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Brookside Solar Farm

Assessment of environmental noise effects

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1.0 INTRODUCTION

Acoustic Engineering Services Ltd (AES) has been engaged to undertake an assessment of environmental noise effects relating to the Brookside Solar Farm project (the project) at 150 and 151 Buckleys Road, and 821 Hanmer Road, Brookside, Selwyn (the site).

The project will comprise construction of a solar array (the solar farm) on the site, located approximately 10 kilometres to the north of Leeston, in the Selwyn District. The solar farm will comprise 5,844 solar panel frames, being installed on the site in three stages over three years.

Certain aspects of the construction and operation of the solar farm will generate environmental noise. We have undertaken an assessment of environmental noise and vibration effects associated with construction and operation of the solar farm.

Once constructed, the solar farm will operate during normal daytime hours being 7:30 am to 8:00 pm, seven days per week. The construction activity will occur from Monday to Saturday, from 7:30 am to 6:00 pm.

The site is shown in figure 1.1.

Figure 1.1 – Site location

A glossary of acoustics terminology is provided in Appendix A.

2.0 ACOUSTIC CRITERIA

The Selwyn District Council District Plan has limits which are relevant for compliance. Other guidance to provide context with regard to noise effects is also discussed in this section. We have been advised that noise emitting items of solar farm plant would not operate outside of the hours of 7:30 am to 8:00 pm, seven days per week, and we have therefore limited our assessment of noise from the activity to that time period.

2.1 Selwyn District Council

2.1.1 Operational noise

According to the Selwyn District Council Operative District Plan (ODP), the site and the surrounding area is zoned Outer Plains (OP). The ODP Rural Volume, Section 9.16 *Activities and noise*, Table C9.3 prescribes the following relevant noise limits for the activity:

- 7:30 am to 8:00 pm – 60 dBA L_{10}, and 85 dBA L_{max}.

The noise limits apply at the notional boundary of any dwelling on a receiving site. Noise must be measured in accordance with the provisions of NZS 6801:1999 *Acoustics – Measurement of environmental sound* and assessed in accordance with NZS6802:1991 *Acoustics – Environmental noise*.

According to the Selwyn District Council Proposed District Plan (PDP), the site and the surrounding area is zoned General Rural (GRUZ). The PDP Part 2, District Wide Matters, General District Wide Matters, Noise-REQ1 prescribes the following relevant noise limit for the activity:

- 7:00 am to 10:00 pm – 55 dB L_{Aeq}.

The noise limit applies at the notional boundary of any noise sensitive activity within any site receiving noise. We note that an L_{max} based daytime noise limit has not been added to the PDP. Noise must be measured in accordance with the provisions of NZS 6801:2008 *Acoustics – Measurement of environmental sound* and assessed in accordance with NZS6802:2008 *Acoustics – Environmental noise*.

2.1.2 Construction noise

The ODP does not prescribe any specific noise limits for construction activity. The PDP does contain noise limits which align with the New Zealand Standard NZS 6803:1999 Acoustics – Construction noise (NZS 6803), which is used widely in New Zealand to control the effects of noise from construction activity.

The relevant noise limits are:

- Monday to Saturday - 7:30 am to 6:00 pm - 70 dB L_{Aeq}, and 85 dB L_{Amax}.

The noise limits are intended to be applied at 1 metre from the most exposed wall of the receiving building, in this case residential dwellings in the GRUZ zone.

2.2 New Zealand Standard NZS 6802

In the current version of NZS 6802:2008 Ac*oustics – Environmental noise* (NZS 6802), the L_{10} noise descriptor for intrusive noise is replaced by L_{eq} to align with both Australian and other international practice. Given the expected steady state type operation of the solar farm equipment, the measured L_{10} noise level is expected to be similar to the measured L_{eq} noise level over the same time period. It would be current best practice to assess noise from the proposed activity in terms of the L_{eq} based noise descriptor prescribed in the current version of NZS 6802.

NZS 6802 suggests a guideline daytime noise limit of 55 dB $L_{Aeq(15\ minute)}$ for "the reasonable protection of health and amenity associated with the use of land for residential purposes".

The Standard also describes how a 3 dB duration adjustment may be applied to sound received for less than 50 % of the daytime period, and a 5 dB adjustment may be applied to sound received for less than 30 % of the daytime period.

NZS6802 also recommends the application of a penalty for noise containing Special Audible Characteristics (SAC), such as tonality or impulsiveness, as these are distinctive characters which may affect the subjective acceptability of noise. In cases where SAC are confirmed to be present, a penalty of up to 5 dB may be appropriate.

2.3 World Health Organisation

Guidelines for Community Noise[1], a document produced by the World Health Organisation based on extensive international research recommends a daytime guideline limit of 55 dB $L_{Aeq(16\ hours)}$ to ensure few people are seriously annoyed in residential situations. A daytime guideline limit of 50 dB $L_{Aeq(16\ hours)}$ is recommended to prevent moderate annoyance. A guideline night-time limit of 45 dB L_{Aeq} is recommended to allow occupants to sleep with windows open.

2.4 Conclusions regarding appropriate noise levels

Based on our understanding that the noise emission from the operating solar farm will be reasonably steady-state in character, we consider that noise limited to the following level (measured and assessed in accordance with NZS 6801:2008 and NZS 6802:2008 respectively), when received at the notional boundary of the neighbouring dwellings would be reasonable:

- Daytime (7:30 am to 8:00 pm) - 55 dB $L_{Aeq(15\ minute)}$.

The nominated L_{Aeq} based noise limit is more stringent than the L_{10} based noise limit prescribed in the ODP, but adopts the conservative daytime hours outlined in the ODP. In accordance with NZS 6802, we consider the inclusion of a 15-minute time interval to the criteria is appropriate.

We consider that construction noise should be managed in accordance with NZS6803:1999.

2.5 Vibration

We do not expect that operation of the solar farm will generate any significant levels of vibration, however some aspects of the construction may generate significant levels of vibration, such as during piling.

The ODP section 9.17 *Activities and blasting and vibration*, Part 9.17.1.2 prescribes that permitted activities which involve vibration from any source comply with New Zealand Standard 2631:1985-89 Parts 1-3. We note that standard is typically used to protect human comfort due to vibration generated by a long-term emission sources such as an industrial facility, and it is not an appropriate standard to use when considering the impacts of vibration from construction activity which occur over a much shorter time frame for any one receiver.

The PDP rule NOISE-R14 contains requirements for activities that generate vibration and prescribes vibration limits which align with the guideline values from the German Standard DIN 4150-3:2016 Vibration in buildings – Part 2: Effects on structures (DIN 4150). That standard gets used widely in New Zealand when assessing the impacts from construction activity.

[1] *Edited by Berglund, B et al. Guidelines for community noise. World Health Organization 1999*

3.0 NOISE ASSESSMENT

Airborne noise modelling was undertaken using SoundPLAN (v8.2) which utilises parameters such as sound power levels for the plant items, locations of the activity and receivers, attenuation of noise over distance and local ground conditions. The modelling included a slightly downwind setting, which enhances propagation from the source to receiver.

The modelling was based on information contained in the following provided documents:

- Technical report titled *Sound Pressure Level in FreeMaq PCSK/FREESUN HEML GEN3 Inverters*, prepared by Power Electronics, dated March 2022.
- Email containing noise emission level for the CAT battery units, dated 22 July 2022.
- Site layouts for Stage A, Stage B and Stage C, prepared by Kea Energy.
- Assessment of Environmental Effects report titled *Brookside Solar Array*, prepared by Boffa Miskell, dated 9 March 2022.

We understand the receivers at the following addresses have provided written approval of all aspects of the proposed solar farm, including around matters of noise and vibration emission:

- 105 Buckleys Road, Leeston
- 115 Buckleys Road, Leeston
- 150 Buckleys Road, Leeston
- 187 Buckleys Road - Leeston
- 821 Hanmer Road, Leeston
- 883 Hanmer Road, Leeston

We have not considered the effects of noise and vibration at these receiver locations.

3.1 Operational noise source levels

To assess the expected level of noise from the operating solar farm, modelling was undertaken which included the cumulative noise emission from all the solar array fixed plant items (in all three stages) operating concurrently.

The sound power level for each plant item was taken from data provided by the manufacturer, and the transformer noise levels were based on guidance from the Australian and New Zealand Standard AS/NZS 60076.10:2009 *Power Transformers*. We have applied a +5 dB penalty to the transformer noise levels to address the potential for special audible characteristics from those sources. We have not applied penalties for special audible characteristics to the inverter or battery sources as we do not consider it likely the operation of these plant items would result in special audible characteristics during the daytime. The source noise levels used in the modelling are shown in table 3.1.

The solar farm will comprise panel arrays which are connected to inverter/battery/transformer skids distributed across the site. The “Single Skid” skids will have one inverter, one battery and one transformer. The “Twin Skid” skids will have two inverters, two batteries and one transformer. The plant items will be arranged in close proximity to each other to allow easy connection, as shown in figure 3.1.

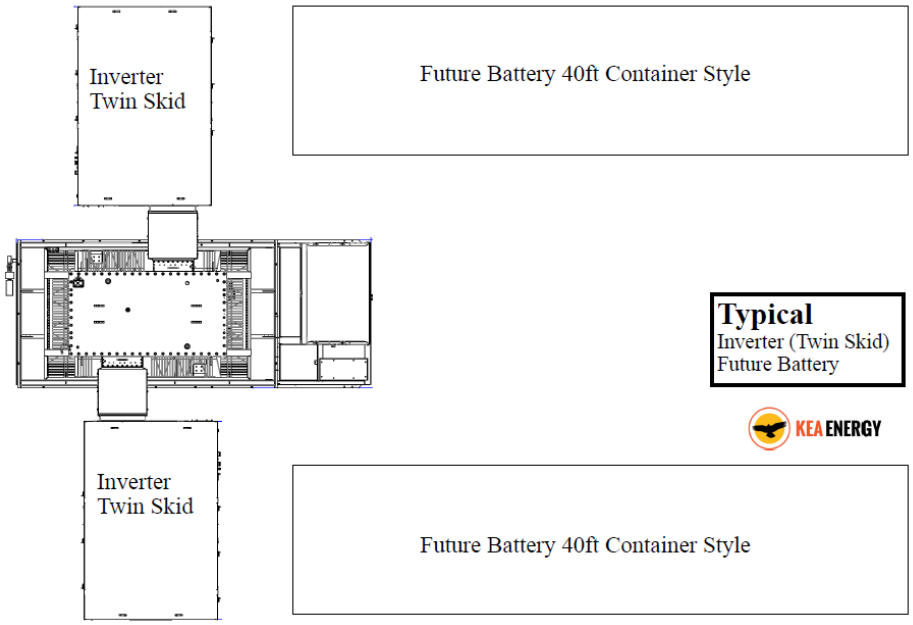

Figure 3.1 – Twin Skid layout

The skid arrangements for each stage will be:

- Stage A – One single skid and one twin skid. The site office will be located next to the twin skid.
- Stage B – Five twin skids.
- Stage C – Seven twin skids.

Table 3.1 – Operational noise source levels

Plant item	Sound power level (dB L_{WA})
Inverter	98
Battery	101
Transformer (4.39 MVA for single inverter skid)	75
Transformer (6.58 MVA for double inverter skid)	78

The operating solar farm will also include other sources of noise such as operation of the site office and intermittent vehicle movements relating to staff moving to and from the site and undertaking maintenance inspections. We do not expect noise from those sources will be acoustically significant when compared with the noise from the fixed plant items.

We understand there would be no mechanical cleaning of the solar panels, or mechanical grass cutting, on the site.

3.2 Expected levels of operational noise

The rating noise levels for the operation of the solar farm are shown in Appendix B. The rating noise levels do not include any duration adjustments.

Given the expected steady state type operation of this equipment, the L_{Aeq}, L_{A10} and L_{Amax} emission levels are likely to be similar. This analysis confirms that the noise levels are expected to comply with the ODP and PDP noise limits (for the daytime) at all the relevant receiver locations.

3.3 Construction noise source levels

The construction activities were modelled based on our understanding of the key noise emitting equipment that would make up the team for each construction activity group, shown in table 3.2.

To provide some context to the noise emission from the equipment listed in table 3.2, the sound power levels for the equipment are what could be expected from typical equipment used throughout the city for roading, construction and demolition projects. The sound power levels were sourced from British Standard BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites*, and AES's noise source database.

Table 3.2 – Modelled construction activities

Activity group	Equipment	Sound Power Level dB L_{WA}
Piling	Pling rig	117
	Truck	96
Civil works	Excavator – 20 to 30 tonne	103
	Grader	106
	Truck	96
Panel construction	Telehandler – 4 tonne	104
	Truck	96
	Hand tools	89
Tree clearing	Chainsaw	117
	Loader	98
	Truck	96

While the construction activity will move around the site, we have modelled the noise from each activity group at the closest distance to each receiver, to capture a worst-case situation for compliance assessment purposes.

We understand there could be more than one piling rig used on the site concurrently, however the piling teams would be spaced apart and the there would not likely be a noticeable increase in the cumulative noise level from piling at any one receiver location. We have adjusted the piling noise source level to reflect an expected 30% on-time during a 15-minute period.

While the noise emission from the planned activity will be reasonably steady state at times, we expect there could be instantaneous maximum noise events that cause levels in the order of 10 to 15 dB higher than those presented in table 3.2.

3.4 Expected levels of construction noise

The noise modelling results are shown for each construction activity in Appendix B. It can be seen that the construction noise levels are expected to comply with the noise limit (70 dB $L_{Aeq(15\ min)}$) at all the adjacent receiver locations, except at 324 Branch Drain Road, Leeston during the piling activity, where we expect there could be an exceedance of up to 4 dB during that activity. More information about piling noise at 324 Branch Drain Road is provided in section 5.2.1.

We expect there could be instantaneous maximum noise events that cause levels in the order of 10 to 15 dB higher than those presented in Appendix B. The noise limit for these transient noise events is 85 dB L_{Amax}, and we expect that maximum noise levels from the construction activity will comply with the L_{Amax} noise limit, however the L_{Amax} noise limit may be exceeded at 324 Branch Drain Road, Leeston during the piling activity.

4.0 VIBRATION ASSESSMENT

We expect the piling activity will generate the most significant level of vibration during the construction works. Given the reasonably large (approximately 30 metres) offset distances between the planned works and the adjacent residential buildings outside the project site, we expect that vibration from the piling works can comply with the guideline values from DIN 4150.

It is not completely clear at this stage which buildings within the site may be sensitive to vibration and the exact offset distances between the piling activity and the buildings. As such, we recommend undertaking measurements of vibration from the piling rig during the early stages of the works, to determine a safe working distance for the activity and to establish a “site law” which can be used to assess the potential for damage to structures within the project site.

5.0 ASSESSMENT OF ENVIRONMENTAL NOISE EFFECTS

The analysis has shown that the operation of the solar farm can comply with the noise limits, and the noise from construction of the project can comply with the noise limits at all but one receiver, for a short period of time. As such, we expect the overall noise effects from the project will be minimal as discussed below.

5.1 Operational noise

The noise from the operation of the project will be 10 dB or more below the ODP noise limits, and more than 5 dB below the PDP limits.

324 Branch Drain Road and 870 Hanmer Road will receive the highest noise levels, where the operational noise is expected to be 48 and 47 dB $L_{Aeq\ (15\ minute)}$ respectively. While this noise level is well below the acceptable level in the zone, there may be times during the day when noise from the solar farm is clearly audible in the areas outside those dwellings, depending on the weather conditions and the presence or absence of other sources of environmental noise, like road traffic noise, noise from birds or animals and agricultural activity. The noise levels inside those dwellings would be in the order of 10 to 17 dB lower (with windows open) than the external levels, depending on the aspect of the internal spaces. Overall, we expect even for these two properties, the noise will not interfere with typical domestic activities and the noise effects will be minimal.

5.2 Construction noise

While the noise from construction activity can generally comply with the noise limits, the duration of the construction activity (three years), and the likelihood that noise levels will at times be significantly higher than the background noise levels, means that it is appropriate to be considerate of neighbours to minimise noise effects as far as practicable. We therefore recommend implementing a Noise Management Plan (NMP) for use during the construction phase of the project. The NMP should be prepared with consideration of the guidance from NZS 6803 and specifically include an element of community relations management.

5.2.1 Construction noise at 324 Branch Drain Road, Leeston

Our analysis has shown there is potential for the noise levels during piling works to exceed the construction noise limits, when the activity occurs within 50 metres from the most exposed (north facing) facade of the dwelling. As such, we recommend that noise be managed to specifically minimise the effects of noise during that activity.

Temporary noise barriers around construction plant can provide a significant and noticeable reduction in noise levels if they can be arranged correctly, however given the height of the piling head, a typical two metre high temporary noise barrier may not provide compliance in this case.

Given the pilling works will likely only be within 50 metres of the dwelling for a period of a few days, it may be practical and effective to communicate with the resident around scheduling the piling works for times that will be most suitable for them, to minimise the effects.

6.0 CONCLUSION

Acoustic Engineering Services Ltd has been engaged to undertake an assessment of environmental noise effects relating to the Brookside Solar Farm project at 150 and 151 Buckleys Road, and 821 Hanmer Road, Brookside, Selwyn (the site).

The project will comprise construction of a solar array on the site, approximately 10 km to the north of Leeston, in the Selwyn District. The solar farm will comprise 5,844 solar panel frames, being installed on the site in three stages over three years.

Certain aspects of the project will generate environmental noise and vibration, however, our analysis has shown the operation of the project can comply with the relevant noise and vibration limits.

We have recommended specific noise control for one receiver during a short period of construction activity, and given the long duration of construction works, have recommended more generally implementing a Noise Management Plan for the construction phases of the project.

We expect that vibration from the piling activity (most vibration intensive) can comply with the relevant guideline values. However, we have recommended undertaking vibration measurements during the early stages of piling to confirm the emission levels and to determine a safe working distance between the piling rig and the adjacent vibration sensitive structures.

Overall, we expect the effects of noise and vibration emission from the construction and operation of the project will be minimal.

Appendix A

Glossary of acoustics terminology

Ambient level	The total noise or vibration level that includes contribution from all sources of noise present in the testing environment.
Decibel [dB]	The measured sound pressure level is typically presented in the units of Decibels. Some typical sound pressure levels include: 30 dB(A) A quiet library or a quiet outdoor location in the country. 45 dB(A) Typical office space or outdoor in a city at night. 60 dB(A) Outdoors in a city centre during the daytime. 70 dB(A) A car passing by on the street. 80 dB(A) Loud music played inside a home. 90 dB(A) A truck passing on the street. 100 dB(A) A loud music concert. 120 dB(A) Very loud noise, possibly causing discomfort.
dB(A)	A-weighted decibels. The human ear is more sensitive to mid frequency sounds. Low and high frequency sounds of the same loudness are not perceived as being as loud. A sound level meter measures all frequencies equally but can then aim to replicate the human response of the ear by using an electronic filter which is called an “A” weighting filter. The sound pressure level in dB(A) gives a closer indication of the subjective loudness of a noise.
$L_{Amax(T)}$	The maximum sound pressure level measured over a given period.
$L_{Aeq\ (T)}$	The “equivalent noise level” is the summation of noise events and integrated over a specific period of time (T). Sometimes called the average noise level.

Appendix B

Expected noise levels

Receiver	Rating noise level dB L_{Aeq} (15 min)	Noise level dB L_{Aeq} (15 min)			
	Operation	Tree clearing	Piling	Panel construction	Civil works
1 Stephens Road, Leeston	42	40	48	41	40
1/388 Brookside and Irwell Road, Leeston	40	41	46	39	38
2 Brookside and Burnham Road, Leeston	39	43	39	32	31
7 Brookside and Burnham Road, Leeston	39	43	39	32	31
10 Stephens Road, Leeston	38	37	40	33	32
15 Stewarts Road, Leeston	43	53	49	43	41
23 Buckleys Road, Leeston	43	50	46	39	38
25 Stephens Road, Leeston	40	39	43	36	35
29 Irwell Rakaia Road, Leeston	42	54	50	43	42
43 Dunsandel and Brookside Road, Leeston	39	48	44	37	36
43 Grahams Road, Leeston	38	38	39	32	31
56 Buckleys Road, Leeston	44	54	51	44	43
63 Grahams Road, Leeston	39	39	40	33	32
71 Stewarts Road, Lesston	39	46	42	35	34
79 Buckleys Road, Leeston	46	58	60	53	52
83 Grahams Road, Leeston	40	40	42	35	34
121 Irwell Rakaia Road, Leeston	36	42	37	30	29
124 Branch Drain Road, Leeston	38	40	40	33	32
140 Caldwell Road, Leeston	38	37	39	32	31
157 Branch Drain Road, Leeston	40	42	44	37	36
180 Grahams Road, Leeston	43	47	57	50	49
191 Branch Drain Road, Leeston	42	46	52	45	44
229 Branch Drain Road, Leeston	43	48	50	43	42
241? Branch Drain Road, Leeston	43	49	48	41	40

241?b? Branch Drain Road, Leeston	42	47	47	40	39
253 Smythes Road, Leeston	37	42	37	30	29
254 Smythes Road, Leeston	37	42	38	31	30
265 Branch Drain Road, Leeston	44	52	47	40	39
277 Branch Drain Road, Leeston	43	48	46	39	38
313 Branch Drain Road, Leeston	45	51	53	46	45
324 Branch Drain Road, Leeston	48	57	74	67	66
337 Brookside and Irwell Road, Leeston	40	40	44	37	36
365 Brookside and Irwell Road, Leeston	42	42	48	41	40
375 Brookside and Irwell Road, Leeston	43	42	50	43	42
381 Brookside and Irwell Road, Leeston	43	42	52	45	44
396 Brookside and Irwell Road, Leeston	42	42	49	42	41
485 Brookside and Irwell Road, Leeston	40	45	41	34	33
870 Hanmer Road, Leeston	47	44	66	59	58
932 Hanmer Road, Leeston	44	45	51	44	43