# Hexham Wind Farm

## Peer Review of Environmental Noise & Vibration Assessment

M240899RP1 Revision A

Thursday, 21 August 2025

Resonate

**Document Information**

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# Glossary

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| A-weighting | A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies. |
| Ambient noise | The overall environmental noise level at a given location caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, insects, animals and the like. It is typically described by the $L_{Aeq}$ metric. |
| Amplitude modulation | The modulation, change, of the loudness of wind turbine noise. Wind turbine noise is generally accepted to have a normal level of modulation (blade 'swish') but has been known to occasionally exhibit excessive amplitude modulation which may be described as a 'thumping' noise and could warrant a special audible characteristic penalty. |
| Background noise | The underlying noise level at a given location, measured in the absence of a noise source under investigation and other industry noise. The background noise is typically described using the $L_{A90}$ metric to reduce the effect of short-term noise sources such as intermittent traffic, lawnmowers, insect, animals and the like. |
| BESS | Battery Energy Storage System |
| CNVMP | Construction Noise and Vibration Management Plan |
| Day period | Monday to Saturday (except public holidays), from 7 am to 6 pm as defined in the Environment Protection EP Regulations. |
| dB | Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. People typically perceive a 10 dB increase in sound as a doubling of loudness. |
| EES | Environment Effects Statement |
| Effective noise level | The level of noise emitted from the commercial, industrial or trade premises and adjusted if appropriate for duration, character and position as defined in Part I, Section B2 of the Noise Protocol. |
| EP Act | Environment Protection Act 2017 |
| EP Regulations | The Victorian Environment Protection Regulations are subordinate legislation to the Environment Protection Act 2017. They give force to noise limits for commercial, industrial and trade premises. |
| EPA | Environment Protection Authority Victoria. |
| ERS | Environment Reference Standard |
| Evening period | Monday to Saturday, from 6 pm to 10 pm; and Sunday and public holidays, from 7 am to 10 pm, as defined in the EP Regulations. |
| Frequency (Hz) | The number of times a sound pressure wave oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. |
| GED | General Environmental Duty – As defined by Section 25(1) of the EP Act, the GED requires that any person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable. |
| Impulsiveness | Transient sound having a peak level of very short duration, typically less than 100 ms. Impulsive sounds are subjectively more annoying than steady sounds. |

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| Involved stakeholder | A dwelling where the landowner has an agreement in place that modifies the applicable noise limit in accordance with Regulation 131B of the EP Regulations. |
| $L_{A90}$ | A-weighted sound pressure level that is exceeded for 90% of the time interval considered. The $L_{A90}$ metric is used to assess wind turbine noise in Victoria and also to quantify the background noise level in an environment. |
| $L_{Aeq}$ | The equivalent continuous A-weighted sound pressure level. It is the value of the A-weighted sound pressure level of a continuous steady sound that has the same acoustic energy as a given time-varying A- weighted sound pressure level when determined over the same measurement time interval. The $L_{Aeq}$ metric is used to quantify the Effective Noise Level from a commercial, industrial or trade premises. |
| Low-noise impact Works | Works conducted outside of Normal Working Hours that are inherently quiet or unobtrusive, for example, manual painting, internal fitouts, and cabling. Low-noise works do not have intrusive characteristics such as impulsive noise or tonal movement alarms. |
| $L_{WA}$ | Sound Power Level - a measure of the acoustic output of a source, independent of distance and referenced to $10^{-12}$ W. |
| Managed-impact Works | Works conducted outside of Normal Working Hours where the noise emissions are managed through actions specified in a noise and vibration management plan (may be part of a broader environmental management plan), to minimise impacts on sensitive receivers. Managed-impact works do not have intrusive characteristics such as impulsive noise or tonal movement alarms. |
| Night period | Between 10 pm and 7 am of the following day as defined in the EP Regulations. |
| Noise Limit | The maximum allowable level of wind turbine noise as established in accordance with NZS 6808:2010. Also refers to the maximum effective noise level allowed in a noise sensitive area for a commercial or industrial premises, as determined in accordance with the Noise Protocol. |
| NMP | Noise Management Plan |
| Noise Protocol | Environmental Protection Authority Publication 1826.4 Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues. |
| Noise sensitive receiver | Refers to a land use that may be sensitive to noise from a construction or operational source. The precise type of sensitive receivers can vary depending on the type of noise source and the legislation or guidelines that apply, but noise sensitive receivers generally include residential land uses (including aged care), educational land uses and hospitals. |
| Normal Working Hours | Defined by EPA Victoria Publication 1834.1 as 7 am to 6 pm weekdays and 7 am to 1 pm on Saturdays. |
| NZS 6808:2010 | New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise*. |
| Special audible characteristics | Special Audible Characteristics are unusual characteristics of wind farm sound that make it more likely to cause adverse community response at lower sound levels. Special audible characteristics are defined by NZS 6808:2010 to include tonality, impulsiveness and amplitude modulation. |
| Tonality | A characteristic of a noise where there is a distinctly higher level over a relatively narrow frequency range. Examples include the reversing signal on a truck or the wheel squeal that sometimes occurs when trains move around a curve. A noise exhibiting tonality is subjectively more annoying than a non-tonal noise at the same level. |

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| Unavoidable works | Construction works that must be conducted outside of Normal Working Hours as they pose an unacceptable risk to life or property or a major traffic hazard and can be justified to occur out of hours. Includes an activity which has commenced but cannot be stopped. |
| Unreasonable noise | Noise defined by the EP Regulations to exceed the established noise limits is prescribed to be unreasonable noise. |

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# 1 Introduction

Resonate has been engaged by Wind Prospect to undertake a peer review of the environmental noise and vibration assessment prepared as part of the Environment Effects Statement (EES) for the Hexham Wind Farm (the Project). The proposed wind farm will consist of up to 106 wind turbines and related infrastructure, including a terminal station and battery energy storage system (BESS), and will be located between the townships of Hesham, Caramut and Ellerslie in Moyne Shire.

## 1.1 EES scoping requirements

The *Scoping Requirements Hexham Wind Farm Environment Effects Statement* (scoping requirements) issued by the Minister for Planning and dated September 2024 set out the requirements for the EES documentation.

The following Evaluation Objective identified within the scoping requirements is relevant to noise and vibration from the Project:

> **Amenity.** To minimise and manage adverse air quality and noise and vibration effects on residents and local communities as far as practicable during construction, operation and decommissioning having regard to applicable limits, targets or standards.

With respect to the above Evaluation Objective, the following scoping requirements apply to the Project that are relevant to noise and vibration:

| Aspect | Scoping requirements relevant to noise and vibration |
|---|---|
| Key issues | • Potential for adverse effects on noise and vibration amenity at sensitive receptors during construction, operation and decommissioning (including for the potential on-site quarry). |
| Existing environment | • Characterise the ambient noise environment in adjacent established residential, farming zone, commercial and open space areas and at other sensitive land use locations.<br>• Identify sensitive receptors that may be subject to effects to amenity from the project including, but not limited to, all dwellings within 3 km of wind turbines, associated infrastructure and potential on-site quarry. |
| Likely effects | • Assess the potential dust, noise and vibration impacts from the potential on-site quarry in accordance with the requirements of *EPA Publication 1823.1 Mining and quarrying: Guide to preventing harm to people and the environment*.<br>• Assess the potential effects of the project on noise and vibration amenity at sensitive receptors, including information that addresses:<br>– how the noise associated with construction of the wind farm and project infrastructure will be managed in accordance with relevant guidelines, such as *EPA Publication 1820.1: Construction – Guide to preventing harm to people and the environment, EPA Publication 1834: Civil Construction, Building and Demolition guide*, *EPA Publication 1695: Assessing and controlling risk: a guide for business*, and having regard to the environmental values for ambient sound defined in the environmental reference standard (ERS) established under the *Environment Protection Act 2017*;<br>– how the operational wind turbine noise will be managed in accordance with Division 5 of Part 5.3 of the Environment Protection Regulations 2021 and relevant guidelines, including DELWP *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* (2021), EPA *Wind Energy Facility Turbine Noise Regulation Guidelines* and *NZS 6808:2010 Acoustics – Wind Farm Noise for the turbines*; and<br>– how operational noise from other relevant project infrastructure such as the on-site terminal station and battery storage facility, and from other potential commercial, |

| Aspect | Scoping requirements relevant to noise and vibration |
|---|---|
| | industrial and trade premises to be developed as part of the project such as the potential on-site quarry and potential concrete batching plants will be managed in accordance with Division 3 of Part 5.3 of the Environment Protection Regulations 2021, *EPA Publication 1826.4: Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* as well as relevant guidelines such as EPA *Commerce Industry and Trade Noise Guidelines* and *Publication 1996: Noise guideline - Assessing low frequency noise*.<br>• If a quarry is to be developed as part of the project, assess the potential noise and vibration (ground and airborne) effects from the proposed on-site quarry activities on sensitive receptors in accordance with guidelines, including, but not limited to, the Earth Resources Guidelines for Ground Vibration and Airblast Limits for Blasting in Mines and Quarries. |
| Design and mitigation | • Describe and evaluate both potential and proposed design responses and/or other mitigation measures (e.g. staging/scheduling of works) which could minimise noise and vibration during construction, operation and decommissioning. |
| Performance objectives | • Describe proposed measures to manage and monitor effects on amenity values and identify likely residual effects, including compliance with standards and proposed trigger levels for initiating contingency measures.<br>• Describe contingency measures for responding to unexpected impacts to amenity values resulting from the project during construction, operation and decommissioning. |

## 1.2 Reviewed document and exclusions

This Peer Review considers the environmental noise and vibration assessments prepared for the Project by Marshall Day Acoustics (MDA), consisting of the following reports:

- Environmental Noise & Vibration Assessment[1]
- Background Noise Monitoring Report[2].

We note that the following items have not been considered as part of this Peer Review, for the reasons detailed below:

- The Environmental Noise & Vibration Assessment identifies a significant number of dwellings at which noise predictions have been carried out. This review has not considered whether all sensitive locations have been identified within three kilometres of the wind farm as required by the scoping requirements.
- The Environmental Noise & Vibration Assessment does not assess the potential impact of noise and vibration on fauna, which is a key issue identified in the scoping requirements for biodiversity and habitat. We understand that this has been addressed as part of a separate flora and fauna technical assessment, which has not been reviewed by Resonate.
- The Environmental Noise & Vibration Assessment excludes the assessment of airblast and vibration from blasting associated with the proposed quarry. It is understood that this has been considered as part of a separate technical assessment. Therefore, this has not been considered in this peer review.

## 1.3 Peer reviewer

This peer review has been undertaken by Tom Evans, who is a Director at Resonate. A copy of the curriculum vitae of the author of this Peer Review is provided in Appendix A.

[1] MDA, 4 August 2025, *Hexham Wind Farm – Environmental Noise & Vibration Assessment*, Rp 002 06Draft 20190086

[2] MDA, 4 August 2025, *Hexham Wind Farm – Background Noise Monitoring*, Rp 003 R01 01Draft 20190086

# 2 Review

## 2.1 Scoping requirements

In our opinion, the information in the Environmental Noise & Vibration Assessment fulfils the scoping requirements. Comments within this report provide context to how the scoping requirements have been addressed.

**SUMMARY**

The assessment identifies and addresses the scoping requirements.

**RECOMMENDATIONS**

None

## 2.2 Legislation, policy and guidelines

The Environmental Noise & Vibration Assessment adopts the following primary legislation, policy and guidelines for the noise and vibration assessment:

- For construction noise:
  - Environment Protection Authority (EPA) Victoria Publication 1834.1 *Civil construction, building and demolition guide* (EPA Publication 1834.1).
- For construction vibration:
  - Transport for NSW *Construction Noise and Vibration Guideline (Roads)* (NSW CNVG).
- For wind turbine noise:
  - *Environment Protection Regulations 2021* (EP Regulations)
  - New Zealand Standard (NZS) 6808:2010 *Acoustics – Wind farm noise*
  - Department of Transport and Planning (DTP) *Planning Guidelines for Development of Wind Energy Facilities* (Victorian Wind Energy Guidelines)
  - EPA web page *Wind Energy Facility Turbine Noise Regulation Guidelines* (EPA web guide), previously noted as Publication 2061
  - EPA-DTP Publication 3011 *Wind Energy Facility Turbine Noise – Technical Guideline* (Technical Guideline)
- For ancillary infrastructure noise, including concrete batching plants and onsite quarry during construction:
  - EPA Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol)
  - EPA Victoria Publication 1996 *Noise guidelines: Assessing low frequency noise* (EPA Publication 1996).

The Environmental Noise & Vibration Assessment also recognises the general environmental duty that is set out in the *Environment Protection Act 2017* (the EP Act) and the *Environment Reference Standard* that was introduced under the EP Act and sets out environmental and human health outcomes sought to be achieved and maintained in Victoria. The ERS includes environmental values, indicators and objectives relevant to the ambient sound environment. A number of other guidelines relevant to the management of noise and vibration in accordance with the applicable legislation and policy are also referenced.

Overall, the legislation, policy and guidelines adopted for the noise and vibration assessment are appropriate and consistent with the requirements applicable to wind energy facilities, including ancillary infrastructure, in Victoria.

We note that the NSW CNVG does not itself set acceptable levels for vibration as, in NSW, these are set under a separate 2006 NSW guideline titled *Assessing Vibration: A Technical Guideline* (NSW Vibration Guideline). Rather,

the NSW CNVG specifies minimum working distances beyond which the vibration criteria set in the NSW Vibration Guideline would be expected to be achieved. As such, compliance with the minimum working distances from the NSW Vibration Guideline is expected to result in the acceptable vibration criteria from the NSW Vibration Guideline being achieved.

**SUMMARY**

The legislation, policy and guidelines adopted for the noise and vibration assessment are appropriate and consistent with the general environmental duty.

**RECOMMENDATIONS**

None

## 2.3 Background noise monitoring

The Background Noise Monitoring Report summarises the results of background noise monitoring conducted in 2023 at seven locations.

The background noise monitoring was undertaken to inform the background noise levels for the purposes of an NZS 6808:2010 noise assessment. However, it is noted that, although the background noise monitoring was conducted and referenced, the Environmental Noise & Vibration Assessment assesses wind turbine noise against the minimum applicable limits under NZS 6808:2010. As such, the Background Noise Monitoring Report does not affect the assessment detailed in the Environmental Noise & Vibration Assessment as to whether the Project can comply with the applicable noise limits.

With respect to the selected locations, NZS 6808:2010 recommends that background noise monitoring be carried out at noise-sensitive locations within the predicted 35 dB $L_{A90}$ noise contour from the wind farm. In the case of the Project, there are three non-stakeholder locations within the predicted 35 dB noise contour. Background noise monitoring was only conducted at one of these locations (D622) and it is understood that this is due to access not being provided to the other two locations (D299 and D620). In addition, background noise monitoring was conducted at six additional locations outside of the predicted 35 dB noise contour. These are spread around the wind farm such that background noise has been measured at locations that would be in different directions from the Project.

Overall, we consider that the background noise monitoring has been conducted in an appropriate manner consistent with NZS 6808:2010, and at a range of locations around the Project that go beyond the minimum requirements of NZS 6808:2010. It is noted that, for location D622, the background noise levels are presented for information only as the property was still under development at the time of the noise monitoring and the calibration drift marginally exceeded the strict requirements of AS 1055:2018. While this does not affect an assessment as to whether the Project can apply with applicable noise limits at D622, the Background Noise Monitoring Report recommends that background noise monitoring be repeated at this site.

Considering the scale of the Project, we expect that additional background noise monitoring would be necessary post-approval but pre-operation to:

- Reflect any changes to the predicted 35 dB $L_{A90}$ noise contour as any expansion of the contour may capture more noise-sensitive locations at which background noise monitoring should be considered.
- Address the commentary in the Background Noise Monitoring Report with respect to D622.
- Provide a pre-construction background noise level for locations at which post-construction noise monitoring would be conducted to enable an assessment of wind turbine noise levels in accordance with NZS 6808:2010.

We expect that this would be addressed through the pre-construction noise assessment that would be conducted to address MM-NV04 set out in the Environmental Noise & Vibration Assessment.

**SUMMARY**

Overall, we consider that the background noise monitoring has been conducted in an appropriate manner consistent with NZS 6808:2010, and at a range of locations around the Project that go beyond the minimum requirements of NZS 6808:2010. It is noted that the background noise monitoring has not been used to justify higher noise limits, with the wind turbine noise from the Project assessed against the minimum applicable noise limits under NZS 6808:2010.

**RECOMMENDATIONS**

The pre-construction noise assessment to be conducted under MM-NV04 should include updated background noise monitoring conducted in a manner consistent with NZS 6808:2010 and sufficient to enable post-construction noise monitoring to be undertaken.

## 2.4 Wind turbine noise

### 2.4.1 Noise limits

The Environmental Noise & Vibration Assessment correctly identifies noise limits, as recommended by NZS 6808:2010 and require by the EP Regulations, consisting of a base limit or, for wind speeds where background noise levels are sufficiently high, a limit of 5 dB above the background noise level. A 40 dB $L_{A90}$ base limit is established for all non-associated noise sensitive locations has been adopted consistent with the minimum applicable noise limits under NZS 6808:2010.

For stakeholder receivers, the Environmental Noise & Vibration Assessment identifies noise limits or criteria as follows:

- For stakeholder receivers within the wind farm boundary: no noise limits as these are excluded as noise-sensitive locations by NZS 6808:2010, however an assessment criterion of 45 dB $L_{A90}$ has been adopted as per the Victorian Wind Energy Guidelines.
- For stakeholder receivers outside of the wind farm boundary: noise limits have been set consistent with the agreement between the Project and the stakeholder, which is understood to result in a noise limit of 40 to 41 dB $L_{A90}$ depending on the agreement.

The wind turbine noise limits in the Environmental Noise & Vibration Assessment are appropriate and consistent with the EP Regulations.

**SUMMARY**

The wind turbine noise limits adopted are consistent with relevant Victorian legislation and guidelines, and consistent with the EP Regulations and NZS 6808:2010.

**RECOMMENDATIONS**

None

### 2.4.2 High amenity areas

NZS 6808:2010 sets a general base noise limit of 40 dB $L_{A90}$ for non-involved residences and other noise-sensitive uses. However, in certain cases, where a 'high amenity' area is deemed to apply, then the base noise limit is reduced to 35 dB $L_{A90}$. The application of a 'high amenity' limit occurs, as per NZS 6808:2010, where a district plan promotes a higher degree of protection of amenity related to the sound of an area than is normal.

In Victoria, guidance on the application of a 'high amenity' to wind farms is given the EPA web guide and Technical Guideline, which state that a high amenity limit should:

- apply to a dwelling located in the following zones predominantly intended for residential development: Low Density Residential Zone (LDRZ), Township Zone (TZ), Rural Living Zone (RLZ), and Green Wedge A Zone (GWAZ)
- not apply to dwellings in the Farming Zone (FZ)
- not be applied in any location where background sound levels are already affected by other specific sources such as road traffic noise, based on Section 5.3.1 of NZS 6808
- only apply for WEF wind speeds up to and including 6 m/s during evening and night-times.
- be applicable only when there is no agreement made in accordance with regulation 131A.

The Environmental Noise & Vibration Assessment identifies that, because the noise-sensitive land uses within the predicted 35 dB noise contour are in a FZ, no high amenity provisions apply. This is consistent with the requirement under NZS 6808:2010 that high amenity only needs to be considered for areas within the predicted 35 dB noise contour.

While TZ are located further from the Project, approximately 4 km or further, these locations are well outside of the predicted 35 dB noise contour and therefore high amenity provisions need not be considered. Furthermore, at these distances, the wind turbine noise levels would be expected to be lower than 35 dB $L_{A90}$ regardless.

**SUMMARY**

The Environmental Noise & Vibration Assessment report correctly identifies that the high amenity provisions of NZS 6808:2010 do not apply, consistent with relevant Victorian guidance.

**RECOMMENDATIONS**

None

### 2.4.3 Wind turbine noise assessment

A wind turbine noise assessment consists of three key elements:

- assumed wind turbine candidate models and sound power levels
- wind turbine noise predictions
- consideration of special audible characteristics.

#### Wind turbine sound power levels

The assessment has been conducted based on a single candidate wind turbine being a Vestas V162-6.8MW wind turbine with a maximum sound power level of 104.5 dB $L_{WA}$.

A 1 dB uncertainty factor has been applied by MDA such that the modelled maximum sound power level is 105.5 dB $L_{WA}$. This could be considered a conservative approach, because out understanding is that Vestas technical specifications already include an uncertainty factor and therefore it would be unlikely that all wind turbines would be operating above the manufacturer-specified level of 104.5 dB $L_{WA}$. However, it offers some conservatism in the noise assessment.

We understand that this is a representative turbine selection and may not be the final turbine model installed at the site. The V162-6.8MW turbine is a relatively quiet turbine as, in our experience, turbines of this capacity may have sound power levels typically in the range of 104 – 108 dB with an uncertainty margin applied. Furthermore, wind turbines in the 7 to 8 MW range tend to have manufacturer-specified sound power levels of 107 dB or higher. Therefore, while the assessment demonstrates that the site is expected to be capable of achieving compliance with the noise limits with a turbine at the lower end of the range of wind turbines available, this will need to be reassessed for the final selected turbine and layout.

The proposed MM-NV04 that requires a pre-construction noise assessment appropriately addresses this, by requiring the final wind turbine layout and selection to undergo a noise assessment to demonstrate how it can comply with the applicable NZS 6808:2010 noise limits. Should a louder wind turbine be selected, then we would expect that one or more of the following may be required to achieve compliance:

- Implementation of stakeholder agreements with affected noise-sensitive locations, should the landowners agree.
- Construction of some, but not all, of the approved wind turbine locations.
- Implementation of a noise curtailment scheme where the predicted noise levels exceed the applicable noise limits.

**SUMMARY**

The adopted sound power levels for the candidate turbines are at the lower end of the typical range of modern turbines in our experience. While the assessment demonstrates predicted compliance with this model, a pre-construction noise assessment will be required to demonstrate that this is still predicted for the final selected wind turbine model(s) and layout.

**RECOMMENDATIONS**

Consistent with the recommended MM-NV04 in the Environmental Noise & Vibration Assessment, a pre-construction noise assessment be prepared prior to the commencement of development based on the final selected wind turbine model(s) and layout, that demonstrates that compliance is predicted with the NZS 6808:2010 noise limits.

### Wind turbine noise prediction methodology

MDA has adopted a wind turbine noise prediction methodology based on ISO 9613-2:1996[3] implemented in general accordance with the UK Institute of Acoustics (IoA) publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (UK IoA Good Practice Guide) with the exception that:

- the receivers have been set at 1.5 m above ground in the noise model rather than 4 m above ground as recommended by the UK IoA Good Practice Guide
- no 2 dB reduction has been applied to adjust $L_{eq}$ sound power levels to $L_{90}$ sound power levels as would be typical in the UK.

We note that the 1.5 m receiver height would lower the predicted noise level by approximately 1.5 dB relative to a 4 m receiver heigh, and this is offset by the fact that the 2 dB reduction in sound power levels has not been applied.

In our experience, and considering the topography around the Project site, the prediction method adopted by MDA will predict the downwind wind turbine noise level to an appropriate degree of accuracy, when measured in accordance with NZS 6808:2010 (using the $L_{A90}$ metric) and assuming that all wind turbines are operating at the assumed sound power level. Given that MDA has allowed a 1 dB uncertainty margin on the wind turbine sound power levels, it is therefore likely that there would be some conservatism in the noise predictions should the V162-6.8MW wind turbine be installed.

MDA note in the Environmental Noise & Vibration Assessment that recent changes to the ISO 9613-2 standard (in the 2024 revision) recommend a 4 m receiver height for wind turbine noise predictions and that this is reflected in the Technical Guideline. While the MDA method differs from that recommended in ISO 9613-2:2024 and the Technical Guideline, we agree with the statement that the use of a 4 m receiver height would have resulted in conservative predictions. We also note that the ISO 9613-2:2024 standard recommends a method to predict the $L_{Aeq}$ wind turbine noise level whereas NZS 6808:2010, as required by the EP Regulations, requires the prediction of an $L_{A90}$ noise level

[3] International Standard ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation*.

that will be approximately 1.5 to 2 dB lower. As such, MDA's approach is consistent with the accurate prediction of an $L_{A90}$ wind turbine noise level as per the Victorian requirements.

Overall, the prediction methodology is considered to provide an appropriate degree of accuracy for an assessment of wind turbine noise against the NZS 6808:2010 noise limits.

**SUMMARY**

The prediction methodology adopted is considered appropriate for the assessment of predicted wind farm noise levels against the applicable NZS 6808:2010 wind farm noise limits. Although the method does differ from that recommended by the Technical Guideline, we consider that the difference in methodology is appropriately justified by MDA.

**RECOMMENDATIONS**

None.

### Special audible characteristics

NZS 6808:2010 requires penalties to be applied where special audible characteristics are measured or predicted to occur at a receiver. Special audible characteristics are defined by NZS 6808:2010 to include tonality, impulsiveness and amplitude modulation. Depending on the nature and frequency of the characteristic, the penalty may be up to 6 dB.

Consistent with the guidance given in the Technical Guideline, the Environmental Noise & Vibration Assessment undertakes its assessment on the basis that no special audible characteristic penalty would apply. This reflects that special audible characteristics are difficult to assess at the pre-construction stage as, generally, insufficient information is available to identify if they are likely to occur. However, it is also consistent with our experience that, while special audible characteristics have been detected on occasion at some wind farms in Australia, our experience is that they are relatively uncommon and, where they are detected at a given wind farm, are only detected infrequently and under specific conditions.

In accordance with NZS 6808:2010 and the EP Regulations, it will be necessary for post-construction testing of special audible characteristics to be carried out to demonstrate that this assumption was correct once the wind farm is operating. If special audible characteristics are identified, and this leads to non-compliance with the noise limits, then noise reduction strategies would need to be identified and implemented to achieve compliance. Such strategies could involve alterations to the turbines to remove the special audible characteristics or operations of the turbines in noise reduced modes as contingency measures.

The Environmental Noise & Vibration Assessment also goes further than the minimum requirements of the EP Regulations and NZS 6808:2010 by recommending MM-NV05, that would require a schedule of sound power level testing of installed wind turbines to show that sound power levels are consistent with the manufacturer-specified sound power level testing. We recommend that this sound power level testing also include near field tonality testing to identify early whether there is any audible tonality that may present a risk of tonality that could attract a penalty under NZS 6808:2010. This would assist in better informing the post-construction noise monitoring that will need to occur under the EP Regulations as it would provide an indication as to the potential for tonality and, if the potential exists, the frequency or frequencies at which this may occur.

**SUMMARY**

The Environmental Noise & Vibration Assessment assumes that special audible characteristics will not occur at residences. We consider this a reasonable approach given the limited occurrence of such characteristics in Australia and the information available at this time, and it is consistent with EPA Publication 3011.

**RECOMMENDATIONS**

MM-NV05 should include a requirement for near field tonality testing in addition to the sound power testing proposed.

A suitable post-construction monitoring program will also need to be implemented for the Project that includes testing for special audible characteristics. This is a requirement of the EP Regulations.

### 2.4.4 Assessment conclusions

The Environmental Noise & Vibration Assessment concludes that predicted wind turbine noise levels are capable of complying with the noise limits at both noise-sensitive locations and stakeholder dwellings. Based on the outcomes of the assessment, three mitigation measures are recommended as follows:

- MM-NV04: Pre-construction noise assessment of wind turbines
- MM-NV05: Schedule of sound power level testing
- MM-NV06: Noise management plan (NMP)

We agree with the above mitigation measures, noting that:

- The pre-construction noise assessment is important as it will need to take account of any change in predicted noise levels arising from a change in wind farm design or wind turbine selection. A suitably qualified and experienced acoustic consultant should prepare the pre-construction noise assessment and should consider the need for additional background noise monitoring. The outcomes of additional background noise monitoring should be included in the pre-construction noise assessment.
- The schedule of sound power level testing should also include a specific reference to near field tonality testing.
- The NMP is a requirement of the EP Regulations.

In addition to the above, the EP Regulations impose requirements for post-construction noise monitoring, an annual statement regarding compliance with noise limits and a requirement for periodic noise monitoring every five years after the Project is operating. The NMP would need to set out how these would be fulfilled.

**SUMMARY**

The Environmental Noise & Vibration Assessment concludes that the Project can achieve compliance with applicable wind turbine noise limits and sets out appropriate mitigation measures relating to wind turbine noise.

**RECOMMENDATIONS**

It is recommended that:

- The pre-construction noise assessment required by MM-NV04 be prepared by a suitably qualified and experienced acoustic consultant and include the outcomes of any additional background noise monitoring deemed necessary.
- The schedule of sound power level testing required by MM-NV05 should also include near field tonality testing.

## 2.5 Ancillary infrastructure including BESS

### 2.5.1 Noise limits

Noise from ancillary infrastructure is not subject to the noise limits of NZS 6808:2010. Rather, noise from ancillary infrastructure has been assessed in accordance with the EP Regulations and Noise Protocol, which is appropriate. The noise limits have been correctly determined for the nearest noise-sensitive locations to the ancillary infrastructure. Consideration has also been given to low frequency noise emissions based on EPA Victoria Publication 1996.

**SUMMARY**

The noise limits adopted for ancillary infrastructure are correct and in accordance with the EP Regulations and Noise Protocol.

**RECOMMENDATIONS**

None.

### 2.5.2 Predicted noise levels and assessment

Noise levels from ancillary infrastructure have been predicted based on the ISO 9613-2 methodology and:

- assumed transformer sound power levels based on sound power data from AS/NZS 60076.10:2023, with the reduced maximum sound power level assumed for the HV transformers
- manufacturer data for a potential battery energy storage system (BESS) based on MDA's library of data.

The predictions include consideration of a +2 dB correction for potential tonality at mains frequency harmonics for transformers as well as from BESS equipment, with tonal noise at these frequencies a potential feature of these noise sources. This assumption is considered appropriate in our experience noting that, in general, BESS noise would be expected to be the dominant noise source and are typically less tonal than transformers.

The predicted noise levels show comfortable compliance at non-stakeholder receivers, but only marginal compliance at two stakeholder receivers with the Night period noise limit and the conservative assumption of 100% fan duty. As there is no relaxation in noise limits that apply to stakeholder receivers for ancillary infrastructure noise under the EP Regulations, it is likely that these would be the controlling receivers from a noise assessment perspective.

It is noted that the assessment undertaken by MDA is based on sound power levels for BESS and HV transformer equipment that is towards the lower end of sound power levels available for this type of equipment. As such and noting that specific suppliers for the BESS and terminal stations have not yet been confirmed, noise will be an important part of the detailed design process. Furthermore, the assessment does not assess the risk of low frequency noise against the thresholds set out in EPA Publication 1996 due to a lack of information at the current time. While we expect that the risk of low frequency noise would be able to be appropriately managed, we note that this will also require consideration during detailed design.

Reflecting the above, the Environmental Noise & Vibration Assessment sets out MM-NV07 which recommends a pre-construction noise assessment be undertaken of ancillary infrastructure including consideration of low frequency noise. We agree with MM-NV07.

**SUMMARY**

The assessment of potential noise for ancillary infrastructure is considered appropriate, and we agree with the conclusion that noise from ancillary infrastructure will require further investigation during detailed design.

**RECOMMENDATIONS**

As recommended by MM-NV07, a condition should be imposed requiring a pre-construction noise assessment for noise from ancillary infrastructure. This should be carried out by a suitably qualified and experienced acoustic consultant.

## 2.6 Construction noise and vibration

### 2.6.1 Assessment criteria

The Environmental Noise & Vibration Assessment reference the following documents to establish assessment criteria for noise and vibration generated by construction works:

- EPA Publication 1834.1 for the assessment of construction noise.
- Noise Protocol for noise associated with batching plants and an on-site quarry.
- NSW CNVG for the assessment of construction vibration.

The adopted assessment criteria for construction noise are considered appropriate for an assessment at this stage of the Project.

As noted in Section 2.2, the NSW CNVG does not itself set vibration criteria but sets minimum working distances at which criteria from the NSW Vibration Guideline would be achieved. Considering the stage of this Project and the low risk of construction vibration, the adopted approach is appropriate.

**SUMMARY**

The adopted construction noise and vibration criteria are appropriate for this stage of an assessment.

**RECOMMENDATIONS**

None

### 2.6.2 Assessment

#### Construction noise

Given the stage that the Project is currently at, the Construction Noise Assessment is based on typical activities expected at the site. Based on our review, it is considered to be based on suitable assumptions around the likely typical worst case sound power levels from construction works that would be expected for the construction of a major wind farm facility.

The assessment, including that of off-site construction traffic, indicates risk that construction noise would be audible and therefore will require measures to be implemented during construction to minimise the risk of harm so far as reasonably practicable.

The Environmental Noise & Vibration Assessment recommends mitigation measure MM-NV01 to manage construction noise and vibration, which requires the development of a construction noise and vibration management plan (CNVMP) that would evaluate the risk associated with the proposed construction methodology and program including:

- Detailing reasonably practicable measures to be implemented to address the GED.

- Detailing and justifying out of hours work, ensuring that any out of hours work is addressed and managed in a manner consistent with EPA Publication 1834.1
- Measures to manage impacts associated with off-site construction traffic.
- Reference to consideration of noise levels in natural areas in addition to that at residential areas.

MM-NV01 is considered an appropriate measure to ensure that the risk associated with construction noise from the Project.

**SUMMARY**

The construction noise assessment is considered appropriate, including the identification of appropriate noise management measures. We agree with the recommended mitigation measure MM-NV01

**RECOMMENDATIONS**

None.

### Construction vibration

A brief construction vibration assessment is documented in the Environmental Noise & Vibration Assessment that concludes that vibration from construction works would be appropriately managed as the separation distances to the nearest residences is greater than the minimum working distances set out under the NSW CNVG for maintaining both human amenity and controlling the risk of cosmetic damage to structures.

We note that MM-NV01 includes a requirement to prepare a CNVMP, that would address vibration from any activities that may occur within 100 m of a sensitive receiver. This is an appropriate inclusion.

**SUMMARY**

The assessment of potential vibration from construction is considered appropriate given the stage of the Project. Significant disruption to sensitive land uses as a result of vibration from general construction works is not expected due to considerable setback distances from the majority of the works.

**RECOMMENDATIONS**

None

### Batching plants and quarries

The noise assessment conducted for the batching plants and quarry operations is, due to the nature of the Project at this stage, preliminary and has been based on typical plant and equipment assumed based on previous assessments at other sites. The assumed sources are considered reasonable for a typical batching plant and quarry operation.

The assessment concludes that predicted noise levels from the potential quarry and batching plant sites can comply with the applicable Noise Protocol Day period limit but, depending on final operational details, could result in noise levels above the Evening and Night limits at some (primarily stakeholder) receivers. As such, operation during the Evening and Night period, if required, would require further investigation.

In addition to MM-NV01, the Environmental Noise & Vibration Assessment sets out the following recommended management measures relevant to the batching plant and quarry operations:

- MM-NV02: a requirement to prepare a Quarry Work Plan prior to commencement of development that would document measures to minimise the risk of harm from noise so far as reasonably practicable and prevent unreasonable noise as per the EP Act and EP Regulations.
- MM-NV03: a requirement to design and operate all temporary batching plants in accordance with relevant EPA publications and implement measures to minimise the risk of harm from noise so far as reasonably practicable and prevent unreasonable noise as per the EP Act and EP Regulations.

We note that MM-NV03 does not involve the submission of any plan to an authority for approval but anticipate that relevant batching plant noise control measures would be documented in the CNVMP prepared under MM-NV01.

**SUMMARY**

The noise assessment for concrete batching plant and quarry operations generally appears appropriate in terms of assumed noise sources and adopted noise limits. The assessment indicates that operation during the Day period is expected to comply with applicable noise limits, but that further consideration would be necessary if the batching plant or quarry sites were to operate outside of Day time periods. The recommended mitigation measures MM-NV01, MM-NV02 and MM-NV03 are considered appropriate for managing the risk of noise associated with batching plant and quarry operations.

**RECOMMENDATIONS**

None

# 3 Summary

Resonate has been engaged by Wind Prospect to undertake a peer review of the environmental noise and vibration assessment prepared as part of the Environment Effects Statement for the Hexham Wind Farm. The proposed wind farm will consist of up to 106 wind turbines and related infrastructure, including a terminal station and battery energy storage system (BESS), and will be located between the townships of Hesham, Caramut and Ellerslie in Moyne Shire.

We consider that the Environmental Noise & Vibration Assessment and Background Noise Monitoring report prepared for the Project demonstrates that the Project is expected to be able to operate in compliance with appropriate noise and vibration criteria, subject to the incorporation of appropriate noise and vibration management measures during construction and operation.

Should the Project be approved, it would be necessary to ensure that the recommended mitigation measures identified in the Environmental Noise & Vibration Assessment are adhered to during construction and operation. Specific to these proposed measures, which we consider to be broadly appropriate, we make the following recommendations:

- The pre-construction noise assessment required by MM-NV04 should be prepared by a suitably qualified and experienced acoustic consultant and include the outcomes of any additional background noise monitoring deemed necessary based on the assessment of the final detailed design of the Project as required by NZS 6808:2010.
- The schedule of sound power level testing required by MM-NV05 should also include near field tonality testing as is normal for near field sound power level testing.
- As recommended by MM-NV07, a condition should be imposed requiring a pre-construction noise assessment for noise from ancillary infrastructure. This should be carried out by a suitably qualified and experienced acoustic consultant.

# Appendix A—CV of peer reviewer

Resonate

Acoustics • EMF • Structural Dynamics • Vibration

# Tom Evans

**Director and Acoustic Consultant**

## Qualifications

Bachelor of Engineering (Mechatronics) (1st Class Honours)
Bachelor of Economics

## Affiliations

Member of Australian Acoustical Society
AAS VIC Division Committee Member
Member of Victorian Planning & Environmental Law Association

## Career history

Tom has 19 years of experience in the assessment of environmental noise and vibration on a wide range of industry sectors through the various planning, design and construction phases of projects.

Tom's particular strengths are his ability to combine his strong technical understanding with excellent communication skills, as well as to understand the different technical, social and environmental opportunities and constraints on a project.

Tom has widely applied noise and vibration regulations to environmental noise and vibration assessments across all Australian jurisdictions. In addition to providing advice on developments across various market sectors, he has been involved in the development of noise and vibration regulations for Local and State Government.

Tom enjoys working on large-scale multidisciplinary infrastructure and industrial projects, where specialty disciplines such as noise and vibration must work closely with the wider project team to develop practical solutions.

## Contact details

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## Key project experience

### Environmental noise and vibration

Environmental noise and vibration assessments and advice to mitigate noise and vibration in accordance with the Environment Protection Regulations and EPA Victoria guidelines:

- Bairnsdale Power Station (VIC)
- Boneo Water Treatment Plant Upgrade (VIC)
- Heywood BESS (VIC)
- Inghams Processing Plant Somerville (VIC)
- Maidstone Tram Maintenance Facility (VIC)
- Sims Resource Renewal Broadmeadows (VIC)
- Suburban Rail Loop East Stabling Facility (VIC)
- Valley Power Project (VIC)
- Warrnambool Line Upgrade Stabling Facility (VIC)
- Western Renewables Link (VIC)

### Wind Energy Facilities

Wind turbine noise background and post-construction noise monitoring and assessments, and pre-construction noise assessments:

- Golden Plains Wind Farm (VIC)
- Macarthur Wind Farm (VIC)
- Mortlake South Wind Farm (VIC)
- Portland Wind Energy Project Stage IV (VIC)
- Warracknabeal Energy Park (VIC)
- Woolsthorpe Wind Farm (VIC)
- Yaloak South Wind Farm (VIC)

### Expert witness

Expert evidence in relation to environmental noise and vibration for court or public hearings:

- Te Rere Hau Wind Farm Resource Consent Hearing (NZ)
- Avonbank Mineral Sands (EES)
- Fosterville Gold Mine (VIC)
- Golden Plains Wind Farm Planning Panel (VIC)
- Suburban Rail Loop Inquiry and Advisory Committee (VIC)
- VIVA Energy Offshore Gas Terminal (VIC)
- Woolsthorpe Wind Farm Planning Panel (VIC)

# Publications and Technical Papers

'A Comparison of Tonal Noise Regulations in Australia', Acoustics 2015, Hunter Valley, November 15-18. T. Evans and J. Cooper.

'Investigation of Additional Insertion Loss from T-profile and Absorptive Noise Barriers', Acoustics 2015, Hunter Valley, November 15-18. D. Jurevicius and T. Evans.

'Tonal noise from wind turbines', Proceedings of 6th International Conference on Wind Turbine Noise, Glasgow, 20-23 April 2015, T. Evans and Jon Cooper

'Analysis of wind turbine low frequency noise prediction accuracy',
Internoise 2014, Melbourne, November 16-19, T. Evans, J. Cooper and V. Alamshah.

'Influence of non-standard atmospheric conditions on turbine noise levels near wind farms'
Internoise 2014, Melbourne, November 16-19, J. Cooper and T. Evans.

'Infrasound levels near windfarms and in other environments', SA EPA and Resonate Acoustics, January 2013, T. Evans, J. Cooper and V. Lenchine.

'Low frequency noise near wind farms and in other environments', SA EPA and Resonate Acoustics, April 2013, T. Evans, J. Cooper and V. Lenchine.

'Accuracy of noise predictions for wind farms', Proceedings of 5th International Conference on Wind Turbine Noise, Denver, 28-30 August 2013, J. Cooper and T. Evans

'Tonality assessment at a residence near a wind farm', Proceedings of 5th International Conference on Wind Turbine Noise, Denver, 28-30 August 2013, J. Cooper, T. Evans and D. Petersen

'Effects of different meteorological conditions on wind turbine noise', Acoustics 2013, Victor Harbor, November 18-20. T. Evans and J. Cooper.

'Automated detection and analysis of amplitude modulation at a residence and wind turbine', Acoustics 2013, Victor Harbor, November 18-20. J. Cooper and T. Evans.

'Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms', Evans T & Cooper J, 2012, *Acoustics Australia*, Vol. 40, No. 1, pp. 28-36.

'Comparison of compliance results obtained from the various wind farm standards used in Australia', Cooper J, Evans T & Najera L, *Acoustics Australia*, Vol. 40, No. 1, pp. 37-44.

'Effect of a 35 dB(A) minimum criterion on a wind farm development', Cook A, Evans T & Brown R, *Acoustics Australia*, Vol. 40, No. 2, pp. 144-146.

'Influence of wind direction on noise emission and propagation from wind turbines', Proceedings of Acoustics 2012, Fremantle, 21-23 November 2012, T. Evans and J. Cooper.

'Influence of upwind turbines on wind turbine sound power output', Proceedings of Acoustics 2012, Fremantle, 21-23 November 2012, J. Cooper and T. Evans.