DISCLAIMER
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EXECUTIVE SUMMARY

This is the December Report in a series of Bald Hill Wind Farm monitoring reports prepared for Mr J. Zakula and participants in the residents’ group who have requested the monitoring.

The monitoring report consists of:

- Noise map of affected residences
- Summary of key information – PSAC vs sound levels and SCADA data
- Sound levels vs Power generation vs ‘PTR’ exceedances
- Regression curves

The datasets are prepared with Class 1 sound level meters holding current calibration certificates. There are six monitoring locations (as of December 2018) and data is downloaded at the end of the month. The data in this Report is prepared from daily data downloaded from monitoring locations; the Noise Tutor system at ML1; weather and wind farm data from BOM sources. Background LA95 data is presented for evaluation of wind farm compliance with approval requirements. Historical background sound levels required under NZS6808:1998 for compliance testing purposes are not available. This Report records:

- Wind farm operational data (sound levels, sound character).
- Weather data to evaluate against sound levels and wind farm operational data.
- Resident’s diaries for special audible characteristics, sleep disturbance, events and assessment of potential or actual nuisance conditions.
- All data is confidential to the individual residents and the diaries and audio recordings are protected by privacy requirements.

The Charts and Tables in this Report are summaries of the detailed data stored on hard-drive at each measurement location.

All Leq, Ln data is A-weighted; All third-octave band data is Z-weighted; Ln is ‘F’ response.

Larson Davis 831 and BSWA data is saved to disk in 10-minute blocks
Noise Tutor charts read from 7am of the nominated day to 7am of the second day.

Weather data is recorded from onsite 10m and 1.5m weather stations, BOM (Pound Creek, Yanakie) measurements and forecasts/simulations from meteoblue

Wind farm operational data is recorded from AEMO data

The Noise Impact Map presents ISO 9613-2 calculated wind farm sound levels at residential locations.
The relevant Bald Hills Wind Farm noise approval condition relating to monitoring sound levels is:

19. The operation of the wind energy facility must comply with the New Zealand Standard ‘Acoustics – The Assessment and Measurement of Sound From Wind Turbine Generators’ (NZ 6806:1998) (the ‘New Zealand Standard’), in relation to any dwelling existing at the date of approval of this document to the satisfaction of the Minister for Planning. In determining compliance with the New Zealand Standard, the following apply:

(a) The sound level from the wind energy facility, when measured outdoors within 10 metres of a dwelling at any relevant nominated wind speed, should not exceed the background level (L95) by more than 5dBA or a level of 40dBA, whichever is the greater.

(b) When sound has a special audible characteristic, the measured sound level of the source shall have a 5 dB penalty added.

(c) Compliance at night must be separately assessed with regard to night-time data. For these purposes the night is as defined in SEPP-N1. For sleep protection purposes. A breach of the standard set out in 19(a), for 10% of the night, amounts to a breach of the condition.

NMS Notes to condition 19:

- The night-time period in SEPP-N1 is the time between 2200 and 0700 hours.
- The expression “6806” should read “6808”.
- The standard does not state what is, or isn’t, a ‘relevant nominated windspeed’. ‘Windspeed’ is a measurement of the speed of the prevailing wind over a discrete time period. Measurement is in m/s with a tolerance of 0.5 m/s.
BALD HILLS NOISE MONITORING
NOISE MAP OF AFFECTED RESIDENCES
DECEMBER 2018
BALD HILLS WIND FARM ISO 9613-2 NOISE MAP AND RESIDENTS’ IN THE MONITORING PROGRAM

Bald Hills
Wind Farm

Noise contours at 1.8m
Default Met Conditions
Each turbine at 104.2 SW(LA)
Levels in L eq
Free-field
SoundPlan v6.0

20.0 - 25.0
25.0 - 30.0
30.0 - 35.0
35.0 - 40.0
40.0 - 45.0
45.0 - 50.0
50.0 - 55.0
55.0 - 60.0
60.0 - 65.0
>= 65.0

Signs and symbols

Wind turbine
NMS Locations
MDA Locations

Scale

CONFIDENTIAL TO J.ZAKULA AND MONITORING PARTICIPANTS  Bald Hills Monitoring and Analysis — DECEMBER 2018 R3 – Noise Measurement Services Pty Ltd
INTRODUCTION – NOISE MAP - HOW TO READ THIS SECTION

A common method of assessing the potential for noise from wind farms is noise impact prediction with a method termed “ISO 9613-2”. NMS has prepared a “standard” noise map showing the predicted sound levels from the wind farm (previous page). The map shows isobars or noise contours and these illustrate the potential variability of sound levels predicted in this way. ISO 9613-2 predicted sound levels have a calculation estimation accuracy (uncertainty) of ±3 dB under default (nominal mild downwind or inversion) conditions. The calculations should not necessarily be expected to agree with the variation in measurements made at a given site on a given day; that is, noise levels will vary day by day, hour by hour, depending on weather conditions.

Conversely, noise impact assessment reports may present single-figure predicted noise levels, Table 1. During our discussions (NMS and Residents) it became apparent that noise impact prediction reports may give the impression that the predictions are the maximum levels of noise experienced. This is not true. Predictions are based on assumptions. Assumptions generate variations. The sound levels recorded in this report during the monitoring program show considerable variability. Secondly, noise is a human perception, not something solely related to maximum sound levels. The charts in this report present evidence of large variations in sound levels and characteristics that help explain the perception of “special audible characteristics” in NZS6808:1998.

Table 1: Bald Hills Wind Farm – Predicted sound levels (LAeq) under ‘Full’ and ‘Curtailment’ measures

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Description</th>
<th>Height (metres)</th>
<th>All turbines operating at 104.2 SWL</th>
<th>All turbines but 4, 40, 46, 47 in curtailment mode</th>
<th>All turbines but 4, 40, 46, 47 “removed”</th>
<th>Closest turbine to receptor (number)</th>
<th>Closest turbine to receptor (distance metres)</th>
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<tr>
<td>ML1</td>
<td>JZ</td>
<td>1.8</td>
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</table>

Approval condition 22 requires noise mitigation measures should breaches of Condition 19 occur. One measure is to reduce the noise from a particular turbine or turbines.
Condition 22
Where condition 19 is found to have been breached, the Minister for Planning shall notify the wind energy facility operator, with a request that steps be taken to ascertain the relevant meteorological circumstances at the time of the breach and to noise optimize the operation of the relevant turbines or turbines in such circumstances. If there is a further breach in similar circumstances, the Minister for Planning shall notify the wind energy facility operator, with a request to noise selectively shut down the operation of the relevant turbine or turbines in those circumstances. In circumstances where optimization or selective shutdown routines have been requested but not reasonably implemented, or have been implemented but have not prevented further instances of recorded breach, the relevant turbine or turbines will be required to be decommissioned and removed.

Curtailment mode in Table 1 is when selected turbines theoretically operate under ‘noise optimization; that is, with a lower sound emission. This approach is shown to be ineffective.
BALD HILLS NOISE MONITORING
SUMMARY OF KEY INFORMATION
PSAC vs SOUND LEVELS and SCADA DATA
DECEMBER 2018
INTRODUCTION – SUMMARY OF KEY INFORMATION - HOW TO READ THIS SECTION

THE INFORMATION AND CHART IN THIS SECTION ARE THE KEYS TO UNDERSTANDING COMPLIANCE / NON-COMPLIANCE ISSUES FOR THE WIND FARM

What is presented, in a glance:
- Background sound levels (LA95) on a day-by-day basis for each residence monitored;
- A trace showing the operation of the windfarm generating power (SCADA value);
- The 40 dB(A) noise limit is exceeded on the days coloured ‘peach’/’transparent red’ (called PTR Coded in the rest of this report);
- The PTR Coded times are nearly always when the turbines are running at above 75% or full generation;
- The PTR Coded times nearly always occur when the wind at ML1 is less than 3m/s;
- Noise complaints (PSAC) from noise affected persons – shown as coloured dots for the day that annoyance or nuisance conditions from personal diaries;
- Potential nuisance conditions can be identified from full or near full power generation and sudden rises/decreases in power generation.

Process:
- Check that the that the turbines are running! This is the black SCADA value line on the chart.
- Check the weather conditions at the residence – wind nominally below 3 m/s (upper range 5 m/s) and no rain.
- Check PTR Coded 10-minute blocks.
- The background LA95 levels for the monitoring locations are recorded on the chart.
- ‘No activity’ background sound levels can be obtained when the turbines are not running.
- Take a background LA95 sound level of 40 dB(A) in any 10-minute block as being the ‘exceedance’ assessment starting point.
- These objective tests supplement subjective (complaint) responses to wind farm activity.
- Only those days that have the turbines operational and having a PSAC tag (coloured dot) for nighttime are considered as being “possibly non-compliant”.
- If special audible characteristics are present (e.g. audible modulation, tones, rumble) a 5 dB penalty is warranted
- The datafiles and audio files can be further assessed to nuisance complaint histories.

Caution:
On a few days the PTR Coding shows that exceedances have occurred when the background sound levels are high yet the wind farm power generation is not high. Compliance / Non-compliance / Potential nuisance assessments are made on the basis of the detailed daily sound levels, wind farm activity, wind/weather conditions and diary entries.
Diary entries for personal Perception of Special Audible Characteristics (PSAC) notation

Residents maintained observation diaries over the period May 2018 to March 2019. The “affected days” that form the basis for the following charts are illustrated in the September listing, following. The listings are prepared from the diary notes compiled for each month from May 2018 to March 2019 and diarists are identified as PSAC1 to PSAC6. The observations are recorded on the PTR – PSAC chart presented on the previous page.

How 'YES' is determined:

- the sounds must have caused the adverse effects noted in the diaries
- the sound of the turbines had to be clearly audible inside the home
- the sound had to be intrusive, annoying and/or disturbing sleep
- some people had problems with pressure sensations rather than audible sound

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Graph Value: 120, 117.5, 115, 113.5, 110, 107.5, 105, 102.5
BALD HILLS NOISE MONITORING
SOUND LEVELS vs POWER GENERATION
vs ‘PTR’ EXCCEDANCES
DECEMBER 2018
INTRODUCTION – PTR EXCEEDANCES - HOW TO READ THIS SECTION

What is presented:

• Background sound levels vs wind power generation for December (summary for the month and daily detail);
  ➢ L95 background sound levels for each residence monitored;
  ➢ Bald Hills power generation shown as the SCADA value (black trace);
  ➢ Wind and rain data from the Pound Creek BOM station and ML1;
• The 40 dB(A) noise limit is exceeded on the days coloured ‘peach’/‘transparent red’ (called PTR Coded in the rest of this report);
• The PTR Coded times are nearly always when the turbines are running at above 75% or full generation;
• The PTR Coded times nearly always occur when the wind at ML1 is less than 3m/s;
• Potential nuisance conditions can be identified from full or near full power generation and sudden rises/decreases in power generation.

Process:

• Check that the that the turbines are running! This is the black SCADA value line on the chart.
• Check the weather conditions at the residence – wind nominally below 3 m/s (upper range 5 m/s) and no rain.
• Check PTR Coded 10-minute blocks.
• The background LA95 levels for the monitoring locations are recorded on the daily charts.
• ‘No activity’ background sound levels can be obtained when the turbines are not running.
• Take a background LA95 sound level of 40 dB(A) in any 10-minute block as being the ‘exceedance’ assessment starting point.
• If the night-time background sounds are dominated by wind turbine noise (e.g. turbine ‘signature tones’, audible shifts in sound level-‘modulation’, ‘rumble’) check data for 10% exceedance.
• As the background sound levels are over 40 dB(A) there is a probability that wind farm noise dominates and consequently potential non-compliance. If special audible characteristics are present (e.g. audible modulation, tones, rumble) a 5 dB penalty is warranted.
• Check night-time sound levels – if PTR Coded 10-minute blocks occur more than 6 times over night then the wind farm may be in non-compliance.
• These objective tests supplement subjective (complaint) responses to wind farm activity as recorded in personal diaries.
• The datafiles and audio files can be further assessed to nuisance complaint histories.

Caution:

On a few days the PTR Coding shows that exceedances have occurred when the background sound levels are high yet the wind farm power generation is not high. Compliance / Non-compliance / Potential nuisance assessments are made on the basis of the detailed daily sound levels, wind farm activity, wind/weather conditions and diary entries.
Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
11 December 2018

Noise Level (dBA), Scada Value

Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
14 December 2018

Exceedance Criteria:

- >40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada > 0
Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
16 December 2018

Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada > 0
Exceedance Criteria:
>40 dB(A) AND <5 m/s wind at ground height AND <0.2 mm rain AND Scada > 0
19 December 2018

- Exceedance
- ML6 Outside LA95
- Rain BOM
- Wind m/s BOM (10m)
- Scada Value
- Wind m/s ML1 (1.5m)

Noise Level (dBA), Scada Value

Wind Speed (m/s), Rain (mm)

Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
20 December 2018

Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada>0
24 December 2018

Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2 mm rain AND Scada >0
25 December 2018

Exceedance Criteria:

>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
26 December 2018

Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
29 December 2018

Exceedance
ML6-Outside-LA95
Rain BOM
Wind m/s BOM (10m)
Wind m/s ML1 (1.5m)
Scada Value

Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
30 December 2018

Exceedance Criteria:
>40dBA AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
31 December 2018

Exceedance Criteria:
>40dB(A) AND <5m/s wind at ground height AND <0.2mm rain AND Scada >0
BALD HILLS MONITORING
REGRESSION CURVES
SOUND LEVELS vs TIME OF DAY
SOUND LEVELS vs WIND SPEED
DECEMBER 2018
INTRODUCTION – REGRESSION CURVES - HOW TO READ THIS SECTION

This section records the sound levels and the regression curves required for compliance analysis under NZS6808.

Clause 5.4 Compliance assessment of NZS6808:1998 states:
To determine conformance with the limits set out in 4.4.2, a comparison shall be made between the best fit regression line of the background sound levels and the regression curve of the operational windfarm corrected for any special audible characteristics. If the background levels were not measured prior to installation (4.5.1), it may be necessary to obtain background sound level measurements for limited periods at critical windspeeds to satisfy 4.4.2 (e.g. if wind turbine or windfarm sound levels exceed 40 dBA L95). This may be for a limited range of windspeeds and directions, with the WTG(s) non-operational.

Decision Process:
- The outdoor sound level meters record the background (LA95) sound levels every 10 minutes. This is 144 samples every 24 hours.
- The sound levels (shown as blue dots in all the following charts) for each monitoring location are presented for day/night and nighttime only. As can be seen, there is considerable variability over each hour and over the whole day or night period. It is common practice to “simplify” this mass of values by calculating an “average” through the process of regression analysis. This creates a curve, the red dotted line in the following two charts, with a confidence interval calculated to include 68% of the sound levels – the solid lines above and below the dotted line.
- The regression line is an average. It is not the real level of sound heard by a person and has little relevance to the assessment of nuisance at a specific point in time. It is, however, the concept applied by NZS6808 to assess compliance. To this must be included the 5dB penalty for special audible characteristics.
- The third and fourth charts in this series present the regression curve concept applied by NZS6808 to assess compliance. In these charts we are concerned only with nighttime data as this is the time when noise complaints are recorded. The charts are referenced to wind speeds at a height of 10 metres and 80 metres. The solid black line in each chart is the noise limit for the location and 10 metre wind speed as applied by a pre-construction (2012) report by Marshall Day Acoustics.
- Blue dots above the solid black line indicate non-compliance.
- The fifth and sixth charts in this series present the regression curve concept applied by NZS6808 to assess compliance. In these charts we are concerned only with the 10% loudest nighttime data as this is the time when noise complaints are recorded and is a specific breach under the approval conditions. The charts are referenced to wind speeds at a height of 10 metres and 80 metres. The solid black line in each chart is the noise limit for the location and 10 metre wind speed as applied by a pre-construction (2012) report by Marshall Day Acoustics.
- Blue dots above the solid black line indicate non-compliance.
December 2018 – ML6 (JM)

Variation in day and night sound levels for the month by time of day/night
The variation in night-time sound levels for the month by time of night
Regression curve of night-time sound levels v. noise limits for the month ref. 10m wind speeds

LA95 at ML6 ref BOM (10m) wind speed, Field Data: December 2018

Field Data Filters: Time Period - Night, Wind Direction - All, Wind < 20m/s, Rain < 5mm, Scada > 1MW, Loudest 10% Only
Pre wind farm background noise levels from H61 and noise limit for comparison. Number of Field Data points: 126

\[
y = 0.0054x^3 + 0.0113x^2 - 0.1333x + 41.817
\]

\[ R^2 = 0.2861 \]
Regression curve of night-time sound levels v. noise limits for the month ref. 80m wind speeds

\[
y = 0.0054x^3 + 0.0113x^2 - 0.1333x + 41.817
\]

\[R^2 = 0.2861\]
Night-time 10% Loudest Sound Levels for December 2018

LA95 at ML6 ref BOM (10m) wind speed, Field Data: December 2018

Field Data Filters: Time Period - Night, Wind Direction - All, Wind < 20m/s, Rain < 5mm, Scada > 1MW, Loudest 10% Only
Pre wind farm background noise levels from H61 and noise limit for comparison. Number of Field Data points: 126

\[ y = 0.0054x^3 + 0.0113x^2 - 0.1333x + 41.817 \]
\[ R^2 = 0.2961 \]