In the matter of the Golden Plains Wind Farm Planning Panels Victoria

Expert Witness Statement of Thomas Ross Evans

Expert of WestWind Energy Pty Ltd

Thursday, 19 July 2018

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1 Introduction

Name and address

1.1 My name is Thomas Ross Evans. I am a Managing Director of Resonate Consultants Pty Ltd (Resonate) at Level 4, 10 Yarra South Yarra Victoria 3141.

Qualifications and experience

1.2 I hold a Bachelor of Engineering with 1st Class Honours (Mechatronic) from the University of Adelaide and a Bachelor of Economics.

1.3 I have worked as a professional acoustic consultant for 12 years. Since commencing my career, I have gained significant experience in the measurement, prediction and assessment of noise generated by wind energy facilities and other sources of environmental noise. I am a Member of the Australian Acoustical Society (MAAS).

1.4 Appendix A contains a statement detailing my qualifications and experience.

Expertise

1.5 My area of expertise is acoustics, including wind farm noise and other environmental noise.

1.6 I have sufficient expertise to make this statement because I have extensive experience in the field of wind farm noise, having been involved in over fifty projects across Australia, New Zealand and Asia. My experience includes the measurement, prediction and assessment of wind farm and other forms of environmental noise. I have presented papers on wind farm noise at national and international conferences, and had multiple papers on the topic published in scientific journals.

1.7 Additionally, I have considerable experience in the assessment of noise and vibration from other sources including industrial facilities, mines and construction sites, with key projects presented in my statement in Appendix A.

2 Scope

Role in Environmental Effects Statement

2.1 The company I am employed by, Resonate Consultants, was engaged by WestWind Energy Pty Ltd to undertake a peer review of the environmental noise and vibration assessment prepared by Marshall Day Acoustics (MDA) for the Golden Plains Wind Farm (the Project) Environmental Effects Statement (EES). The MDA Environmental Noise & Vibration Assessment that I reviewed was included as Appendix Q to the EES.

2.2 The Peer Review I prepared was included as Appendix N.2 to the EES (Resonate Report reference M171050RP1C, dated 22 February 2018).

2.3 I adopt the Peer Review as the basis for this expert witness statement and my evidence.

Instructions

2.4 I have been instructed by White and Case, on behalf of WestWind Energy, to prepare a witness statement and give expert evidence at the panel hearing with respect to the findings of my report with respect to the noise impacts of the Project and associated quarry. I have also been instructed to address submissions that have been received that are relevant to my area of expertise.

2.5 This statement provides a summary of my peer review and expert opinion regarding the noise impacts of the Project, as well as a response to the key submissions raising issues relating to noise.

Documents reviewed and considered

2.6 Information I have considered in the preparation of this statement is documented in Appendix B. Most notably, my statement considers:

- MDA Environmental Noise & Vibration Assessment for Golden Plains Wind Farm included as Appendix Q to the EES, dated 23 February 2018.
- MDA Background Noise Monitoring Report for Golden Plains Wind Farm, included as Appendix N.3 of the EES, dated 5 April 2018.
- The Golden Plains Wind Farm layout and noise sensitive receiver locations as documented in Appendix C of this statement and as taken from Appendix Q of the EES.
- The current requirements of the Golden Plains Planning Scheme Clause 52.32 and the Department of Environment, Land, Water and Planning (DELWP) *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria*, November 2017 (Victorian Guidelines).
- New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010).

3 Wind turbine noise

3.1 This section of my statement discusses my findings and opinions regarding the wind turbine noise impact of the Project. Other potential sources of noise and vibration are discussed in following sections.

Background noise levels

3.2 Appendix N.3 of the EES included a Background Noise Monitoring report prepared by MDA that reported on background noise measurements conducted at 15 locations around the wind farm in accordance with NZS 6808:2010.

3.3 I was not asked to consider the Background Noise Monitoring report as part of my EES Peer Review because wind turbine noise levels from the site were predicted to comply with the minimum applicable noise limits and, therefore, the predicted compliance of the site was not reliant on the outcomes of the background noise monitoring. That is, wind turbine noise from the Project was predicted to comply with the applicable noise limits regardless of the existing levels of noise in the environment.

3.4 Considering the Background Noise Monitoring report as part of this statement, I am of the opinion that the background noise monitoring has generally been conducted in accordance with NZS 6808:2010. The measurements demonstrate that, at low wind speeds, background noise levels are generally below 30 dB(A), increasing as the wind speed at the wind farm increases. Night time background noise levels are lower than all-time background noise levels, which is typical in my experience. Importantly, the measured background noise levels are generally below 35 dB(A) up to a wind speed of at least 9 m/s at the wind farm, particularly at night time. As this is the wind speed at which the candidate wind turbines generally reach their maximum sound power level, it means that the site will effectively need to be designed to achieve compliance with the minimum NZS 6808:2010 noise limit of 40 dB(A) at non-involved receivers.

3.5 While I consider that the background noise monitoring has generally been conducted in accordance with NZS 6808:2010, I note that:

- At 6 of the 15 monitoring locations, the total number of valid data points analysed was less than the 1440 minimum specified by NZS 6808:2010, generally due to a lack of availability of wind data. For five of these locations, over 1200 valid data points were obtained and there is unlikely to be a significant difference between the analysed dataset and a dataset with 1440 data points.
- Less than 2000 valid data points were obtained for all but 3 of the monitoring locations. In my experience, a background noise dataset with less than 2000 valid data points may indicate a lack of data for particular wind directions that could still occur frequently at the site. While this is not a concern for the purposes of this planning stage assessment, it may present a concern for the operator of the site during post-construction monitoring should significant portions of data be collected in wind directions where there is limited background data.
- Monitoring was conducted at 9 non-involved locations, yet the EES reports that up to 89 non-involved sensitive locations may be exposed to wind farm noise levels of 35.0 dB(A) or greater depending on the wind turbine noise model selected. NZS 6808:2010 requires that monitoring be conducted 'where wind farm sound levels of 35 dB $L_{A90(10min)}$ or higher are predicted noise noise-sensitive locations'. Clause 7.1.5 allows for representative measurement sites to be selected and I consider that a reasonable approach for a Project such as this where a relatively large number of residences fall inside the 35 dB(A) predicted noise level contour. Generally, the monitoring locations included in the Background Noise Monitoring report provide reasonable coverage of the site, although I note there are limited non-involved monitoring locations to the north of the Project site.

3.6 Given the above comments, I consider that there would be benefit to conducting additional background noise monitoring prior to the commencement of operation at the site, including at additional non-involved residences to the north of the site. Depending on the timing of the monitoring, this would provide the benefits of:

- Ensuring that up-to-date and extensive background data is available for each of the monitoring sites.

- Providing additional background noise monitoring locations around the site at which operational noise monitoring can be conducted. It is more difficult for conduct operational wind turbine noise monitoring at locations at which no background noise monitoring has been conducted, and therefore it is preferable for background data to be available for a reasonable spread of receivers around the Project.
- Depending on the timing of the monitoring, any additional background noise monitoring could be referenced to any permanent meteorological masts that will be installed at the site. NZS 6808:2010 requires that the same wind speed measurement locations be used for both operational and background noise monitoring. It is therefore it is beneficial for background noise monitoring data to be referenced to wind speed measured at permanent meteorological mast sites.

3.7 Overall, as earlier stated, the EES assessment demonstrates that the site is expected to be able to operate in compliance with the relevant wind farm noise limits without relying on background noise levels and therefore I consider that my comments above can be addressed post-approval. I note that it is normal for wind farm developers to undertake additional pre-construction noise monitoring post-approval and prior to operation for the reasons I have listed above.

Wind turbine noise limits

New Zealand Standard NZS 6808:2010

3.8 The EES Scoping Requirements, Clause 52.32 of the Golden Plains Planning Scheme and the Victorian Guidelines all identify that the relevant standard for the assessment of wind turbine noise from the Project is NZS 6808:2010.

3.9 NZS 6808:2010 establishes noise limits that wind farms must achieve during operation at noise-sensitive locations. The wind farm noise limits, as defined by NZS 6808:2010, are 40 dB(A) L_{90} or the background level (L_{90}) plus 5 dB(A), whichever is the greater, unless the high amenity limits are deemed to apply. The background noise levels are correlated with wind speed measured at the site, such that different limits apply for different wind speeds when the background noise levels exceed 35 dB(A) L_{90}.

3.10 Clause 5.1.2 and Clause 5.1.3 NZS 6808:2010 state that the limits “provide a satisfactory level of protection against sleep disturbance” and are also “appropriate for protecting the health and amenity of residents for most noise sensitive activities”. The exception to this latter statement is explained by NZS 6808:2010 to be high amenity areas, which I discuss further below.

3.11 Noise-sensitive locations, as defined by NZS 6808:2010, include residential dwellings and buildings of similar usage such as rest homes, educational buildings, child care facilities and temporary accommodation such as hotels and motels.

3.12 Importantly, no specific noise limits are set by NZS 6808:2010 for noise-sensitive locations on the defined wind farm site. The Victorian Guidelines recommends a limit of 45 dB for involved dwellings.

3.13 The MDA Environmental Noise and Vibration Assessment Report correctly identifies the noise limits for non-stakeholder dwellings as 40 dB(A) L_{90} or the background level plus 5 dB, and assesses the Project against the 40 dB(A) limit. The limits are applied to residences (dwellings), one school and one child care centre in the area surrounding the Project, consistent with the definitions of NZS 6808:2010 for noise-sensitive locations.

3.14 I consider the wind turbine noise limits established in the MDA Environmental Noise and Vibration Assessment Report to be appropriate and consistent with relevant planning requirements for wind farms in Victoria.

High amenity areas

3.15 For most circumstances, NZS 6808:2010 advises that a base wind farm noise limit of 40 dB(A) L_{90} is appropriate. However, Section 5.3 of the Standard advises that, in special circumstances, the application of a 35 dB(A) L_{90} base limit may be appropriate. Such areas are termed "high amenity areas" and it is necessary to consider whether the high amenity limits are applicable for Golden Plains Wind Farm in accordance with Clause 52.32 of the Golden Plains Planning Scheme.

3.16 The definition of "high amenity areas" in NZS 6808:2010 is specific to New Zealand planning systems but the Victorian Guidelines suggest that guidance as to its application in Victoria can be found in the Victorian Civil and Administration Tribunal (VCAT) determination for the Cherry Tree Wind Farm.

3.17 The VCAT determination for the Cherry Tree Wind Farm included the following justification as to why the high amenity criterion was not applicable to that proposal:

> 107. We were invited by the respondents to treat the subject land and the locality as a high amenity area. This invitation meets with the immediate conundrum that the language of the standard is not translatable to the Victorian planning framework. The "plan" referred to in section 5.3 is a plan as defined by the Resources Management Act of New Zealand. Section 43AA of that Act defines "plan" to mean "a regional plan or a district plan". No such animals exist under the Victorian legislation.
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> 108. Applying the standard mutatis mutandis to the Victorian experience we treat the plan referred to in the standard as a planning scheme approved under the Planning and Environment Act 1987. The Mitchell Planning Scheme does not anywhere expressly or by implication "promote a higher degree of protection of amenity related to the sound environment of a particular area". Approaching the matter by a process of elimination it can be seen with certainty that the controls contained within the Farming zone, which includes most of the locality, do not answer this description. The purpose of the Farming zone is to encourage agricultural use, which is not an inherently quiet land use. In fact reference to the zone purposes confirms that agricultural use is to be preferred to residential use if there is potential conflict between the two.
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> 109. Accordingly the Tribunal concludes that the subject land and its locality is not capable of designation as a high amenity area because it does not possess the necessary characteristics of such an area as specified in the NZ standard.

3.18 With respect to the Golden Plains Wind Farm proposal, I note that the Planning Scheme defines the area in which the wind farm and nearest noise sensitive receivers are located as a Farming Zone, similar to the definition of the land around the Cherry Tree Wind Farm which was the subject of the above VCAT decision. The stated Purpose of the Farming Zone as included in the Planning Scheme is to "provide for the use of land for agriculture" and to "ensure that non-agricultural uses, including dwellings, do not adversely affect the use of land for agriculture."

3.19 The exceptions to this within the predicted 35 dB(A) noise level contour from the wind farm are noise-sensitive locations in the township of Rokewood, which is to the north of the wind farm site. Dwellings within Rokewood are located in a Township Zone and there is also a Low Density Residential Zone (LDRZ), albeit without a noise-sensitive location identified in it. These zones are not specifically addressed by the VCAT determination for the Cherry Tree Wind Farm.

3.20 The consideration of whether a particular zone warrants application of a high amenity limit is primarily a planning matter. The Planning Permit Application prepared by Jacobs, and included in the Golden Plains Wind Farm EES, concluded that neither the Township Zone nor the LDRZ warranted application of a high amenity limit based on their stated purposes under the Planning Scheme.

3.21 On the basis of the above, with particular consideration of the VCAT determination for the Cherry Tree Wind Farm proposal, it is apparent that the Golden Plains Planning Scheme does not envisage a higher level of amenity for the subject site and surrounding land. Therefore, my opinion is that the high amenity limit does not apply to this proposal.

Stakeholder dwellings

3.22 NZS 6808:2010 does not specify noise limits for noise-sensitive uses of landowners located on the defined wind farm site and the model permit conditions contained in Appendix B of the Victorian Guidelines state that the NZS 6808:2010 limits do not apply to stakeholder or involved dwellings where a suitable agreement has been entered into between the landowner and proponent. The Victorian Guidelines recommend a base limit of 45 dB(A) (rather than the normal 40 dB(A)) be considered for stakeholder dwellings where such an agreement has been entered into, but I note that this limit is, in my experience, not written into permit conditions applied to wind farms in Victoria.

3.23 Reflecting the above, I consider that a 45 dB(A) target for stakeholder dwellings on the wind farm would be appropriate. In all cases, noise levels from the wind farm at stakeholder dwellings would need to be managed in an agreement with the relevant landowner that meets the requirements of the model permit conditions in the Victorian Guidelines.

Candidate wind turbines

3.24 The MDA Environmental Noise and Vibration Assessment Report conducted an assessment of wind turbine noise from the Project on the basis of two potential candidate wind turbine models, with maximum sound power levels as detailed in Table 1. The sound power levels include a 1 dB uncertainty factor to account for potential variations in sound power level that may occur in installed WTGs. Both WTG models are noted as having serrated trailing edges on the blades which typically provides a minor reduction in sound power levels relative to blades without the serrated trailing edges.

Table 1 Maximum sound power levels for candidate wind turbines

Wind turbine	Sound power level in dB(A) at octave band centre frequency in Hz								Overall, dB(A)
	31.5	63	125	250	500	1000	2000	4000	
Senvion 3.6M140	75.8	85.8	93.0	97.8	99.9	99.5	95.5	89.7	105.0
Vestas V150 4.2 MW	78.2	87.8	94.8	99.1	100.8	99.9	96.3	90.1	105.9

3.25 I consider the sound power levels presented in Table 1 to be suitably representative of typical wind turbine models in the range of turbine capacities that the Project is considering (3 to 5 MW).

3.26 The MDA Environmental Noise and Vibration Assessment Report states that octave band sound power levels have been used for the predictions, with the octave band sound power data based on manufacturer-specified values for the Vestas V150 4.2 MW turbine. For the Senvion turbine, the manufacturer-specified octave band sound power levels for a similar turbine (Senvion 3.20M122) have been adopted for the Senvion 3.6M140 due to a lack of manufacturer octave band data for that model. I consider this an appropriate approach for the Senvion turbine and expect that the octave band data for the Senvion 3.0M122 turbine would provide an appropriate representation of the frequency spectrum for the Senvion 3.6M140 turbine at this stage of the assessment.

3.27 I note that the candidate turbines are not necessarily those that will be installed as part of the Project, with the turbine selection and procurement process to occur post-approval. While the majority of currently available wind turbine models have sound power levels similar to those presented in Table 1 where they use serrated trailing edges on the blades, I am aware of a small number of models that have sound power levels 1 – 2 dB higher than those assumed in the EES. I address the potential for changes to predicted noise levels from the site post-approval later in this statement.

Predicted wind turbine noise levels

Prediction methodology

3.28 The MDA Environmental Noise and Vibration Assessment Report documented the following prediction methodology:

- Sound power levels as detailed in Table 1.
- Hub heights of 130 m (Senvion 3.6M140), 115 m and 155 m (both Vestas V150-4.2MW).
- ISO 9613-2[1] prediction algorithm as implemented in SoundPLAN Version 7.4 environmental noise prediction software.
- Topographical information for the site obtained from VicMap (10 m height contours).
- Topographic shielding limited to 2 dB with shielding evaluated based on the WTG source being located at tip, rather than hub, height.
- A correction of 3 dB added to the predicted noise level where potential concave slope or valley effects were detected in accordance with the UK Institute of Acoustics (IoA) Good Practice Guide[2] for wind turbine noise.
- Ground absorption factor of 50%.
- Receiver height of 1.5 m above ground.
- A temperature of 10ºC and relative humidity of 70%.

3.29 I consider the prediction methodology documented above to be consistent with good practice for wind turbine noise predictions in Australia, with the results of such predictions found to agree well with measured noise levels for operating sites in Australia in comparable environments based on a technical paper I authored.[3] I expect that the predictions will be representative of downwind noise levels, with wind farm noise levels at residences expected to be lower during periods of upwind and crosswind conditions.

3.30 The methodology is also largely consistent with the UK IoA Good Practice Guide for wind turbine noise with the exception that:

- The IoA Good Practice Guide recommends adoption of a 4 m receiver height instead of a 1.5 m receiver height. In practice, this increases predicted noise levels by approximately 1.5 dB.
- The IoA Good Practice Guide states that a -2 dB correction can be applied to the sound power levels to adjust them from L_{eq} to L_{90}. This has not been done in the MDA assessment.

It is apparent that the above two deviations effectively balance out such that I expect the predictions to be consistent with, or marginally higher than, what the UK IoA GPG methodology would predict.

Predicted noise levels

3.31 Based on the sound power data presented in Table 1, the methodology detailed above and the proposed turbine layout and noise-sensitive receiver locations shown in Appendix C, I have carried out my own predictions of wind turbine noise levels from the Project for the candidate WTG that results in the highest predicted noise levels (Vestas V150-4.2MW at 115 m hub height). The predicted noise levels are tabulated in Appendix D and compared to the predictions tabulated in the MDA Environmental Noise and Vibration Assessment Report. I note that my predictions are within 0.1 dB of MDA's, which indicates that the wind farm noise prediction methodology was implemented correctly.

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

[2] Institute of Acoustics, 2013, *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*.

[3] Evans T & Cooper J, 2012, 'Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms', *Acoustics Australia*, vol. 40(1), pp 28 – 36.

3.32 The predictions tabulated in Appendix D and in the MDA Environmental Noise and Vibration Assessment Report demonstrate that:

- Predicted noise levels for all non-involved sensitive receivers are 39 dB(A) or lower, which is lower than the base noise limit of 40 dB(A).
- Predicted noise levels at most involved residences are 45 dB(A) or lower, with up to four stakeholder receivers having predicted noise levels exceeding the 45.0 dB(A) target level adopted in the EES depending on the WTG model and hub height considered. The highest predicted noise level at any stakeholder residence is 47 dB(A).

3.33 Considering the above, the predicted noise levels indicate that wind turbine noise from the site is expected to achieve compliance with the base noise limits determined in accordance with NZS 6808:2010 and the Victorian Guidelines at non-stakeholder noise sensitive uses.

3.34 The non-stakeholder noise sensitive uses considered in the noise assessment include the school and childcare centre in Rokewood. The highest predicted wind turbine noise level at these locations is 38 dB(A), and therefore below the NZS 6808:2010 base noise limit of 40 dB(A).

3.35 Predicted noise levels at a small number of involved stakeholder dwellings may exceed the 45 dB(A) reference noise level. I consider that it would be desirable for the predicted noise levels to achieve compliance with 45 dB(A) at these locations and that, given the relatively small exceedances, this may be possible dependent on the final wind turbine selections and layout. However, I also note that the Project will be able to operate in accordance with relevant planning requirements and the model planning permit conditions from the Victorian Guidelines as long as suitable agreements are enacted and maintained with the relevant landowners of stakeholder properties.

Special audible characteristics

3.36 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.

3.37 The predicted noise levels in Appendix D and in the MDA Environmental Noise and Vibration Assessment assume that no penalty applies to the wind turbine noise levels as it is not possible to undertake a detailed assessment at this stage. Should a penalty apply for special audible characteristics at the nearest residences, then there may be a risk that the NZS 6808:2010 limits would be exceeded, depending on the level of the penalty, the frequency with which it occurs and the background noise levels at the locations at which it occurs.

3.38 It is normal and reasonable for wind farm noise predictions at the planning stage to be predicted with the assumption that no penalties for special audible characteristics would apply. In our experience, special audible characteristics have only been identified at operating Australian wind farms in limited cases. The MDA Environmental Noise and Vibration Assessment considered the information available regarding the candidate wind turbines, based on limited information supplied by the manufacturers that no penalisable tones are expected.

3.39 Given the fact that special audible characteristics are not able to be predicted with accuracy at this stage, it will be necessary for post-construction testing of special audible characteristics to be carried out in accordance with Clause 7.5.4 of NZS 6808:2010. If special audible characteristics are identified, and this leads to non-compliance with the noise limits, then mitigation of the wind turbine noise may be required.

Management of wind turbine noise

3.40 Section 7.10 of the MDA Environmental Noise and Vibration Assessment details noise management options for wind turbine noise, including measures to reduce noise levels should this be required if higher than expected noise levels are observed during commissioning or post-construction testing. The nominated measures include curtailment, where turbines are operated at a lower sound power level for a given wind speed and direction where a noise level reduction is required, by controlling the blade pitch. When wind turbines are operated in such a mode, there is typically a reduction in associated power generation.

3.41 The implementation of noise curtailment strategies can be checked through review of the wind farm Supervisory Control and Data Acquisition (SCADA) system, which logs operational parameters for each wind turbine in 10-minute or finer intervals. Therefore, regulation of a noise curtailment strategy would be possible through measures such as:

- Requiring the wind farm operator to publish operational data for specific wind turbines where a curtailment strategy is implemented for particular conditions.
- Requiring the wind farm operator to submit analysis of their operational data at regular (e.g. annual) intervals or in response to noise complaints, conducted by an independent wind engineer, that demonstrates that the site has operated in compliance with the requirements of a required curtailment strategy.

3.42 The implementation of a noise curtailment strategy, if it were to be required, is not dissimilar to situations where other sources of environmental noise implement noise management strategies in order to comply with noise limits. For example:

- An industrial facility that limits truck deliveries to particular times of day.
- A facility that does not operate particular facilities or items of external mechanical plant at night time.

In each of the above cases, which are relatively common in my experience, noise control is dependent on the management of the site operator.

Changes to wind farm design post-approval

3.43 Changes to the Project layout and/or wind turbine selection can occur post-approval and could result in changes to the predicted noise levels at noise sensitive locations.

3.44 In general, I would expect any changes in predicted noise levels to be relatively small. The majority of currently available wind turbine models that I am aware of have sound power levels lower than or similar to the candidate wind turbines considered for the Project when fitted with serrated trailing edges on the blades. However, there are a small number of models that have sound power levels higher than 106 dB(A) that could result in predicted noise levels in excess of 40 dB(A) at non-involved dwellings. Given the maximum predicted EES noise level at any non-involved location is 39.3 dB(A), exceedance of the base noise limit would require a wind turbine with a sound power level of approximately 106.5 to 107 dB(A) or above.

3.45 In the event that the above occurred post-approval, a noise curtailment strategy could be implemented such that predicted noise levels achieve compliance with the NZS 6808:2010 limits. The effectiveness of any such strategy would need to be verified as part of post-construction noise monitoring.

4 Other sources of noise and vibration

Ancillary noise

4.1 Ancillary infrastructure noise from the Project during operation refers predominantly to noise from power transformers. Noise from this source are not subject to the noise limits from NZS 6808:2010 and the EES Noise and Vibration Assessment Report assessed transformer noise separately, against the recommendations of the Environment Protection Authority (EPA) Victoria Publication 1411 *Noise from industry in Regional Victoria* (NIRV) guidelines. This is the appropriate instrument against which to assess noise from power transformers at the site.

4.2 The NIRV guidelines recommend an effective night time noise criterion of 34 dB(A) for ancillary noise at noise-sensitive locations, which is correctly identified within the EES. Higher noise criteria apply at other times of day but, as the transformers will operate 24 hours, it is appropriate to apply the recommended night criteria

4.3 The EES Noise and Vibration Assessment Report adopted a sound power level for the transformers of up to 105 dB(A) depending on the rating and based on AS 60076-10:2009 *Power transformers – Determination of sound levels*. A +2 dB tonality adjustment was applied to the sound power levels to reflect the fact that transformer noise is typically tonal in nature. I consider the sound power levels and ISO 9613-2 prediction methodology to be appropriate based on the information available at this stage of the assessment.

4.4 The predicted noise levels for the ancillary facilities presented in the EES Noise and Vibration Assessment Report are 1 to 2 dB below the night time noise criterion at two noise-sensitive locations (one of which is an involved landowner) on the assumption that tonality from transformers would only be just detectable. If tonality is clearly audible at these locations, as it may be in situations where the transformer noise level is above 30 dB(A), then a +5 dB adjustment would apply (rather than +2 dB). Under this scenario noise levels from ancillary facilities could be non-compliant with the recommended noise levels from the NIRV.

4.5 Overall, I expect that noise from ancillary infrastructure will be able to achieve compliance with the NIRV criteria during detailed design as a number of measures are available to increase the margin of compliance. These include the selection of quieter transformers, or the inclusion of enclosures or barriers for the transformers. To ensure the NIRV noise criteria are achieved from ancillary infrastructure, I consider it appropriate that noise from this source be assessed and addressed during detailed design and considered as part of any post-construction noise testing.

Construction noise and vibration

4.6 Construction noise and vibration from the Project (from activities not related to quarry operations) was assessed in the EES Noise and Vibration Assessment Report against noise and vibration criteria and management procedures established in the EPA Victoria *Noise Control Guidelines* and NSW *Assessing Vibration: A Technical Guideline*.

4.7 At this stage of the Project, any assessment of construction noise and vibration is indicative only. The EES Noise and Vibration Assessment Report makes reasonable assumptions about typical construction noise and vibration sources and indicates that, generally, typical worst-case construction noise levels are likely to be in the range of 50 – 60 dB(A) at non-involved sensitive receivers when works are occurring in relatively close proximity. Vibration levels are likely to be relatively low.

4.8 Given these predictions, my prior experience with wind farm projects and the typical distances from work areas to noise-sensitive locations, I consider that construction noise and vibration from the Project can be suitably managed through measures such as:

- The restriction of work to standard working hours, unless unavoidable in which case work practices should consider the requirements for out of hours work in the *Noise Control Guidelines*.

- The development and effective implementation of a construction noise and vibration management plan in accordance with relevant publications such as the *Noise Control Guidelines.*
- The development and implementation of effective community consultation and complaint handling procedures with respect to construction noise and vibration, documented in the construction environmental management plans.

4.9 Should blasting be required during construction works, then it will be necessary for blasting to be managed in accordance with a blasting plan that would document measures to be implemented to manage noise, airblast and vibration levels in accordance with the Department of Economic Development, Jobs, Transports and Resources (DEDJTR) *Ground Vibration and Airblast Limits for Blasting in Mines and Quarries* (DEDJTR Guidelines).

Quarry noise, airblast and vibration

4.10 A temporary quarry is proposed as part of the Project, to be located centrally adjacent to Meadows Road and north of the Ledwells Road intersection. Due to the potentially significant period of operation of the quarry, up to four years, noise from the quarry has been assessed against the NIRV criteria for permanent or semi-permanent sources rather than against criteria for temporary and transient construction sources.

4.11 The NIRV guidelines set effective noise criteria for the quarry, as correctly identified in the EES, of:

- 46 dB(A) during the day
- 41 dB(A) during the evening
- 36 dB(A) at night.

I understand that the quarry will only operate during the daytime.

4.12 Blasting may also occur at the site and therefore any blasting operations would need to be conducted to achieve the airblast and vibration levels in accordance with DEDJTR Guidelines.

4.13 The EES Environmental Noise and Vibration Assessment conducted a preliminary assessment of the quarry and noted that predicted noise levels exceeded the daytime NIRV criteria at one location by 1 dB, a location for which the landowner is involved with the Project. At all non-involved locations, the predicted noise levels would be less than 40 dB(A).

4.14 I consider that the preliminary assessment indicates that the quarry is unlikely to have an unacceptable noise impact on non-involved residences if restricted to daytime operations. While predicted noise levels marginally exceed the NIRV criteria at one involved location, this may be considered acceptable given that the quarry is not a permanent fixture in the environment and given financial involvement of the landowner in the Project. Additionally, it is likely that additional noise control measures can be implemented into a detailed Quarry Work Plan to achieve a 1 dB reduction in predicted noise levels at this location. This could include the selection of quieter equipment or the creation of suitable bunds around the quarry site using leftover spoil.

4.15 Airblast and ground vibration has not been assessed at this stage but given the separation distance of approximately 800 m from the quarry, I expect that the DEDJTR Guidelines limits for airblast and ground vibration can be achieved with appropriate control of blasting. Measures that can be implemented for blasting operations include:

- control of charge sizes and delay to reduce peak airblast and ground vibration levels
- controlled trial blasting to confirm suitable prediction parameters for normal blasting
- monitoring regimes to ensure that the DEDJTR Guideline limits are not exceeded.

4.16 I understand that management of the quarry would be carried out in accordance with an approved Quarry Work Plan. I would expect that the Quarry Work Plan would include management and monitoring measures to address the above items.

5 Permit conditions

Proposed noise-related conditions

5.1 I have been provided with noise-related conditions for the project that I understand are being proposed by DELWP and WestWind Energy. The noise-related conditions and my suggestions and comments are provided below:

Noise-related condition		Suggestion / comment
In conditions 11-17: • 'ancillary infrastructure' means the terminal station and collector stations. • 'the Standard' means New Zealand Standard 6808:2010, Acoustics – Wind Farm Noise. • 'noise sensitive locations' are locations defined as such in the Standard which existed as at 17 August 2017. • 'NIRV' means EPA publication 1411: Noise from Industry in Regional Victoria. • 'noise sensitive areas' are locations defined as such in the Glossary in NIRV. • 'the first turbine operating' means the time from which a turbine first commences generating electricity. • 'the last turbine is operating' means the time from which the last turbine first commences generating electricity.		None.
Wind Farm Performance Requirement		
11	Subject to condition 12, at any wind speed, noise from the operation of the wind turbines, when measured at noise sensitive locations, must comply with the limits specified in clause 5.2 of the Standard.	None.
12	The limits specified in condition 11 do not apply if an agreement has been entered into with the owner of the noise sensitive location that waives compliance with condition 11. Evidence of the agreement must be provided to the satisfaction of the responsible authority upon request, and be in a form that applies to the land upon which the noise sensitive location is located for the life of the wind energy facility.	None.
Ancillary Infrastructure Performance Requirements		
13	Subject to condition 14, noise from ancillary infrastructure associated with the wind energy facility must comply with the relevant recommended noise levels for noise sensitive areas in accordance with NIRV.	None.
14	The limits specified in condition 13 do not apply if an agreement has been entered into with the owner of a noise sensitive area which waives compliance with condition 13. Evidence of the agreement must be provided to the satisfaction of the responsible authority upon request, and be in a form that applies to the land upon which the noise sensitive area is located for the life of the wind energy facility.	None.

Noise-related condition		Suggestion / comment
Pre-construction assessment		
15	Before development starts, a Pre-construction Noise Assessment based on the final turbine layout and turbine model to be installed and the detailed design of the ancillary infrastructure must be undertaken and the results submitted to the responsible authority. The Pre-construction Noise Assessment must be prepared in accordance with the Standard and NIRV, and must demonstrate to the satisfaction of the responsible authority that the facility will comply with the performance requirements specified in conditions 11 and 13.	Proposed condition 5 allows micro-siting of turbines up to 100 m. Changes of this magnitude typically have negligible effects on predicted noise levels. I assume that micro-siting of turbines would not be considered a change of layout that would trigger the need for a pre-construction noise assessment under condition 15.
Operating acoustic compliance assessment		
16	A Post-construction Acoustic Compliance Report, prepared in accordance with the Standard and NIRV, which demonstrates whether the facility complies with the performance requirements specified in conditions 11 and 13, must be submitted to the responsible authority within: a. 6 months of the first turbine operating (in respect of demonstrating compliance with condition 11); and b. 6 months of the ancillary infrastructure commencing operations (in respect of demonstrating compliance with condition 13). Further Post-construction Acoustic Compliance Reports prepared in accordance with this condition must be submitted to the responsible authority annually from the date of the first report being submitted until the last turbine is operating.	None.
Noise Management Plan		
17	Before development starts, a Noise Management Plan must be submitted to and endorsed by the responsible authority. When endorsed the plan will form part of this permit. The Noise Management Plan must specify details of:	None.
17a.	Post-construction Acoustic Compliance Reports: detailing how these will be prepared in accordance with the Standard and NIRV, to demonstrate whether or not the facility complies with the performance requirements in conditions 11 and 13.	No recommended changes. I note that, in accordance with the Standard, this will require the assessment of special audible characteristics.
17b.	Noise Investigation Reports: detailing procedures for when complaints are received in accordance with the endorsed Complaints Investigation and Response Plan (condition 80) or when potential non-compliance with the performance requirements in conditions 11 and 13 is otherwise detected.	None.
17c.	Noise Remediation Plans: detailing procedures for when non-compliance with the performance requirements in conditions 11 and 13 is found to have occurred.	None.

Noise-related condition		Suggestion / comment
17d.	The requirements for each of the documents referred to in conditions 17(a) and 17(b), including what matters they must address, and when they must be submitted.	None.
18	The endorsed Noise Management Plan must be implemented to the satisfaction of the responsible authority. The endorsed Noise Management Plan must not be altered or modified without the written consent of the responsible authority.	None.
Peer review of noise reports and plans		
19	The Pre-Construction Noise Assessment required under condition 15, the Noise Management Plan required under condition 17, and each report and remediation plan required under condition 17, must be prepared by a suitably qualified and experienced acoustician.	None.
20	The Pre-Construction Noise Assessment required under condition 15, Noise Management Plan required under condition 17, acoustic compliance reports required under condition 17 and the noise remediation plan required under condition 17, must be accompanied by a peer review from an environmental auditor appointed under Part IXD of the *Environment Protection Act 1970* verifying that the report or plan is suitable, and meets the requirements of this permit.	I note that independent auditors are not typically qualified and experienced in acoustic assessments. Therefore, I would consider it beneficial for the reports to also be peer reviewed by a suitably qualified and experienced acoustician. In my opinion this is particularly important for the Noise Management Plan, which would likely define highly technical wind farm specific acoustic procedures. While I note Condition 22 allows this to occur, it only does so in the event that an auditor cannot be retained.
21	If requested by the responsible authority, the noise investigation reports required under condition 17 must be accompanied by a report from an environmental auditor appointed under Part IXD of the *Environment Protection Act 1970* verifying that the report or plan is suitable, and meets the requirements of this permit.	
22	If an auditor appointed under Part IXD of the Environment Protection Act 1970 cannot be retained for any of the requirements under Conditions 19 and 20, written consent of the Responsible Authority may be sought to provide a peer review from a suitably qualified and experienced independent acoustic engineer instead.	None.
23	The environmental auditor or peer reviewer must be a different author to the author of the report being reviewed.	None.

Additional proposed condition

5.2 I understand that Mr Christophe Delaire, an acoustic expert witness of WestWind Energy, has proposed an additional condition in relation to near field sound power testing of turbines installed at the site. Mr Delaire's proposed example condition is:

A Near Field Testing Report shall be prepared to assess the results of sound power level testing of a representative sample of turbines by:

a. Verifying that the sound power levels and tonal audibility levels, accounting for test uncertainty, are equivalent to or less than the values adopted as the basis of the pre-construction noise report; or

b. Verifying that predicted noise levels determined on the basis of the sound power level test results are below the planning permit noise limits which apply at noise sensitive locations, using the same prediction methodology used for the pre-construction noise assessment required under condition 15.

If the results of the sound power level test indicate results (for the sound power level or tonal audibility levels) that are significantly different from the data referenced in the pre-construction noise assessment, the Near Field Testing Report must address these differences and outline whether additional sound power level testing is warranted to verify and assess the noise emissions of other wind turbines at the site.

5.3 Generally, near field testing of wind turbines is undertaken to assess the sound power levels and near field tonality from installed wind turbines, with the test results used to determine if the wind turbine complies with relevant guarantees provided by the wind turbine supplier as part of the procurement contract with the wind farm owner. Near field testing is not normally relevant to planning approval conditions as planning approval should consider the 'far-field' wind turbine noise levels measured at noise-sensitive locations (e.g. dwellings).

5.4 However, in the case of this Project I am supportive of Mr Delaire's proposed condition for near field testing because:

- A requirement for sound power level testing was included in the recommended Environmental Performance Requirements documented in the EES Noise and Vibration Assessment Report. Therefore, the inclusion of such a condition is consistent with the recommendations of the EES.
- The results of far field wind farm noise level measurements at residences can often be unclear as they are highly susceptible to changes in background noise levels that can occur over time (e.g. due to growth or changes in vegetation around a dwelling). Near field sound power level testing can provide a clearer indication of whether the turbine noise emissions are consistent with that assumed as part of the Pre-Construction Noise Assessment.
- Given the relative size of this Project, the results of any near field sound power level testing can be used to:
  - determine if any changes in wind turbine sound power levels (relative to the assumed level from the Pre-Construction Noise Assessment) introduce a requirement for additional far field measurements at residences
  - determine if any near field tonality exists to inform far field tonality assessments at residences.

Construction Noise and Vibration Management Plan

5.5 The currently proposed condition 40 includes a requirement for a Construction Noise and Vibration Management Plan, to be incorporated into the Construction Environmental Management Plan. I consider that this condition is appropriate and in accordance with the recommendations of the EES. Effective implementation of a Construction Noise and Vibration Management Plan developed in accordance with this condition will appropriately manage potential noise and vibration impacts associated with construction works for the project.

6 Response to key submissions

6.1 I have reviewed the key submissions that raise issues relating to noise and vibration, specifically submissions numbered 7, 12, 14 – EPA Victoria, 15, 18, 19, 21 – Earth Resources Regulation (DEDJTR), 22, 25 and 26.

6.2 The following table summarises the key issues raised in the submissions, the submissions in which it was raised, and my response.

Comment / issue	Submissions	Response
Concern that background noise monitoring was not conducted at property	26	Background noise monitoring was conducted at a number of locations around the site and revealed that ambient background noise levels are typically below 35 dB(A) up to the wind speeds at which the candidate turbines reach their maximum sound power level, meaning that compliance is required with the base limits from NZS 6808:2010 and not a background-adjusted limit. For the proposed layout and candidate turbines, wind turbine noise levels from the proposed Golden Plains Wind Farm are not predicted to exceed the base limits from NZS 6808:2010. Therefore the Project's compliance is not reliant on background noise monitoring results. However, given some of the concerns around the background noise monitoring conducted to date, I expect that additional background noise monitoring would be conducted prior to the site commencing operation to: • Ensure that a representative number of non-involved receiver sites are selected around the Project, including on the northern side of the site. While I do not consider it necessary to monitor at all residences within the 35 dB predicted noise level contour, a suitable number of background noise monitoring sites should be selected around the wind farm boundary to cover the directions in which noise-sensitive uses are located (subject to access being granted by landowners). • Provide a suitably robust set of background data for each selected monitoring site. • Provide background noise monitoring data that is referenced to hub height wind speed and direction data measured at the location of the permanent wind monitoring sites that will be installed. Depending on the timing of the monitoring, this could potentially be carried out with temporary SODAR devices installed at the location of future permanent mast sites. • Provide up-to-date background noise data to minimise the risk of changes in background noise levels that can occur between background and operational noise surveys (i.e. due to changes in local vegetation around a monitoring site). • Ensure that there is sufficient background noise monitoring sites to enable post-construction operational noise monitoring to occur at a suitable number of locations where background noise monitoring has occurred.

Comment / issue	Submissions	Response
Concern that background noise monitoring was not conducted at adequate number of sites on northern side of site	15, 19	As noted above, I agree that it would be desirable to have a greater number of background noise monitoring locations to the north of the site and that this would need to be addressed post-approval. I note that, as predicted wind turbine noise levels at residences are below 40 dB(A), the results of background noise monitoring will not alter predicted compliance of the wind farm with the NZS 6808:2010 noise limits.
Concern that EES states there were concerns around accuracy of wind data for background noise monitoring	19	The EES Environmental Noise and Vibration Assessment Report identified limitations associated with the wind data used during the background noise surveys and stated that 'any future use of the background noise data during the development or operation of the project would involve reanalysis with a refined wind data set based on additional measurements of site wind trends and patterns'. The predicted compliance of operational noise from the Project is not reliant on the background noise data. However, as noted above, I consider it appropriate for an updated and robust background noise monitoring survey to be conducted post-approval, with the data referenced to hub height wind speeds measured at the permanent wind speed monitoring sites.
Request for noise assessment to be independent and data collection publicly available in real time	19, 22, 25	The model Planning Permit conditions include a requirement for all noise assessments to be conducted by a suitably qualified and experienced acoustician, and peer reviewed by an accredited environmental auditor. Noise monitoring systems that present noise measurement data in near real-time are available and could be considered. However, it is important to note that background or operational noise assessments conducted in accordance with NZS 6808:2010 are not able to be conducted in real-time as: • The assessment requires a minimum of 1440 10-minute data points in order to determine the measured noise levels used for the compliance assessment. • All noise monitoring data includes a mixture of wind turbine noise and ambient/extraneous noise. Therefore, consideration needs to be given by a suitably qualified acoustician as to whether extraneous noise has influenced the data.
Concern that farm accommodation site not included in the noise assessment	19	The nominated farm accommodation site is located at the edge of the 3 km zone around turbine locations for which noise-sensitive locations were considered. It is located near to receiver AD27-b, for which both MDA and I have predicted a maximum wind turbine noise level of 30 dB(A), which is well below the minimum applicable NZS 6808:2010 limit of 40 dB(A).
Concern about appropriateness of wind turbine noise limits	15, 25	The wind turbine noise limits in NZS 6808:2010 are stated to "provide a satisfactory level of protection against sleep disturbance" and "appropriate for protecting the health and amenity of residents for most noise sensitive activities."

Comment / issue	Submissions	Response
Concern about effects of infrasound	15, 18	Section 7.8 of the EES Environmental Noise and Vibration Assessment provides a summary of research into infrasound from wind farms that I concur with. I was a co-author of a study into infrasound with the SA EPA that found that infrasound levels near wind farms were no higher at locations near wind farms than at comparable locations away from wind farms. Neither the Victorian Guidelines nor NZS 6808:2010 require assessment of infrasound from wind farms.
Concern that EES noise graphs show noise levels at house will be above 40 dB on windy days	18	The graphs referred to in the EES show the background noise level measured at various locations around the Project – i.e. the level of noise that already exists in environment. Under high wind speeds, background noise levels around residences increase and can reach above 40 dB(A) as shown in the EES. The predicted wind turbine noise levels at all non-involved noise sensitive locations are below 40 dB(A) for all wind speeds.
Concerns about accuracy of wind turbine noise predictions	15, 19, 22, 25, 26	The wind turbine noise prediction procedures documented within the EES are consistent with good practice in Australia. The prediction methodology used has been shown to have good agreement between measured and predicted noise levels as discussed within my statement. Given the above, I expect that the predictions will result in accurate predictions of downwind wind farm noise levels when measured and assessed in accordance with NZS 6808:2010. For situations and times where a residence is upwind or crosswind of the wind farm, I expect that the wind turbine noise levels will be lower than predicted.
Concern about predicted noise levels at school, child care centre and community health centre	15	The highest predicted wind turbine noise levels at these uses are in the order of 38 dB(A) outdoors. For comparison, Australian / New Zealand Standard AS/NZS 2107 recommends internal noise levels of 35 – 45 dB(A) for educational spaces. Given that there will be a reduction in the order of 10 dB from outdoors to indoors allowing for a partially open window, the internal wind turbine noise levels within these buildings is expected to be below these recommended noise levels. In my experience, many health centres, schools and child care centres throughout Victoria are exposed to external noise levels well above 40 dB(A) due to sources such as traffic and rail noise.

Comment / issue	Submissions	Response
Concerns about compliance monitoring procedures implemented on previous projects, including objective assessment of special audible characteristics	12	I expect that a planning condition equivalent to Condition 17 of the Victorian Guidelines model conditions will be included in any issued Permit that requires the proponent to develop a Noise Management Plan detailing compliance monitoring procedures to be carried out in accordance with NZS 6808:2010. NZS 6808:2010 requires consideration of special audible characteristics as part of any post-construction monitoring, and establishes objective assessment criteria for tonality and amplitude modulation. This Noise Management Plan will be peer reviewed by an accredited environmental auditor verifying that it is suitable and meets the requirements of NZS 6808:2010. As per my earlier statement, I would also consider it appropriate that the Noise Management Plan be peer reviewed by a suitably qualified and experienced acoustic consultant given its importance to effective operational assessment of the wind turbine noise.
Cumulative effects of proposed wind farm and existing Mt Mercer Wind Farm	15, 19, 25, 26	No cumulative assessment of wind farm noise was undertaken in the EES due to the considerable distance between the Project and Mount Mercer Wind Farm. The minimum distance between the predicted 35 dB(A) downwind noise level contour from Golden Plains Wind Farm and the nearest WTG from Mount Mercer Wind Farm is approximately 8 km. At this distance, it is not expected that noise levels from Mount Mercer would increase the wind turbine noise level above 35 dB(A), particularly given that a dwelling located in between the two sites cannot be downwind of both at the same time.
Concerned about level of wind turbine noise, can already hear audible sound from Mt Mercer approximately one night out of four at 8 km away	19	While the NZS 6808:2010 noise limits are established to provide protection for the health and amenity of residents, they do not (and do not seek to) ensure inaudibility of wind turbine noise at noise sensitive locations. This is consistent with noise regulation for other sources of environmental noise, such as industrial facilities, where no requirements are established for inaudibility. The audibility of wind turbine noise at a residence will depend on a number of factors such as wind direction, wind speed at turbines, wind speed at ground level at the residence, and general background noise level at the residence from other sources. I expect that residents will hear noise from the wind farm at times, most likely when downwind of the site at night time as the background noise level at residences is typically lower at these times. However, at all times the wind farm noise level is expected to be at a level which provides a reasonable level of protection of health and amenity in accordance with NZS 6808:2010.
Under the impression from negotiations with WestWind that noise levels will not exceed 35 dB and any impact in excess of this will be remedied.	7	I was not privy to discussions between the submitter and proponent but note that wind turbine noise from the site only need achieve a noise level of 40 dB(A) in order to achieve compliance with the relevant noise limits. I note that the EES predicts noise levels of 34 dB(A) or lower at the residences on the lots nominated in the relevant Submission.

Comment / issue	Submissions	Response
Given the uncertainties related to blasting impacts, ERR is likely to require a blasting impact assessment and blast monitoring once the quarry is operating.	21 – ERR (DEDJTR)	I agree that a blast impact assessment prior to the commencement of blasting at the quarry and blast monitoring during operation are appropriate for this Project.

7 Summary

7.1 Having reviewed the proposed Golden Plains Wind Farm Project and the noise and vibration assessment included in the EES, as well as the submissions received, I am of the opinion that the Project can operate in accordance with relevant requirements that apply in Victoria relating to noise and vibration. This is consistent with my Peer Review that was included with the EES submission.

7.2 As per my Peer Review, I confirm that I consider that the MDA Environmental Noise and Vibration Assessment Report prepared for the EES is satisfactory. It identifies appropriate noise and vibration assessment criteria and documents predicted wind turbine noise levels based on reasonable assumptions and a prediction methodology that is consistent with good practice in Australia.

7.3 To ensure adequate management of noise and vibration during construction and operation, I consider that:

- Additional background noise monitoring should be conducted in accordance with NZS 6808:2010 at a representative number of locations around the Project site, prior to operation of the Project. While compliance of the Project is not expected to be reliant on background noise levels, NZS 6808:2010 does require background noise monitoring to be conducted at locations within the 35 dB(A) contour and a robust background dataset enables operational noise monitoring to occur more efficiently.
- Post-construction (operational) noise monitoring of wind turbine noise will need to occur in accordance with NZS 6808:2010 as required by the model conditions Victorian Guidelines. This should include an assessment of special audible characteristics as required by NZS 6808:2010.
- A detailed pre-construction assessment of ancillary power transformers should be prepared and submitted to the responsible authority as, currently, predicted compliance of ancillary infrastructure is marginal with respect to the NIRV recommended noise levels. This should be supported by operational noise testing of the transformer sites.
- A construction noise and vibration management plan should be developed and implemented detailing the methods that will be used to manage potential construction noise and vibration impacts during construction, including consultation and complaint handling procedures.
- A detailed assessment of quarry noise, airblast and vibration should be prepared and submitted as part of the Quarry Work Plan detailing how potential impacts will be managed in accordance with the NIRV and DEDJTR Guidelines.

7.4 With the application of appropriate planning conditions to address the above, in line with the proposed planning conditions provided by WestWind and DELWP, I expect that noise and vibration impacts from the Project can be satisfactorily managed during construction and operation.

8 Declaration

8.1 I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

19 July 2018

Appendix A—Qualifications & experience

Qualifications

Bachelor of Engineering (Mechatronic) – 1st Class honours, 2006
Bachelor of Economics, 2005

Professional associations

MAAS – Member of the Australian Acoustical Society
Member of the Victorian Planning and Environmental Law Association

Employment history

April 2018 – Present	Managing Director, Resonate Consultants, Melbourne
July 2012 – April 2018	Associate Director, Resonate Consultants, Melbourne / Adelaide
January 2012 – July 2012	Senior Acoustic Engineer, AECOM, Adelaide
November 2006 – December 2011	Acoustic Engineer, AECOM (previously Bassett Acoustics), Adelaide
November 2005 – November 2006	Vacation / Part-Time Employment in Acoustics, Bassett Acoustics, Adelaide

Professional experience

Since commencing my career as a professional acoustic consultant, I have gained significant experience in the field of wind farm noise, including pre- and post-construction noise monitoring, noise prediction and assessment against relevant guidelines and standards.

Significant projects I have worked on include the Macarthur Wind Farm, Oaklands Hill Wind Farm, Hallett Hill Wind Farm, North Brown Hill Wind Farm and Burgos Wind Farm. I was also recently appointed as an independent acoustic expert to provide advice on appropriate consent conditions for the Te Rere Hau Wind Farm in Palmerston North, New Zealand, and was then engaged as an expert witness for Palmerston North City Council during the hearing process into the revised consent conditions.

I have authored and co-authored a number of papers in technical journals and conference proceedings with respect to wind farm noise, including the international Wind Turbine Noise Conference held in Glasgow in 2015. A paper I authored on the accuracy of wind turbine noise predictions that was published in the 2012 edition of Acoustics Australia has been widely referenced, including in the UK Institute of Acoustics document *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind farm noise*.

In 2013, two colleagues and I were awarded the Australian Acoustical Society Excellence in Acoustics Award for the development of a method for tonality assessment at a wind farm.

I have also gained considerable experience in the assessment of environmental noise and vibration from other sources, including industrial facilities, construction facilities and transport infrastructure. Key projects I have been involved in include:

- Melbourne Metro Tunnel Project – advisor on noise and vibration for construction and operation for the University of Melbourne, Peter MacCallum Cancer Centre and Royal Melbourne Hospital.
- Noise SEPPs Impact Analysis – managed an impact study into the EPA Victoria Noise SEPPs and NIRV
- Port of Melbourne Port Capacity Upgrade
- Angas Zinc Mine, Strathalbyn
- Holden Manufacturing Facility, Elizabeth
- Point Wilson Explosives Area Remediate

Appendix B—Information considered

I have considered the following documents in the preparation of this statement of evidence:

- *Scoping Requirements for the Golden Plains Wind Farm Project*, dated December 2017
- MDA Environmental Noise & Vibration Assessment for Golden Plains Wind Farm included as Appendix Q to the EES, dated 23 February 2018.
- MDA Background Noise Monitoring Report for Golden Plains Wind Farm, included as Appendix N.3 of the EES, dated 5 April 2018.
- Jacobs, 23 April 2018, *Golden Plains Wind Farm Planning Permit Application Report*
- The Golden Plains Wind Farm layout and noise sensitive receiver locations as documented in Appendix C of this statement and as taken from Appendix Q of the EES.
- Golden Plains Planning Scheme
- Department of Environment, Land, Water and Planning (DELWP) *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria*, November 2017 (Victorian Guidelines).
- New Zealand Standard NZS 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010).
- The recently issued Rifle Butts Wind Farm Planning Permit, reference PA1800327.
- International Standard ISO 9613-2, 1996, *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation*.
- Vestas document No. 0067-4767_03 *V150-4.2 MW – Third octave noise emission*, 13 November 2017
- *Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors* [2013] VCAT 521
- DEDJTR *Environmental guidelines – Ground Vibration and Airblast Limits for Blasting in Mines and Quarries*, 15 July 2015.
- EPA Publication 1411 *Noise from Industry in Regional Victoria*, October 2011
- EPA Publication 1254 *Noise Control Guidelines*, October 2008
- UK Institute of Acoustics, 2013, *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*.
- Evans T & Cooper J, 2012, 'Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms', *Acoustics Australia*, vol. 40(1), pp 28 – 36.
- Australian Standard AS 60076-10:2009 *Power transformers – Determination of sound levels*.
- NSW Department of Environment and Conservation, 2006, *Assessing Vibration: A Technical Guideline*.

Resonate

Appendix C—Project layout information

Project wind turbine layout

All coordinates given as GDA94 / MGA Zone 54.

Turbine	Easting	Northing	Turbine	Easting	Northing	Turbine	Easting	Northing
GP001	728745	5804263	GP031	732217	5806046	GP061	735063	5799055
GP002	729152	5804867	GP032	732188	5801309	GP062	735116	5801080
GP003	729492	5805489	GP033	732402	5799963	GP063	735141	5797594
GP004	729599	5803943	GP034	732398	5804499	GP064	735327	5799686
GP005	729817	5806040	GP035	732516	5805242	GP065	735423	5801653
GP006	730020	5802627	GP036	732575	5801854	GP066	735611	5803646
GP007	729919	5804507	GP037	732621	5806706	GP067	735740	5802224
GP008	730152	5806596	GP038	732774	5798972	GP068	735861	5797542
GP009	730232	5805071	GP039	732741	5803525	GP069	735911	5802907
GP010	730405	5801929	GP040	732848	5805799	GP070	736112	5798840
GP011	730518	5807148	GP041	733104	5804147	GP071	736258	5799505
GP012	730551	5803771	GP042	733215	5799528	GP072	736191	5801467
GP013	730624	5805602	GP043	733477	5804714	GP073	736218	5797111
GP014	730797	5802482	GP044	733452	5801627	GP074	736538	5797621
GP015	730966	5806155	GP045	733557	5800081	GP075	736603	5800053
GP016	731034	5804255	GP046	733634	5798856	GP076	736662	5798211
GP017	731035	5803054	GP047	733695	5805610	GP077	737026	5798778
GP018	731171	5799657	GP048	733794	5802180	GP079	737438	5799339
GP019	731235	5804877	GP049	733899	5800634	GP080	737583	5797617
GP020	731308	5806708	GP050	733925	5804072	GP081	737685	5798324
GP021	731349	5800323	GP051	734167	5799355	GP082	737747	5799907
GP022	731402	5801412	GP052	734241	5801187	GP083	738008	5796986
GP023	731456	5803566	GP053	734309	5802544	GP084	738262	5798675
GP024	731540	5802103	GP054	734375	5797973	GP085	738343	5797555
GP025	731816	5800764	GP055	734454	5803286	GP086	738392	5799331
GP026	731854	5802614	GP056	734569	5799902	GP087	738815	5799798
GP027	732013	5803970	GP057	734583	5801739	GP088	738868	5793063
GP028	732033	5798656	GP058	734588	5797015	GP090	738940	5795207
GP029	732069	5799418	GP059	734702	5798560	GP091	739028	5798660

Turbine	Easting	Northing	Turbine	Easting	Northing	Turbine	Easting	Northing
GP030	732175	5803152	GP060	734805	5800492	GP092	739101	5793648
GP093	739239	5795766	GP127	741725	5799647	GP160	743647	5795972
GP094	739369	5797339	GP128	741765	5800373	GP161	743931	5794610
GP095	739434	5799148	GP129	741839	5798069	GP162	744025	5795365
GP096	739471	5794196	GP130	742011	5794938	GP163	744061	5796612
GP097	739643	5797986	GP131	742105	5796790	GP164	744105	5789657
GP098	739681	5796300	GP132	742170	5793018	GP165	744036	5788660
GP099	739712	5799954	GP133	742219	5791848	GP166	744168	5793257
GP100	739709	5792922	GP134	742221	5798598	GP167	744408	5795860
GP101	739862	5794718	GP135	742272	5793749	GP168	744640	5793725
GP102	739805	5798585	GP136	742447	5797343	GP169	744732	5788886
GP103	740035	5796851	GP137	742456	5790495	GP170	744828	5792537
GP104	740040	5793400	GP138	742476	5795651	GP171	744898	5794322
GP105	740127	5795306	GP139	742514	5791145	GP172	744931	5790691
GP106	740279	5798970	GP140	742563	5799069	GP173	745034	5789473
GP107	740318	5800401	GP141	742652	5792345	GP174	745087	5796204
GP108	740116	5797470	GP142	742611	5794238	GP175	745140	5793148
GP109	740443	5794013	GP143	742794	5797821	GP176	745317	5790096
GP110	740759	5799502	GP144	742819	5796203	GP177	745366	5791168
GP111	740470	5795859	GP145	742980	5794784	GP178	745386	5791809
GP112	740518	5792815	GP146	743054	5789651	GP179	745471	5796712
GP113	740736	5794580	GP147	743070	5792906	GP180	745491	5793710
GP114	740812	5796411	GP148	743109	5793529	GP181	745538	5795467
GP115	740942	5800729	GP149	743132	5798448	GP182	745808	5792510
GP116	740963	5800075	GP150	743114	5791598	GP183	745881	5796019
GP117	740984	5793280	GP151	743157	5796776	GP184	745841	5790514
GP119	741269	5792022	GP152	743254	5790767	GP185	745896	5794209
GP120	741326	5793833	GP153	743330	5795389	GP186	746137	5792994
GP121	741392	5799063	GP154	743359	5788564	GP187	746058	5794855
GP122	741384	5795693	GP155	743428	5794152	GP188	746355	5788240
GP123	741496	5797517	GP156	743474	5799000	GP189	746316	5796735
GP124	741611	5792574	GP157	743483	5792152	GP190	746489	5795504
GP125	741629	5791346	GP158	743547	5797371	GP191	746484	5793520

Turbine	Easting	Northing	Turbine	Easting	Northing	Turbine	Easting	Northing
GP126	741668	5794385	GP159	743606	5789228	GP192	746739	5792260
GP193	746759	5788881	GP206	747936	5792606	GP219	746286	5789895
GP194	746844	5794030	GP207	745964	5789142	GP220	749410	5794787
GP195	746862	5795919	GP208	748052	5791084	GP221	749415	5791518
GP196	746957	5792809	GP209	748079	5794466	GP222	749391	5790590
GP197	747128	5794640	GP210	748261	5793145	GP223	738366	5796442
GP198	745453	5788777	GP211	747366	5788903	GP224	749775	5795280
GP199	746877	5789470	GP212	748391	5795006	GP225	749878	5795889
GP200	747259	5791481	GP213	748569	5791793	GP226	749940	5794002
GP201	747394	5793361	GP214	748633	5793690	GP227	750057	5790834
GP202	747509	5795164	GP215	748729	5791106	GP228	750283	5794555
GP203	747617	5792088	GP216	748766	5790513	GP229	750622	5791159
GP204	747470	5789486	GP217	748912	5792346	GP230	750614	5795098
GP205	747711	5793893	GP218	748981	5794225	GP231	750665	5790338

Noise-sensitive locations

All coordinates given as GDA94 / MGA Zone 54.

ID	Easting	Northing	Type	ID	Easting	Northing	Type
D35 - a	725951	5805306	Dwelling	N36 - c	735753	5806766	Dwelling
F32 - a	727015	5802349	Dwelling	N37 - a	735309	5807414	Dwelling
F35 - a	727236	5805534	Dwelling	O34 - a	736257	5804501	Dwelling
G30 - a	728994	5800930	Dwelling	O34 - b	736311	5804493	Dwelling
H28 - a	729859	5798327	Dwelling	P20 - a	737916	5790852	Dwelling
H30 - a	729369	5800291	Dwelling	P31 - a	737563	5801100	Dwelling
H32 - a	729064	5802091	Dwelling	P31 - c	737462	5801204	Dwelling
H38 - a	729116	5808096	Dwelling	Q30 - a	738607	5800844	Dwelling
H38 - b	729285	5808898	Dwelling	Q31 - a	738592	5801449	Dwelling
I26 - a	730060	5796521	Dwelling	Q31 - b	738434	5801699	Dwelling
I39 - a	730161	5809849	Dwelling	Q31 - c	738632	5801871	Dwelling
K27 - a	732355	5797605	Dwelling	Q31 - e	738967	5801890	Dwelling
L25 - a	733029	5795769	Dwelling	Q31 - f	738733	5801881	Dwelling
L26 - a	733373	5796960	Dwelling	Q31 - g	738785	5801858	Dwelling
L38 - a	733936	5808242	Dwelling	Q31 - h	738828	5801838	Dwelling
L38 - b	733229	5808692	Dwelling	Q31 - i	738852	5801805	Dwelling
L39 - b	733422	5809554	Dwelling	Q31 - j	738886	5801813	Dwelling
L39 - c	733411	5809378	Dwelling	Q31 - k	738901	5801800	Dwelling
L39 - d	733548	5809456	Dwelling	Q31 - l	738922	5801794	Dwelling
L39 - e	733978	5809056	Dwelling	Q31 - m	738791	5801735	Dwelling
L39 - f	733930	5809110	Dwelling	Q31 - o	738965	5801387	Dwelling
M35 - b	734689	5805847	Dwelling	Q32 - a	738225	5802138	Dwelling
M37 - a	734049	5807888	Dwelling	Q32 - b	738341	5802115	Dwelling
M37 - b	734617	5807932	Dwelling	Q32 - c	738402	5802176	Dwelling
M37 - c	734822	5807599	Dwelling	Q32 - d	738354	5802214	Dwelling
M37 - d	734842	5807361	Dwelling	Q32 - e	738723	5802232	Dwelling
M38 - a	734342	5808410	Dwelling	Q32 - f	738594	5802128	Dwelling
N25 - a	735734	5795678	Dwelling	Q32 - g	738769	5802008	Dwelling
N25 - b	735596	5795705	Dwelling	Q34 - a	738393	5804213	Dwelling
N36 - a	735394	5806857	Dwelling	R20 - ab	739297	5790184	Dwelling
N36 - b	735629	5806537	Dwelling	R20 - a	739599	5790079	Dwelling

ID	Easting	Northing	Type	ID	Easting	Northing	Type
R31 - aa	739526	5801566	Dwelling	R31 - r	739050	5801658	Dwelling
R31 - ab	739349	5801407	Dwelling	R31 - s	739122	5801682	Dwelling
R31 - ad	739657	5801387	Dwelling	R31 - t	739160	5801671	Dwelling
R31 - ai	739170	5801275	Dwelling	R31 - u	739179	5801657	Dwelling
R31 - aj	739146	5801363	Dwelling	R31 - v	739202	5801649	Dwelling
R31 - ak	739292	5801418	Dwelling	R31 - w	739214	5801639	Dwelling
R31 - al	739182	5801416	Dwelling	R31 - z	739198	5801563	Dwelling
R31 - am	739182	5801499	Dwelling	R32 - a	739051	5802266	Dwelling
R31 - an	739132	5801532	Dwelling	R32 - b	739072	5802112	Dwelling
R31 - ao	739070	5801564	Dwelling	R32 - c	739059	5802044	Dwelling
R31 - ap	739420	5801443	Dwelling	R32 - d	739014	5802017	Dwelling
R31 - aq	739450	5801493	Dwelling	R33 - a	739269	5803149	Dwelling
R31 - ar	739402	5801462	Dwelling	T17 - a	741311	5787868	Dwelling
R31 - as	739355	5801496	Dwelling	T17 - b	741231	5787929	Dwelling
R31 - at	739367	5801474	Dwelling	T32 - a	741562	5802587	Dwelling
R31 - av	739381	5801528	Dwelling	T32 - b	741355	5802435	Dwelling
R31 - aw	739370	5801553	Dwelling	U18 - a	742342	5788137	Dwelling
R31 - ax	739294	5801500	Dwelling	U18 - b	742142	5788754	Dwelling
R31 - az	739497	5801582	Dwelling	U18 - c	742095	5788744	Dwelling
R31 - b	739619	5801552	Dwelling	U31 - a	742715	5801859	Dwelling
R31 - ba	739575	5801533	Dwelling	V30 - a	743058	5800426	Dwelling
R31 - bb	739227	5801576	Dwelling	W17 - a	744979	5787808	Dwelling
R31 - bc	739220	5801563	Dwelling	W28 - a	744889	5798050	Dwelling
R31 - bd	739214	5801548	Dwelling	Y28 - a	746420	5798391	Dwelling
R31 - be	739422	5801198	Dwelling	Y28 - b	746653	5798644	Dwelling
R31 - c	739104	5801611	Dwelling	Z28 - a	747222	5798153	Dwelling
R31 - f	739045	5801510	Dwelling	AA27 - a	748944	5797036	Dwelling
R31 - g	739245	5801523	Dwelling	AB18 - a	749623	5788015	Dwelling
R31 - h	739254	5801555	Dwelling	AC17 - a	750863	5787865	Dwelling
R31 - j	739397	5801638	Dwelling	AC18 - a	750884	5788946	Dwelling
R31 - k	739370	5801644	Dwelling	AC22 - a	750880	5792226	Dwelling
R31 - n	739324	5801676	Dwelling	AD23 - a	751144	5793660	Dwelling
R31 - q	739009	5801990	Dwelling	AD25 - a	751734	5795954	Dwelling

ID	Easting	Northing	Type	ID	Easting	Northing	Type
AD27 - a	751435	5797880	Dwelling	N32 - a (H)	735097	5802650	Involved dwelling
AD27 - b	751807	5797990	Dwelling	O30 - a (H)	736089	5800639	Involved dwelling
AD27 - c	751647	5797700	Dwelling	Z20 - b (H)	747303	5790693	Involved dwelling
AD27 - d	751648	5797808	Dwelling	L33 - a (H)	733445	5803136	Involved dwelling
AE18 - a	752191	5788243	Dwelling	W20 - a (H)	744108	5790465	Involved dwelling
AE25 - a	752600	5795678	Dwelling	H32 - b (H)	729369	5802123	Involved dwelling
AF25 - a	753439	5795155	Dwelling	M34 - a (H)	734796	5804089	Involved dwelling
R31 - af (C)	739374	5801396	Childcare	Z20 - a (H)	747119	5790617	Involved dwelling
R31 - ae (S)	739387	5801377	School	L32 - a (H)	733047	5802703	Involved dwelling
V18 - a (H)	743717	5788539	Involved dwelling	AD24 - a (H)	751495	5794790	Involved dwelling
T27 - a (H)	741991	5797694	Involved dwelling	W21 - a (H)	744079	5791417	Involved dwelling
G35 - b (H)	728737	5805100	Involved dwelling	W21 - b (H)	744354	5791698	Involved dwelling
Z25 - a (H)	747970	5795356	Involved dwelling	AC22 - b (H)	750698	5792190	Involved dwelling
X18 - a (H)	745588	5788290	Involved dwelling	P25 - a (H)	737560	5795728	Involved dwelling
T24 - a (H)	741497	5794967	Involved dwelling	AA18 - a (H)	748183	5788086	Involved dwelling
M28 - a (H)	734156	5798638	Involved dwelling	H37 - a (H)	729072	5807342	Involved dwelling
R27 - a (H)	739006	5797794	Involved dwelling	R31 - d (H)	739706	5801597	Involved dwelling
N28 - a (H)	735286	5798317	Involved dwelling	P24 - b (H)	737293	5794965	Involved dwelling
K30 - a (H)	732563	5800781	Involved dwelling	R32 - e (H)	739971	5802442	Involved dwelling
O32 - a (H)	736392	5802326	Involved dwelling	P24 - a (H)	737032	5794683	Involved dwelling
N26 - a (H)	735644	5796755	Involved dwelling	AA27 - b (H)	748226	5797449	Involved dwelling
W25 - a (H)	744707	5795176	Involved dwelling	M24 - a (H)	734445	5794808	Involved dwelling
M35 - a (H)	734161	5805068	Involved dwelling	M24 - b (H)	734394	5794808	Involved dwelling
V20 - a (H)	743847	5790367	Involved dwelling	O24 - a (H)	736740	5794684	Involved dwelling
J28 - a (H)	731263	5798929	Involved dwelling	U32 - a (H)	742962	5802812	Involved dwelling
K32 - a (H)	732993	5802497	Involved dwelling	V32 - a (H)	743040	5802814	Involved dwelling
W25 - b (H)	744836	5795147	Involved dwelling	AA25 - a (H)	748193	5795262	Involved dwelling

Resonate

Appendix D—Comparison of predictions

The following table compares my highest predicted wind turbine noise levels (Resonate predictions) to the predictions presented in the EES Environmental Noise and Vibration Assessment (EES predictions).

The comparison is shown for the Vestas V150 4.2MW candidate wind turbine at a hub height of 115 m. This corresponds to the candidate wind turbine scenario with the highest predicted wind turbine noise level from the EES.

ID	Resonate prediction	EES prediction	Difference	ID	Resonate prediction	EES prediction	Difference
	dB(A)	dB(A)	dB(A)		dB(A)	dB(A)	dB(A)
D35 - a	29.4	29.4	0	N36 - c	32.3	32.2	0.1
F32 - a	31.3	31.3	0	N37 - a	31.8	31.8	0
F35 - a	32.5	32.4	0.1	O34 - a	36.5	36.5	0
G30 - a	34.9	34.9	0	O34 - b	36.3	36.3	0
H28 - a	33.6	33.6	0	P20 - a	32.7	32.7	0
H30 - a	35.1	35	0.1	P31 - a	38.9	38.9	0
H32 - a	37.4	37.4	0	P31 - c	38.8	38.7	0.1
H38 - a	33.5	33.5	0	Q30 - a	39.3	39.3	0
H38 - b	31.3	31.3	0	Q31 - a	37.1	37.1	0
I26 - a	30.8	30.8	0	Q31 - b	36.5	36.5	0
I39 - a	29.5	29.4	0.1	Q31 - c	36	36	0
K27 - a	37.5	37.5	0	Q31 - e	35.9	35.9	0
L25 - a	33.4	33.4	0	Q31 - f	36	36	0
L26 - a	37.3	37.3	0	Q31 - g	36	36	0
L38 - a	32.3	32.3	0	Q31 - h	36.1	36.1	0
L38 - b	31.9	31.9	0	Q31 - i	36.2	36.1	0.1
L39 - b	28.5	28.5	0	Q31 - j	36.1	36.1	0
L39 - c	30	30	0	Q31 - k	36.2	36.2	0
L39 - d	28.8	28.8	0	Q31 - l	36.2	36.2	0
L39 - e	30.2	30.2	0	Q31 - m	36.3	36.3	0
L39 - f	30.2	30.2	0	Q31 - o	37.4	37.4	0
M35 - b	37.1	37	0.1	Q32 - a	35.8	35.7	0.1
M37 - a	33.1	33	0.1	Q32 - b	35.7	35.7	0
M37 - b	31.2	31.2	0	Q32 - c	35.5	35.5	0
M37 - c	32	32	0	Q32 - d	35.5	35.5	0
M37 - d	32.4	32.4	0	Q32 - e	35.2	35.2	0

Resonate

ID	Resonate prediction	EES prediction	Difference	ID	Resonate prediction	EES prediction	Difference
	dB(A)	dB(A)	dB(A)		dB(A)	dB(A)	dB(A)
M38 - a	31.3	31.3	0	Q32 - f	35.5	35.5	0
N25 - a	36.5	36.5	0	Q32 - g	35.7	35.7	0
N25 - b	36.5	36.5	0	Q34 - a	32.4	32.4	0
N36 - a	32.8	32.7	0.1	R20 - ab	33.6	33.6	0
N36 - b	32.9	32.9	0	R20 - a	33.9	33.9	0
R31 - aa	37.2	37.2	0	R31 - r	36.6	36.6	0
R31 - ab	37.6	37.6	0	R31 - s	36.5	36.5	0
R31 - ad	38	38	0	R31 - t	36.6	36.6	0
R31 - ai	37.9	37.9	0	R31 - u	36.6	36.6	0
R31 - aj	37.6	37.6	0	R31 - v	36.7	36.7	0
R31 - ak	37.5	37.5	0	R31 - w	36.7	36.7	0
R31 - al	37.4	37.4	0	R31 - z	36.9	36.9	0
R31 - am	37.1	37.1	0	R32 - a	35	35	0
R31 - an	37	37	0	R32 - b	35.4	35.4	0
R31 - ao	36.9	36.9	0	R32 - c	35.6	35.5	0.1
R31 - ap	37.5	37.5	0	R32 - d	35.6	35.6	0
R31 - aq	37.4	37.3	0.1	R33 - a	33.2	33.2	0
R31 - ar	37.4	37.4	0	T17 - a	33	33	0
R31 - as	37.3	37.3	0	T17 - b	33	33	0
R31 - at	37.4	37.3	0.1	T32 - a	33.7	33.7	0
R31 - av	37.2	37.2	0	T32 - b	34.3	34.3	0
R31 - aw	37.1	37.1	0	U18 - a	36.6	36.6	0
R31 - ax	37.2	37.2	0	U18 - b	37.4	37.4	0
R31 - az	37.1	37.1	0	U18 - c	37.2	37.2	0
R31 - b	37.3	37.3	0	U31 - a	34.3	34.3	0
R31 - ba	37.3	37.3	0	V30 - a	37.8	37.8	0
R31 - bb	36.9	36.9	0	W17 - a	39	39	0
R31 - bc	36.9	36.9	0	W28 - a	38.4	38.4	0
R31 - bd	37	37	0	Y28 - a	35.5	35.5	0
R31 - be	38.5	38.5	0	Y28 - b	34.5	34.5	0
R31 - c	36.7	36.7	0	Z28 - a	35	35	0
R31 - f	37	37	0	AA27 - a	35.9	35.8	0.1

ID	Resonate prediction	EES prediction	Difference	ID	Resonate prediction	EES prediction	Difference
	dB(A)	dB(A)	dB(A)		dB(A)	dB(A)	dB(A)
R31 - g	37.1	37.1	0	AB18 - a	33.2	33.2	0
R31 - h	37	37	0	AC17 - a	31.2	31.2	0
R31 - j	36.8	36.8	0	AC18 - a	34.2	34.2	0
R31 - k	36.8	36.8	0	AC22 - a	37.5	37.5	0
R31 - n	36.6	36.6	0	AD23 - a	37.1	37.1	0
R31 - q	35.7	35.7	0	AD25 - a	34.3	34.3	0
AD27 - a	30.7	30.7	0	N32 - a (H)	43	43	0
AD27 - b	29.9	29.9	0	O30 - a (H)	42.4	42.4	0
AD27 - c	30.7	30.7	0	Z20 - b (H)	42.2	42.2	0
AD27 - d	30.5	30.5	0	L33 - a (H)	42.6	42.6	0
AE18 - a	29.8	29.8	0	W20 - a (H)	42.5	42.5	0
AE25 - a	31.7	31.7	0	H32 - b (H)	39.2	39.2	0
AF25 - a	29.8	29.8	0	M34 - a (H)	40.8	40.8	0
R31 - af (C)	37.7	37.7	0	Z20 - a (H)	41.9	41.9	0
R31 - ae (S)	37.6	37.6	0	L32 - a (H)	42.8	42.7	0.1
V18 - a (H)	46.6	46.6	0	AD24 - a (H)	37.4	37.4	0
T27 - a (H)	46.2	46.2	0	W21 - a (H)	42.2	42.2	0
G35 - b (H)	42.7	42.7	0	W21 - b (H)	42.3	42.3	0
Z25 - a (H)	44.2	44.2	0	AC22 - b (H)	38.1	38.1	0
X18 - a (H)	43	43	0	P25 - a (H)	39.1	39.1	0
T24 - a (H)	45.1	45.1	0	AA18 - a (H)	36.8	36.8	0
M28 - a (H)	44.8	44.8	0	H37 - a (H)	36.1	36.1	0
R27 - a (H)	44.7	44.7	0	R31 - d (H)	37.2	37.2	0
N28 - a (H)	44	43.9	0.1	P24 - b (H)	37	36.9	0.1
K30 - a (H)	43.6	43.6	0	R32 - e (H)	34.6	34.6	0
O32 - a (H)	41.9	41.8	0.1	P24 - a (H)	36	36	0
N26 - a (H)	41.7	41.7	0	AA27 - b (H)	35.3	35.3	0
W25 - a (H)	44.2	44.1	0.1	M24 - a (H)	33.1	33.1	0
M35 - a (H)	41.3	41.3	0	M24 - b (H)	33.1	33.1	0
V20 - a (H)	42.8	42.8	0	O24 - a (H)	35.5	35.5	0
J28 - a (H)	40.9	40.9	0	U32 - a (H)	31.8	31.8	0
K32 - a (H)	43	43	0	V32 - a (H)	31.7	31.7	0

ID	Resonate prediction	EES prediction	Difference	ID	Resonate prediction	EES prediction	Difference
	dB(A)	dB(A)	dB(A)		dB(A)	dB(A)	dB(A)
W25 - b (H)	44	44	0	AA25 - a (H)	45.6	45.6	0