

APPENDIX 10 ACOUSTIC ASSESSMENT





ASSESSMENT OF NOISE EFFECTS

MASTERTON SOLAR AND ENERGY STORAGE FARM WAINGAWA

> PREPARED FOR NZ Clean Energy Ltd

> > DATE 27 February 2024



Assessment of noise effects prepared by Styles Group for NZ Clean Energy Ltd.

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Executive summary

Styles Group has predicted and assessed the noise effects from the construction and operation of the proposed Masterton Solar and Energy Storage Farm (**MSES**) at 3954A State Highway 2 (the **Site**). This report has been prepared to accompany the resource consent application.

We have used noise modelling software to predict the cumulative noise emissions from the operation of electro-mechanical plant in the Battery Energy Storage System (**BESS**) and substation area and from the inverter stations distributed throughout the photovoltaic (**PV**) array.

The noise modelling demonstrates that the proposal can comply the noise limits in the Operative and Proposed District Plan when measured and assessed at all existing notional boundaries on adjacent sites. Noise levels from all other operational and site maintenance activities will be managed to comply with the Operative and Proposed District Plan noise limits

We have recommended a condition of consent requiring the applicant to prepare and submit a Construction Noise Management Plan (**CNMP**). The CNMP will set out the specific noise mitigation measures required to ensure that noise can be managed to comply with the guideline noise limits in NZS 6803:1999: *Acoustics – Construction Noise* at all adjacent receivers.

We have recommended conditions of consent based on our findings.



1.0 Introduction

NZ Clean Energy Ltd has engaged Styles Group to predict and assess the noise effects from the construction and operation of the proposed Masterton Solar and Energy Storage Farm (**MSES**) at 3954A State Highway 2 (the **Site**).

This report includes:

- An assessment of the construction and operational noise levels in accordance with the Operative Wairarapa Combined District Plan (**ODP**) and the Proposed Wairarapa Combined District Plan (**PDP**) noise standards
- ii. Recommended conditions of consent.

This report should be read in conjunction with the application site plans and the Assessment of Environmental Effects. A glossary of acoustical terms used within this document is attached as Appendix A.

2.0 The proposal

NZ Clean Energy Ltd propose to construct, operate and maintain a 138Ha agrivoltaic solar farm that will generate renewable electricity using photovoltaic technology. The solar farm will connect to the national grid via Transpower's Masterton substation located at 113 Cornwall Road.

The project will involve the following noise sources:

- Construction noise over a period of approximately 12-18 months (worst-case)
- Operational noise from the electro-mechanical plant inside the Battery Energy Storage System (BESS) and substation area and from the inverter stations distributed throughout the photovoltaic (PV) array. Noise is primarily generated from the thermal management systems (air cooling fans) contained within the plant. We have used noise modelling software to predict the cumulative noise levels from plant across the surrounding environment.
- Operational noise from tracking motors¹ that enable the PV panels to move and follow the movement of the sun during the day.
- Occasional maintenance activities typically involving quad bike or small farm utility vehicles. The solar farm will be operated by up to three staff and the site will be grazed by sheep. Noise from operation and maintenance activities (including vehicle movements) will be intermittent and generate a low level of noise.

Figure 1 displays the site layout. Most of the noise generating electro-mechanical plant (transformers, central inverters and batteries) are consolidated within the proposed substation

¹ Tracking systems typically utilise a 24V DC motor



and BESS area. There are approximately twelve noise-generating solar inverter stations distributed throughout the PV array.



Figure 1 MSES Layout

3.0 The zoning of the Site and surrounding area

Figure 2 displays the ODP zoning arrangements across the Site and surrounding land. The Site and the adjacent land to the north-western, south-eastern and western boundaries are zoned Special Rural. The land to the south of the site is zoned Primary Production. State Highway 2 (**SH2**) runs along the north-western boundary. The land on the northern side of SH2 is zoned Industrial. Transpower's Masterton substation is located on the northern side of Cornwall Road.





Figure 2 ODP Zoning of the Site and surrounding area

4.0 Receivers

The Site is located in the context of a rural environment with a low intensity of residential development surrounding the Site. SH2 separates the Site from the Industrial Zone to the north-west.

The District Plan controls the noise levels that are received at the notional boundary² of any residential dwelling in a Rural Zone. The construction noise standards apply when measured and assessed³ 1m from the façade of any occupied building.

Figure 3 and Table 1 overleaf identify the closest receivers. The table identifies whether the site is vacant or occupied by a residential unit and provides approximate separation distances between the receiver and the closest proposed operational noise source and the closest potential area of construction work.

Vacant sites are denoted with an asterisk in Figure 3 and Table 1.

² Defined by the ODP as - A line 20 metres from the wall of a habitable building used for residential purposes. If the site boundary is closer than 20 metres to the building at any point, the site boundary is to be treated as the notional boundary at that point.

³ In accordance with New Zealand Standard NZS 6803:2008 Acoustics - Construction Noise





Figure 3 and Table 1- Adjacent receivers

Receiver ID	Receiver address/ Legal description	Residential dwelling?	Operational noise: Separation distance from notional boundary to closest noise source	Construction Noise: Separation distance from closest construction work to building façade
		Со	nwall Road	
A*	4022 SH2	Balance Agrinutirents fertliser depot	No notional boundary	>100m
B*	51 Cornwall Road Lot 2 DP 325931	No- vacant site (53Ha)	No notional boundary	No notional boundary
C*	99 Cornwall Road Lot 1 DP 75496	No- vacant site (10ha)	No notional boundary	No notional boundary
D*	Lot 1 DP 7208	No – Transpower NZ Ltd substation	No notional boundary	No notional boundary
		Н	ughes Line	
E	573 Hughes Line	Yes	>450m to closest plant in the array >500m to substation/ BESS area	>100m



Receiver ID	Receiver address/ Legal description	Residential dwelling?	Operational noise: Separation distance from notional boundary to closest noise source	Construction Noise: Separation distance from closest construction work to building façade	
F	577 Hughes Line	Yes	>450m to closest plant in the array >500m to substation/ BESS area	>100m	
G	558 Hughes Line	Yes	>400m to closest plant in the array >670m to substation/ BESS area	>120m	
н	542 Hughes Line	Yes	>320m to closest plant in the array >700m to substation/ BESS area	>130m	
I	532 Hughes Line	Yes	>320m to closest plant in the array >700m to substation/ BESS area	>130m	
J	510 Hughes Line	Yes	>225m to closest plant in the array >800m to substation/ BESS area	>180m	
К	271 Perrys Toad	Yes	>1000m	>2000m	
East Taratahi Road					
L	61 East Taratahi Road	Yes	>500m to closest plant in the array >1400m to substation/ BESS area	>500m	
		Wi	iltons Road		
M*	Lot 200 DP 571486	No	No notional boundary	No notional boundary	
			SH2		
N	3920 SH2 Lot 1 DP 27627	Yes	>100m to closest plant in the array >500m to substation/ BESS area	>30m	
0	3954A SH2 (part of the parent site- written approval provided)	Yes (dwelling currently vacant)	>100m to closest plant in the array >500m to substation/ BESS area	30m	
Industrial Zone receivers	Various	No	>150m to closest plant in the array>400m to substation/ BESS area	>45m	



5.0 Operational noise standards applying to the proposal

5.1 Operative District Plan

Rule 4.5(f) *Noise limits* controls the level of noise generated from a site in a Rural Zone and received at a notional boundary of another site in a Rural Zone, or site boundary in a Residential Zone. The rule is reproduced below:

(i) The sound level from activities within any site, excluding mobile sources associated with primary production (e.g. tractors, harvesters), shall not exceed the following limits within any measurement time interval in the stated time-frames, when assessed at any point within the notional boundary of any dwelling on any site within the Rural Zone but excluding any dwelling on the property where the sound levels are generated, and at any point within the boundary of any site within the Residential Zone:

Daytime	7:00am – 7:00pm	55 dBA L ₁₀	
Nighttime	7:00pm – 7:00am	45 dBA L ₁₀	
	9:00pm – 7:00am	75 dBA L _{max}	

 All sound levels shall be measured in accordance with NZS 6801:1999
 "Acoustics – Measurement of Environmental Sound" and assessed in accordance with NZS 6802:1991 "Assessment of Environmental Sound".

The proposal is to comply with the ODP noise standards at all notional boundaries.

5.2 Proposed District Plan

Standard NOISE-S1(7) of the PDP proposes the following noise limits between sites in the Rural Zone:

Noise emitted from any activity within a Rural Zone or Future Urban Zone shall not exceed the following noise limits at any point within the notional boundary of any noise sensitive activity on any other site within a Rural Zone or Future Urban Zone, or at any point within the boundary of any other site within a Residential Zone or Māori Purpose Zone:

- a. Daytime (7.00am to 7.00pm): 55 dB L_{Aeq(15min);}
- b. Evening: (7.00pm to 10.00pm): 50 dB L_{Aeq(15min)};
- c. Night time: (10.00pm to 7.00am): 45 dB L_{Aeq(15min)}; and
- d. Night time: (10.00pm to 7.00am): 70 dB L_{Amax}

All sound levels shall be measured in accordance with NZS 6801:2008 Acoustics - Measurement of Environmental Sound and assessed in accordance with NZS 6802:2008 Acoustics - Environmental Sound.

The proposal is to comply with the PDP noise standards at all notional boundaries.



5.3 General comment on ODP and PDP noise standards

Rule 4.5(f) of the ODP refers to the outdated L_{10} descriptor⁴ and the superseded (1999 and 1991) versions of NZS6801 and 6802. The PDP noise standards adopt the L_{Aeq} descriptor and the current (2008) versions of New Zealand Acoustics Standards NZS6801 and NZS6802.

The *Noise and Vibration Metrics Standard* of the National Planning Standards⁵ requires new District Plans to adopt the L_{Aeq} descriptor and 2008 versions of NZS6801 and NZS6802.

The difference between the ODP noise limits (prescribed in terms of L_{10}) and the PDP noise limits (prescribed in terms of L_{Aeq}) is approximately 1-2dB for a noise source that does not vary much over time. This is a very small difference that would not be perceptible in this environment. The ODP noise limits of 55 dBA L_{10} during the day and 45 dBA L_{10} at night are equivalent to approximately 53 dB L_{Aeq} and 43 dB L_{Aeq} respectively.

Essentially, compliance with the ODP noise limits will enable compliance with the noise limits proposed by the PDP.

6.0 Operational noise modelling and predictions

We have used Brüel & Kjær Predictor computer noise modelling software to predict the operational noise effects from the electro-mechanical plant located in three areas:

- i. The BESS area
- ii. The substation and switch station area adjacent to the BESS
- iii. The twelve inverter stations distributed throughout the PV array.

The predictions are based on the methods in International Standard ISO 9613-1/2 *Acoustics* – *Attenuation of sound during propagation outdoors*. The calculations assume meteorological conditions that slightly enhance propagation in all directions in accordance with NZS 6801:2008. The Brüel & Kjær Predictor software is globally recognised and has been successfully implemented on many projects throughout New Zealand.

The noise models are based on the following assumptions.

6.1.1 BESS plant

The plant inside the BESS will enable the energy produced on the Site to be stored and discharged into the national grid, as required to meet demand during peak periods (predominantly during the evening period).

 $^{^4}$ The L_{10} descriptor was replaced with the L_{Aeq} metric in the 1999 version and subsequent versions of NZS6801 and NZS6802.

⁵ The NPS enables a local authority to prescribe noise limits, provided any plan rule to manage noise emissions is in accordance with the mandatory noise measurements and symbols prescribed in the *Noise and Vibration Metrics Standard* of the NPS. This requires noise levels to be expressed in the LAeq and LAFMAX descriptors and noise levels to be measured and assessed in accordance with New Zealand Standards NZS 6801:2008 *Acoustics – Measurement of environmental sound* and NZS 6802:2008 *Acoustics – Environmental noise.*



The location of the BESS area has been selected to achieve the greatest separation distances from existing notional boundaries and for its proximity to the Transpower substation on Cornwall Road.

The BESS area will include the following noise sources:

- i. **240 battery containers:** The batteries are designed to operate in a controlled temperature environment. The containers that house the batteries include HVAC systems to regulate the thermal environment of the batteries. The noise modelling assumes a worst-case scenario where all container HVAC systems are operating at full load, during the day or night. In reality, the HVAC systems are only likely to operate at full load when the batteries are charging or discharging at a high rate. The noise model assumes that the batteries are oriented with the HVAC unit facing into the Site (and away from the nearest receivers).
- **ii. 2 medium-voltage (MV) transformers:** Transformer noise is generated from the electromagnetic hum generated by the coils changing the current, and the cooling fans that keep the plant cool when it operates at high load.
- **iii. 24 power station inverters:** Noise is generated from the operational hum that occurs when DC power stored in the batteries is converted to AC power used in the grid. The inverters also include cooling fans.

6.1.2 Substation and switchstation plant

The proposed substation area includes the following noise sources:

- i. **1 switch station building:** The switch station building includes an HVAC unit to ensure electrical plant is stored at optimum thermal conditions.
- **ii. 2 high-voltage (HV) transformers:** Transformer noise is generated from the electromagnetic hum generated by the coils changing the current, and the cooling fans that keep the plant cool.

6.1.3 Inverter stations distributed across the array

Each of the twelve inverter stations will include one pair of inverters. The inverters generate noise when the plant is generating electricity during daylight hours. The plant will idle and generate no or only a very low level of noise during low light conditions.

6.1.4 Noise model parameters

The input parameters for the noise models are set out in Table 1.

Table 2: Predictor noise model input parameters						
Parameters/calculation settings	Details					
Software	Brüel & Kjær Predictor V2023					
Calculation method	ISO 9613.1/2					
Meteorological parameters	Single value, $C0 = 0$					



Parameters/calculation settings	Details		
Ground attenuation over land	Ground factor: 0.8 (grazed pasture)		
Air temperature	293.15 K		
Atmospheric pressure	101.33k Pa		
Air humidity	60%		
Source heights (relative)	PV inverters 1m above ground. Transformer station (MVPS) up to 2.5m above ground Central Inverter (UP) 3m above ground HVAC- battery containers 2m		
Receiver heights (relative)	1.5 m above ground		

6.1.5 Sound power levels of plant items

Our assessment is based on the sound power level specifications that have been provided to us by the Project Team (set out below). The exact plant to be used on site will be confirmed as part of the procurement and detailed design phase. A condition of consent is proposed that will require the applicant to demonstrate that the final plant arrangements will comply with the operational noise limits.

	Octave band sound power levels (dB LwA)								
Plant	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Overall dBA
HV Transformer	91	93	88	88	82	77	72	65	88 + 5 dB for special audible character*
Battery/ HVAC Based on manufacturer data confirming 60 dBA at 1.5m	80	80	73	69	64	62	59	55	72
Inverter units Based on manufacturer data confirming 78 dB at 1m	66	66	78	80	81	82	75	75	86
MV Transformers	78	80	75	75	69	64	59	52	75 + 5 dB for special audible character*

Table 3: Frequency spectrum data for plant

* We have applied a +5dB adjustment to allow for potential special tonal audible character from the HV transformer and MV transformer, in accordance with NZS6802:2008.



6.2 Operating assumptions

The noise models for the BESS and substation are based on the following assumptions:

- i. The noise model assumes a worst-case scenario where all plant is operating at 100% during the day time or night time period. This assumption takes into account the ODP prescribed timeframe for night time⁶ and the potential for the plant to generate electricity during sunny evenings during the warmer months. In reality, we expect that:
 - The BESS plant will operate at 100% load when charging or discharging.
 - The inverter stations will only generate noise when generating electricity in sunny conditions. The inverters will idle and generate no or only a very low level of noise during low light conditions.
- ii. No adjustment for duration has been applied.
- iii. The noise model takes into account the screening provided by the PV panel structures.

6.2.1 Noise levels from tracking system motors

The solar panels will be mounted using a tracking system to enable the panels to rotate to follow the movement of the sun. Tracking systems typically utilise a 24V DC motor day. Our review of the sound power level data for tracking system motors confirms the level of noise emissions is very low⁷ and will be much lower than the solar plant. We have not modelled tracking motor noise levels due to their very low noise levels. The cumulative noise levels from plant noise and tracking motors can readily comply with the noise limits.

7.0 Noise level contours

7.1 BESS and substation noise levels

The noise level contours in Appendix B illustrate the likely propagation of noise levels from the BESS and substation area for comparison with the ODP daytime and night time noise limits.

The noise level contours in Appendix C illustrate the likely propagation of noise levels from the BESS and substation area for comparison with the daytime and night time noise limits proposed by the PDP.

The 55 dB L_{10} and 55 dB L_{Aeq} contours represent the approximate separation distance required for the activity to achieve compliance with the ODP and PDP daytime noise limits when all plant is operating at full load during the day.

⁶ The ODP prescribed time frame for night time commences at the early hour of 7:00pm and concludes at 7:00am. The PDP proposed to introduce an evening timeframe when a noise limit of 50 dB L_{Aeq} applies between 7:00pm – 10:00pm, with the night time noise limits of 45 dB L_{Aeq} applying between 10:00pm to 07:00am.

⁷ Based on NexTracker Motor Sound Test Summary



The 45 dB L_{10} and 45 dB L_{Aeq} contours represents the approximate separation distance required for the activity to achieve compliance with ODP and PDP nighttime noise limits when all plant is operating at full load during the night.

The noise level contours in Appendices B and C indicate that the activity can operate in compliance with the ODP and PDP daytime and nighttime noise limits when measured and assessed at the notional boundary of any existing dwelling on another site. Compliance is generally achieved by a significant margin. Existing notional boundaries are well separated from the daytime and night time noise contours by more than 350m.

7.2 Inverter station noise

The noise level contours in Appendix D illustrate the likely propagation of noise levels from the inverter stations distributed across the array. The noise level contours show that inverter noise is localised. The noise level contours show that the noise levels from the inverter stations will comply with the ODP and PDP noise limits at all notional boundaries on adjacent sites. Inverter noise levels above the relevant noise limits are not expected to propagate over any vacant land where a dwelling could potentially be established in the future.

8.0 Assessment of noise effects

8.1 Noise effects at existing notional boundaries

The BESS area has been located to achieve ample separation distances from existing dwellings. The noise modelling we have undertaken demonstrates that the noise emissions from the MSES will readily comply with the ODP and PDP noise limits at all existing notional boundaries.

The noise level contours represent the noise levels from all plant operating at full load. In reality, we understand that the noise levels from the BESS plant operating at maximum discharge rates will be confined to short periods when demand for electricity peaks. The noise emissions from the BESS discharging at slower rates will result in a lower level of noise emissions.

We expect that for the majority of time, the noise from the operation of the solar farm will not be audible at all existing notional boundaries. We expect that there may be occasions when electro-mechanical plant noise will be audible. These occasions are likely to occur during calm meteorological conditions, and when power generation is at or near peak in sunny conditions, or the BESS is discharging to the grid at a high rate.

We understand that the ODP provides for the establishment and operation of renewable energy facilities in the rural environment. Section 4.2(11) of the District Plan recognises that large scale connected facilities "*need to locate in the rural environment because of their land area and siting requirements*".

We consider that the ODP provides a reasonable expectation to the community that noise associated with large scale connected renewable energy facilities should be expected in the rural zone, along with the noise from traditional primary production activities.



8.2 Noise levels across vacant sites

The ODP and PDP noise limits apply at any existing notional boundary. The noise limits do not apply at vacant sites that are not occupied by a residential dwelling.

The noise level contours provide an indication of the area of land on each site that is inside or within 20m of the night time (45 dB L_{10}) or day time (55 dB L_{10}) noise contours. The noise level contours are indicative only. The contours demonstrate that the proposal may not comply with the relevant noise limits in the event that future dwellings are established inside or within 20m of the night time (45 dB L_{10}) or day time (55 dB L_{10}) contours on 51 and 99 Cornwall Road.

The noise level contours demonstrate that the total area of land on 51 and 99 Cornwall Road within the 45 dB L_{10} contour comprises a relatively small proportion of the overall landholding. We understand that it is unlikely that future dwellings would be likely to establish on the land inside the 45 dB L_{10} contour given the opportunity to establish building platforms in alternative locations that would achieve a greater separation distance from the Transpower Substation.

The establishment of dwellings on 51 and 99 Cornwall Road *may* require the applicant to implement noise mitigation measures in the event that noise levels from the activity cannot comply with the relevant noise limits when measured and assessed at a possible future notional boundary on 51 and 99 Cornwall Road.

8.3 Noise levels at the Industrial Zone

The ODP does not control the level of noise received in the Industrial Zone. Notwithstanding, the noise modelling demonstrates that the noise levels received at the sites in the Industrial Zone will be low. The noise levels from the Site are unlikely to be audible above road-traffic noise from SH2 during the daytime.

9.0 Construction noise

The ODP and PDP both control construction noise levels in accordance with the recommended construction noise limits in NZS6803:1999 Acoustics - Construction Noise (**NZS6803**).

Rule 21.1.13(c) of the ODP requires that:

- Construction noise shall be measured and assessed in accordance with NZS6803:1999 "Acoustics – Construction Noise" and shall not exceed the noise limits set out in Table 2 of that Standard for the timeframes stated.
- ii) Provided that the provisions of the standard related to the duration of construction events and the more or less stringent noise limits applicable in such circumstances shall apply.

NOISE-S2(1) of the PDP includes a similar rule to control noise levels from construction activities. NOISE-S2(1) requires:

Construction noise shall be measured, assessed, managed, and controlled in accordance with the requirements of New Zealand Standard NZS 6803:2008 Acoustics - Construction Noise.



NZS6803 provides guideline noise limits that are based on the duration of construction works at any one location, and the occupation of the receiving site. NZS 6803:1999 provides recommended noise limits based on the following durations of construction work:

- i. Up to 14 days (short-term duration)
- ii. More than 14 days but less than 20 weeks (typical duration)
- iii. More than 20 weeks (long-term duration).

We understand that the construction phase will extend for up to 18 months. The project is subject to NZS6803's recommended construction noise limits for long-term duration projects⁸.

Construction activity will take place between 7:30am and 6:00pm, Monday to Saturday, when NZS6803 recommends that a noise limit of 70 dB L_{Aeq} and 85 dB L_{AFmax} applies when measured and assessed 1m from the façade of any occupied dwelling in a rural zone or occupied building in an industrial area.

The proposal is to comply with NZS6803's recommended construction noise limits for longterm projects at all receivers that have not provided a written approval. These limits are reproduced in Table 4 below⁹.

Time of Week	Time Period	Long-term duration (dBA)		
Time of week	Time Period	L _{eq}	L _{max}	
	0630-0730	55	75	
Weekdeve	0730-1800	70	85	
weekdays	1800-2000	65	80	
	2000-0630	45	75	
	0630-0730	45	75	
Saturdaya	0730-1800	70	85	
Saturdays	1800-2000	45	75	
	2000-0630	45	75	

Table 4 - NZS6803 recommended upper limits for construction noise received in residential zones and dwellings in rural areas

⁹ The limits in Table 2 represent the noise limits for a "long-term" construction project (exceeding 20 weeks). If the duration of construction work can be completed within 20 weeks, the "typical duration" noise levels from NZS6803:1999 will apply. The daytime noise limit for typical duration construction work could then be increased from 70 dB to 75 dB L_{Aeq} in accordance with NZS6803:1999.



Time of Week	Time Period	Long-term duration (dBA)		
Time of week	Time Fenou	L _{eq}	L _{max}	
	0630-0730	45	75	
Sundays and public	0730-1800	55	85	
holidays	1800-2000	45	75	
	2000-0630	45	75	

The noise levels from construction work are required to be assessed at the façade of any occupied building¹⁰ and typically over a 15-to-60 minute period. There is no averaging or other adjustment over the day, night or any other period. The noise limits set out in NZS6803 must be complied with for every 15-to-60 minute period during the works.

9.1 Proposed construction activities

We understand that the construction phase will involve the following activities and noise sources:

- Removal of existing internal fencing and large vegetation
- Formation of a stabilised site access at the primary site entrance to Cornwall Road
- Heavily vehicle movements to deliver materials (maximum of approximately 60 per day) to the construction laydown area adjacent to the site entrance.
- Earthworks to form trenching and the formation of the hard stand area for the BESS and substation area (compacted gravel)
- Installation of PV tracking tables using lightweight piling equipment
- Construction of the structure for mounting the PV panels and fencing
- Installation of plant, cabling and other electrical and auxiliary equipment

We understand that noisy construction work and heavy vehicle movements will be undertaken between 7:30 am and 6:00 pm, Monday to Saturday. There will be no noisy works in the evening or on Sundays. Noisy construction works include earthworks, trenching, piling, PCU installation, use of generators and air compressors and heavy vehicle movements.

Quieter activities may be undertaken outside of these hours if they are generally inaudible at the neighbouring sites. This may include electrical testing and commissioning, bracket

¹⁰ The limits apply at 1 m from the façade and 1.2 to 1.5 m above the relevant floor level of any building that is occupied during the works. They do not apply at unoccupied buildings.



installation, cable management works, surveying, office and administrative work, PV module installation, use of hand tools and light vehicle movements.

9.2 Minimum setback distances to achieve compliance with construction noise standards

Appendix E provides minimum separation distances for construction noise sources that may require additional mitigation when used near to any occupied building. These are the shortest distances that the activities can be undertaken from the most exposed ground-level facade of the nearest occupied building whilst remaining compliant with the consented noise limits.

Noise source levels are based on our database of construction noise measurements undertaken by Styles Group on numerous projects nationwide. They are in accordance with best practice and are generally consistent with guideline noise data provided in NZS 6803:1999 Appendix C *Guide to Sound Level Data on Site Equipment and Site Activities*.

9.3 Closest receivers and compliance with construction noise standards

We have identified that the noise from piling works may require mitigating using scheduling¹¹ or physical screens or alternate piling methods in order to comply with the permitted noise standards where those works come close to the dwelling at 3920 SH2¹².

We have recommended a condition requiring the applicant to prepare and implement a Construction Noise Management Plan (CNMP). The CNMP will be used to outline the mitigation methods that must be adopted when works are in proximity to this receiver to enable compliance with the construction noise standards. Mitigation methods may include use of alternative piling methods (i.e. auger, screw or bored piling), use of screening or completing the works when the building is not occupied.

The construction noise levels are expected to comply with the noise limits at other occupied buildings and dwellings. We have not identified any concerns relating to vibration effects given the proposed construction activities and separation distances to the receivers (including the closest receiver identified above).

10.0 Recommended conditions of consent

We recommend the following conditions of consent are imposed.

1. Compliance with operational noise limits

The consent holder shall provide Council with an acoustic assessment from a suitably qualified and experienced acoustic expert that demonstrates the selected plant and layout arrangements will achieve compliance with the noise limits in Condition 2. The

¹¹ To complete the work when no one is home

¹² We understand that the dwelling on 3954A SH2 is currently vacant and also owned by the owner of the Site. We understand that the landowner will provide a written approval to authorise temporary and intermittent exceedances of construction noise effects when works are in close proximity to the dwelling.



report shall be provided to the satisfaction of the Council a minimum of 6 weeks prior to construction of the solar farm.

2. Noise limits

The noise (rating) level from the operation of the solar farm shall comply with the following noise limits when measured and assessed at any notional boundary:

Daytime	7:00am – 7:00pm	55 dBA L ₁₀	
Nighttime	7:00pm – 7:00am	45 dBA L ₁₀	
	9:00pm – 7:00am	75 dBA L _{max}	

All sound levels shall be measured in accordance with NZS 6801:1999 "Acoustics – Measurement of Environmental Sound" and assessed in accordance with NZS 6802:1991 "Assessment of Environmental Sound".

3. Construction noise levels

Construction noise levels at the façade of any occupied dwelling or building* shall comply with the following limits, when measured and assessed in accordance with NZS 6803:1999: *Acoustics – Construction Noise*:

Time period	Maximum noise levels		
nine period	L _{Aeq(15min)}	L _{AFMax}	
7:30am- 6:00pm, Monday to Saturday	70 dB	85 dB	
All other times and on Public Holidays	45 dB	70 dB	

*These noise limits shall not apply at any building where a written approval has been provided for construction noise exceedances.

Advice Note: The limits above represent the noise limits for a "long-term" construction project (exceeding 20 weeks). If the duration of the construction phase as observed for any particular receiver can be completed within 20 weeks, the "typical duration" noise levels from NZS6803:1999 will apply at that receiver. The daytime noise limit for typical duration construction work may be increased from 70 dB to 75 dB in accordance with Table 2 of NZS6803:1999. The construction noise limits do not apply at any building that is unoccupied.

4. Construction noise management plan (CNMP)*

The consent holder shall prepare and submit a CNMP to Council a minimum of 10 days prior to commencement of construction work. The objective of the CNMP is to set out the methods and procedures that will be used to ensure compliance with the relevant noise limits in NZS 6803:1999: *Acoustics – Construction Noise*.



The CNMP shall set out:

- a) The applicable permitted noise standards
- b) The programme of works and hours of operation
- c) Identification of surrounding noise sensitive receivers
- d) Written communication with occupants of all buildings within 50 m of the site of the works in writing at least ten (10) days prior to the commencement of activities on site. The written advice shall set out:
 - (i) a brief overview of the construction works.
 - (ii) the working hours and expected duration,
 - (iii) all mitigation measures to be implemented.
 - (iv) the procedure for recording concerns/complaints regarding noise.
 - (v) Details of the management and mitigation measures required to comply with the relevant noise limits when piling works are undertaken within 45m of any occupied building that has not provided written approval.

*Recommended condition 4 does not apply if all receivers within 50m of the extent of works provide their written approval to the application for resource consent.

11.0 Conclusion

Styles Group have predicted and assessed the construction and operational noise emissions from the MSES.

The noise modelling demonstrates that the proposal can comply the noise limits in the Operative and Proposed District Plan when measured and assessed at all existing notional boundaries on adjacent sites. Noise levels from all other operational and site maintenance activities will be managed to comply with the Operative and Proposed District Plan noise limits.

We have recommended conditions of consent that will ensure that the noise from the Site will be managed to comply with the relevant noise limits at any notional boundary, including any notional boundary that may be established on 51 Cornwall Road (Lot 2 DP 325931) and 99 Cornwall Road (Lot 1 DP 75496).

Construction noise levels can be managed to comply with the guideline noise limits in NZS 6803:1999: *Acoustics – Construction Noise.* We have recommended a CNMP is prepared and implemented to manage compliance at the closest receiver.

We have recommended conditions of consent based on our findings.



Appendix A Glossary of terms

Noise	A sound which serves little or no purpose for the exposed persons and is commonly described as 'unwanted sound'. The definition of noise includes vibration under the Resource Management Act.
dB (decibel)	The basic measurement unit of sound. The logarithmic unit used to describe the ratio between the measured sound pressure level and a reference level of 20 micropascals (0 dB).
A-weighting	A frequency filter applied to the full audio range (20 Hz to 20 kHz) to approximate the response of the human ear at lower sound pressure levels.
Ambient noise	Ambient noise is the total of all noise within a given environment, comprising a composite of sounds from sources near and far.
Background noise	See L _{A90(t)} .
L _{A10} (dB)	A statistical noise descriptor. The A-weighted sound level which is just exceeded for 10% of the measurement period (t). Sometimes referred to as the average maximum noise level.
La90(t) (dB)	The A-weighted sound level in decibels equalled or exceeded for 90% of the of the measurement interval. It is the component of the total sound that subjectively is perceived as continuously present. Used in New Zealand as the descriptor for background noise in the 2008 versions of the N.Z. Standards NZS 6801 and NZS 6802.
L _{Aeq(t)} (dB)	The A-weighted equivalent sound pressure level with the same energy content as the measured varying acoustic signal over a sample period (t). The preferred metric for sound levels that vary over time because it takes into account the total sound energy over the time period of interest.
L _{AFmax} (dB)	The maximum A-weighted sound pressure level recorded during the measurement period using a fast time-weighting response.
L _{WA} (dB)	Sound power level (LWA) is the acoustical energy emitted by a sound source. It is an absolute value and is not affected by distance or the environment. The LWA is used in computer noise modelling to calculate the sound pressure level (e.g. LAeq) at a given distance.
Noise rating level	A derived noise level used for comparison with a noise limit.
Notional boundary	A line 20 metres from any side of a residential unit or other building used for a noise sensitive activity, or the legal boundary where this is closer to such a building.
NZS 6801:2 008	N.Z. Standard NZS 6801:2008 Acoustics – Measurement of environmental sound.
NZS 6802:2 008	N.Z. Standard NZS 6802:2008 Acoustics – Environmental noise.
NZS 6801:1991	N.Z. Standard NZS 6801:1991 Acoustics – Measurement of environmental sound.



NZS 6802:1991	N.Z. Standard NZS 6802:1991 Acoustics – Environmental noise.
NZS 6803:1999	N.Z. Standard NZS 6803:1999 Acoustics – Construction noise.
The Act	The Resource Management Act 1991.
s16	Section 16 of the Act 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".
ISO 9613- 1/2	International Standard ISO9613-1/2 Attenuation of sound during propagation outdoors
CNMP	Construction noise management plan. A document to help the contractor manage noise emissions during construction works.



Appendix B Indicative BESS/ substation noise rating level contours- $$L_{A10}$$



ISO 9613, [version of Area - Layout update 17-10-23 - Unmitigated] , Predictor V2023 Licensed to Styles Group, NZ



Appendix C Indicative BESS/ substation noise rating level contours-LAeq





ISO 9613, [version of Area - Layout update 17-10-23 - Unmitigated] , Predictor V2023 Licensed to Styles Group, NZ



Appendix D Indicative noise level contours- BESS/ Substation and Inverter stations



ISO 9613, [version of Area - Layout update 17-10-23 - Unmitigated - 45-50-55 L10 - 18-12-23], Predictor V2023 Licensed to Styles Group, NZ

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Appendix E Construction noise level predictions

Table 5 sets out minimum separation distances for potential construction noise sources on the Site. These are the shortest distances that the construction activities can be undertaken from the most exposed ground-level facade of the nearest occupied building whilst remaining compliant with the permitted noise limits. For separation distances less than 30 m the ground type has been assumed to be hard and reflective.

If construction activities near to any dwelling are required within the separation distances stated in the table below and no written approval is provided by the occupant, further noise mitigation measures will be required to achieve compliance. These measures shall be specified in the Construction Noise Management Plan (**CNMP**) required by recommended Condition 4.

Noise source levels are based on our database of construction noise measurements undertaken by Styles Group on numerous projects nationwide. They are in accordance with best practice and are generally consistent with guideline noise data provided in NZS 6803:1999 Appendix C *Guide to Sound Level Data on Site Equipment and Site Activities*.

Construction activity	Reference noise level 10 m from plant	Minimum distance for compliance (unmitigated)	Minimum distance for compliance (mitigated)
Driven piling (ramming machine)	83 dB L _{Aeq}	44 m	20 m
Soilmec drill rig	79 dB L _{Aeq}	39 m	13 m
Directional drill	77 dB L _{Aeq}	31 m	11 m
Plate compactor	77 dB L _{Aeq}	31 m	11 m
14-t bulldozer*	77 dB L _{Aeq}	31 m	11 m
7-t bulldozer*	73 dB LAeq	20 m	7 m
6-t padfoot roller*	73 dB L _{Aeq}	20 m	7 m
Concrete pump and truck discharging	72 dB L _{Aeq}	18 m	7 m
Front end loader	72 dB L _{Aeq}	18 m	7 m
Excavator mounted 600 kg drop hammer	72 dB L _{Aeq}	18 m	7 m

 Table 5: Noise sources and calculated separation distances for compliance with noise limits



Construction activity	Reference noise level 10 m from plant	Minimum distance for compliance (unmitigated)	Minimum distance for compliance (mitigated)
Excavation and loading trucks with 30 t excavator**	72 dB L _{Aeq}	18 m	7 m
100 t mobile crane under load	71 dB L _{Aeq}	16 m	6 m
Excavation and loading trucks with 20 t excavator	69 dB L _{Aeq}	13 m	< 5 m
Generator	66 dB L _{Aeq}	10 m	< 5 m
5-t vibratory compaction roller	66 dB L _{Aeq}	10 m	< 5 m
20-t grader*	65 dB L _{Aeq}	9 m	< 5 m
Use of power tools	65 dB L _{Aeq}	9 m	< 5 m
10-t grader*	62 dB L _{Aeq}	7 m	< 5 m
Watercart (10,000L)	62 dB L _{Aeq}	7 m	< 5 m
Idling dump truck	62 dB L _{Aeq}	7 m	< 5 m
5-t static compaction roller	62 dB L _{Aeq}	7 m	< 5 m

* The reference level assumes the plant is making short passes near to the site boundary. When the plant makes longer passes or moves away from the boundary the level will be lower.