MARSHALL DAY Acoustics

HELIOS SOLAR FARM - ONGAONGA
ASSESSMENT OF NOISE EFFECTS

Rp 002 20230480 | 16 November 2023

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SUMMARY

Marshall Day Acoustics has been engaged by Helios to assess noise for a proposed solar farm over approximately 228-hectares. The proposal involves the construction and operation of a photovoltaic (PV) solar farm, energy storage and a substation / transmission line. The proposed location is Taylor Road, Ongaonga, Central Hawkes Bay.

The key elements of the proposal are detailed below.

- 26 decentralised inverters. These inverters would be distributed throughout the farm and would be used in the generation of power from the solar panel arrays.
- 2,212 tracker motors associated with the solar panel arrays.
- A battery energy storage system (BESS) situated in the northeast area of the site. This is likely to comprise 28 packaged battery units.
- Two 50MVA transformers located near the BESS.
- An electricity transmission line**.** Energy would be fed from this system to Transpower's existing Waipawa substation, approximately 1.7 kilometres to the northeast.

The proposed solar farm is well removed from the nearest rural dwelling receivers. The proposed key noise sources (inverters / BESS) are at least 350 metres from a dwelling.

Our overall conclusions are given below.

- Rating noise levels at the nearest receivers readily comply with the Proposed District Plan noise rules (and with the Operative District Plan noise rules) for both the daytime and night-time periods and for all assessed scenarios of operation.
- During the daytime, rating noise levels are within range of the measured ambient noise levels (and up to four decibels above the logged background noise level). We expect that noise from the solar farm would have minimal if any effect on the existing acoustic environment at near receivers.
- During the night-time (and under a worst-case operation scenario), rating noise levels are up to three decibels higher than the night-time ambient noise level and up to six decibels above the background noise level. We expect that noise from the solar farm will be audible at night at the nearest receivers, at times. Noise from the solar farm is most likely to be audible during times of low background noise (low wind and low insect activity) and / or when the BESS is operating near to full load. However, noise from the solar farm is not expected to be intrusive.
- Rating noise levels are low overall and within all national and international guidelines for environmental noise levels that are typically applied within New Zealand. This would result in low risk of annoyance arising.
- We consider that overall, the solar farm would be reasonable in terms of the RMA.
- Compliance with the construction noise limits is expected to occur. A Construction Noise and Vibration Management Plan (CNVMP) could be considered to reduce effects on nearby properties.
- Conditions of resource consent have been recommended.

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1.0 INTRODUCTION

Marshall Day Acoustics has been engaged by Helios Energy Limited (Helios) to undertake a noise assessment for a proposed solar farm near Ongaonga, Central Hawkes Bay District.

This report addresses noise from the proposed operation and from construction. It is intended to form part of an application for resource consent. A glossary of terminology is included in Appendix A.

2.0 APPLICATION SITE

The proposed 100 MVA (AC) solar farm is located at Taylor Road, Ongaonga. The 228-hectare site is currently used for livestock grazing in several ownerships. Of the ownerships, only 126 Taylor Rd contains an existing dwelling.

Surrounding land use is also rural / farming. Ongaonga village is located approximately 1 kilometre north of the site. The Tukituki River is approximately 200 metres south of the site and the Ongaonga Stream is approximately 200 metres northeast of the site. The site is located approximately 1.7 kilometres southwest of Transpower's Waipawa substation.

Terrain of the site and surrounds is a mix of flat and sloping. Over the length of the site[1], elevation ranges from approximately 180 metres at the east boundary to 210 metres at the west boundary.

The proposed solar farm is well removed from the nearest dwelling receivers. The proposed key noise sources (inverters / BESS) are at least 350 metres from a dwelling.

Surrounding receivers are listed in Table 1 and depicted in Figure 1.

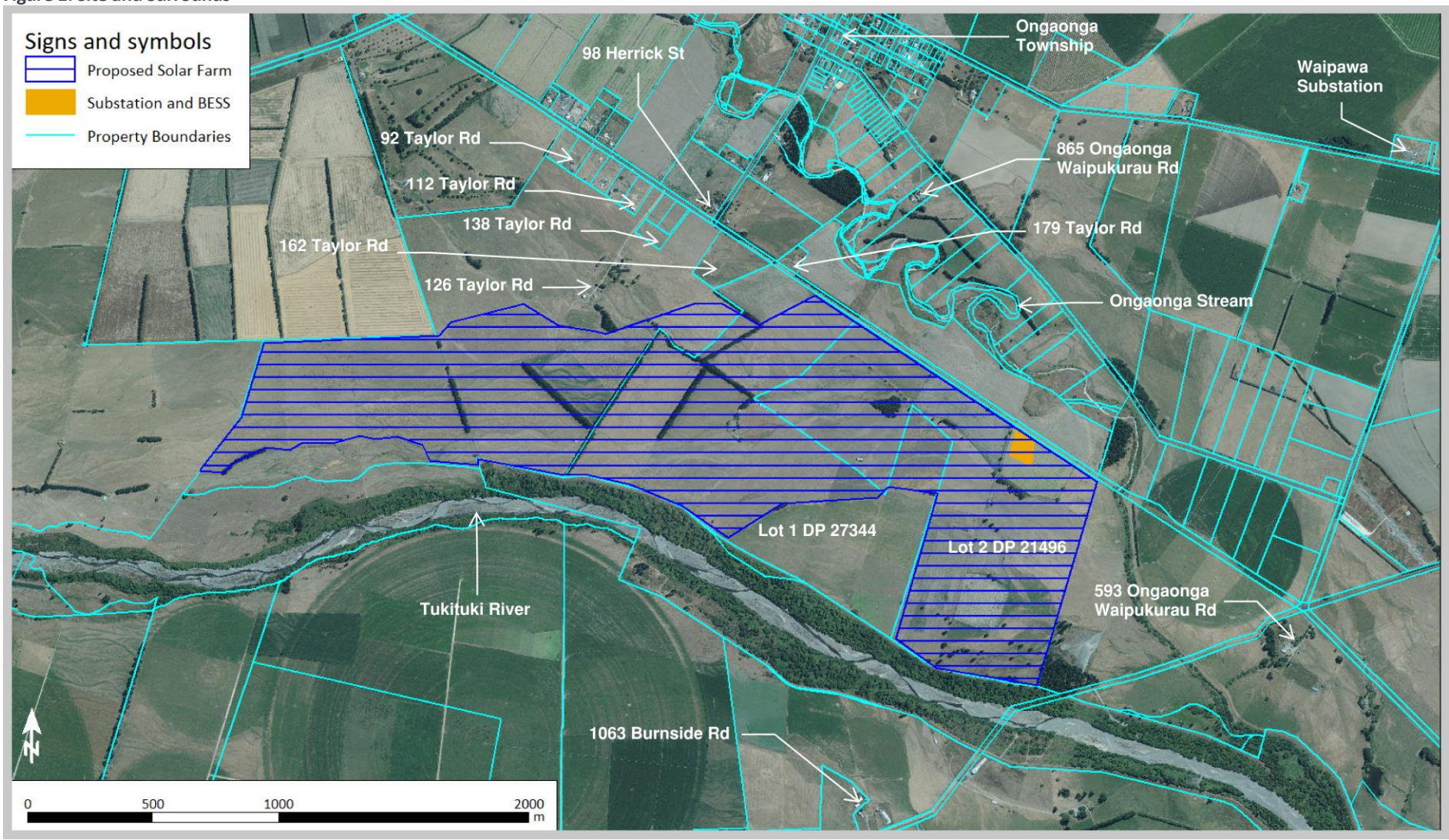
Table 1: Surrounding Receivers

Address	Use[1]	Approx distance of closest dwelling notional boundary (m) [1]	
		To solar farm boundary	To nearest key noise source (inverter / BESS)
Compliance receivers:			
92 – 112 Taylor Rd [2]	Rural Residential	430 - 570	640 - 810
128, 130 and 138 Taylor Rd [2]	Rural Residential	260 - 350	520 - 610
179 Taylor Rd	Rural Residential	110	350
98 Herrick St	Rural Residential	350	650
593 Ongaonga Waipukurau Rd	Farm Dwelling	890	>1000
865 Ongaonga Waipukurau Rd	Rural Residential	500	630
1063 Burnside Rd	Rural Residential	600	840
Other Receivers:			
126 Taylor Rd [3]	Farm Dwelling	230	400
162 Taylor Rd [4]	Grazing / Unbuilt	60	380

Note 1: Existing land use and distances have predominantly been determined from aerial photography and are indicative. The noise model uses specific distances between source and receiver.
Note 2: Some of these sites are unbuilt. In which case, noise levels have been calculated at the legal boundary of the most affected sites.
Note 3: Written approval is anticipated from this receiver as they are leasing land to Helios for part of the solar farm.
Note 4: This site is unbuilt, therefore it is not strictly a compliance receiver. Noise has been assessed at the legal boundary for informational purposes.

[1] Three kilometres in the east-west direction.

Figure 1: Site and Surrounds



3.0 PROPOSAL

Most of the approximate 228-hectare site would be used for the solar farm arrays and associated infrastructure.

Refer to Appendix B for a site map showing the proposed design.

3.1 Facility Description

Solar panel arrays would be installed across the site in rows spaced six to eight metres apart to allow access by equipment for maintenance. Access to the site would be off Taylor Road.

The key operational noise sources would be from the following plant.

- **26 decentralised inverters**. An inverter turns Direct Current (DC) created by the photovoltaic cells to alternating current (AC) current used in the electricity grid[2]. These inverters would be distributed throughout the farm and would be used in the generation of power from the solar arrays. The total generation power rating of the farm would be around 109 MW[3].
- **2,212 tracker motors** associated with the solar panel arrays. The individual solar panel arrays would be attached to tracker motors[4].
- **Battery Energy Storage System (BESS)** situated in the northeast area of the site. This is likely to comprise a series of 3 MW packaged battery units. This may comprise the following:
  - 28 Tesla Megapack Units; or
  - 14 Power Electronics FS4390K 4.39MW inverters with 28 Jinko Suntera battery units; or
  - other battery storage units as determined during detailed design.
- **Two 50MVA transformers** located near the BESS. The transformers would convert energy between 33kV and 110kV.
- **An electricity transmission line.** Energy generated from this system will be transferred to the existing Waipawa substation located approximately 1.7 kilometres to the northeast via a new 110kV overhead line.

Power generation at the solar farm would occur during daylight/sunshine hours. In summer, operating daylight hours could begin earlier than the prescribed[5] daytime period that begins at 7am, although this will be at low solar and inverter loads.

The BESS component of the farm may operate during the day and night periods. The battery storage will likely export and import AC energy to and from the grid. During periods of low demand, AC energy will likely be imported from the grid and stored in the batteries for later export – this can occur at night, normally for a period of a few hours. We understand that the BESS could occasionally operate near full load during the day or night, particularly during very hot days / nights in summer

[2] No specific inverter supplier has been selected at this stage of the project. There are two major manufacturers of inverters that are used on most solar projects (SMA and Power Electronics), although other manufacturers may be considered.

[3] This is the alternating current generation power. The power of each inverter is nominally 4200 kVA.

[4] Trackers consist of many solar panels on a frame that tilts vertically to align the panels to the sun throughout the day. The trackers are rotated around a central horizontal axis by a small DC motor (approximately 300 watts running at 24V DC). The motor is the main noise source associated with each tracker. The tracker motors are understood to operate intermittently during daylight hours and only for a short period as they are only required to make small incremental adjustments to the trackers. DC motors are quiet, even under continuous load and operation, and the collective sound power level of many tracker motors is not normally significant when considered over the total area of a solar farm site.

[5] Refer to Section 5 for discussion of the District Plan noise rules and statutory timeframes.

and when the batteries are being 'aggressively' charged or discharged. Generally, the BESS is expected to operate at lower loads (40 – 60%), especially in colder ambient temperatures. We have assessed noise for both operating scenarios.

3.2 Written Approvals

It is assumed that written approval will be obtained from the owner of 126 Taylor Road as they are leasing land to Helios for the solar farm site.[6]

3.3 Acoustic Mitigation

Acoustic mitigation such as enclosure or attenuation of the inverters is not considered necessary on this project to meet the night-time noise limits or to provide a reasonable level of acoustic amenity.

However, attenuation options for the inverters are available if needed, for example, some inverter manufacturers have shrouds / lined bends that can be provided to the inverter intake and discharge ventilation openings. These result in modest attenuation of overall A-weighted noise levels[7].

4.0 EXISTING NOISE ENVIRONMENT

Site visits to install and retrieve a noise logger were carried out on Friday 21 July 2023 and Tuesday 25 July 2023, respectively. Logged data was analysed for just over a 3-day period coinciding with settled weather. Attended measurements were also made, primarily during the second site visit. Weather during the second site visit was also settled with low wind and no rain.

The purpose of the measurements was to establish ambient and background noise levels representative of the site and surrounding sites. The logger measurement position (MP1) was within the proposed site boundary and approximately 500 metres south of Taylor Road and 500 metres north of the Tukituki River. It is considered representative of the area generally, especially sites distant from roads and influenced by river sound. During the attended measurement, the dominant noise sources at MP1 were the Tukituki River and birds.

To further characterise the ambient noise environment of the area, additional attended measurements were taken at MP2 (near 179 Taylor Road) and at MP3 (toward the west on Taylor Road and approximately 600 metres east of State Highway 50). At MP2 and MP3 birds and distant traffic were dominant noise sources.

Noise levels at all measurement positions were generally quiet and typical of a rural area with low human activity. No tonal noise sources were noted.

As the solar farm may operate outside the prescribed daytime period, logged ambient data has been analysed for the Central Hawkes Bay District Plan prescribed daytime and night-time periods[8]. Table 2 summarises the logged results. Table 3 summarises the attended measurement results.

Refer to Appendix D for a map showing the measurement positions, photographs, and a measured 48-hour data sample.

[6] Council must not, when considering the application, have regard to any effect on a person who has given their written approval to the application (Section 104 (3) of the Resource Management Act 1991).

[7] These solutions likely attenuate higher frequencies and may be effective at reducing tones from the inverter bridge circuit, therefore potentially having the added benefit of reducing the 'annoying' (special audible character) nature of the noise source. However, this information is not provided in the manufacturer's data.

[8] Prescribed daytime hours are: 0700 to 2200 hours. Prescribed night-time hours are: 2200 to 0700 hours. Refer to Section 5.0 for a discussion of the Operative and Proposed District Plan noise rules.

Table 2: Measured Ambient Noise Levels (logged)

Logger Position	Measurement		Overall Measured Level (dB) [1]			
	Start / End Date & Time	Duration	Daytime hours[2]		Night-time hours[2]	
			L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}
MP1 ~500 metres south of Taylor Road	21 July 2023 10pm to 25 July 7am	~ 3 days	55	33	36	33

Notes to Table 2:
(1) An explanation of technical terms is provided in Appendix A
(2) See footnote 7.

Table 3: Measured Ambient Noise Levels (attended)

Measurement Position	Measurement		Measured Level (dB) [1]			Noise Source [2]
	Start Date / Time	Duration min:sec	L_{Aeq}	L_{A90}	L_{AFmax}	
MP1	21 July 2023 12:23 pm	2:02	37	35	50	River, birds, distant cattle. Note: measurement interrupted due to light rain.
MP1	25 July 2023 2:46pm	15:02	33	29	62	Birds, river, cattle, distant aircraft, distant traffic, distant house construction.
MP2 (179 Taylor Rd)	25 July 2023 2:16pm	15:04	30	27	49	Birds, distant traffic, sheep, distant aircraft, distant house construction, insects, dog bark, cattle eating grass.
MP3 (west end of Taylor Rd)	25 July 2023 3:48pm	15:08	37	30	49	Distant traffic, birds, farm bike (mid-distance), cattle, dog bark, hammering, distant aircraft. Note: paused out four cars passing by on Taylor Rd and near farm bike activity.

Note to Table 3:
(1) An explanation of technical terms is provided in Appendix A.
(2) Dominant sources are underlined.

Table 2 shows that the logged daytime ambient noise level was 55 dB L_{Aeq}, and the night-time level was 36 dB L_{Aeq}. Both the daytime and night-time background noise levels were 33 dB L_{A90}. The background noise level is likely controlled by the Tukituki River.

Table 3 shows the attended daytime ambient levels at all measurement positions ranged from 30 to 37 dB L_{Aeq}, substantially lower than the logged daytime ambient level (55 dB L_{Aeq}). The graph of logged data over a 48-hour period (Appendix D), shows significant variability in daytime ambient levels, generally ranging from 35 – 70 dB L_{Aeq}. This suggests periods of high noise (possibly due to nearby farm activity) plus periods of very low daytime noise. The attended measured daytime background noise levels ranged from 27 to 35 dB L_{A90}, within range of the logged background level (33 dB L_{A90}).

Attended measurement levels were similar at all measurement positions.

5.0 NOISE PERFORMANCE STANDARDS

The Operative Central Hawkes Bay District Plan (1 May 2003) has been reviewed and a 'decisions' version of the Proposed District Plan was publicly notified on 25 May 2023. The Operative District Plan and Proposed District Plan provide zoning and noise assessment standards for the site.

5.1 Zoning

The application site is situated on land zoned *Rural* in the Operative District Plan, and *Rural Production* in the Proposed District Plan, as are surrounding sites. Refer to the zoning maps provided in Appendix C.

5.2 Noise Limits

Operative District Plan (Rule 4.9.11)

The relevant limits are:

- 55 dB L_{A10} - 6:00am - 11.00pm Monday to Saturday
- 45 dB L_{A10} - at all other times
- 75 dB L_{Amax} - at all other times

These apply at and within the notional boundary of sites in the *Rural* zone. Refer to Appendix C for a copy of Rule 4.9.11.

Proposed District Plan (Rule NOISE-S4)

The relevant limits are:

- 55 L_{Aeq} - 0700 - 2200 hours
- 45 L_{Aeq} / 70 L_{Amax} - at all other times

These are to be measured and assessed within the notional boundary of sites in the *Rural Production* zone. Refer to Appendix C for a copy of Rule NOISE-S4.

The Proposed District Plan noise rule is generally more conservative than the Operative District Plan noise rule. It is also more in line with noise rules used at other districts throughout New Zealand and the most recent NZS6802 standard[9]. We recommend use of the Proposed District Plan noise rule for this assessment – compliance with the proposed version of the District Plan will also result in compliance with the operative version.

The constraining limit is the night-time limit, 45 dB L_{Aeq}, as power may be generated during the prescribed night period (before 7am during longer daylight hours), and the BESS may also operate at night. The L_{AFmax} limit will not constrain this operation as any solar farm noise emissions will be fairly constant in level and will not generate loud noise events.

5.3 Measurement and Assessment Standards

Section NOISE-S1 of the Proposed District Plan states that noise will be measured and assessed using NZS 6801:2008 *Acoustics – Measurement of Environmental Sound* and NZS 6802:2008 *Acoustics – Environmental Noise*. These standards are in line with the proposed noise limit measurement parameter (L_{Aeq}) and are the most recent versions of the standard. We recommend use of these standards rather than the 1991 versions referred to in the Operative District Plan.

[9] Although we note that it does not allow for averaging during the day-time period.

5.4 Construction Noise

Section NOISE-S5 of the Proposed District Plan states that construction noise must comply with the provisions of NZS6803:1999 *Acoustics - Construction Noise*. This is the most recent version of the construction noise standard, and we consider it the appropriate standard to use. NZS6803 construction noise guidelines are given in Appendix E.

5.5 Resource Management Act

Under the provisions of the Resource Management Act 1991 (RMA) there is a duty to adopt the best practicable option to ensure that noise (including vibration[10]) from any development does not exceed a reasonable level. Specifically, Sections 16 and 17 reference noise effects as follows.

Section 16 states that "every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level".

Section 17 states that "every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person, whether or not the activity is in accordance with –

(a) Any of sections 10, 10A, 10B and 20A; or

(b) A national environmental standard, a rule, a resource consent, or a designation".

6.0 OPERATIONAL NOISE LEVELS

6.1 Modelling Methodology and Noise Sources

We prepared a noise model using SoundPLAN® environmental noise modelling which considers factors such as the terrain, screening by buildings, and ground effect. Calculations have been carried out using ISO 9613-2:1996 "*Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*". Noise levels have been calculated under meteorological conditions that are favourable to sound propagation[11] and represent the 'worst case' propagation situation[12].

It is assumed that the generation part of the solar farm would primarily operate during the prescribed daytime period from 7am to 10pm. In summer, the solar farm generation may also operate before 7am (prescribed night period). As the solar farm could operate for more than 80% of the prescribed daytime period (particularly during summer), no duration correction[13] has been applied. The BESS is assumed to be available to operate at any time and would be used to store and discharge electricity based on the demand and electricity price variation throughout the day and night.

The main noise sources from the proposed solar farm would be the decentralised generation inverters (distributed across the farm among the photovoltaic panels) and the BESS.

When the solar farm is generating electricity, we expect that the decentralised inverters will work at lower power during times of low solar gain (early morning / evening) and at full power during times

[10] RMA 1991 Part 1 Section 2 Interpretation: Noise includes vibration.

[11] These are set out in ISO9613-2 and represent downwind or temperature inversion conditions.

[12] Under most daytime meteorological conditions, noise levels will be lower than calculated. This is because when the solar farm is operating at full generation, it will be during periods of high solar gain (typically during the middle part of the day). In general, high solar gain conditions correspond with conditions that are not favourable to sound propagation, as sound will refract upward when air temperatures reduce with increasing altitude (temperature lapse). In temperature lapse conditions, noise levels are expected to be around five decibels lower than calculated for the temperature inversion condition.

[13] In accordance with NZS 6802:2008 and the Proposed District Plan daytime noise rule of 55dB $L_{Aeq(15\text{-}min)}$.

of high solar gain. We have assumed that prior to 7am the inverters will work at approximately 10% load. We understand that inverter noise levels will reduce at low loads. A reduction in sound power level of four decibels has been allowed for at 10% power output. This assumption should be confirmed with the manufacturers or through measurement once the solar farm is commissioned.

Inverter units will likely have directivity[14]. We have calculated these for south directivity (the noisiest side, south facing). Other orientations may change received noise levels. Orienting inverter units with the noisiest side(s) away from the nearest receivers would be beneficial in terms of noise emissions.

Noise levels generated by the BESS have been derived from data from several manufacturers. There is wide variability in noise data between manufacturers. We have assessed noise levels based on both a typical level of noise emission (50% fan load for the loudest BESS unit reviewed) from the BESS and a reasonable worst-case noise emission (near 100% fan load for the loudest BESS unit reviewed). The fan load will depend on the ambient air temperature and is expected to be lower through the winter.

Inverter and BESS noise levels will reduce at low fan speeds[15].

Manufacturers data shows that the solar farm central inverters and BESS have tonal characteristics at various frequencies. Available data shows that inverter tonal character is eliminated at low loads (10% power output). However, we have conservatively applied a tonality correction to all periods.[16]

The following sound power data (Table 4) has been used in the preparation of this noise model. Data has relied on advice given by a range of manufacturers or from previous measurements carried out by Marshall Day Acoustics. The applicant must confirm this data with suppliers prior to final procurement of power infrastructure.

Table 4: Sound Power Levels

Noise Source	Sound Power Level dBA re 10^{-12} Watts	Number of Units	Directivity	Operation time
Decentralised inverters (associated with the PV panels)				
DC / AC inverter 4 MVA	93 dB L_{WA} (AC end) 88 dB L_{WA} (DC end)	26	Included	Sunshine hours
Tracker modules	74 dB L_{WA} (emission when moving) = 98 (total L_w for all trackers across total farm)	2212	None	Sunshine hours

[14] Depending on the orientations of the air intake and outlet on the final units selected.

[15] The simplified relationship between fan speed and noise is 50*log(RPM1/RPM2). Data from manufacturers typically shows a strong correlation between reduced fan speeds and reduced noise levels.

[16] In accordance with NZS6802:2008, a five-decibel penalty has been applied for tonality. Tonality from inverters is expected to occur at higher frequencies. Tonality from the BESS is expected to occur at both low and high frequencies. Higher frequencies are attenuated with distance due to air and ground absorption, as well as topographical screening. Given the distances involved, tonality may not be audibly present at the receivers, However, we have allowed for tonality to be present at low levels at all the receiver locations.

Noise Source	Sound Power Level dBA re 10^{-12} Watts	Number of Units	Directivity	Operation time
Containerised Battery Storage (BESS)	Fan load (50%): 94 dB L_{WA} Reasonable worst-case fan load: 99 dB L_{WA}[17]	28	None	Daytime and night-time (normally for a few hours at night)
Auxiliary Transformers (50MVA)	90 dB L_{WA}	2	None	All times

6.2 Noise Level Calculations

Noise levels have been calculated at the notional boundaries of the nearest receivers.

We have calculated 'daytime' and 'night-time' noise levels on the assumption that the decentralised inverters will operate at lower power during the prescribed night period (before 7am). We have also calculated 'daytime' and 'night-time' scenarios for the BESS operating at 'typical' load and at a 'reasonable worst-case' load.

Table 5 summarises the results of our calculations.

Table 5: Calculated Noise levels

Receiver Location	Noise Limits [daytime / night] (dB L_{Aeq})	Calculated Rating Noise Level (dB L_{Aeq})			
		Typical BESS fan load		Worst-case BESS fan load	
		Day	Night	Day	Night
Compliance receivers:					
92 – 112 Taylor Rd [1]	55 / 45	28 - 30	27 - 29	31 - 33	30 - 33
128, 130, 138 Taylor Rd [1]	55 / 45	31 - 32	30 - 31	34 - 35	34
179 Taylor Rd	55 / 45	35	35	39	39
98 Herrick St	55 / 45	31	31	35	35
593 Ongaonga Waipukurau Rd	55 / 45	33	33	38	38
865 Ongaonga Waipukurau Rd	55 / 45	34	34	39	39
1063 Burnside Rd	55 / 45	33	32	37	37
Other receivers:					
126 Taylor Rd [2]	55 / 45	32	31	35	34
162 Taylor Rd [3]	55 / 45	35	34	38	37

Note 1: Noise levels have been calculated at the legal boundary of the most affected (unbuilt) sites.
Note 2: Written approval is anticipated from this receiver as they are leasing land to Helios for part of the solar farm.
Note 3: This site is unbuilt, therefore it is not strictly a compliance receiver. Noise has been assessed at the legal boundary for informational purposes.

[17] BESS units show a very wide range of noise emissions. The highest fan load noise level in this table represents the reasonable worst case noise emission for the loudest BESS units reviewed. Many manufacturers indicate lower noise levels.

As per Table 5, our calculations show that for the compliance receivers:

Daytime

- both the 'typical' and 'reasonable worst-case' BESS fan loads readily comply with the District Plan noise limit (55 dB L_{Aeq})
- for the 'typical' BESS scenario, calculated noise levels are within range of the attended measured daytime ambient noise levels (30 – 37 dB L_{Aeq}) and well below (up to 20 dB below) the logged daytime ambient noise level (55 dB L_{Aeq}). Calculated levels are also within range of the logged background noise level (33 dB L_{A90})
- for the 'reasonable worst-case' BESS scenario, calculated noise levels are up to two decibels higher than the attended measured daytime ambient noise levels and well below (up to 16dB) the logged daytime ambient noise level. Calculated levels are up to four decibels higher than the logged background noise level (33 dB L_{A90})

Night-time

- both the 'typical' and 'reasonable worst-case' BESS fan loads readily comply with the District Plan noise limit (45 dB L_{Aeq})
- for the 'typical' BESS scenario, calculated noise levels are less than the night-time ambient noise level (36 dB L_{Aeq}). Calculated levels are up to two decibels above the background noise level (33 dB L_{A90})
- for the 'reasonable worst-case' BESS scenario, calculated noise levels are up to three decibels higher than the night-time ambient noise level (36 dB L_{Aeq}). Calculated levels are up to six decibels above the background noise level (33 dB L_{A90}).

6.3 Operational Traffic

Operational traffic is not expected to be significant. Based on our experience with other solar farms, we anticipate that the likely number of vehicle movements per day would be about 12, with no truck movements in the night period. This level of vehicle activity would not risk breaching the noise limits.

7.0 SUMMARY OF OPERATIONAL NOISE EFFECTS

Rating noise levels at the nearest receivers readily comply with the Proposed District Plan noise rules (and with the Operative District Plan noise rules) for all periods of the day and all assessed scenarios of operation.

During the daytime, rating noise levels are within range of the measured ambient noise levels (and up to four decibels above the logged background noise level). We expect that daytime noise would be reasonable and would have minimal effect on the existing acoustic environment.

During the night-time (and under a worst-case operation scenario), rating noise levels are up to three decibels higher than the night-time ambient noise level and up to six decibels above the background noise level. We expect that noise from the solar farm will be audible at night at the nearest receivers. Noise from the solar farm is most likely to be audible during times of low background noise (low wind and low insect activity) and / or when the BESS is operating with higher fan speed (typically during summer). However, noise from the solar farm is not expected to be intrusive.

Rating noise levels are low overall and within all national and international guidelines for environmental noise levels that are typically applied within New Zealand. This would result in low risk of annoyance arising.

We consider that overall, the solar farm would be reasonable in terms of the RMA.

8.0 CONSTRUCTION NOISE LEVELS

8.1 On-site Construction

Construction of the solar farm is likely to involve the following:

- delivery of panels, inverters and other infrastructure, requiring trucks and small cranes
- earthworks would occur using trucks, loaders and excavators
- a 'Vermeer PD10 Pile Driver' to impact drive the support piles into the ground.

The total duration of solar farm construction on this site is expected to be up to 12-months and to take place between 7:30 to 18:00 hours, Monday to Saturday. The total duration of piling is likely to be longer than 20 weeks, however the activity will not be stationary during this time and piling in any one location will occur for less than 20 weeks. Based on section c7.2.1 of NZS 6803:1999, the appropriate NZS 6803 noise limit is 75 dB L_{Aeq}.

The noise limits apply at 1 metre outside the façades of occupied buildings.

All significant equipment likely to be used on the project is listed in Table 6. The sound levels given are based on measurements we have made of similar plant or from BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites* Part 1: Noise.

Table 6: Activity Specific Noise Levels at 1m from a building façade (without screening)

Item/Activity	Operating Sound Power Level (dB L_{WA})	Noise Level (dB L_{Aeq})				75dBA Limit Setback (m)
		110m	250m	350m	500m	
Large earthmoving trucks (operating within the site)	108	59	50	46	43	25m
Excavators and other earthmoving plant	103	54	45	41	38	14m
Vermeer PD10 Pile Driver (impact piling)	123	74	65	61	58	100m
Concrete truck & pump	103	54	45	41	38	14m
Truck idling	91	42	33	29	26	4m

The closest dwelling to the solar farm (PV panel extent) is 179 Taylor Road, approx. 110 metres from the site, and beyond the setback distances for all anticipated construction activities. Construction activity would therefore comply with the 75 dB L_{Aeq} noise limit. There would be no perceptible vibration.

The nearest neighbouring property is 162 Taylor Road. However, this site does not contain a dwelling and therefore is not subject to the construction noise standard limits.

8.2 Construction Vehicles on Public Roads

Truck and light vehicle movements will occur on Taylor Road and the surrounding road network due to construction activities. These are public roads and the District Plan construction noise and vibration limits do not technically apply to activities on these roads, although we note that vehicles using these roads would generate noise levels that largely comply with NZS6803 guidelines.

We expect that during construction, the number of vehicle movements in the area would increase significantly. This is because there are currently few vehicles using these roads. During a 15-minute measurement adjacent to Taylor Road and near State Highway 50 (on a Tuesday at 4pm) (MP3), only

four vehicles passed by. It is possible that construction related traffic could increase traffic noise levels on these roads perceptibly; however, traffic noise levels would still remain relatively low.

8.3 Construction Noise and Vibration Management

A Construction Noise and Vibration Management Plan (CNVMP) is often recommended as a condition of resource consent where an activity cannot comply with the guidelines in NZS 6803:1999 (or to manage effects even when compliance with the standard is expected to be achieved). In this case, compliance is expected to occur, although compliance may be marginal when piling is occurring at the closest part of the site to 179 Taylor Road.

Regardless of compliance, construction noise will be readily audible at nearby dwellings. A CNVMP is not necessarily required but could be considered to reduce effects or to mitigate against a very brief exceedance of the construction noise limit.

Typically, a CNVMP includes measures such as: a process for communication with neighbours regarding timing of particularly noisy activities, mitigation options (if needed), general best-practice operating procedures to reduce noise, and a process for handling complaints.

9.0 RECOMMENDED NOISE CONDITIONS

1. The noise level from the operation of the solar farm shall meet the following noise limits at the notional boundary of dwellings existing at the time of consent (as shown on Map X) on another site in the *Rural / Rural Production* zone:

   - 0700 - 2200 hours – 55 L_{Aeq}
   - All other times – 45 L_{Aeq} / 70 L_{AFmax}

   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.

2. Construction activities shall not exceed the limits recommended in, and shall be measured and assessed in accordance with, New Zealand Standard NZS 6803: 1999 “Acoustics – Construction Noise” and German Standard DIN 41503:2016 Vibration in buildings – Part 3: Effects on structures [vibration]. If an exceedance is possible, it must be managed through a Construction Noise and Vibration Management Plan (CNVMP)

APPENDIX A GLOSSARY OF TERMINOLOGY

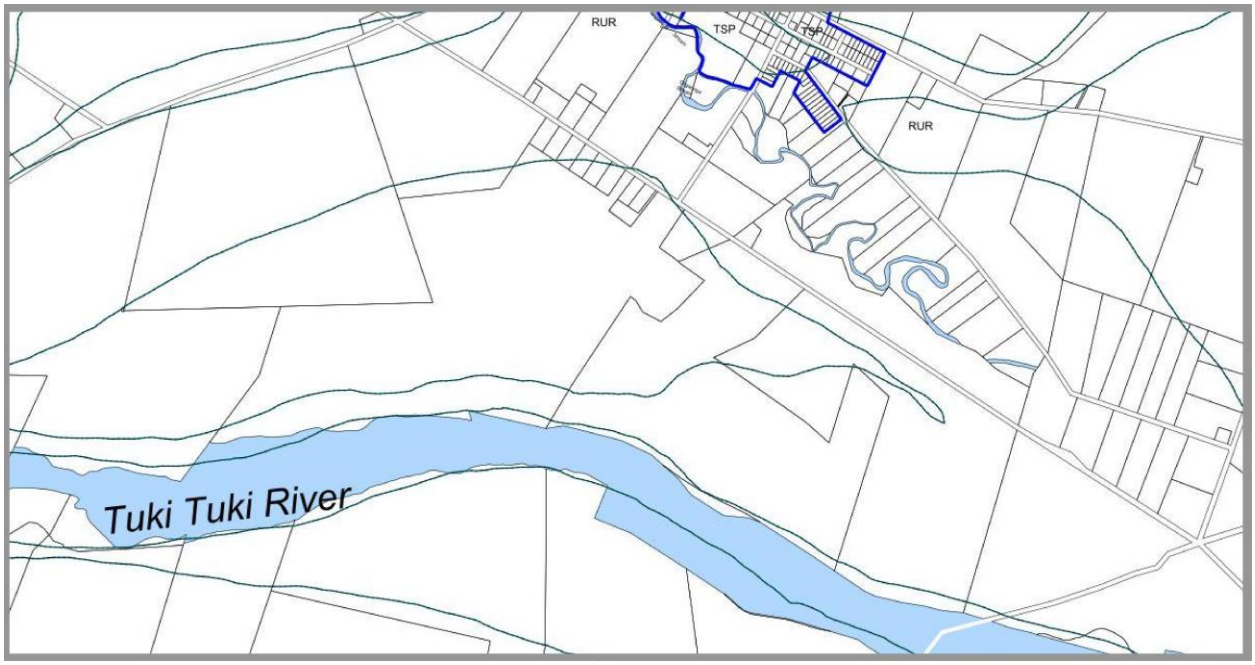
Background sound	The sound that is continuously present in a room or outdoor location. Often expressed as the A-weighted sound level exceeded for 90 % of a given time period i.e. L_{A90}.
Emission	Sound that is generated by and propagates away from a source.
Frequency	Sound occurs over a range of frequencies, extending from the very low (e.g. thunder) to the very high (e.g. mosquito buzz). Measured in units of Hertz (Hz). Humans typically hear sounds between 20 Hz and 20 kHz. High frequency acuity naturally reduces with age. Most adults can hear up to 15 kHz.
Hertz (Hz)	The unit of frequency, named after Gustav Hertz (1887-1975). One hertz is one pressure cycle of sound per second. One thousand hertz – 1000 cycles per second – is a kilohertz (kHz).
Immission	Sound received at one location from a source(s) at another location(s).
Initial sound	Total sound present in an initial situation before a change to the existing situation occurs. This definition is from ISO 1996.
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
Notional boundary	A line 20 metres from any side of a dwelling, or the legal boundary where this is closer to the dwelling. This definition is from NZS 6802:2008.
Octave band	The interval between one frequency and its double. Sound is divided into octave bands for analysis. The typical octave band centre frequencies are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz.
Prescribed time frame	'Daytime', 'night-time', 'evening', or any other relevant period specified in any rule or national environmental standard. This definition is from NZS 6802:2008.
Rating level	A derived level used for comparison with a noise limit. Takes into account any and all corrections described in NZS 6801 and NZS 6802, e.g. duration, special audible character, residual sound etc. This definition is from NZS 6802:2008.
Reference time interval	The time interval over which the time average A-weighted sound pressure levels is determined. Typically 15 minutes. This definition is from NZS 6802:2008.
Residual sound	The total sound remaining at a given position in a given situation when the specific sounds under consideration are suppressed or are an insignificant part of the total sound. This definition is from NZS 6802:2008.
Special audible characteristics	Distinctive characteristics of a sound that make it more likely to cause annoyance or disturbance. A penalty of up to 5 decibels can be applied when

	assessing sounds with SAC Examples are tonality – a hum or a whine) and impulsiveness – bangs or thumps.
Specific sound	A component of total sound that can be identified as associated with a specific source. Specific sound is the 'sound of interest' in an assessment. This definition is from NZS 6802:2008.
A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
C-weighting	A frequency weighting used to approximate the response of the human ear to sounds with strong low frequency components (typically between 25 and 125 Hz) at high noise levels (typically greater than 85 decibels).
dB	Decibel. The unit of sound level.
L_{A10}	The A-weighted sound level exceeded for 10% of the measurement period, measured in dB. Commonly referred to as the average maximum noise level.
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{A95}	The A-weighted sound level exceeded for 95 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period. Usually measured with a fast time–weighting i.e. L_{AFmax}

APPENDIX B SITE LAYOUT PLAN

APPENDIX C DISTRICT PLAN ZONE MAPS AND NOISE RULES

C1 Operative Central Hawkes Bay District Plan Zone Map and Noise Rules



Note: the area outside the town boundary (dark blue line) is zoned RUR (Rural).

Rural Zone Noise Rules

4.9.11 Noise

On any site, activities, , shall be conducted such that the following noise levels are not exceeded at nor within the notional boundary of any residential unit, other than residential units on the same site as the activity:

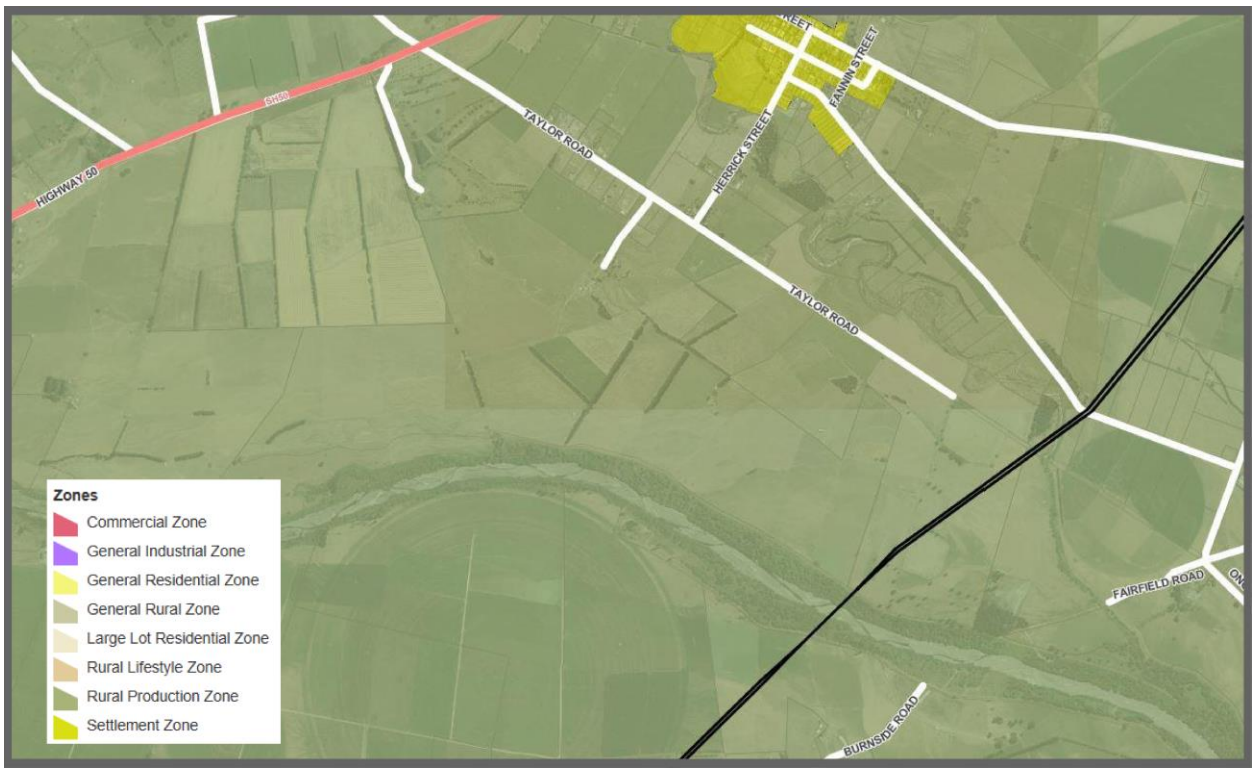
- 55dBA L10 - 6:00am - 11.00pm Monday to Saturday
- 45dBA L10 - at all other times
- 75dBA Lmax - at all other times

Exemptions

i Residential, Farming and Forestry Activities shall be exempt from the above provided that the activity shall comply with the requirements of Section 16 of the Resource Management Act.

ii The 75dBA Lmax noise limit shall not apply to on-site sirens required by Service Emergency Service Activities, provided that the activity shall comply with the requirements of Section 16 of the Resource Management Act.

C2 Proposed Central Hawkes Bay District Plan Zone Map and Noise Rules



Part 2 District Wide Matters

General District Wide Matters

NOISE - Noise

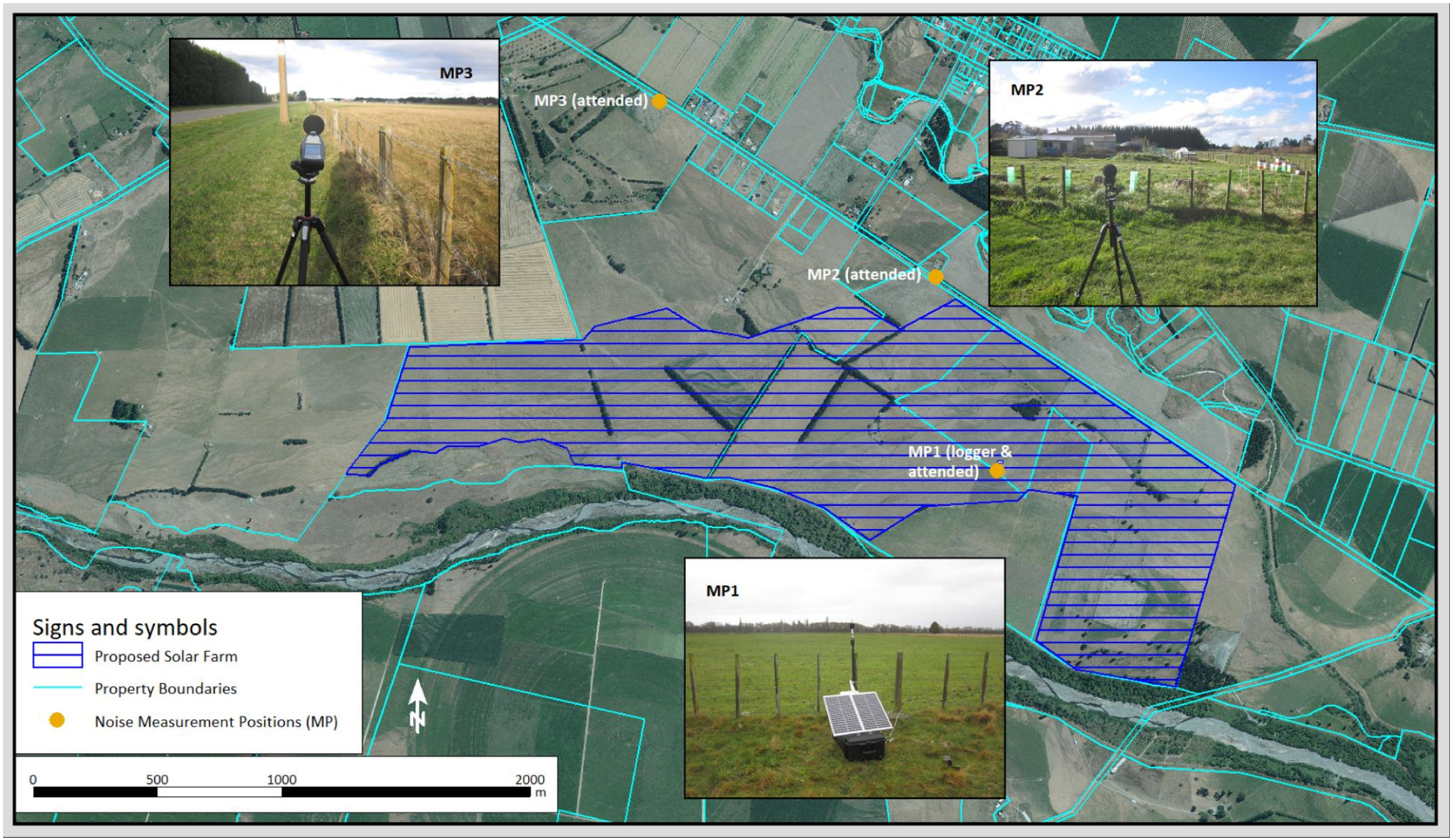
NOISE-R1 Emission of noise	
All Zones	**1. Activity Status: PER** **Where the following conditions are met:** a. Compliance with: i. NOISE-S1; ii. NOISE-S2; iii. NOISE-S3; iv. NOISE-S4; and v. NOISE-S5.

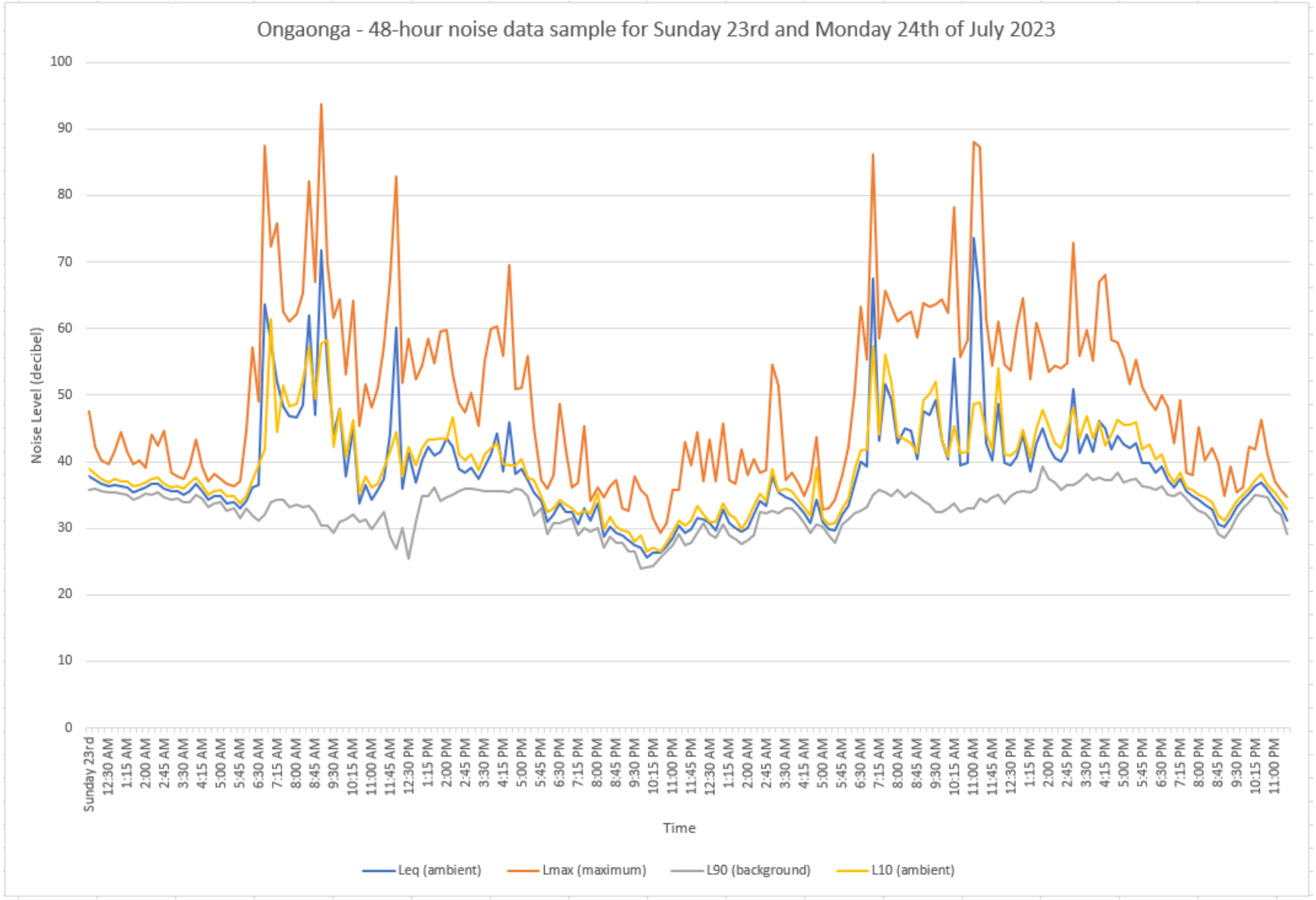
NOISE-S1 Measurement and Assessment of Noise	
1. General	1. Noise will be measured and assessed using the following standards: a. NZS 6801:2008 Acoustics – Measurement of Environmental Sound b. NZS 6802:2008 Acoustics – Environmental Noise c. **NZS 6803:1999 Acoustics – Construction Noise** d. NZS 6805:1992 Airport Noise Management and Land Use Planning e. NZS 6806: 2010 Acoustics – Road Traffic Noise: New and altered roads f. NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas g. NZS 6808: 2010 Acoustics – Wind farm noise h. NZS 6809:1999 Acoustics – Port Noise Management and Land Use Planning 2. Noise levels will be measured and assessed within the site boundary of the noise receiver unless specified otherwise. The assessment position for houses, dwellings and habitable buildings in the General Rural Zone, the Rural Production Zone and the Rural Lifestyle Zone is within the notional boundary as defined in NZS6801. *Note: When it becomes evident a measurement location is not suitable, Council may, through the resource consent process, agree to the use of an alternative measurement location.*

NOISE-S4 Noise Limits – Zone Specific	
Receiving Zone(s):	
General Rural Zone **Rural Production Zone**	4. Noise from any activity (other than those specific activities in NOISE-S5) must not exceed the following limits (dB) v zones: a. To be measured and assessed within the notional boundary: i. 0700 - 2200 hours – 55 $L_{Aeq(15\ min)}$ ii. All other times – 45 $L_{Aeq(15\ min)}$ / 70 L_{Amax}

NOISE-S5 Exemptions and Noise Limits for Specific Activities. *Note: Regardless of the exemptions below, all land uses are subject to section 16 and Part 12 of the RMA.*	
All Specific Activities listed under this standard	1. Noise shall be measured within the site boundary of a receiving site, or within the notional boundary of rural dwellings or habitable buildings (where stated)
Construction	2. Exempt from NOISE-S4. Must comply with the provisions of NZS6803:1999 – Construction Noise.

APPENDIX D NOISE MEASUREMENT POSITIONS AND LOGGED RESULTS





APPENDIX E CONSTRUCTION NOISE RULES (NZS6803:1999)

NZS6803:1999 sets out the following noise limits:

"Residential zones and dwellings in rural areas:

Table 2 – Recommended upper limits for construction noise received in residential zones and dwellings in rural areas

Time of week	Time period	Duration of work					
		Typical duration (dBA)		Short-term duration (dBA)		Long-term duration (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and public holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

"Industrial or commercial areas:

Table 3 – Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year

Time period	*Duration of work*		
	Typical duration	***Short-term duration***	***Long-term duration***
	L_{eq} (dBA)	*L_{eq} (dBA)*	*L_{eq} (dBA)*
0730-1800	*75*	*80*	*70*
1800-0730	*80*	*85*	*75*

Notes in the standards to the tables above:

7.2.5

The night time limits in Table 2 shall apply to activities carried out in industrial or commercial areas where it is necessary to prevent sleep interference, specifically where there are residential activities, hospitals, hotels, hostels, or other accommodation facilities located within commercial areas. The limits in Table 2 may also be used to protect other specific noise sensitive activities at certain hours of the day.

7.2.6

One major factor which should be considered is whether there is a relatively high background sound level (L_{90}) due to noise from sources other than construction work at the location under investigation. In such cases limits should be based on a determination of the existing level of noise in the area (a "background plus" approach).

7.2.7

Where there is no practicable method of measuring noise outside a building, the upper limits for noise measured inside the building shall be the levels stated in tables 2 and 3 minus 20 dBA. This is considered to be a typical value for the sound reduction normally achieved in New Zealand buildings with doors and windows closed."