelihood of sleep disturbance, the potential of maximum noise level events from operation of the solar farm during the night time period has been considered in this assessment. In accordance with the NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is the greater, and/or
- L_{AFmax} 52dB(A) or the prevailing RBL plus 15dB, whichever is the greater.

Where there are noise events found to exceed the initial screening level, further analysis is undertaken to identify:

- The likely number of events that might occur during the night assessment period,
- The extent to which the maximum noise level exceeds the rating background noise level.

During the night time period (before 7am during summer months) only mechanical plant will be operating, including the tracking motors, inverters, air conditioning units for the EES and transformers. Noise emissions from these plant items are considered to be continuous with no potential for high peak noise level events. Therefore, the L_{Amax} noise levels experienced at the identified receivers will be similar to the predicted $L_{Aeq,15min}$ noise levels shown in Table 5.5. Hence, it is expected that both the $L_{Aeq,15min}$ and L_{AFmax} will be well below the nominated sleep disturbance criteria of 40dB(A) and 52dB(A), respectively.

6 Vibration Assessment

Vibration generating activities would occur only during the construction phase of the project. There are no vibration generating activities expected during the operational phase. As the nearest identified receivers unrelated to the project are in excess of 30m from the proposed construction activities, structural damage due to vibration is not expected. Assessment for vibration impact on human comfort is assessed in accordance with EPA requirements.

6.1 Vibration Criteria

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the EPA's *'Assessing Vibration; a technical guideline'* (DECC, 2006). The guideline provides criteria which are based on British Standard BS 6472-1992 *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 6.1 provides definitions and examples of each type of vibration.

Table 6.1 – Types of Vibration

Type of Vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

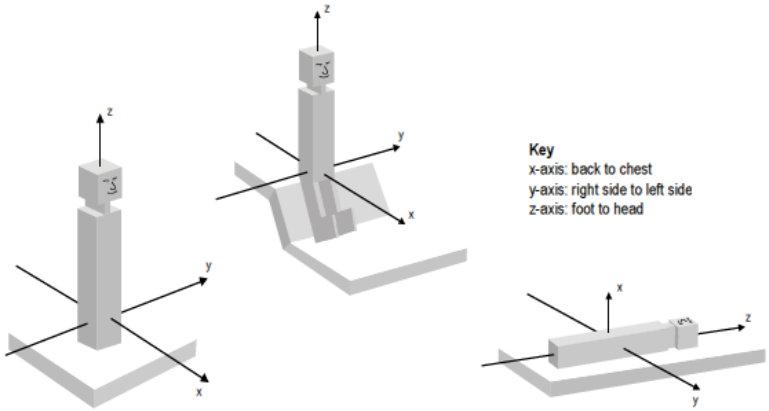
The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *"Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472)."*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore,

application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 2. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 2 – Orthogonal Axes for Human Exposure to Vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 6.2 for the applicable receiver type.

Table 6.2 – Preferred and Maximum Levels for Human Comfort

Location	Assessment Period[1]	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

Notes: 1. Daytime is 7:00am to 10:00pm and Night-time is 10:00pm to 7:00am

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 6.3 for the applicable receiver type.

Table 6.3 – Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26

Notes: 1. Daytime is 7:00am to 10:00pm and Night-time is 10:00pm to 7:00am

6.2 Potential Vibration Impacts

Based on the proposed plant items presented in Table 4.3 and Table 4.4, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 6.4 below. The assessment is relevant to the identified receiver locations.

Table 6.4 – Potential Vibration Impacts for Identified Receivers

Receiver Location	Approx. Distance to Nearest Buildings from Works	Type of Nearest Sensitive Buildings	Assessment on Potential Vibration Impacts	Vibration Monitoring
Receiver R1	300m	Residential	Very low risk of adverse comments	Not required
Receiver R2	110m	Residential	Very Low risk of adverse comments	Not required
Receiver R3	130m	Residential	Very low risk of adverse comments	Not required
Receiver R4	110m	Residential	Very low risk of adverse comments	Not required
Receiver R5	140m	Residential	Very low risk of adverse comments	Not required
Receiver R6	250m	Residential	Very low risk of adverse comments	Not required
Receiver R7	30m	Residential	Low risk of adverse comments	Not required
Receiver R8	250m	Residential	Very low risk of adverse comments	Not required
Receiver R9	300m	Residential	Very low risk of adverse comments	Not required
Receiver R10	240m	Residential	Very low risk of adverse comments	Not required
Receiver R11	410m	Residential	Very Low risk of adverse comments	Not required
Receiver R12	390m	Residential	Very low risk of adverse comments	Not required
Receiver R13	420m	Residential	Very low risk of adverse comments	Not required
Receiver R14	420m	Residential	Very low risk of adverse comments	Not required
Receiver R15	480m	Residential	Very low risk of adverse comments	Not required
Receiver R16	560m	Residential	Very low risk of adverse comments	Not required
Receiver R17	910m	Residential	Very low risk of adverse comments	Not required
Receiver R18	760m	Residential	Very low risk of adverse comments	Not required
Receiver R19	450m	Residential	Very low risk of adverse comments	Not required

Receiver Location	Approx. Distance to Nearest Buildings from Works	Type of Nearest Sensitive Buildings	Assessment on Potential Vibration Impacts	Vibration Monitoring
Receiver R20	240m	Residential	Very low risk of adverse comments	Not required
Receiver R21	130m	Residential	Very low risk of adverse comments	Not required
Receiver R22	430m[1]	Residential	Very low risk of adverse comments	Not required
Receiver R23	550m[1]	Residential	Very low risk of adverse comments	Not required

Notes: 1. Distance to easement construction works

The potential for adverse comments to vibration impacts during the construction works was determined to be very low to low due to the large distances between the receiver locations and the construction activities. Furthermore, it was noted that at the closest receiver, Receiver R7, the approximate distance to the nearest building has been conservatively determined from the boundary of the solar farm and it is expected that any works are expected to be undertaken at larger distances based on the PV footprint. Therefore, additional vibration mitigation measures and vibration monitoring are not required at the identified receiver locations during construction works associated with the Project.

7 Road Traffic Noise Assessment

Noise impact from the potential increase in traffic on the surrounding road network due to construction and operational activities is assessed against the NSW 'Road Noise Policy' (RNP). The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessing noise impact and determining mitigation measures for sensitive receivers that are potentially affected by road traffic noise associated with the construction and operation of the subject site, with the aim of preserving the amenity appropriate to the land use.

Vehicle access to the subject site will be via three access points on Toorak Road and one access point on Research Road. Vehicles will access Toorak Road from the north via Canal Street (see Figure 3). Based on the traffic numbers provided by the client, the peak vehicle movements during the construction stage of the project are presented in the following table. Furthermore, vehicle movements will only occur during the day time period when construction works occur.

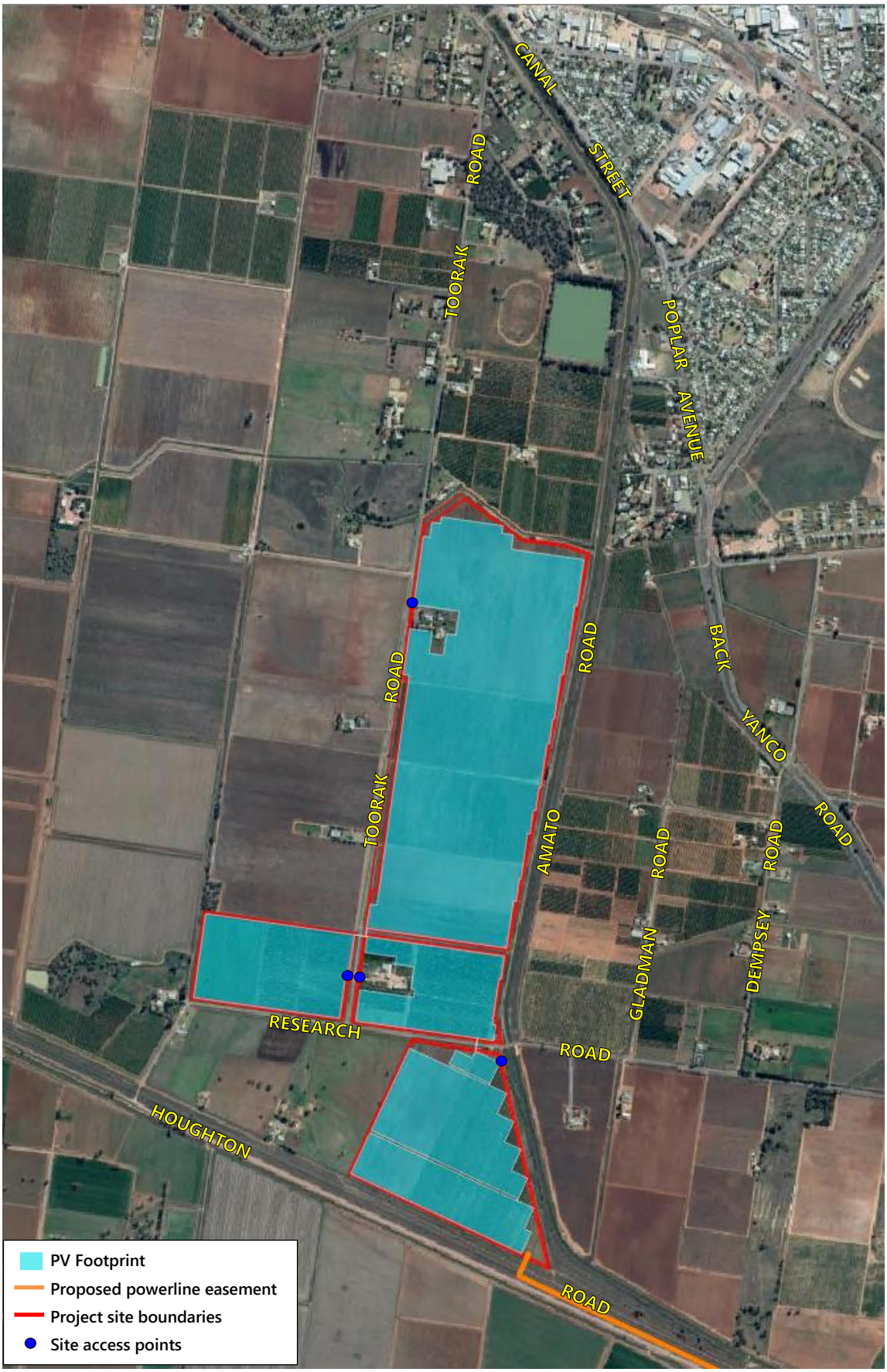
Table 7.1 – Summary of the Estimated Construction Traffic Volumes During Peak Construction

Vehicle Type	Movements Per Day (Peak)	Average Hourly Movements[1]
Cars/ light vehicles	20 (10 in / 10 out)	2
Trucks/ heavy vehicles	72 (36 in / 36 out)	7

Notes: 1. Average hourly movements based on movements per day / 11 (representing construction hours from 7am to 6pm)

During the operational stage, vehicle access to the site will be maintenance vans and delivery trucks (3 x site staff light vehicle and 5 x miscellaneous courier deliveries per week) which would occur on an irregular basis. Therefore, traffic noise impacts during the operational stage of the project would be minimal and insignificant and will not be assessed further.

Figure 3 – Site, Surrounding Roads and Site Access Points



7.1 Road Traffic Noise Criteria

Based on functionality, Toorak Road and Research Road are categorised as a local roads. For existing residences affected by additional traffic on existing local roads generated by land use developments, the following RNP road traffic noise criteria apply.

Table 7.2 – RNP Road Traffic Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria	
		Day 7am – 10pm	Night 10pm – 7am
Local road	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,(1\ hour)}$ 55 (external)	$L_{Aeq,(1\ hour)}$ 50 (external)

7.2 Predicted Road Traffic Noise

Results of the road traffic noise predictions are presented in the table below. It is noted that the predicted noise levels represent the traffic noise contribution from the vehicle movements associated with the construction works and does not take into account existing traffic noise levels as existing traffic volumes along Toorak Road and Research Road are unknown.

Table 7.3 – Predicted Road Traffic Noise Contribution Levels Along Public Roads, dB(A) $L_{Aeq(1\ Hour)}$

Receiver	Criteria	Traffic Movements	Speed (km/h)	Approx. Distance to Road	Predicted Noise Level	Comply?
Nearest receivers	$L_{Aeq,\ (1\ hour)}$ 55	As per Table 7.1	60	13m[1]	54	Yes

Notes: 1. Assumed distance to closest receiver to Toorak Road.

From the above table, traffic noise levels from the additional traffic during the construction stage of the Project is predicted to comply with the applicable noise criterion at the nearest affected receivers along Toorak Road and Research Road.

As the construction traffic noise levels are temporary and comply with the RNP criteria set above, it indicates that the traffic noise levels due to the construction works for the solar farm would not adversely affect the existing residences along Toorak Road and Research Road.

8 Conclusion

Renzo Tonin and Associates has completed an environmental noise and vibration assessment for the proposed Yanco Solar Farm.

Noise emissions from the construction phase of the project were predicted to generally comply with the construction noise management levels at the nearest affected receivers; however, some exceedances were predicted for Receivers R1 to R10 and R20 to R21 during the construction of the solar farm while construction works are undertaken in close proximity to the receiver. In-principle recommendations were provided in Section 4.4 to limit the potential impact of noise generated during construction works to acceptable levels.

Noise emissions from the operational phase of the solar farm were predicted to comply with the nominated criteria at the nearest affected receivers.

Given the large separation distance between the nearest affected receivers and the subject site, vibration impacts resulting in structural damage to buildings at the nearest affected receivers were determined to be negligible and there would be low risks of adverse comments from occupants of dwellings due to construction vibration.

Road traffic noise impacts on residential properties along the access route were found to comply with the relevant RNP criteria.

APPENDIX A Glossary of Terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 110dB Operating a chainsaw or jackhammer 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Long-Term Noise Monitoring Methodology

B.1 Noise Monitoring Equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave Band Data	Logger Location(s)
RTA04 (CESVA SC310)	Type 1	1/1	L1

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

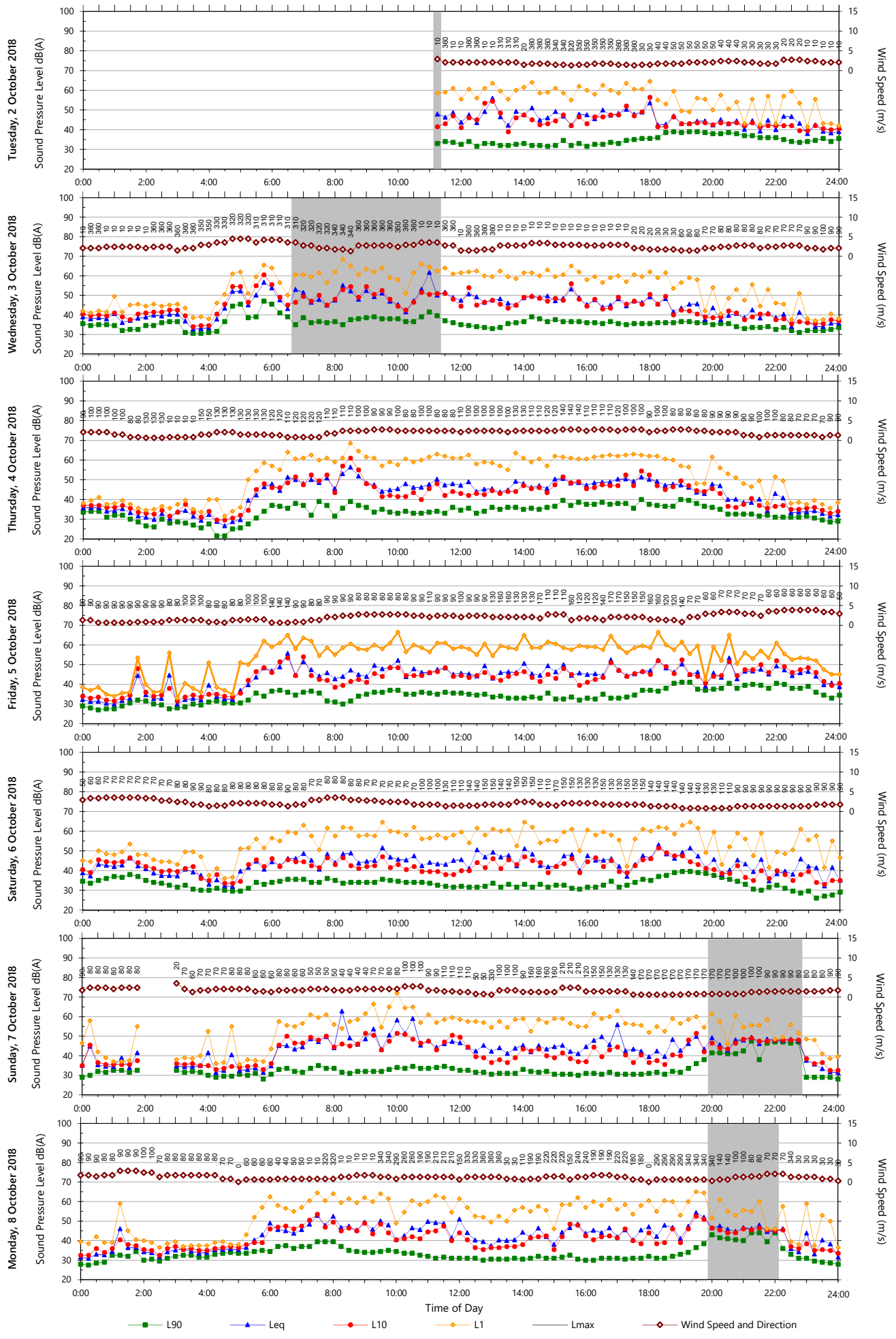
B.2 Meteorology During Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW NPfI. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs Time Graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Long Term Noise Monitoring Results



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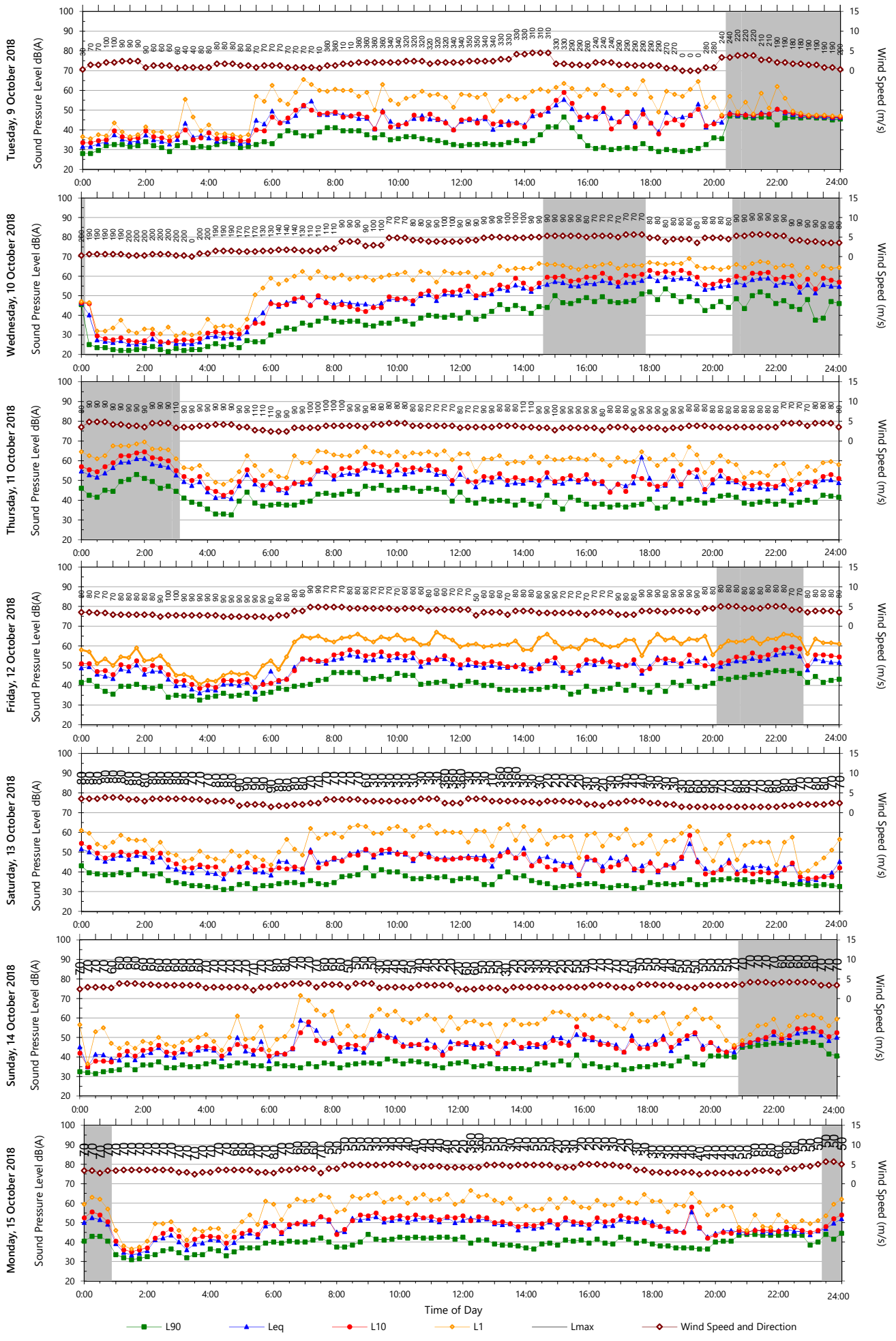

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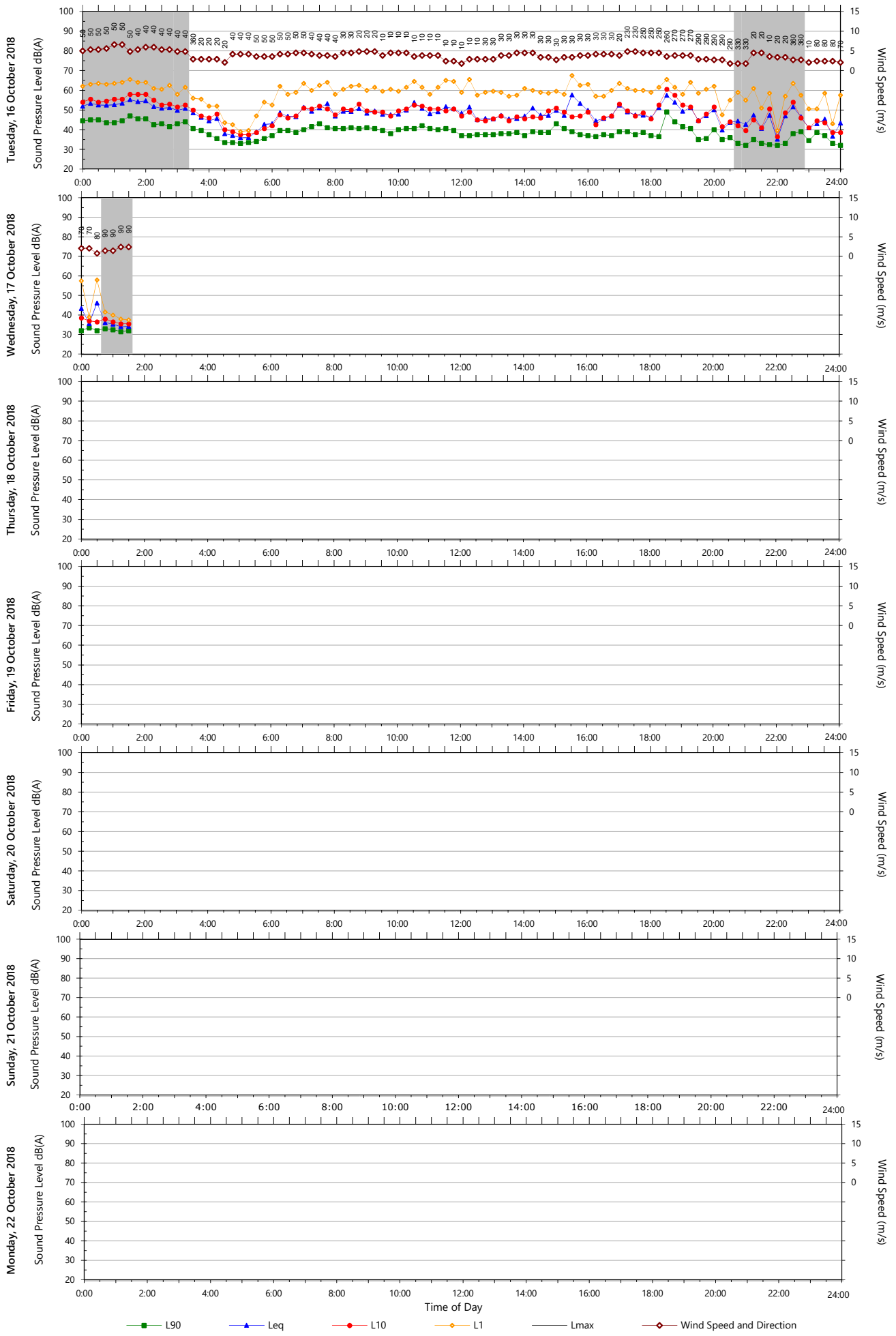

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