

BEFORE THE HEARING PANEL

IN THE MATTER OF The Resource Management Act 1991

AND

**IN THE MATTER OF An application (202.2022.136.1) for resource
consents to establish and operate a solar
farm at 410 Mangamaire Road, Pahiatua**

BETWEEN Energy Bay Limited

AND Tararua District Council

STATEMENT OF EVIDENCE OF MARY HAMILTON

1.0 INTRODUCTION

- 1.1 My full name is Mary Catherine Hamilton, and I am currently employed as an acoustician with the acoustical consulting practice of Marshall Day Acoustics.
- 1.2 I hold a degree of Bachelor of Science from the University of Otago (1991) and a degree of Master of Applied Science from James Cook University, Australia (1998). For 12 years I have worked in the field of acoustics, noise measurement and control in the United States and New Zealand. For the past 10 years I have been employed by Marshall Day Acoustics. My principal role is to undertake assessments for the environmental emission of noise and consider their impact against the relevant district plan requirements and the existing ambient environment. I have been involved in 15 solar farm resource consent applications.
- 1.3 I have been involved in this project since June 2022. I undertook site visits in June 2022, and prepared the original acoustic assessment for the proposal in July 2022.
- 1.4 I have read the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note (2023) and I agree to comply with it. I can confirm that the issues addressed in this statement are within my area of expertise and that in preparing my evidence I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2.0 SCOPE OF EVIDENCE

- 2.1 My evidence will address noise matters related to the project.
- 2.2 My evidence is structured as follows:
- noise assessment summary
 - response to comments raised by Councils' acoustic expert, Dr Stephen Chiles
 - comments on submissions
 - comments on the planning report, and
 - recommended noise conditions.

2.3 My evidence updates and highlights key points from my report Rp 001 20220340 [dated 28 July 2022], a report prepared to form part of the AEE. In giving this evidence I refer to and confirm that report.

3.0 SUMMARY OF NOISE ASSESSMENT REPORT

3.1 I prepared my assessment in July 2022. This included an ambient noise survey and the calculation of noise from the key identified operational noise sources: 13 inverters and associated transformers, and 2100 tracker motors associated with the solar panel arrays. The inverters are the primary operational noise source. The assessment also addressed construction noise.

3.2 I provide a brief summary of operational noise, below.

3.2.1 The solar farm would operate during daylight hours. At certain times of year (notably summer), operating daylight hours could begin earlier and extend later than the District Plan prescribed daytime period of 7am to 7pm.

3.2.2 Noise limits during the District Plan prescribed night-time period (7pm to 7am) are the constraining limits. These are: 45dB $L_{Aeq(15-min)}$ and 75dB L_{AFmax} .

3.2.3 During times of lower solar gain (such as after 7pm), I expect inverter noise levels to be lower than during times of high solar gain. However, data detailing the relationship between inverter load and solar gain is not yet available from the manufacturer and therefore my assessment for the night-time period is conservatively based on the worst-case scenario (100% inverter load)¹.

3.2.4 Based on available manufacturers' data, the inverters are also expected to have appreciable directivity (i.e., one side is noisier). However, as positioning of the inverters for directivity considerations had not been finalised through detailed design, my assessment is conservatively based on a worst-case directivity scenario for all inverters.

¹ In my report I provided a scenario for 10% load on the inverter bridge circuit, however I understand that this data still allows for full fan speeds. It is typical for fan speeds to vary with ambient temperatures, thus at low ambient temperatures and low solar loads noise levels are likely to be much lower than I have set out in my report. There is normally a substantial difference between noise at 100% fan speed and at 60 to 70% fan speed.

- 3.2.5 I measured existing ambient and background noise levels over a three-day period that corresponded with stable weather conditions. Measured ambient (L_{Aeq}) and background (L_{A90}) noise levels are detailed as follows:
- Daytime (0700 to 1900 hours): ambient = 41 decibels (dB); background = 32 dB
 - Night-time (1900 to 0700 hours): ambient = 35 dB; background = 27 dB
- 3.2.6 Under a worst-case scenario (worst case directivity and 100% inverter load), I calculated compliance with the District Plan noise limits.
- 3.2.7 Based on the measured ambient and background noise levels, I determined that there is risk that the solar farm could generate electro-mechanical noise at levels that appreciably exceed the existing night-time (evening/early morning) ambient and background noise levels at near receivers.
- 3.2.8 I recommended that attenuation of the inverters (through methods such as, selection, positioning for directivity, partial or full enclosure) be undertaken as part of detailed design to reduce the intrusiveness of any noise audible outside the solar farm, and as part of RMA Section 16 duties. I proposed a condition of consent in this regard. The condition was drafted with the intent of not being overly prescriptive and to allow refinement of the attenuation design on site during construction.
- 3.3 I provide a brief summary of construction noise, below.
- 3.3.1 My construction noise assessment identified setback distances from likely key construction activities (such as impact pile driving) to meet the long-term duration (greater than 20-weeks) daytime construction noise limits (70dB L_{Aeq} and 85dB L_{AFmax}), as defined in the construction noise standard (NZS 6803:1999).
- 3.3.2 Eight receivers were identified as being potentially within the setback distances of key construction activities.
- 3.3.3 I advised that depending on the final construction plan, resource consent may be required to breach the construction noise limits and/or a construction noise and vibration

management plan (CNVMP) may be necessary to assess and manage construction effects on near receivers.

4.0 RESPONSE TO COMMENTS RAISED BY COUNCILS' ACOUSTIC EXPERT

- 4.1 I have reviewed Dr Stephen Chiles acoustic report, dated 1 August 2023 including the Appendix A Memorandum, dated 5 November 2022. Overall, there appears to be a broad level of agreement over most technical matters. Dr Chiles usefully raises some issues for further consideration by the hearing panel – I respond to these here.
- 4.2 In the section 'Sound and vibration levels', Dr Chiles states, "While, MDA includes cautious assumptions, there is inherent uncertainty associated with the prediction, particularly in relation to the assumed source levels in Table 3."
- 4.2.1 The source data for the inverters is based on data received from manufacturers. As I discussed in my report, I have referred to data from SMA as the most likely supplier of the inverters and used sound power levels that I consider representative of these inverters. My colleague contacted SMA recently to discuss the noise data they have available, and they confirmed the data used in my assessment is current based on the information they have available to provide.
- 4.2.2 Dr Chiles states there is inherent uncertainty in data. I agree that at resource consent stage it is necessary to utilise the best available dataset but recognise where the plant used in the final design could differ (either at commissioning or through eventual replacement of inverters, etc). Dr Chiles points out that my approach is cautious. I agree that I have taken a conservative approach. My expectation is that inverter noise levels will actually be appreciably lower than I have allowed for during early morning or evening as ambient temperatures in New Zealand are unlikely to mean that fans will need to run at 100%. However, as manufacturers are unable to provide this resolution of detail at this time, I have simply allowed for the worst case.
- 4.3 In the section 'Sound and vibration levels', Dr Chiles states, "A minor factor is that MDA has applied a 5 dB penalty for special audible characteristics (tonality), whereas under NZS6802 this could be 6 dB, increasing calculated levels by 1 dB."

- 4.3.1 Dr Chiles has usefully noted this matter. In my report, I addressed tonality but did not discuss the reference test method. The benefit of using modern, well-written standards is that they include provisions to assess these types of issues.
- 4.3.2 If a situation arose where very narrow tones occurred from inverters that were audible outside the solar farm, it might be reasonable to use the narrow band assessment method set out in NZS6802:2008 to identify them and penalise them appropriately. This would require a detailed measurement analysis that is not possible at resource consent stage as the manufacturer's data is not at a high enough resolution to undertake this type of analysis². Dr Chiles is likely to agree that this detailed method could potentially be used in an assessment of compliance, should the need arise.
- 4.3.3 As Dr Chiles has stated, applying a six-decibel penalty would increase calculated levels by one decibel. This is a very small change. Noise levels that are one decibel different are not noticeably different to most people.
- 4.3.4 We understand that written approval has been provided by 129 Tutaekara Road, 154 Tutaekara Road, 346 Mangamaire Road and 410 Mangamaire Road. Therefore, even in a worst-case scenario, the application of a six-decibel penalty would not result in noise levels being above the District Plan night-time noise rule at any dwelling that has not given written approval to the project.
- 4.4 In the section 'Sound and vibration levels', Dr Chiles states, "MDA has not made a quantitative assessment of operational traffic noise, but states compliance with permitted activity standards based on an assumption of limited traffic and no heavy vehicle movements at night."
- 4.4.1 I consider that a qualitative assessment is reasonable in this case as very few light vehicle movements are anticipated, and no truck movements are anticipated in the night period. However, I have since undertaken a calculation to confirm this assumption. I have calculated that up to 80 vehicles per day (including 20 truck movements) would comply with the

² It would be very unusual for any manufacturer of any type of mechanical plant to provide narrow band noise level data. Most fans, transformers, boilers, etc manufacturers would, at best, provide data in 1/3 octaves. My assessment for this project is based on 1/3 octave noise data.

daytime noise limit at the receivers nearest to the identified access roads. Given that there should be few or no routine vehicle movements to an operational solar farm at night, I am confident compliance will occur. Note that based on MDA's experience with other solar farms, I anticipate that the likely number of vehicle movements per day would be about 12.

4.5 In the section 'Sound and vibration levels', Dr Chiles states, "Vibration: The MDA report (and wider application) does not address operational or construction vibration. From experience with other types of similar equipment and based on the solar farm equipment described by MDA, operational vibration is expected to be negligible beyond the site boundary. From experience with other projects and based on the description of construction activity in the MDA report, construction vibration might exceed the district plan permitted activity standard."

4.5.1 I agree that operational vibration would be negligible beyond the site boundary.

4.5.2 As Dr Chiles noted, I did not address construction vibration in my report. The main likely source of construction vibration would be piling, likely using a Vermeer-type pile driver. This is a high frequency, short-throw hammer pile rig which is quite different in scale to a large drop hammer piling rig (which are often used in large construction projects). The experience of my colleague who has visited a solar farm construction site (is that construction vibration is only perceptible fairly close to the piling rig. Ground vibration was not typically perceptible at 30 metres, even when lying in direct contact with the ground.

4.5.3 I consider that construction vibration could be effectively managed through a Construction Noise and Vibration Management Plan (CNVMP), which would take into account recommended setback distances and other mitigation measures, as needed.

4.6 In his section 'Potential noise effects', Dr Chiles summarises my conclusions regarding the effects of operational noise and generally agrees with my findings, further commenting that the potential noise effects could be largely avoided by adopting the best practicable option in the solar farm layout and equipment design, generally as laid out in my report. However, Dr Chiles also raises a question regarding the tracker motors. Dr Chiles states, "From the MDA report it is unclear whether regular cycles of the tracker motors would be audible and

potentially cause greater annoyance due to the intermittent characteristics not represented by the predictions of average sound levels.”

- 4.6.1 Tracker motors will generate noise levels of around 25 dBA at 90 metres when in operation, however operation only occurs intermittently, for short period to reorient the arrays. In general, the tracker motors do not contribute significantly to the rating sound level as it is the inverters that generate the most noise. It is possible that DC motors may be audible when in operation during periods of low background noise, however overall DC motor noise is expected to be low.
- 4.7 In his section ‘Potential noise effects’, Dr Chiles comments on construction noise and vibration and states that a Construction Noise and Vibration Management Plan (CNVMP) could be used to result in temporary construction effects that should be acceptable for most people in the nearest houses. As discussed, in my noise assessment and in Section 4.5.1 (above), I also recommend the use of a CNVMP to minimise and manage construction noise and vibration effects. However, in the main body of his evidence (Paragraph 10), Dr Chiles notes that Solar Bay have advised that they are confident that the construction noise standards will not be breached.
- 4.8 It would certainly be possible to comply with NZS6803 at all times, however this may involve the selection of an alternative piling method, or effective piling method such as a shroud or dolly, or (in the worst case if the above is not practicable) an avoidance of piling in specific areas close to dwellings. MDA’s correspondence with piling contractors is that they are not yet willing to provide certainty that they can use shrouds or dollies in Vermeer-type piling rigs.
- 4.9 In my view, an exceedance of the NZS6803:1999 guidelines can be addressed through the diligent implementation of a noise management plan. Any exceedances are likely to be brief and effects can likely be mitigated through careful planning and communication (e.g., by piling during the least sensitive times). I agree that it needs to be clear whether the construction noise rule of the District Plan is proposed to be exceeded.

4.10 In the section 'Conditions', Dr Chiles recommends modifications and some additions to my recommended conditions of consent. In general, I agree with Dr Chiles comments and have redrafted the recommended conditions accordingly in Section 7.0 (below).

5.0 COMMENTS ON SUBMISSIONS

5.1 I have read the seven submissions. Four submissions raised noise as an issue and are discussed below.

5.2 Submission 2 from Amy Blackwell at 2226 Tutaekara Road, raised noise as an issue, generally. General noise matters have been addressed in my report and in my evidence.

5.3 Submission 4 from Patricia, Terrence and John Moore, owners of 162-ha on Dougherty Road, raised noise as an issue, specifically asking "With regard to noise levels from the inverters. Is the noise going to be constant or only during daylight hours? At night-time the noise could be quite irritating and invasive. E.g. if you are having a BBQ with friends, or relaxing at the end of the day enjoying the evening."

5.3.1 My response is that the inverters will generate noise only during daylight hours and are likely to generate lower noise levels during times of lower solar gain (such as early morning and evening³). Also, the intention of the recommend Noise Conditions 4 and 5 (See Section 7.0, below) is to minimise/eliminate irritating noise characteristics (such as tonal character) at compliance locations (nearby homes).

5.4 Submission 6 from Stewart and Karen Smith at 126 Tutaekara Road, raised noise as an issue generally and specifically asked, "will construction generate more noise than the expected forward operative noise?"

5.4.1 My response is that construction noise will be louder than operational noise during the piling phase and potentially at times during earthworks and preparation. Construction piling near any one dwelling is typically only for a short period as piling progresses quickly across the farm.

³ Noting that my assessment has considered the worst-case scenario as I previously discussed.

5.5 Submission 7 from Wayne Morris, 154A Tutaekara Road, raised noise as an issue stating, “Secondly the noise and dust so close to our house will affect us (it won’t be a quick job).”

5.5.1 The solar farm will generate noise during construction but the recommended noise conditions of consent (see Section 7.0, below) are intended to manage noise to a level that is reasonable. Construction piling near any one dwelling is typically only for a short period as piling progresses quickly across the farm.

6.0 COMMENTS ON THE PLANNING REPORT

6.1 I have read The Section 42A Planning Report prepared by Andrew Bashford and dated 9 August 2023. Mr Bashford discusses noise effects in Sections 58 to 66. Mr Bashford summarises the conclusions of my noise assessment and points raised by Dr Chiles (and discussed in Section 4.0, above).

6.2 I agree with Mr. Bashford’s summary of my noise assessment and Dr Chiles comments. The only sections of the planning report that I need to discuss are Sections 63 and 65, regarding construction noise.

6.3 Sections 63 and 65 state that the applicant has confirmed that they will comply with the construction noise limits and expects the limit to be set as a condition of consent.

6.3.1 The construction noise standard (NZS 6803: 1999) is effectively a best practice guideline and the limits set in the standard should be met as far as practicable. However, it is not always possible to meet the limits in the standard. If limits cannot be met, they are managed through mitigation measures, detailed in a Construction Noise and Vibration Management Plan. Therefore, if the applicant did propose to breach the limits, I consider it appropriate that the condition regarding the construction noise standard should be written to reflect this uncertainty (refer to my comments in Section 4.7 and 4.8 and to recommended Noise Condition 3, below).

6.3.2 If the applicant accepts that they will comply with NZS6803:1999 at all times, then a Construction Noise and Vibration Management Plan is still recommended.

7.0 CONDITIONS

7.1 It is recommended that the following noise conditions are imposed on any consent granted.

1. The noise level from all operation of the solar farm shall meet the following District Plan noise limits at the notional boundary of any existing dwellings (refer to Map XX) on another site in the *Rural* zone where written approval has not been provided to exceed the noise limits:
 - 55 dB $L_{Aeq(15-min)}$ from 0700 to 1900 hours
 - 45 dB $L_{Aeq(15-min)}$ and 70dB L_{AFmax} from 1900 to 0700 hours.
2. Noise levels shall be measured and assessed in accordance with *NZS 6801:2008 Acoustics – Measurement of Environmental Sound* and *NZS 6802:2008 Acoustics – Environmental Noise*.
3. Noise and vibration from construction activities shall, as far as practicable, not exceed the limits recommended in, and shall be measured and assessed in accordance with, the following standards, *NZS 6803: 1999 Acoustics – Construction Noise [noise]* and German Standard *DIN 41503:2016 Vibrations in buildings – Part 3: Effects on structures [vibration]*. Construction noise and vibration shall be managed through a Construction Noise and Vibration Management Plan (CNVMP). All practicable attenuation measures shall be implemented. The CNVMP shall be provided to Council prior to construction.
4. Detailed design of the project shall include an attenuation design for the inverters. The attenuation design shall consider selection, orientation, and acoustic screening (though barriers), enclosure, lined ducting, or other measures as appropriate. The attenuation design shall minimise overall sound levels and eliminate intrusive sound characteristics (such as tonality (as defined by NZS 6802:2008)) at receiver/compliance locations, where it is practicable to do so. The attenuation design shall aim to achieve noise levels that are appreciably below the District Plan night-time noise limits when measured at compliance locations. The attenuation design should be undertaken by a recognised acoustician and a report detailing the recommended attenuation option(s) for each inverter shall be submitted to council prior to commencement of construction. It is recognised that the attenuation design may require commissioning works on site during construction to suitably refine and improve the attenuation design.

5. During the first daylight savings period after the solar farm becomes operational, compliance monitoring shall be undertaken to confirm compliance with the limits specified in Condition 1 and to assess the effectiveness of the attenuation design specified in Condition 4. Monitoring shall be undertaken by an experienced acoustician. It is likely that measurements will need to be taken close to the inverters as well as at compliance locations, and when the solar farm is operational during the prescribed night-period (i.e. in the evening after 7pm). Within 10 working days of the monitoring, a report shall be provided to Council detailing the compliance results and certifying that measures required under Condition 4 have been implemented and that intrusive sound characteristics have been minimised at compliance locations. In the event that intrusive sound characteristics are present at compliance locations, additional attenuation options shall be implemented, as appropriate. The effectiveness of any additional attenuation options shall be confirmed via additional monitoring and reporting to Council.

Mary Hamilton

16 August 2023