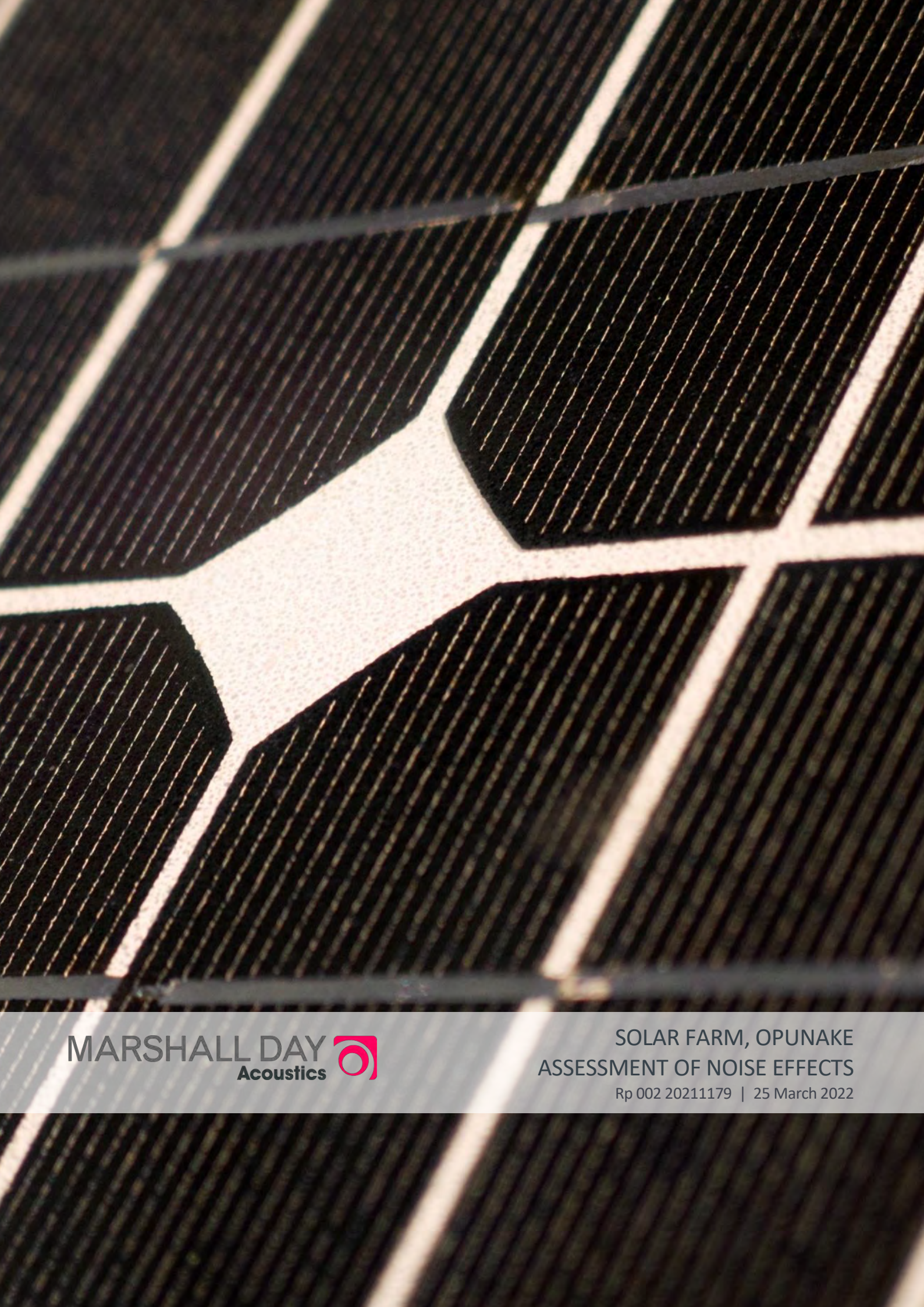

MARSHALL DAY Acoustics

SOLAR FARM, OPUNAKE
ASSESSMENT OF NOISE EFFECTS

Rp 002 20211179 | 25 March 2022

84 Symonds Street
PO Box 5811
Victoria Street West
Auckland 1142 New Zealand
T: +64 9 379 7822 F: +64 9 309 3540
www.marshallday.com

Project: **SOLAR FARM, OPUNAKE**

Prepared for: **Energy Farms Ltd**
c/- Reyburn and Bryant
PO Box 191
Whangarei 0140

Attention: **Thomas Keogh**

Report No.: **Rp 002 20211179**

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SUMMARY

Marshall Day Acoustics has been engaged by Energy Farms Ltd. to undertake a noise assessment for a proposal to construct and operate a solar farm near Opunake, South Taranaki District.

The key operational noise sources would be from eleven inverters installed predominantly central to the site and a battery energy storage system. The proposed separation distance between these key operational noise sources and the nearest receiver notional boundary is approximately 350 metres.

The solar farm would primarily operate during daylight hours but would also operate during the night period.

The proposed solar farm is calculated to comply with the Operative South Taranaki District Plan noise rules at all existing notional boundaries and at the nearest legal boundaries for the daytime, evening, and night-time periods.

Noise from the solar farm would be low overall and within all national and international guidelines for environmental noise levels that are typically applied within New Zealand.

Calculated noise levels from the solar farm were compared with logged ambient and background daytime, evening, and night-time noise levels.

During the daytime, it is likely that the solar farm would often be inaudible at near receivers. Given the low overall noise level from the solar farm, daytime solar farm noise levels are considered to be reasonable and would have little or no effect on amenity.

During the evening, it is likely that the solar farm would be audible at times at near receivers. Given the low overall noise level from the solar farm, evening solar farm noise levels are considered to be reasonable and would have little effect on amenity.

During the night-time, solar farm noise levels are expected to be audible at the nearest existing dwellings. Noise from the solar farm would be more noticeable and annoying if the sound sources (e.g., inverters) are appreciably tonal.

We consider that final selection of the inverters should avoid and/or mitigate tonal characteristics and have proposed a condition of consent in this regard. If the tonality of the units is well controlled, there is considered little risk of annoyance arising.

We consider that during final design of the battery energy storage system, an assessment to confirm adequate attenuation of the system should be undertaken. We have proposed a condition of consent in this regard.

Taking into account the above discussion and provided that the tonal character of the proposed mechanical plant (including the inverters) can be avoided and/or mitigated, we consider that overall, the solar farm would be reasonable in terms of the RMA.

Construction noise is expected to comply with the construction noise limits. Due to separation distances, a construction noise and vibration management plan is unlikely to be necessary to manage construction effects on near receivers.

Conditions of resource consent have been recommended.

TABLE OF CONTENTS

1.0 INTRODUCTION

Marshall Day Acoustics has been engaged by Energy Farms Ltd. to undertake a noise assessment for a proposal to construct and operate a solar farm near Opunake, South Taranaki 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 solar farm would be located at 575 and 574 Kina Road. These properties are located north and south of Kina Road, respectively and are 112-hectares and 77-hectares, respectively. The site is located approximately 36-km southwest of New Plymouth city centre, 5-km east of SH 45 (South Road), and 9-km north of Opunake town centre. The properties are currently used as grazing land for dairy farming. Surrounding land uses are rural. The site is predominantly flat at an elevation of 120m to 130m. Surrounding sites have similar topography.

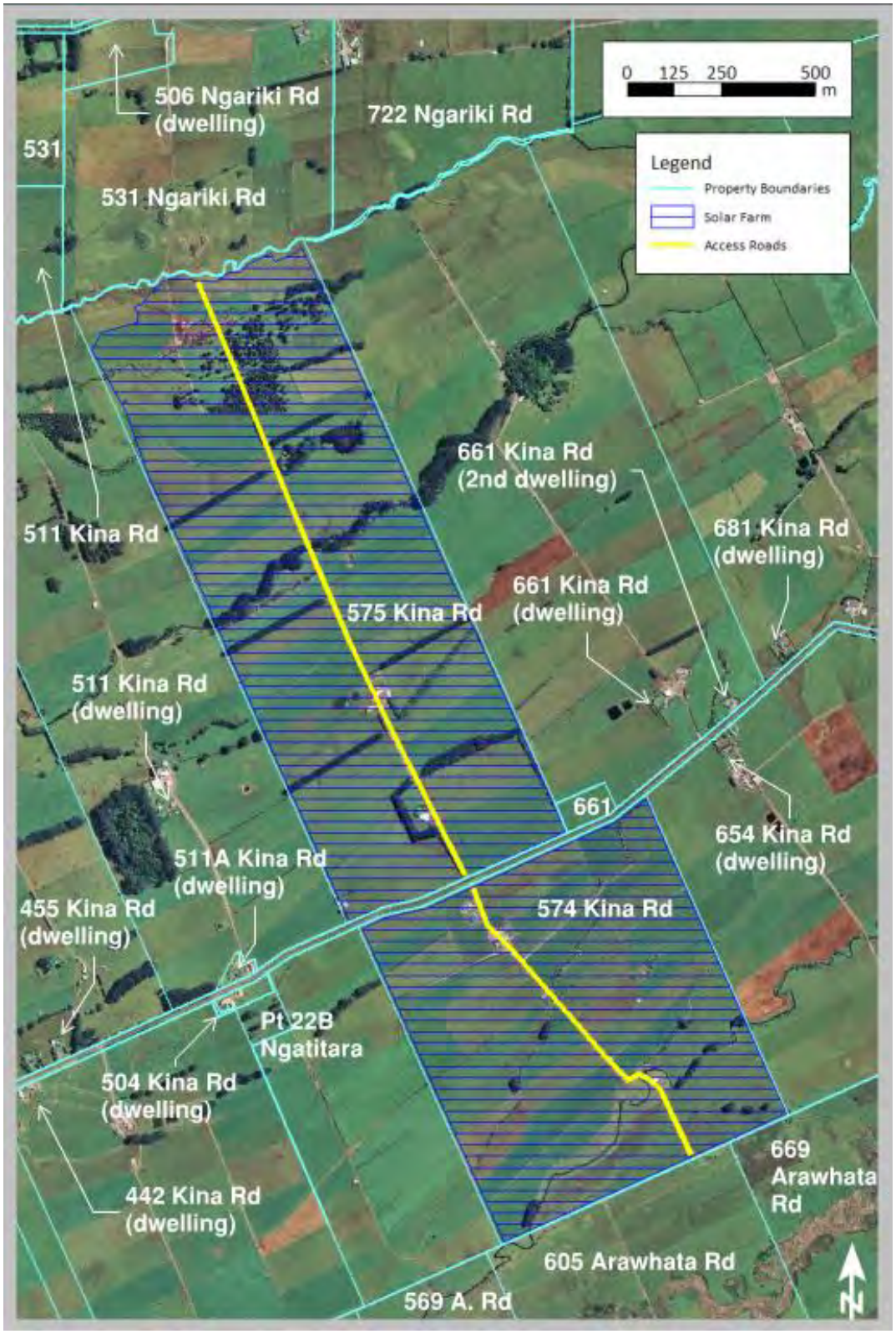
Surrounding receivers are listed in Table 1 and depicted in Figure 1.

Table 1: Surrounding Receivers

Receiver Address[1]	Existing Use[2]	Estimated distance[2]
422 Kina Rd	Farm with dwelling(s)	980m
455 Kina Rd	Farm with dwelling(s)	800m
504 Kina Rd	Rural residential	375m
511 Kina Rd	Farm with dwelling(s)	280m / 8m to legal boundary
511A Kina Rd	Rural residential	285m
654 Kina Rd	Farm with dwelling(s)	240m / 15m to legal boundary
661 Kina Rd	Farm with dwelling(s)	340m / 10m to legal boundary
681 Kina Rd	Farm with dwelling(s)	700m
506 Ngariki Rd	Rural residential	640m
531 Ngariki Rd[3]	Farm with dwelling(s)	790m / 10m to legal boundary
722 Ngariki Rd	Farm with dwelling(s)	1.8km
529 Arawhata Rd	Farm with dwelling(s)	1.2km
569 Arawhata Rd[4]	Rural residential	1km
605 Arawhata Rd	Farm with dwelling(s)	1km / 10m to legal boundary
669 Arawhata Rd	Farm with dwelling(s)	860 / 10m to legal boundary
Pt 22B Ngatitara	grazing (unbuilt)	15m to legal boundary

Notes:
1) Re. the application properties: we understand that the two existing houses on 574 Kina Road and the second house on 575 Kina Road (539 Kina Road on the Taranaki Regional Council GIS website) would be removed.
2) Existing land use and distances have been determined from aerial photography. Distances are from the nearest proposed solar farm boundary to the identified notional boundary (unless stated otherwise). Refer to Section 5.0 for a discussion regarding the notional boundary.
3) The identified dwelling for 531 Ngariki Road is on the north side of Ngariki Road. No dwellings associated with this address were identified on the south side of Ngariki Road.
4) Based on the Taranaki Regional Council GIS website, this property is also part of 529 Arawhata Rd.

Figure 1: Site and Surrounds



3.0 PROPOSAL

3.1 Facility Description

The solar farm would be installed over approximately 170 hectares. Solar panels (4.8 metres high approx.) would be installed in rows spaced about 5.5 metres apart to allow access by agricultural machinery / grazing animals. Access to the site would be via Kina Road.

The key operational noise sources are summarised below:

- **11 inverters** – situated central to the site - an inverter turns Direct Current (DC) created by the photovoltaic cells to alternative current (AC) current used in the grid. [1]
- **up to seven Tesla 3MW powerpack battery storage blocks (BESS**) – situated near the switchyard on the south side of Kina Rd and enclosed within a building/structure. The battery blocks store AC or DC power for later use. [2]
- **one transformer** – situated in the switchyard on the south side of Kina Rd - a transformer changes the current and voltage of AC electricity.

The proposed separation distance between these key operational noise sources and the nearest receiver notional boundary is approximately 350 metres.

The individual solar panel arrays would be attached to trackers[3]. For this assessment, we have assumed a total of 1521 trackers (and associated motors) could be installed as part of the project, with approximately 60 percent on the north side of Kina Road and 40 percent on the south side of Kina Road.

The solar farm would primarily operate during daylight hours but would also operate during the night period. During the night, electricity may be discharged from the batteries to the grid and the solar farm may also import electricity from the grid for storage within the battery units. In summer, operating daylight hours could begin earlier and extend later than the prescribed daytime period of 7am to 7pm.

Refer to the site layout in Appendix B.

3.2 Written Approvals

To our knowledge, written approvals have not been obtained for any of the nearby properties[4].

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[1] Final selection of the inverters is yet to be made. This assessment is based on manufactures' data for inverters that have been proposed at other solar farms around New Zealand. We have assumed that the inverters would have tonal and directivity properties. To our knowledge, limited manufacture's data is available for solar farm inverters, but all show tonal characteristics at various frequencies. We consider it essential for final selection of the inverters to include a detailed analysis of the tonal character. Final selection should be made to avoid and/or mitigate tonal characteristics as even at low noise levels, tonal properties can have a negative effect on acoustic amenity at neighbouring sites.

[2] Manufactures data for the Tesla 3MW powerpack units was unable to be obtained. This assessment is based on data derived from other battery storage units. Energy Farms Ltd. must confirm this data with suppliers prior to final procurement of power infrastructure. The battery storage system building is yet to be designed. We have assumed that it would provide a minimum sound attenuation of 10 decibels.

[3] 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 motor (approximately 300 watts). 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. Refer to Appendix D for an image showing the solar tracker with tilt actuator mechanism.

[4] 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).

3.3 Acoustic Mitigation

Acoustic mitigation, such as acoustically rated fencing, is not considered necessary and is not proposed as part of the project.

4.0 EXISTING NOISE ENVIRONMENT

A site visit was carried out on Sunday 19 December 2021, during which time an attended noise measurement was taken, and noise loggers were installed at each address. The loggers collected data until Sunday 2 January 2022.

Logged data was analysed for the pre-Christmas / New Year period, over four days from 10pm on the 19th December to 10pm on the 23rd of December 2021. Weather conditions were noted to be reasonably stable during this period of data collection. According to historic data from the New Plymouth airport weather station, there was no rainfall during this period; however, it was moderately windy. Recorded wind speeds ranged between 1 and 24 mph but were generally less than 15 mph (24kph / 7mps). The day with the least wind was the 20th of December 2021.

During the attended measurement on the 19th December 2021, a light breeze (less than 3 m/s) was blowing from the north. Measurement conditions were within the normal parameters for measuring noise.

The purpose of the measurements was to establish ambient noise levels representative of the site and surrounding sites. Logger placement was determined by site specific conditions and practical restraints (including access, the need to secure equipment, and stock use of paddocks). As far as practical, loggers were situated distant from main lanes, the milking sheds, Kina Road, trees / significant vegetation, and creeks. Measurement positions are as follows:

- MP 1 (logger and attended measurement location) was situated on 575 Kina Road approximately 250m south of the milking shed, 270m north of Kina Road and 55m east of the main farm lane.
- MP 2 (second logger position) was situated on 574 Kina Road approximately 250m east of the milking shed and main farm lane, 170m south of Kina Road, and adjacent to a minor access lane.

Refer to Appendix C for a map showing the measurement positions and site photographs. The monitoring sites are considered representative of the area generally.

Tables 2 and 3 summarise the attended and logged measurement results. Refer to Appendix C for sample logged data, including a graph depicting the 24-hour period for the 20th of December 2021.

Table 2: Measured Ambient Noise Levels (attended)

Measurement Position	Measurement		Measured Level (dB) (1)			Noise Source (2)
	Start Date / Times	Duration min:sec	L_{Aeq}	L_{A90}	L_{AFmax}	
MP1 - 270m north of Kina Rd	19 Dec 2021 11:45 am	15:02	40	34	64	Birds, insects, occasional traffic, light breeze, occasional voice / dog bark

Notes to Table 2:

(1) An explanation of technical terms is provided in Appendix A
(2) The controlling noise sources are underlined

As shown in Table 2, the attended measured ambient noise level was 40 dB L_{Aeq} and the background level was 34 dB L_{Aeq}. At the time of measurement, the dominant noise source was birds. Other noise sources were irregular traffic on Kina Road, insects, a light breeze, a dog barking (occasional), and voices (occasional).

Table 3: Measured Ambient Noise Levels (logged) - Analysed period: 19 to 23 December 2021 (4 days)

MP1 (575 Kina Rd) Overall Measured Levels (dB) by Period														
7am to 7pm			**7pm to 10pm**			**10pm to 7am**			**10pm to 5am**			**5am to 7am**		
L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}
51	38	75	49	35	74	53	33	80	36	33	57	59	43	80
MP2 (574 Kina Rd) Overall Measured Levels (dB) by Period														
7am to 7pm			**7pm to 10pm**			**10pm to 7am**			**10pm to 5am**			**5am to 7am**		
L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}	L_{Aeq}	L_{A90}	L_{AFmax}
51	40	79	44	35	63	47	33	70	41	33	62	53	41	70

As shown in Table 3, at MP1 and MP2, the daytime logged ambient level was 51 dB L_{Aeq} and the background level was 38 to 40 dB L_{A90}. The ambient and background logged levels are notably higher than the attended fifteen-minute measurement, which shows the variation in ambient noise level (likely with wind)[5]. The measurement results show that daytime levels drop to 40 dB L_{Aeq} at times.

The prescribed District Plan night-time (10pm to 7am) ambient noise levels were 47 (MP2) and 53 (MP1) dB L_{Aeq}, substantially higher than what would normally be expected in a rural area. This is explained by the dawn chorus occurring from approximately 5am (confirmed by sample audio recordings). Activity at the milking sheds was also considered a possible source of noise early in the morning but this was not confirmed by audio analysis of the logged data. Refer to Appendix C for 15-minute summary data for the night-time period.

For assessing effects, we consider that data for the period 10pm to 5am better represents the prescribed night-time period. We have used the following ambient and background noise data (derived from the logged data) in this assessment.

- Daytime: 51 dB L_{Aeq} and 38 to 40 dB L_{A90}.
- Evening: 44 to 49 dB L_{Aeq} and 35 dB L_{A90}.
- Night-time: 36 to 41 dB L_{Aeq} and 33 dB L_{A90}.

[5] The logged ambient 15-min measurement taken at approximately the same time as the attended measurement correlates within one decibel, showing that this is due to actual variation in noise level and not instrument error.

5.0 NOISE PERFORMANCE STANDARDS

The Operative South Taranaki District Plan – updated 22 January 2021 (District Plan) provides the appropriate zoning and noise assessment standards for the site.

5.1 Zoning

Figure 3 shows zoning at the application and neighbouring sites. The application site is situated on land zoned *Rural* (depicted in white), as are the surrounding sites.

Figure 3: Site Zoning

Source: Operative South Taranaki District Plan – Rural Map 03[6]

5.2 Noise Standards

Section 11.2.2 of the District Plan provides permitted activity noise standards for the *Rural* zone. They are summarised below and reproduced in Appendix E.

There are two sets of limits for the *Rural* zone. The more stringent limits apply within the notional boundary of dwellings. Less stringent limits apply within the legal boundary of all sites (built or unbuilt).

The relevant limits within the notional boundary are:

- 55 dB $L_{Aeq(15min)}$ from 7am to 7pm
- 50 dB $L_{Aeq(15min)}$ from 7pm to 10pm
- 45 dB $L_{Aeq(15min)}$ and 75dB L_{AFmax} from 10pm to 7am.

The relevant limits within the legal boundary are:

- 55 dB $L_{Aeq(15min)}$ at all times, and
- 85dB L_{AFmax} from 10pm to 7am.

[6] https://www.southtaranaki.com/repository/libraries/id:27mlbegko1cxbyf94es5/hierarchy/Documents/District%20Plan/District%20Plan%202015/Maps%20Rural/Rural%20Maps%2003.pdf

5.3 Measurement and Assessment Standards

The District Plan states that sound levels shall be measured and assessed in accordance with *NZS 6801:2008 Acoustics – Measurement of Environmental Sound* and *NZS 6802:2008 Acoustics – Environmental Noise.*

The District Plan states that construction noise should comply with NZS 6803: 1999 *Acoustics - Construction Noise*.

5.4 Resource Management Act

Under the provisions of the Resource Management Act (RMA) there is a duty to adopt the best practicable option to ensure that noise (including vibration[7]) 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 Noise Sources and Modelling Methodology

The main noise sources from the proposed solar farm would be the inverters and the battery storage system. Tracker motors and the transformer have also been considered for this assessment, although these sources would generate lower noise levels.

We prepared a noise model using SoundPLAN® environmental noise modelling which takes into account 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*".

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

As discussed in Section 3.1, limited manufacture's data is available for solar farm inverters, but all show tonal characteristics at various frequencies. We consider it essential for final selection of the inverters to include a detailed analysis of the tonal character. Final selection should be made to avoid and/or mitigate tonal characteristics as far as practicable as even at low noise levels, tonal properties can have a negative effect on acoustic amenity at neighbouring sites.

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. Available data suggests that tonal character will also reduce (or be eliminated) at lower loads; however, this should be further assessed as part of the detailed analysis into tonal character discussed above.

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

When the solar farm is generating electricity, we expect that the inverters will work at low power during times of low solar gain (early morning / evening) and at full power during times of high solar gain. When the solar farm is importing / exporting electricity between the battery storage system and the grid (including during the night), we have allowed for the inverters to operate at full power.

As discussed in Section 3.1, manufactures data for the Tesla 3MW powerpack units (or other measurement data specific to these units) was unable to be obtained. This assessment is based on data derived from other types of battery storage units. Energy Farms Ltd. must confirm this data with suppliers prior to final procurement of power infrastructure.

A battery storage system building is part of the proposal but is yet to be designed. We have assumed that it would provide a minimum sound attenuation of 10 decibels.

Table 4: Sound Power Levels

Noise Source	Sound Power Level dBA re 10^{-12} Watts	Number of Units	Directivity	Operation time
DC / AC inverter	**AC end** 92 @ 100% load 88 @ 10% load **DC end** 86 @ 100% load 82 @ 10% load	11	Included	Daylight and Night-time hours
Tracker modules	76 (emission when moving) = 96 (total L_w for all trackers)	1501	None	68 seconds movement every 15 minutes – daylight hours
Transformer	78	1	None	Daylight and night-time hours
Batteries	92	7	None	Daylight and night-time hours

6.2 Noise Level Calculations

Noise levels have been calculated at the notional[8] boundaries of the nearest receivers and at the legal boundaries of adjacent properties. The noise levels have been calculated under meteorological conditions that are favourable to sound propagation[9] and represent the 'worst case' situation.

It is important to note that under most daytime metrological 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.

[8] The notional boundary is 20-metres from a dwelling or the legal boundary if this is closer to the dwelling.

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

Inverter units will likely have appreciable directivity; however, as their orientation is unknown, we have undertaken calculations for all directions (north, south, east, and west) and have reported the worst-case result for each receiver position.

Calculations take into consideration a special audible character[10] correction in accordance with NZS 6802:2008. In accordance with the District Plan $L_{Aeq(15min)}$ noise rule, as the solar farm could potentially operate for more than 80% of the prescribed daytime period (particularly during summer), and as it would also operate at night, no duration correction has been applied.

Results are given in Table 5.

Table 5: Calculated Noise Levels

Receiver Location	District Plan daytime / evening / night-time Noise Limit(s) dB $L_{Aeq(15-min)}$	100% LOAD Calculated Noise Level dB $L_{Aeq(15-min)}$	10% LOAD Calculated Noise Level dB $L_{Aeq(15-min)}$
Notional boundary receivers:			
422 Kina Rd	55 / 50 / 45	26	22
455 Kina Rd	55 / 50 / 45	28	24
504 Kina Rd	55 / 50 / 45	34	30
511 Kina Rd	55 / 50 / 45	35	31
511A Kina Rd	55 / 50 / 45	34	30
654 Kina Rd	55 / 50 / 45	35	31
661 Kina Rd	55 / 50 / 45	35	31
681 Kina Rd	55 / 50 / 45	30	26
506 Ngariki Rd	55 / 50 / 45	28	24
531 Ngariki Rd	55 / 50 / 45	26	22
722 Ngariki Rd	55 / 50 / 45	18	14
529 Arawhata Rd	55 / 50 / 45	20	16
569 Arawhata Rd	55 / 50 / 45	23	19
605 Arawhata Rd	55 / 50 / 45	23	19
669 Arawhata Rd	55 / 50 / 45	24	20
Legal boundary receivers:			
Pt 22B Ngatitara	55	40	36
511 Kina Rd	55	41	37
654 Kina Rd	55	41	37
661 Kina Rd	55	41	37
531 Ngariki Rd	55	40	37
605 Arawhata Rd	55	40	37
669 Arawhata Rd	55	38	34

[10] Spectral data shows potential tonality; therefore, a five-decibel special audible character penalty has been applied to both load scenarios.

As per Table 5, our calculations show that:

- the proposal would readily comply with the District Plan noise limits

Daytime

- calculated noise levels are less than the logged average daytime ambient level (51 dB L_{Aeq}) by at least ten decibels at all receivers
- calculated noise levels are less than the logged daytime background noise level (38 to 40 dB L_{A90}) at all notional boundary receivers by at least three decibels

Evening

- calculated noise levels are less than the logged evening ambient noise levels (44 to 49 dB L_{Aeq}) at all receivers
- calculated noise levels are equivalent to or less than the logged evening background noise level (35 dB L_{A90}) at notional boundary receivers

Night-time

- calculated noise levels are equivalent to or less than the logged night-time ambient noise levels (36 to 41 dB L_{Aeq}) at all receivers
- calculated noise levels are up to two-decibels higher than the logged night-time background noise level (33 dB L_{A90}) at notional boundary receivers

Operational traffic is not expected to be significant. Occasional movements to the solar farm would not risk breaching the day-time noise rule. Heavy vehicle movements are not expected to occur during the night period.

7.0 NOISE LEVEL DISCUSSION

Noise from the solar farm would be low overall and within all national and international guidelines for environmental noise levels that are typically applied within New Zealand.

The proposed solar farm is expected to operate during the daytime and night-time and is calculated to comply with the District Plan noise rules at all existing notional boundaries and at the nearest legal boundaries.

During the daytime, calculated solar farm levels are substantially less than the logged ambient noise level and are less than or within range of the logged background noise level, at all receivers. It is likely that the solar farm would often be inaudible at near receivers during the daytime. Given the low overall noise level from the solar farm, daytime solar farm noise levels are considered to be reasonable and would have little or no effect on amenity.

During the evening, calculated solar farm levels are less than the logged ambient noise level at all receivers, but are equivalent to the background level at some notional boundary receivers. It is likely that the solar farm would be audible at times at near receivers when the farm is operating during the evening. Given the low overall noise level from the solar farm, evening solar farm noise levels are considered to be reasonable and would have little effect on amenity.

During the night-time, calculated solar farm levels are equivalent to or less than the logged night-time ambient noise levels and one or two decibels higher than the background noise level at five notional boundary receivers. Therefore, the solar farm is expected to be audible at the nearest existing dwellings. Noise from the solar farm would be more noticeable and annoying if the sound sources (e.g., inverters) are appreciably tonal. As discussed in Sections 3.0 and 7.0, we consider that final selection of mechanical plant should avoid and/or mitigate tonal characteristics as far as practicable. If tonality is well controlled, there is considered to be little risk of annoyance arising, particularly at the existing dwellings.

Taking into account the above discussion and provided that the tonal character of the proposed mechanical plant (including the inverters) can be avoided and/or mitigated, we consider that overall, the solar farm would be reasonable in terms of the RMA.

8.0 CONSTRUCTION NOISE LEVELS

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

- delivery of panels, inverters and other infrastructure, requiring trucks and small cranes
- some earthworks using trucks, loaders and excavators
- a piling rig to drive the support piles into the ground. These may be hammered, vibropiled or bored depending on ground conditions. We expect that a vibropiling rig will likely be used, but alternative forms of piling have been taken into account.

We have assumed that construction would take place over a period greater than 20-weeks and between the hours 7:30 to 18:00, Monday to Saturday. Therefore, the 'long-term duration' construction noise limits: 70 dB L_{Aeq} and 85 dB L_{AFmax} would apply. The noise limits apply at 1m 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 made by Marshall Day Acoustics 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})				70dBA Limit Setback (m)
		100m	150m	200m	500m	
Large Trucks	108	60	56	52	43	40
Excavators and other earthmoving plant	106	58	54	50	41	33
Impact piling (no mitigation)	123	75	71	67	58	158
Impact piling (small or with dolly)	114	66	62	58	49	69
Vibropiling (excavator driving small piles)	106	58	54	50	41	33
Bored or screw piles (small rig)	103	55	51	47	38	25
Concrete truck & pump	103	55	51	47	38	25
Truck idling	91	43	39	35	26	6

The site area (works area) is at least 260 m from the façades of surrounding sensitive receivers (dwellings) and therefore well beyond the setback distances given in Table 6[11].

Due to the separation distances, a construction noise and vibration management plan (CNVMP) is unlikely to be necessary to assess and manage construction effects on near receivers. However, if any of the following are proposed, the need for a CNVMP should be reconsidered:

[11] Note that this assessment does not take into account the dwellings on the subject sites. If these dwellings are not removed, they will likely be within the setback distances for most of the activities listed above.

- works within the setback distances given in Table 6
- construction outside the hours 07:30 to 18:00, Monday to Saturday
- significant construction equipment additional to that listed in Table 6.

9.0 RECOMMENDED NOISE CONDITIONS

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 on another site in the *Rural* zone:

   Within the notional boundary:

   - 55 dB $L_{Aeq(15min)}$ from 7am to 7pm
   - 50 dB $L_{Aeq(15min)}$ from 7pm to 10pm
   - 45 dB $L_{Aeq(15min)}$ and 75dB L_{AFmax} from 10pm to 7am.

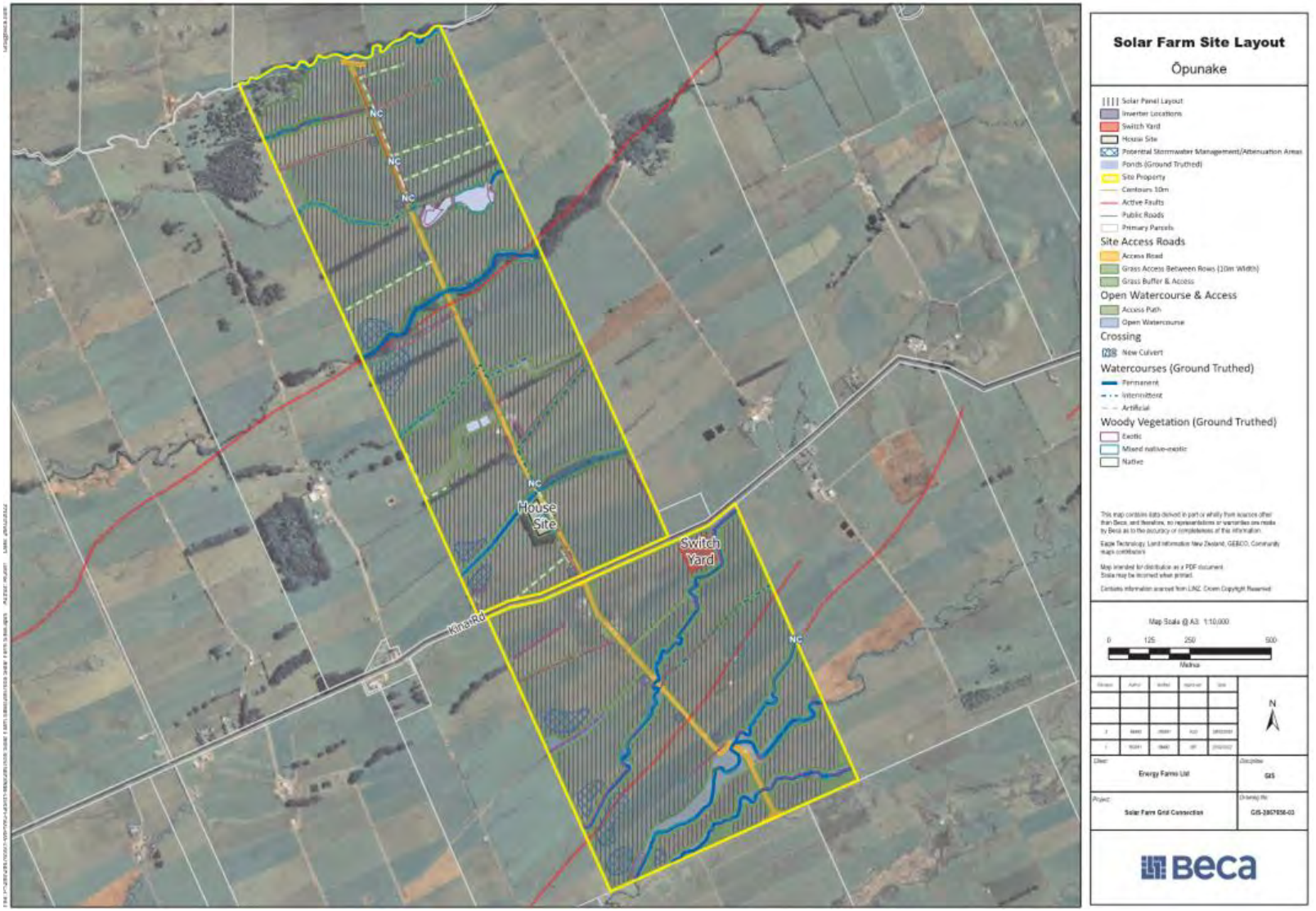
   Within the legal boundary:

   - 55 dB $L_{Aeq(15min)}$ at all times, and
   - 85dB L_{AFmax} from 10pm to 7am
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 from construction activities shall, as far as practicable, not exceed the limits recommended in, and shall be measured and assessed in accordance with, New Zealand Standard NZS 6803: 1999 *"Acoustics – Construction Noise".* Where exceedances of the guidelines in this standard are identified as likely to occur, they shall be managed through a construction noise and vibration management plan and all practicable noise attenuation measures shall be implemented to reduce noise.
4. Upon final selection of the inverters, an assessment of noise tonality (as defined by NZS 6802:2008) and attenuation options (as necessary to mitigate tonality as far as practicable) shall be undertaken. The assessment shall be undertaken by a recognised acoustician and approved by council prior to commencement of construction.
5. During final design of the battery energy storage system (BESS), an assessment to confirm adequate attenuation of the BESS shall be undertaken. The assessment shall be undertaken by a recognised acoustician and approved by council prior to commencement of construction.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient Noise	Ambient Noise is the all-encompassing noise associated with any given environment and is usually a composite of sounds from many sources near and far.
dBA	A measurement of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
L_{eq}	The time averaged sound level (on a logarithmic/energy basis) over the measurement period (normally A-weighted).
L_{90}	The sound level which is equalled or exceed for 90% of the measurement period. L_{90} is an indicator of the mean minimum noise level and is used in New Zealand as the descriptor for background noise (normally A-weighted).
L_{10}	The sound level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level and is used in New Zealand as the descriptor for intrusive noise (normally A-weighted).
L_{AFmax}	The maximum sound level recorded during the measurement period (normally A-weighted).
NZS 6801:1991	New Zealand Standard NZS 6801:1991 *"Measurement of Sound"*
NZS 6802:1991	New Zealand Standard NZS 6802:1991 *"Assessment of Environmental Sound"*
NZS 6803:1999	New Zealand Standard NZS 6803:1999 "*Acoustics – Construction Noise*"
Prescribed time frame	'Daytime', night-time', 'evening', or any other relevant period specified in any rule or national environmental standard or in accordance with 8.3.2 in NZS 6802:2008.

APPENDIX B PROPOSED SITE PLAN



APPENDIX C NOISE MEASUREMENT POSITIONS AND SAMPLE OF LOGGED RESULTS

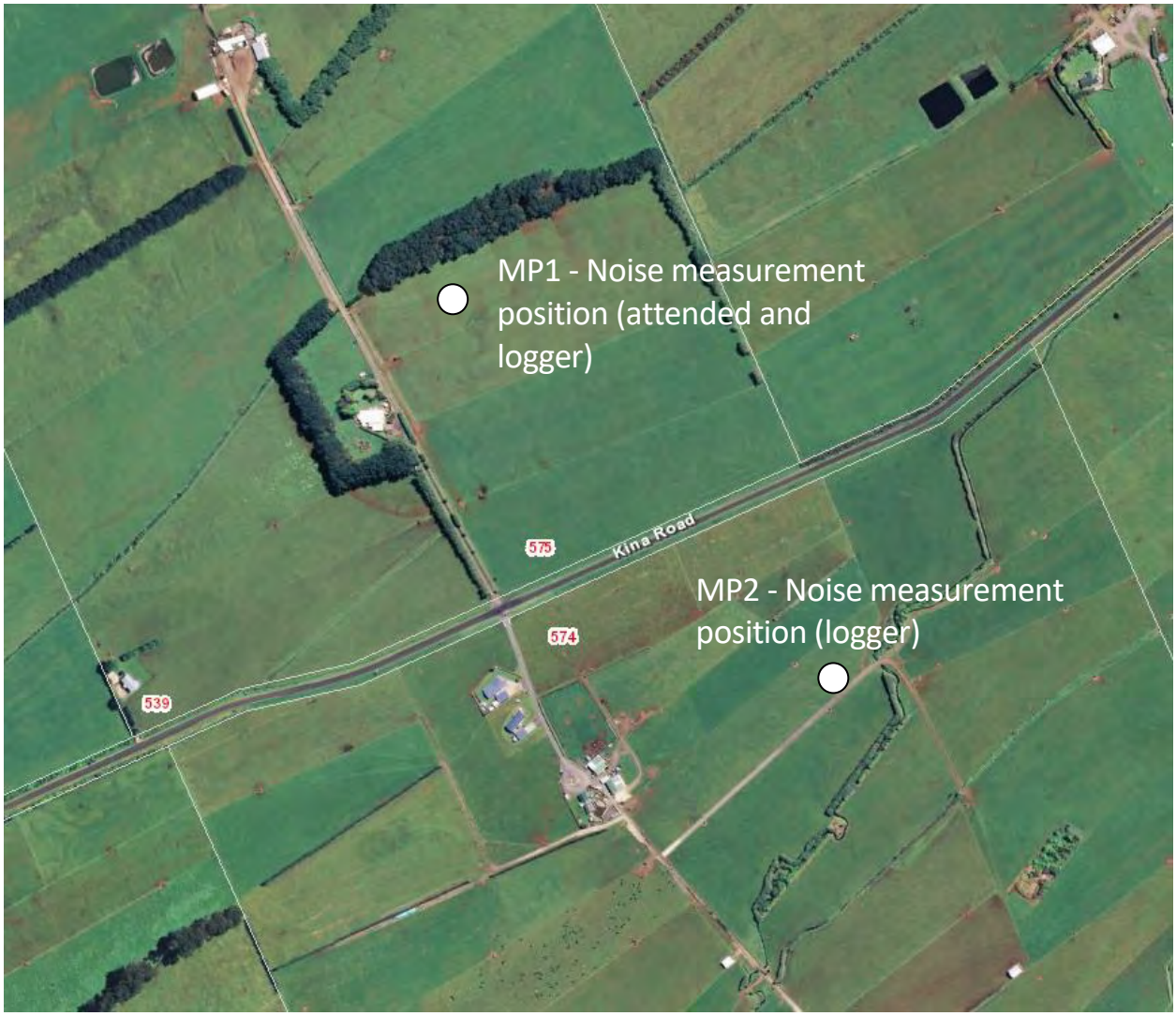
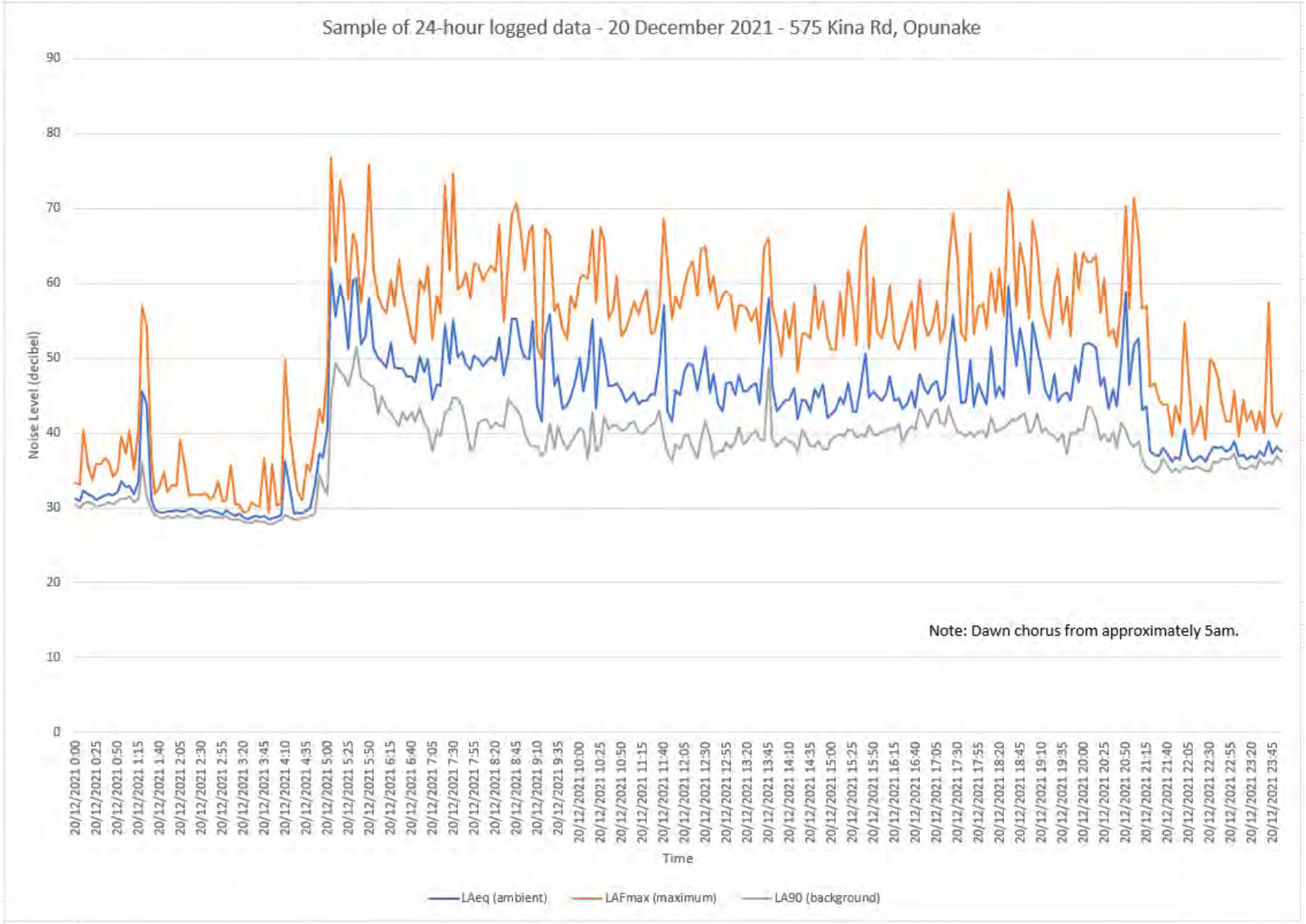


Photo 1: MP1 – 575 Kina Road – facing east

Photo 2: MP1 – 574 Kina Road – facing east



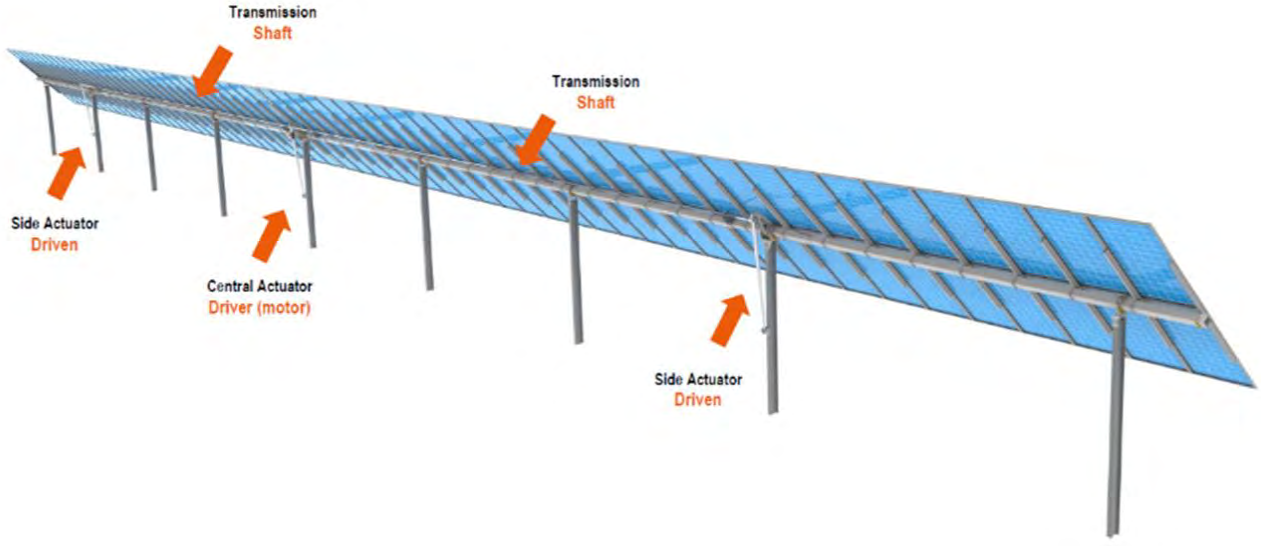
Prescribed District Plan Night (2200 to 0700) sample data for the 19/20, 20/21 and 21/22 of December 2021. Note that the dawn chorus significantly increases noise levels from approx. 0500 hours.

End	20/12/2021 7:00		
Location	575 Kina Rd		
Weighting	A		
Data type	Leq		
Unit	dB		
Period start	Leq	Lmax	L90
19/12/2021 22:00	29.5	35.5	28.8
19/12/2021 22:15	30.2	37.5	29.2
19/12/2021 22:30	31.5	38.8	29.8
19/12/2021 22:45	31.4	34.1	30.2
19/12/2021 23:00	31.5	40	30.3
19/12/2021 23:15	31.5	34.5	30.5
19/12/2021 23:30	31.6	34	30.7
19/12/2021 23:45	31.6	46.5	30.4
20/12/2021 0:00	31.5	40.3	30.2
20/12/2021 0:15	31.5	35.8	30.4
20/12/2021 0:30	31.7	36.7	30.5
20/12/2021 0:45	32.5	39.6	30.9
20/12/2021 1:00	32.5	40.3	31.1
20/12/2021 1:15	43.1	57	31.6
20/12/2021 1:30	30.2	36.9	29
20/12/2021 1:45	29.5	34.8	28.7
20/12/2021 2:00	29.6	39.1	28.8
20/12/2021 2:15	29.8	31.9	28.9
20/12/2021 2:30	29.5	32	28.8
20/12/2021 2:45	29.3	33.5	28.7
20/12/2021 3:00	29.4	35.7	28.5
20/12/2021 3:15	28.8	30.5	28.1
20/12/2021 3:30	28.8	30.7	28.1
20/12/2021 3:45	28.6	36.7	27.9
20/12/2021 4:00	32.7	49.7	28.4
20/12/2021 4:15	30.9	40.4	28.5
20/12/2021 4:30	29.7	35.8	28.8
20/12/2021 4:45	36.1	43.3	29.9
20/12/2021 5:00	58	76.9	35.5
20/12/2021 5:15	57.4	73.7	47.4
20/12/2021 5:30	59	66.7	48.4
20/12/2021 5:45	55.1	75.9	46.5
20/12/2021 6:00	49.5	58.2	43.6
20/12/2021 6:15	50.1	63.1	41.7
20/12/2021 6:30	48	59.1	42.3
20/12/2021 6:45	48.6	60.5	41.7
Overall	48.7	76.9	28.8

End	21/12/2021 7:00		
Location	575 Kina Rd		
Weighting	A		
Data type	Leq		
Unit	dB		
Period start	Leq	Lmax	L90
20/12/2021 22:00	38.3	54.8	35.2
20/12/2021 22:15	36.6	43.5	35.1
20/12/2021 22:30	37.9	49.7	35.7
20/12/2021 22:45	37.8	44.1	36.5
20/12/2021 23:00	37.8	45.7	35.5
20/12/2021 23:15	36.7	42.9	35.4
20/12/2021 23:30	37.9	57.4	36
20/12/2021 23:45	37.6	42.7	36.1
21/12/2021 0:00	38.4	44.9	36.7
21/12/2021 0:15	39.1	49.1	37.4
21/12/2021 0:30	39.4	48.4	37.6
21/12/2021 0:45	39.3	48.9	37.5
21/12/2021 1:00	39.5	50.1	37.7
21/12/2021 1:15	39.2	45.4	37.7
21/12/2021 1:30	39.2	50.3	37.4
21/12/2021 1:45	38.5	45.2	36.8
21/12/2021 2:00	39.5	50.3	37.5
21/12/2021 2:15	40.3	48.6	38.4
21/12/2021 2:30	40.6	50.6	37.8
21/12/2021 2:45	38.2	44.6	36.5
21/12/2021 3:00	37.5	45.9	35.9
21/12/2021 3:15	38.3	43.9	36.8
21/12/2021 3:30	41.2	51	37.9
21/12/2021 3:45	40.8	48.4	38.5
21/12/2021 4:00	39.9	49.2	38
21/12/2021 4:15	39.3	46.1	37.6
21/12/2021 4:30	39.1	51.3	37.2
21/12/2021 4:45	39.6	51.2	37
21/12/2021 5:00	64.7	76.1	39.9
21/12/2021 5:15	64.8	77	49.3
21/12/2021 5:30	57.9	73.3	45.3
21/12/2021 5:45	53.4	64.7	46.3
21/12/2021 6:00	63.8	79.5	46.4
21/12/2021 6:15	50.7	63.5	44.2
21/12/2021 6:30	49.7	60.2	44.2
21/12/2021 6:45	48.8	59.9	42.8
Overall	54.3	79.5	36.5

End	22/12/2021 7:00		
Location	575 Kina Rd		
Weighting	A		
Data type	Leq		
Unit	dB		
Period start	Leq	Lmax	L90
21/12/2021 22:00	29.3	42.4	26.6
21/12/2021 22:15	28.9	45.6	27.7
21/12/2021 22:30	31.6	37	28.5
21/12/2021 22:45	31.7	37.8	29.5
21/12/2021 23:00	32.7	38.1	30.2
21/12/2021 23:15	32.3	40.8	29.7
21/12/2021 23:30	32	38.3	29.8
21/12/2021 23:45	33	38.2	30.5
22/12/2021 0:00	33.2	44.3	30.5
22/12/2021 0:15	32.3	42.8	30
22/12/2021 0:30	31.3	35.5	29.6
22/12/2021 0:45	31.3	36.2	30.2
22/12/2021 1:00	30.7	40.9	29.4
22/12/2021 1:15	29.6	34.4	27
22/12/2021 1:30	27.9	33.3	27
22/12/2021 1:45	44.1	57.4	27.8
22/12/2021 2:00	28.7	37.9	27.3
22/12/2021 2:15	28.2	36.6	27.3
22/12/2021 2:30	28	36.4	26.9
22/12/2021 2:45	27.7	31.5	26.9
22/12/2021 3:00	27.8	38.1	26.8
22/12/2021 3:15	27.7	31.5	27
22/12/2021 3:30	28.1	30.6	27.3
22/12/2021 3:45	28	35.4	27.1
22/12/2021 4:00	28.4	33	27.6
22/12/2021 4:15	33.8	44	28.1
22/12/2021 4:30	30.6	39.1	27.6
22/12/2021 4:45	37.4	47.6	32
22/12/2021 5:00	64.7	82	42.6
22/12/2021 5:15	60.4	72.8	50.1
22/12/2021 5:30	59.2	65.5	49.1
22/12/2021 5:45	52.8	64.3	44.8
22/12/2021 6:00	59.7	77.6	44.2
22/12/2021 6:15	57.8	75.8	43.1
22/12/2021 6:30	52.9	67.1	42.6
22/12/2021 6:45	49.3	60.7	42.4
Overall	52.9	82	27.4

APPENDIX D TRACKER ARRANGEMENT



APPENDIX E OPERATIVE SOUTH TARANAKI DISTRICT PLAN NOISE RULES

11.2 PERFORMANCE STANDARDS – PERMITTED ACTIVITIES

The following Performance Standards apply to all permitted activities, except those exempt from the standards as set out in Section 11.2.1.

Except where otherwise expressly provided for, noise is to be measured and assessed in accordance with NZS 6801:2008 Acoustics - Measurement of Environmental Sound and NZS 6802:2008 Acoustics – Environmental Noise.

11.2.1 ACTIVITIES THAT ARE EXEMPT FROM THE NOISE PERFORMANCE STANDARDS

The following activities are exempt from the specific noise performance standards in Chapters 8, 11 and 18 and shall be controlled separately by reference to and Sections 16 and 17 of the RMA and by the application of relevant New Zealand Noise Standards where these are applicable:

(a) Aircraft being operated during or immediately before or after flight, except for helicopter noise as part of a Temporary Military Training Activity as set out in Rule 11.2.10.

(b) Vehicles being driven on a road (within the meaning of Section 2(1) of the Transport Act 1998), or within a site as part of or compatible with a normal residential activity.

(c) Trains on rail lines (public or private), including at railway yards, railway sidings or stations. However, this exemption does not apply to the testing (when stationary), maintenance, loading or unloading of trains.

(d) Sounds specifically generated by construction, maintenance and demolition activities which shall be assessed, managed and controlled by reference to NZ S6803:1999 Acoustics – Construction noise.

11.2.2 RURAL ZONE AND TOWNSHIP ZONE

1. Noise generated by any activity in the Rural Zone and Township Zones shall not exceed the following noise limits:

   (i) when measured at any point within the boundary of any other Rural Zoned site:

All times	55dB $L_{Aeq\ (15\ min)}$
10pm to 7am	85dB $L_{Aeq\ (15\ max)}$

   (ii) when measured at any point within the notional boundary of any dwelling on any other Rural Zoned site:

7am to 7pm	55dB $L_{Aeq\ (15\ min)}$
7pm to 10pm	50dB $L_{Aeq\ (15\ min)}$
10pm to 7am	45dB $L_{Aeq\ (15\ min)}$
10pm to 7am	75dB L_{Amax}

APPENDIX F 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."