Appendix J Updated Noise Assessment

RENZO TONIN & ASSOCIATES
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Acoustics
Vibration
Structural Dynamics

OXLEY SOLAR FARM

Construction & Operational Noise & Vibration Assessment

10 June 2022

NGH

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1 Introduction

Renzo Tonin & Associates was engaged to conduct an environmental noise and vibration assessment of the proposed Oxley Solar Farm, located approximately 14 km south-east of Armidale in New South Wales (NSW), as part of the Environmental Impact Statement (EIS) for the project. Noise and vibration impacts from the construction and operation phases of the project will be 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 Oxley Solar Farm project includes the construction and operation of a solar photovoltaic (PV) plant and associated infrastructure, with a capacity of approximately 215 MW. The subject site is located north and south of Gara Road, just west of the intersection with Silverton Road, approximately 14 km south-east of Armidale in NSW, within the Armidale Regional Council Local Government Area (LGA). Silverton Road runs south from Waterfall Way which connects Armidale to the coast.

In response to the public and agency submissions, the Oxley Solar Farm has made significant changes to the proposal. The primary changes are:

1. A reduced development footprint in response to public submissions and the site's constraints. This includes:
   a. A more refined development footprint based on further civil design, to provide greater certainty regarding the extent of the final infrastructure layout. This includes 'constructability' buffers, to ensure the areas presented are inclusive of all environmental controls and activities required to construct and operation the project.
   b. No infrastructure is now proposed in the moderate constraint native vegetation between Gara Road and Gara River or the area immediately south of Gara River, on the site's south west. Increased setbacks from Gara River on the site's north-eastern boundary. This reduces the impacts on native vegetation and the potential to impact Gara River, an issue raised in several community submissions.
   c. No solar panels would be installed in areas of Box Gum Woodland with a vegetation integrity score of 30 or more. This vegetation is a Serious and Irreversible Impact candidate and only impacts that cannot be avoided (limited fencing and access alignments) are now proposed within this vegetation.
   d. No infrastructure now proposed in land immediately adjoining the Oxley Wild Rivers National Park. This was undertaken to address community concerns in relation to protecting the values of the park. The closest infrastructure would now be approximately 300 m distant, in the site's south-eastern corner.

1. Access and road upgrades:
   a. While only one main site entry location would be developed, two options are now presented and assessed to address uncertainties in relation to land tenure for Option 1. Both options have been informed by further civil design to provide greater certainty regarding the location of the final route. Both options are supported by the roads' authority.
      i. Option 1, slightly west of the access presented in the EIS; A new access point and intersection established, running directly south from Waterfall Way (Grafton Road).

ii. Option 2, turning off Waterfall Way (Grafton Road) about 750 m west of Option 1, via the exiting Council landfill access road, and running east to join the project site via a new access track.

b. Causeway upgrades across Gara River. This will improve access during flooding events for the project, neighbours of the project and local traffic.

c. It is noted that the access presented in the EIS is not considered viable anymore, due to further safety investigations. Both Option1 and Option 2 are equally likely and will be assessed.

Key development and infrastructure components would include:

- Approximately 385,280 PV solar panels mounted on either fixed or tracking systems, both of which are considered feasible:
  - Fixed-tilted structures in a north orientation; or
  - East-west horizontal tracking systems.
- Approximately 43 Power Conversion Units (PCU) composed of two inverters, a transformer and associated control equipment to convert DC energy generated by the solar panels to 33kV AC energy.
- An onsite 132kV substation containing up to two transformers and associated switchgear to facilitate connection to the national electricity grid via the existing 132kV transmission lines onsite.
- Steel mounting frames with driven or screwed pile foundations.
- Underground power cabling to connect solar panels, combiner boxes and PCUs.
- Underground auxiliary cabling for power supplies, data services and communications.
- Buildings to accommodate a site office, indoor 33kV switchgear, protection and control facilities, maintenance facilities and staff amenities.
- Internal access tracks for construction and maintenance activities.
- An energy storage facility with a capacity of up to 50MWh (i.e., 50 MW power output for one hour) and comprising of lithium-ion batteries with inverters.
- Perimeter security fencing about 2.3m high.
- Native vegetation planting to provide visual screening onsite and for specific receivers.

During the construction phase, temporary ancillary facilities would be established on the site and may include:

- Laydown areas

- Construction site offices and amenities
- Car and bus parking areas for construction staff.

2.2 Regulatory Requirements

Noise and vibration impacts are assessed in accordance with a number of 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)
- NSW 'Road Noise Policy' (RNP – DECCW, 2011).

2.3 Receiver Locations

The nearest affected receivers were identified through aerial maps and are presented in Table 2.1.

Table 2.1 – Receiver Locations

ID	Address	Description
R3	686 Gara Road, Metz	Residential property located approximately 760 m west of both Option 1 and Option 2 development areas
R4	111 Blue Hole Road, Castle Doyle	Residential property located approximately 1,135 m southwest of both Option 1 and Option 2 development areas
R5	445 Silverton Road Metz	Residential property located approximately 650 m east of both Option 1 and Option 2 development areas
R6	8 Argyle-Mining Vale Road, Metz	Residential property located approximately 725 m north-west of the Option 1 access road and approximately 260 m north of the Option 2 access road
R7	109 Blue Hole Road, Castle Doyle	Residential property located approximately 1,390 m southwest of both Option 1 and Option 2 development areas
R8	52 Argyle-Mining Vale Road, Metz	Residential property located approximately 685 m north-west of the Option 1 access road and approximately 360 m north of the Option 2 access road
R9	1392 Grafton Road, Metz	Residential property located approximately 1,000 m east of both Option 1 and Option 2 development areas
R10	597 Gara Road, Metz	Residential property located approximately 800 m west of both Option 1 and Option 2 development areas
R11	692 Silverton Road, Metz	Residential property located approximately 720 m east of both Option 1 and Option 2 development areas
R13	761-765 Silverton Road, Metz	Residential property located approximately 780 m west of both Option 1 and Option 2 development areas
R17	1060 Grafton Road, Metz	Residential property located approximately 2,000 m west of the Option 1 access road and approximately1,435 m west of the Option 2 access road

ID	Address	Description
R22	771 Silverton Road, Metz	Residential property located approximately 1,500m south of both Option 1 and Option 2 development areas
R26	1474 Castledoyle Road, Castle Doyle	Residential property located approximately 2,700m south of both Option 1 and Option 2 development areas

Figure 1 and Figure 2 provides details of the site options, surrounds and receiver locations.

2.4 Hours of Operation

2.4.1 Construction

The construction phase of the proposal would take about 12 – 18 months. The peak construction period would be a shorter period of about 6 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 up to five (5) staff on site during the following standard hours:

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

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

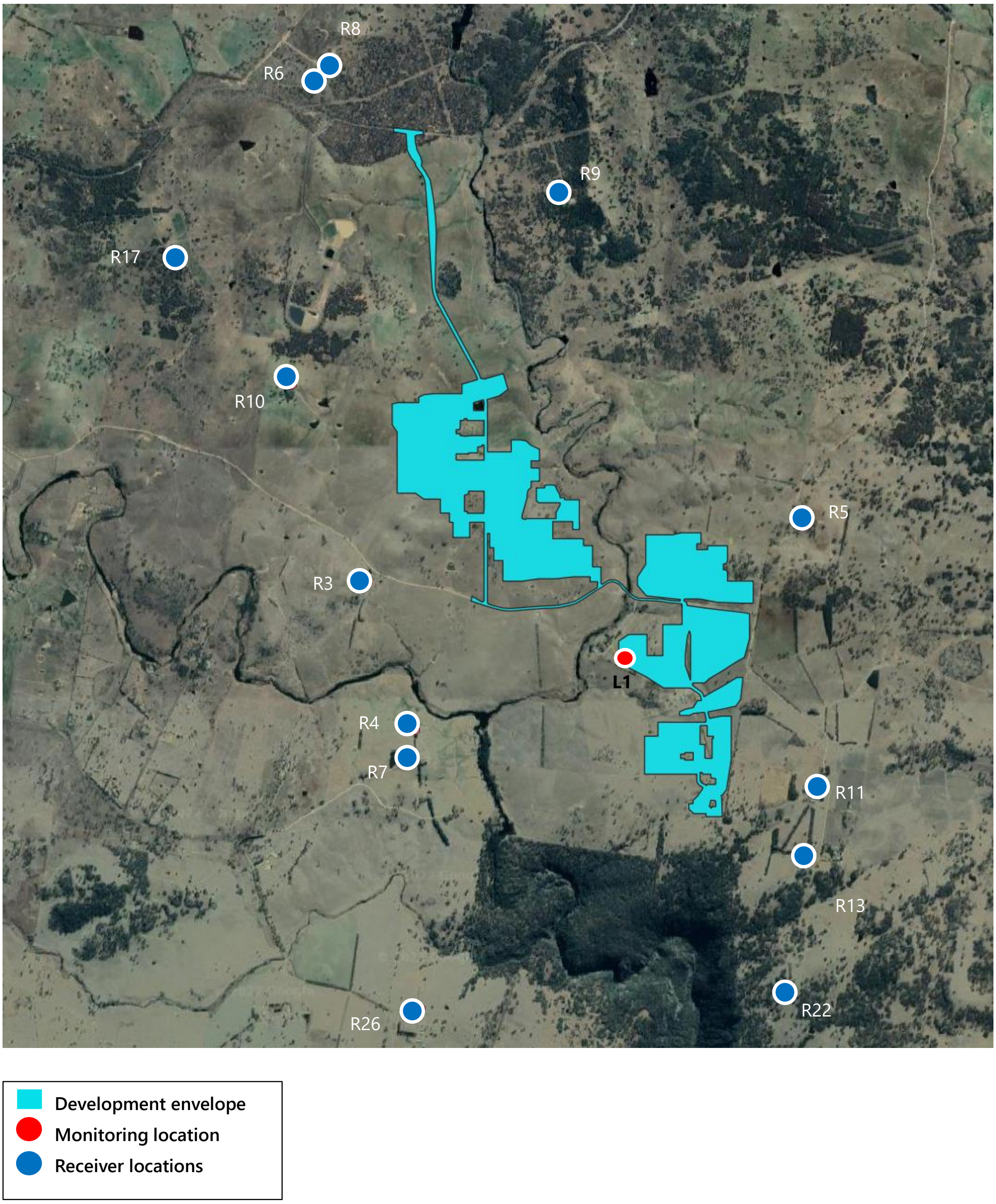
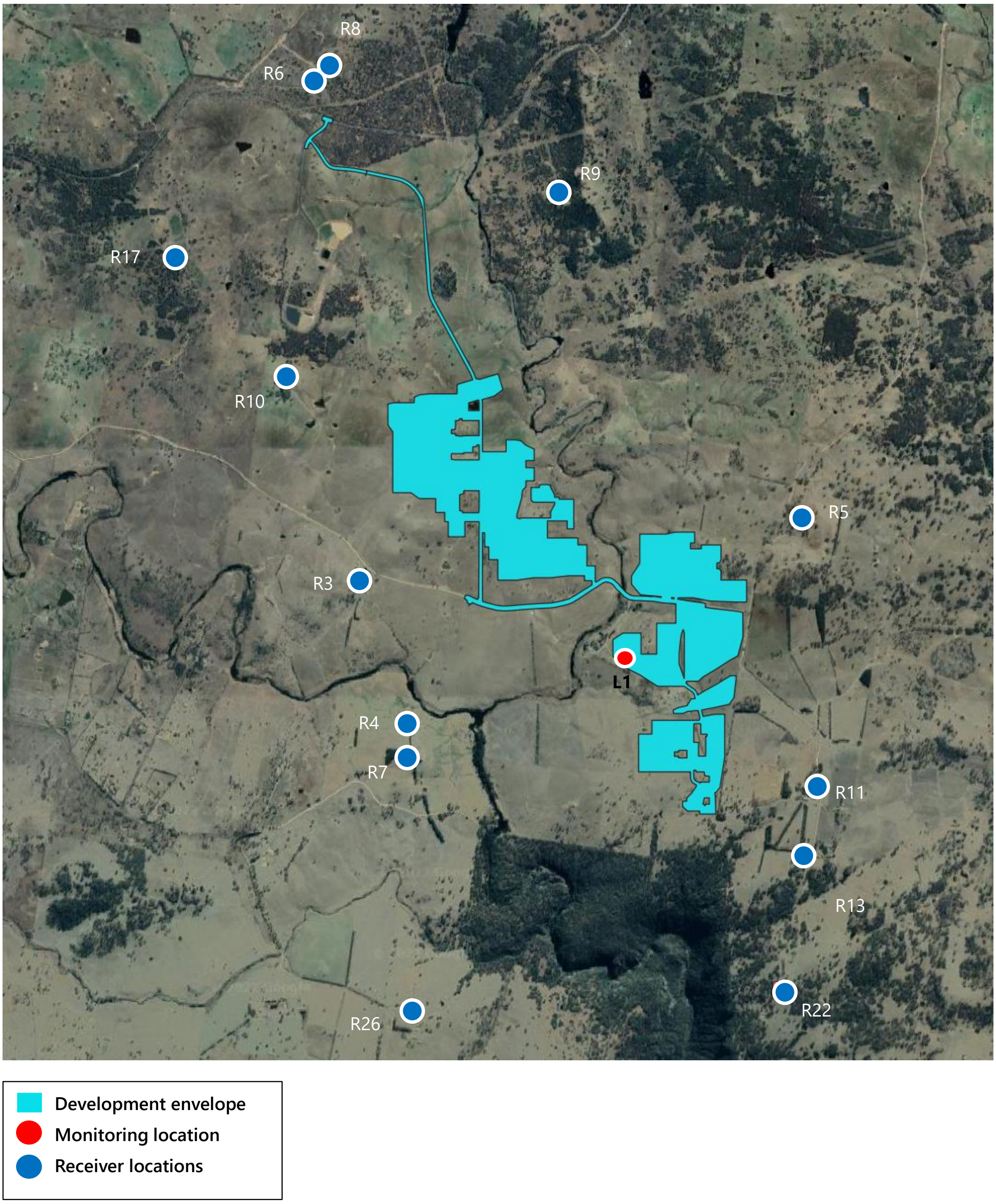


Figure 2 – Option 2 Site Layout, Surrounds and Receiver and Noise Monitoring Locations



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 NPfI requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The 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 Location

Noise monitoring is to be undertaken at the nearest or potentially most affected receiver locations; or if this is not available, then at a location considered to have a noise environment representative of the nearest or potentially most affected receiver locations. In this case the representative location where noise monitoring was undertaken is presented in Table 3.1.

Table 3.1 – Noise Monitoring Location

ID	Address	Description
L1	914 Gara Road, Metz	Noise monitor was installed in the 'free field' (ie. away from building facades) on the subject site. Noise data represents the background and ambient noise environment for receivers surrounding the project area.

To quantify the existing ambient noise environment, long-term (unattended) noise monitoring was conducted at Location L1 between Monday 4th and Thursday 21st May 2020.

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 NPfI.

3.2 Existing Background & Ambient Noise Levels

Existing background and ambient noise levels are presented in Table 2.1 below. The noise monitor was positioned outdoors in the 'free-field' (i.e.. away from building facades). Construction and operation noise from the site should be assessed in the free-field at the potentially most affected residential boundaries and therefore, the representative noise levels listed in Table 2.1 are directly applicable.

Table 3.2 – 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 – 914 Gara Road, Metz	24	22	20	45	32	38

The identified receivers surrounding the subject site are all classified as rural under NPfI guidelines. It was found that the background noise levels were typical for a rural area.

Based on Table 2.1 on page 10 of the NPfI, where background noise levels are less than the minimum assumed RBLs of 35 dB(A) during the day period, 30 dB(A) during the evening period and 30dB(A) during the night period, the minimum assumed RBL's are adopted instead for all receiver locations nominated in Table 3.2. Therefore, the background noise levels have been set at the levels detailed in the fourth column of Table 3.3 below.

Table 3.3 – Applicable RBL, dB(A)

Time of Day	Measured Existing Background (L_{90}), dB(A)	Minimum RBLs, dB(A)[1]	Applicable RBL, dB(A)
Day	24	35	**35**
Evening	22	30	**30**
Night	20	30	**30**

Notes: 1. In accordance with Table 2.1 of the NSW NPfI

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.

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 (NML) at Residential Receivers, dB(A)

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(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 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: • 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 + 5 dB(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 2.1, the proposed construction hours and the above ICNG requirements. Given that construction works are to occur during the daytime period as presented in Section 2.4.1, only the daytime period will be assessed.

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

Location Description	Day L_{A90} Background Noise Level (RBL)	Day Noise Management Level $L_{Aeq,15\ min}$
All residential receivers	35[1]	**45**

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

4.2 Construction Noise Sources

The following tables lists typical plant and equipment likely to be used by the contractor to carry out the necessary construction works for the project.

Table 4.3 – Typical Construction Equipment & Sound Power Levels

Plant Item	Plant Description	Number of Items	L_{Aeq} Sound Power Levels, dB(A) re. 1pW (single item)
1	Small pile driving rig[1]	6	114
2	Crane[1]	2	110
3	Drum roller	2	109
4	Padfoot roller	2	109
5	Wheeled loader	2	109
6	Dump truck	4	108
7	30t Excavator	8	107
8	Grader	4	107
9	Chain trencher	2	104
10	Water truck	4	104
11	Telehandler	4	98
12	Forklift	4	90

Notes: 1. Only used for construction of solar farm and not for construction of access roads

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 the CadnaA (version 2021 MR 1) 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 4.4 and Table 4.5 present the construction noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant and equipment associated with the proposed development site Option 1 and Option 2, respectively. The noise level ranges represent the noise source being located at the furthest to the closest proximity to each receiver location.

Table 4.4 – Option 1 – Predicted $L_{Aeq,15\ min}$ Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq,15\ min}$ Construction Noise Levels												
		R3	R4	R5	R6	R7	R8	R9	R10	R11	R13	R17	R22	R26
Noise Management Level[1]		*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Small pile driving rig[1]	<20-35	<20-30	<20-37	<20	<20-28	<20	<20-27	<20-34	<20-27	<20-35	<20-22	<20-27	<20
2	Crane[1]	<20-31	<20-26	<20-33	<20	<20-24	<20	<20-23	<20-30	<20-23	<20-31	<20	<20-23	<20
3	Drum roller	<20-30	<20-25	<20-32	<20-30	<20-23	<20-31	<20-26	<20-29	<20-22	<20-30	<20	<20-22	<20
4	Padfoot roller	<20-30	<20-25	<20-32	<20-30	<20-23	<20-31	<20-26	<20-29	<20-22	<20-30	<20	<20-22	<20
5	Wheeled loader	<20-30	<20-25	<20-32	<20-30	<20-23	<20-31	<20-26	<20-29	<20-22	<20-30	<20	<20-22	<20
6	Dump truck	<20-29	<20-24	<20-31	<20-29	<20-22	<20-30	<20-25	<20-28	<20-21	<20-29	<20	<20-21	<20
7	30t Excavator	<20-28	<20-23	<20-30	<20-28	<20-21	<20-29	<20-24	<20-27	<20-20	<20-28	<20	<20-20	<20
8	Grader	<20-28	<20-23	<20-30	<20-28	<20-21	<20-29	<20-24	<20-27	<20-20	<20-28	<20	<20-20	<20
9	Chain trencher	<20-25	<20-20	<20-27	<20-25	<20-18	<20-26	<20-21	<20-24	<20	<20-25	<20	<20	<20
10	Water truck	<20-25	<20-20	<20-27	<20-25	<20-18	<20-26	<20-21	<20-24	<20	<20-25	<20	<20	<20
11	Telehandler	<20	<20	<20-21	<20	<20	<20-20	<20	<20	<20	<20	<20	<20	<20
12	Forklift	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Up to 3 (noisiest) plant operating concurrently		<20-37	<20-33	<20-40	<20-35	<20-31	<20-36	<20-31	<20-36	<20-29	<20-37	<20-25	<20-29	<20-21

Notes: 1. Only used for construction of solar farm and not for construction of access roads

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

Based on the predicted construction noise levels for Option 1 presented in the table above, the predicted construction noise levels at all receivers will comply with the construction noise management level.

Furthermore, construction noise levels at all receivers are predicted to be below the highly noise affected level of 75 dB(A).

Therefore, no further reasonable and feasible noise mitigation measures are required to reduction construction noise impacts for Option 1.

Table 4.5 – Option 2 – Predicted $L_{Aeq,15\ min}$ Construction Noise Levels at Receiver Locations, dB(A)

Plant Item	Plant Description	Predicted $L_{eq,15\ min}$ Construction Noise Levels												
		R3	R4	R5	R6	R7	R8	R9	R10	R11	R13	R17	R22	R26
Noise Management Level[1]		*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*	*45*
1	Small pile driving rig[1]	<20-35	<20-31	<20-37	<20	<20-29	<20	<20-27	<20-34	<20-27	<20-35	<20-22	<20-27	<20
2	Crane[1]	<20-31	<20-27	<20-33	<20	<20-25	<20	<20-23	<20-30	<20-23	<20-31	<20	<20-23	<20
3	Drum roller	<20-30	<20-26	<20-32	<20-40	<20-24	<20-37	<20-26	<20-29	<20-22	<20-30	<20-23	<20-22	<20
4	Padfoot roller	<20-30	<20-26	<20-32	<20-40	<20-24	<20-37	<20-26	<20-29	<20-22	<20-30	<20-23	<20-22	<20
5	Wheeled loader	<20-30	<20-26	<20-32	<20-40	<20-24	<20-37	<20-26	<20-29	<20-22	<20-30	<20-23	<20-22	<20
6	Dump truck	<20-29	<20-25	<20-31	<20-39	<20-23	<20-36	<20-25	<20-28	<20-21	<20-29	<20-22	<20-21	<20
7	30t Excavator	<20-28	<20-24	<20-30	<20-38	<20-22	<20-35	<20-24	<20-27	<20-20	<20-28	<20-21	<20-20	<20
8	Grader	<20-28	<20-24	<20-30	<20-38	<20-22	<20-35	<20-24	<20-27	<20-20	<20-28	<20-21	<20-20	<20
9	Chain trencher	<20-25	<20-21	<20-27	<20-35	<20	<20-32	<20-21	<20-24	<20	<20-25	<20	<20	<20
10	Water truck	<20-25	<20-21	<20-27	<20-35	<20	<20-32	<20-21	<20-24	<20	<20-25	<20	<20	<20
11	Telehandler	<20	<20	<20-21	<20-29	<20	<20-26	<20	<20	<20	<20	<20	<20	<20
12	Forklift	<20	<20	<20	<20-21	<20	<20-18	<20	<20	<20	<20	<20	<20	<20
Up to 3 (noisiest) plant operating concurrently		<20-37	<20-33	<20-40	<20-45	<20-31	<20-42	<20-31	<20-36	<20-29	<20-37	<20-28	<20-29	<20-21

Notes:
1. Only used for construction of solar farm and not for construction of access roads
2. **Bold** font represents exceedance of the NML

Based on the predicted construction noise levels for Option 2 presented in the table above, the predicted construction noise levels at all receivers will comply with the construction noise management level.

Furthermore, construction noise levels at all receivers are predicted to be below the highly noise affected level of 75 dB(A).

Therefore, no further reasonable and feasible noise mitigation measures are required to reduction construction noise impacts for Option 2.

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). 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 3.3, the intrusiveness noise level for the residential receivers are determined in Table 5.1.

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

Period	RBL, dB(A)	Intrusiveness Noise Level, $L_{Aeq,15min}$, dB(A)
Daytime	35	35+5 = **40**
Evening	30	30+5 = **35**
Night-time	30	30+5 = **35**

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:

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

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 $L_{Aeq,15minute}$ level in order to standardise the time periods.

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

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	
			$L_{Aeq,period}$	$L_{Aeq,15\ min}$
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-Saturday, Day 7.00am to 6.00pm; Evening 6.00pm to 10.00pm; Night 10.00pm to 7.00am
2. On Sundays and Public Holidays, Day 8.00am to 6.00pm; Evening 6.00pm to 10.00pm; Night 10.00pm to 8.00am
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

5.1.3 Summary of Project Noise Trigger Levels

In accordance with the NPfI the project noise trigger level, which is the lower (i.e.. 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 ID	Address	$L_{Aeq,15\ min}$ Project Noise Trigger Levels		
		Day	Evening	Night
R3	686 Gara Road, Metz	40	35	35
R4	111 Blue Hole Road, Castle Doyle	40	35	35
R5	445 Silverton Road Metz	40	35	35
R6	8 Argyle-Mining Vale Road, Metz	40	35	35
R7	109 Blue Hole Road, Castle Doyle	40	35	35
R8	52 Argyle-Mining Vale Road, Metz	40	35	35
R9	1392 Grafton Road, Metz	40	35	35
R10	597 Gara Road, Metz	40	35	35
R11	692 Silverton Road, Metz	40	35	35
R13	761-765 Silverton Road, Metz	40	35	35
R17	1060 Grafton Road, Metz	40	35	35
R22	771 Silverton Road, Metz	40	35	35
R26	1474 Castledoyle Road, Castle Doyle	40	35	35

Notes:
1. Monday-Saturday, Day 7.00am to 6.00pm; Evening 6.00pm to 10.00pm; Night 10.00pm to 7.00am
2. On Sundays and Public Holidays, Day 8.00am to 6.00pm; Evening 6.00pm to 10.00pm; Night 10.00pm to 8.00am
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period

5.2 Operational Noise Sources

The proposed solar farm considers two options for the configuration of the PV panels:

1. Fixed configuration, where the panels would be placed on fixed frames running in rows from east to west and tilted to the north; or

2. Single axis tracking, where the panels would be in rows configured in a north to south direction and the panels would track the sun from east to west throughout the day.

The single axis tracking system involves the panels being driven by motors to 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 9,300 tracking units (ATI DuraTrack Tracker or equivalent) will be to be evenly distributed across the solar farm area.

In addition to the trackers, the site will require the operation of up to 45 PCUs (SMA MV Power Station or equivalent) with each PCU containing two (2) inverters and one (1) transformer, which will be evenly distributed across the solar farm area.

A new substation will also be located in on the site. The dominant noise source from the new substation will be from two (2) 100MVA transformers (generic brand). There will also be a battery storage system (generic brand) located in this area.

During operations, it is assumed that five (5) staff members will attend site daily during the day time period to inspect the equipment. It is also assumed that each staff member will travel around the subject site in a light vehicle.

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 (9,300 in total)	81 (each)[1]
2	PCU inverter (86 in total)	88 (each)[1]
3	PCU transformer (43 in total)	83 (each)[1]
4	Substation transformer (2 in total)	96 (each)[1]
5	Battery storage unit	87 (each)[1]
6	Light vehicle (5 in total)	88 (each)[1]

Notes: 1. Based on sound power level data from past projects and/or RT&A's acoustic database

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

5.3 '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 inverters and transformers are considered to be tonal in nature. Therefore, a 5dB(A) penalty has been applied to the predicted noise contributions from the inverters and transformers.

5.4 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 the CadnaA (version 2020 MR 1) 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 – 3 m/s wind velocity at 10 m 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 and Table 5.6 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) associated with the proposed development site Option 1 and Option 2, respectively.

Table 5.5 – Option 1 – Predicted $L_{Aeq,15\ min}$ Operational Noise Levels at Residential Receiver Locations, dB(A)

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion[1]	
Receiver R3	*40*	*35*	*35*	24	30	30	Yes
Receiver R4	*40*	*35*	*35*	<20	26	26	Yes
Receiver R5	*40*	*35*	*35*	23	30	29	Yes
Receiver R6	*40*	*35*	*35*	<20	<20	20	Yes
Receiver R7	*40*	*35*	*35*	<20	24	24	Yes
Receiver R8	*40*	*35*	*35*	<20	<20	20	Yes
Receiver R9	*40*	*35*	*35*	20	27	26	Yes
Receiver R10	*40*	*35*	*35*	22	29	28	Yes
Receiver R11	*40*	*35*	*35*	22	28	27	Yes
Receiver R13	*40*	*35*	*35*	<20	26	25	Yes
Receiver R17	*40*	*35*	*35*	<20	20	21	Yes
Receiver R22	*40*	*35*	*35*	<20	<20	<20	Yes
Receiver R26	*40*	*35*	*35*	<20	<20	<20	Yes

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion[1]	

Notes: 1. Applicable for the night time period only

Table 5.6 – Option 2 – Predicted $L_{Aeq,15\ min}$ Operational Noise Levels at Residential Receiver Locations, dB(A)

Receiver Location	Project Noise Trigger Levels			Predicted Operational Noise Levels			Comply? (Yes/No)
	Day	Evening	Night	Calm & Isothermal Conditions	Slight to Gentle Breeze	Moderate Temperature Inversion[1]	
Receiver R3	*40*	*35*	*35*	24	30	30	Yes
Receiver R4	*40*	*35*	*35*	<20	26	26	Yes
Receiver R5	*40*	*35*	*35*	23	30	29	Yes
Receiver R6	*40*	*35*	*35*	<20	<20	22	Yes
Receiver R7	*40*	*35*	*35*	<20	24	24	Yes
Receiver R8	*40*	*35*	*35*	<20	<20	21	Yes
Receiver R9	*40*	*35*	*35*	20	27	26	Yes
Receiver R10	*40*	*35*	*35*	22	29	28	Yes
Receiver R11	*40*	*35*	*35*	22	28	27	Yes
Receiver R13	*40*	*35*	*35*	<20	26	25	Yes
Receiver R17	*40*	*35*	*35*	<20	20	22	Yes
Receiver R22	*40*	*35*	*35*	<20	<20	<20	Yes
Receiver R26	*40*	*35*	*35*	<20	<20	<20	Yes

Notes: 2. Applicable for the night time period only

Based on the predicted operational noise levels presented in the tables above for both Option 1 and Option 2, predicted noise levels at the nearest receivers comply with the nominated criteria under all scenarios and meteorological conditions. Compliance with the nominated criteria under all scenarios and meteorological conditions will also achieved for the additional 17 receivers discussed in Section 4.3.

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

5.5 Sleep Disturbance Assessment

To assess the likelihood of sleep disturbance, the potential of maximum noise level events from premises 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:

- $L_{Aeq,15\ min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, 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, only mechanical plant will be operating, including the tracking motors, inverters and the substations. 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 and Table 5.6. Hence, it is expected that both the $L_{Aeq,15\ min}$ and L_{AFmax} will be well below the nominated sleep disturbance criteria of 40 dB(A) and 52 dB(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 are in excess of 185m from the subject site, structural damage due to vibration is not expected. Assessment for construction 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.

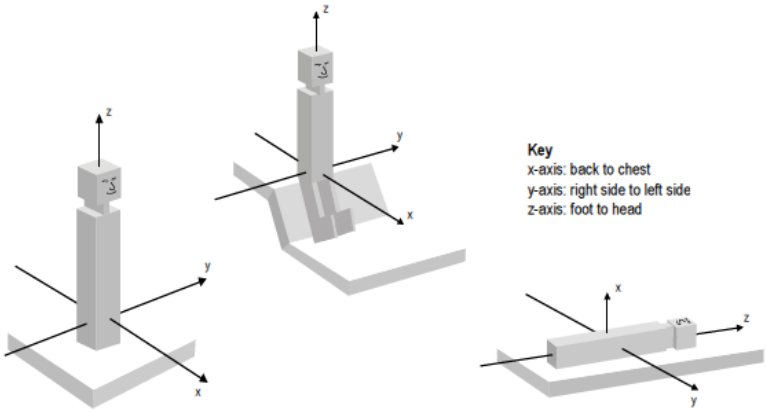
Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

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 3. 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 3 – 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 receivers.

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, 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 R3	760 m	Residential	Very low risk of adverse comments	Not required
Receiver R4	1,135 m	Residential	Very low risk of adverse comments	Not required
Receiver R5	650 m	Residential	Very low risk of adverse comments	Not required
Receiver R6	Option 1 : 725 m Option 2: 260 m	Residential	Very low risk of adverse comments	Not required
Receiver R7	1,390m	Residential	Very low risk of adverse comments	Not required
Receiver R8	Option 1 : 685 m Option 2: 360 m	Residential	Very low risk of adverse comments	Not required
Receiver R9	1,000 m	Residential	Very low risk of adverse comments	Not required
Receiver R10	800 m	Residential	Very low risk of adverse comments	Not required
Receiver R11	720 m	Residential	Very low risk of adverse comments	Not required
Receiver R13	780 m	Residential	Very low risk of adverse comments	Not required
Receiver R17	Option 1: 2,000 m Option 2: 1,435 m	Residential	Very low risk of adverse comments	Not required
Receiver R22	1,500 m	Residential	Very low risk of adverse comments	Not required
Receiver R26	2,700m	Residential	Very low risk of adverse comments	Not required

The potential for adverse comments to vibration impacts during the construction works was determined to be very low due to the large distances between the receiver locations and the construction activities. 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.

The site access for both Option 1 and Option 2 would be off Waterfall Way (Grafton Road) north of the site Based on information 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	Vehicle Movements Per Day (two-way)
Semi-Trailers	46
B-Doubles	4
Oversized vehicles	2
Standard trucks	10
Water tankers	30
Buses	40
Cars	60
Total	**192**

During the operational stage, vehicle access to the site will be maintenance vans or delivery trucks which would occur on an irregular basis. Traffic noise impacts during the operational stage of the project would be minimal and insignificant and will not be assessed further.

7.1 Road Traffic Noise Criteria

Based on functionality, Waterfall Way (Grafton Road) is categorised as an arterial road. For existing residences affected by additional traffic on existing arterial 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, dB(A)	
		Day 7am – 10pm	Night 10pm – 7am
Freeway/arterial/sub-arterial roads	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)

Further to the above, the RNP states the following for land use developments generating additional traffic:

> *"For existing residences and other sensitive land uses affected by **additional traffic on existing roads generated by land use development**, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'."*

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 due to existing general traffic flows as existing traffic volumes along Waterfall Way (Grafton Road) are unknown.

Table 7.3 – Predicted Road Traffic Noise Contribution Levels Along Public Roads, dB(A) $L_{Aeq,15\ hour}$

Receiver	Criteria	Traffic Movements	Speed (km/h)[1]	Distance to Road (m)[2]	Predicted Noise Level	Exceed?
Residences on Waterfall Way (Grafton Road)	$L_{Aeq,15\ hour}$ 60	As per Table 7.1[3]	100	20	56	No

Notes:
1. Based on posted speed limit
2. Based on closest typical distance from facade of dwelling to the road
3. Includes semi-trailers, B-doubles and oversized vehicles, standard trucks, water tankers and buses
4. Includes cars

From the above table, it can be seen that road traffic noise level contributions from the vehicle movements associated with the construction works are at least 4 dB(A) below the applicable noise criterion based on dwellings being 20 m from the roads. Given that residences are located within a rural environment, distances between the road and the dwellings would likely be significantly greater than 20 m.

Furthermore, as the predicted levels are 4 dB(A) less than the traffic noise criterion, it is not expected that the traffic noise contribution from the construction vehicles would result in an exceedance of the traffic noise criterion and/or increase the existing traffic noise levels by more than 2 dB(A).

Therefore, traffic noise levels as a result of the construction works for the solar farm would not adversely contribute to the existing traffic noise levels at the most affected residences along the surrounding roads.

8 Conclusion

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

Noise emissions from the construction phase of the project were predicted to comply with the nominated criteria at the nearest affected receivers for both development site options.

Noise emissions from the operational phase of the project were predicted to comply with the nominated criteria at the nearest affected receivers for both development site options.

Given the large separation distance between the nearest affected receivers and both development site options, vibration impacts resulting in structural damage to buildings at the nearest affected receivers are determined to be negligible and there is a very low risk of adverse comments from occupants of dwellings due to construction vibration.

Road traffic noise impacts due to additional traffic generated during the construction phase of the development on residential properties along the access routes were found to comply with the relevant RNP criteria for both development site options.

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 100dBThe sound of a rock band 110dBOperating a chainsaw or jackhammer 120dBDeafening
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.

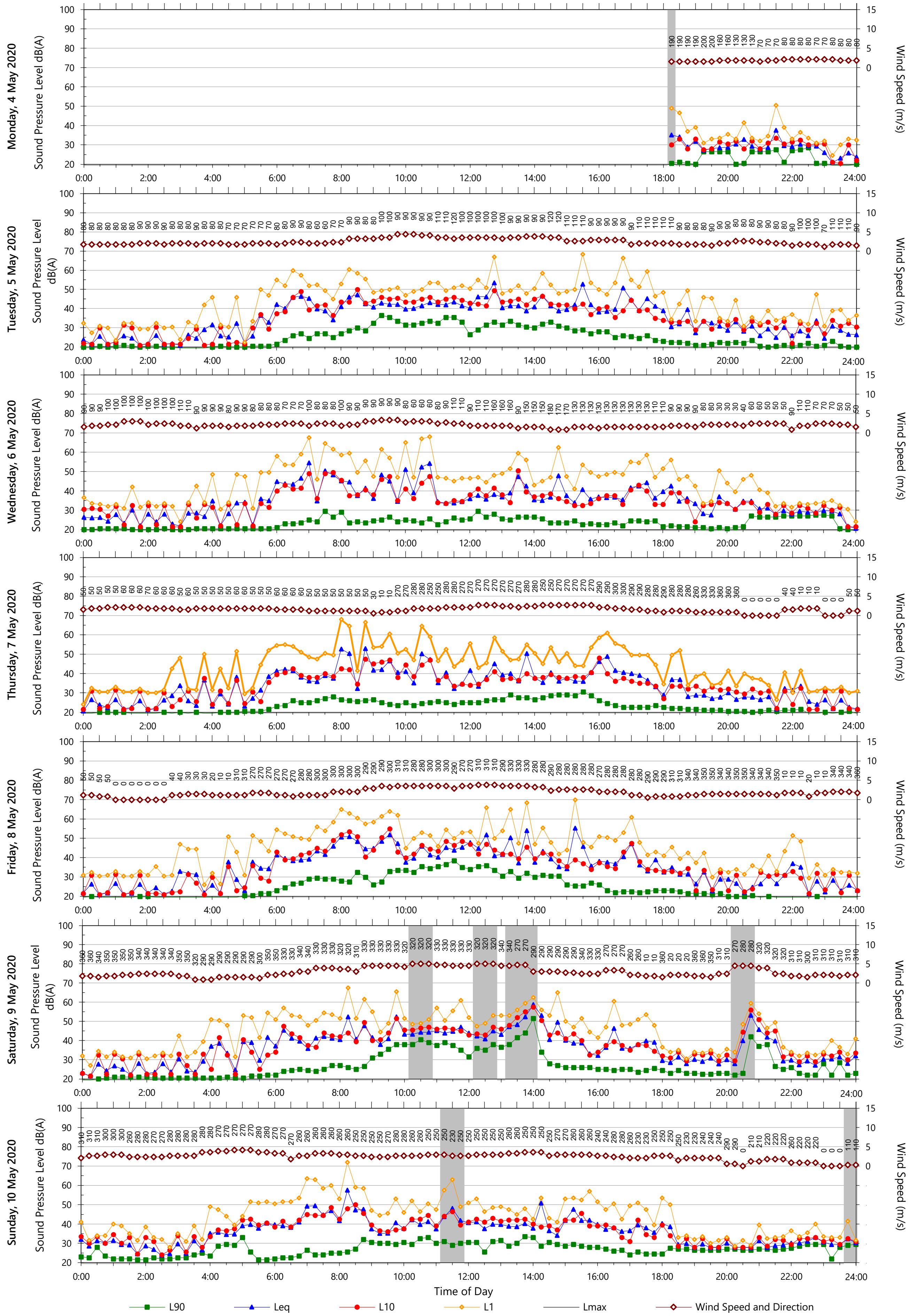
B.2 Meteorology During Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. 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

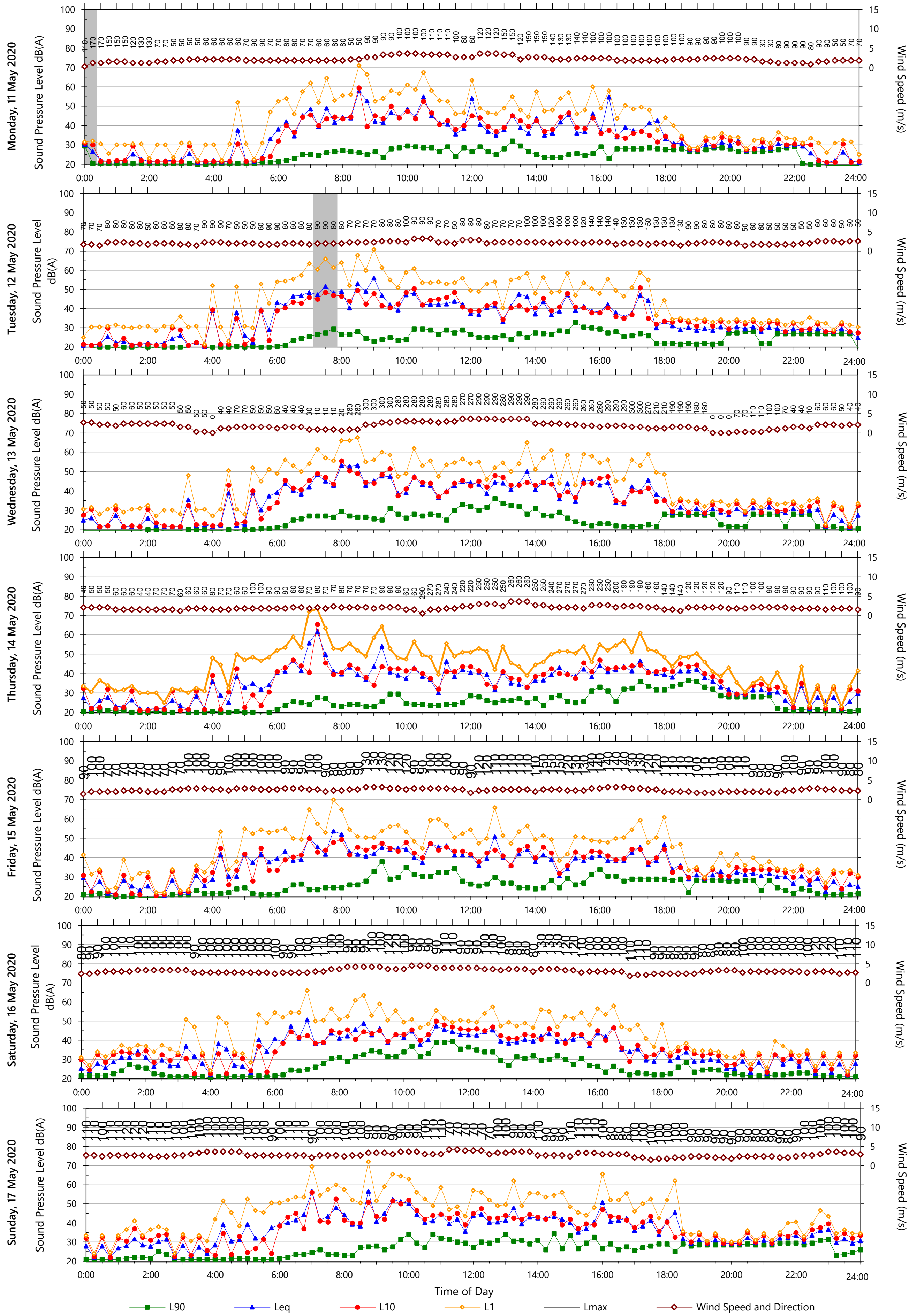
Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise 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



Data File: R:\AssocSydProjects\TL001-TL050\TL049 wc Oxley Solar Farm EIS\4 Field Work\Logger\2020-05-04_18-00-00_001_RTA.xls

Template: QTE-26 Logger Graphs Program (r31)



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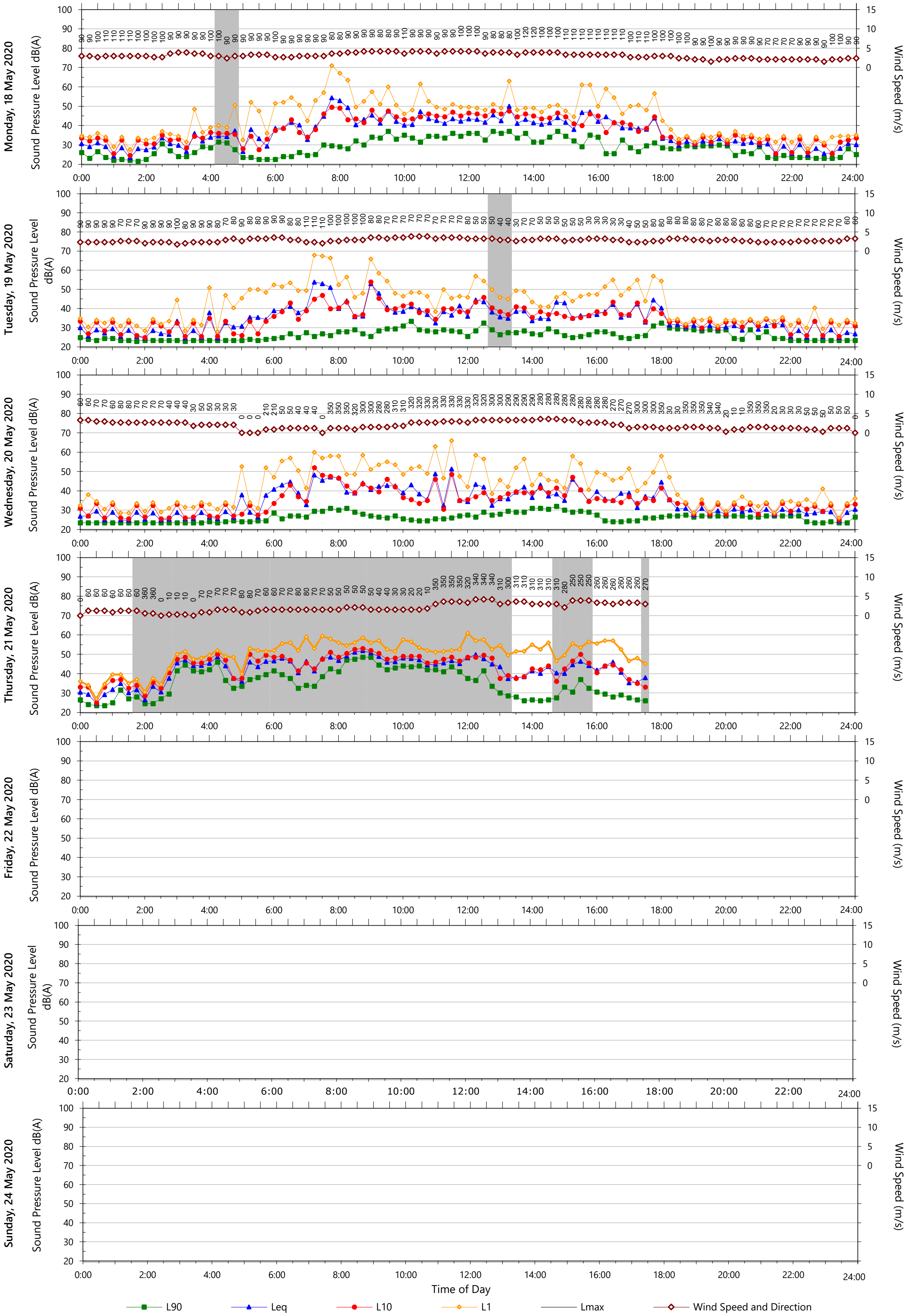

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Template: QTE-26 Logger Graphs Program (r31)