MT EMERALD WIND FARM

EIS Submissions - Response to Noise Matters

Rp 003 2012376ML

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MARSHALL DAY Acoustics

6 Gipps Street
Collingwood 3066 Victoria Australia
T: +613 9416 1855 F: +613 9416 1231
A.C.N. 006 675 403
www.marshallday.com

Project: **MT EMERALD WIND FARM**

Prepared for: **RATCH-Australia**
Level 4, 231 George St

Brisbane Queensland 4000

Attention: **Terry Johannesen**

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1.0 INTRODUCTION

Ratch Australia has commissioned Marshall Day Acoustics to address the submissions made in relation to the noise impact assessment of the proposed Mt Emerald Wind Farm.

This document is to be read in conjunction with the Marshall Day Acoustics (MDA) report Rp 001 R02 2012376ML dated 16 April 2014 titled *Mt Emerald Wind Farm – Noise Impact Assessment* (subsequently referred to in this document as the *MDA Noise Impact Assessment*).

This document commences with a schedule of noise related submissions and the associated responses in Section 2.0. Subsequent sections provide supporting information, including the results of additional analysis of background noise levels, construction activities and ancillary infrastructure undertaken after the MDA Noise Impact Assessment.

Noise levels presented in this report consistently adopt the international convention for the notation of weighted decibel information. Accordingly, where a sound level is A-weighted to approximate the human ear's response to sound, the weighting is denoted by a subscript in the symbol. For example, A-weighted equivalent noise levels are reported as dB L_{Aeq}. Alternative conventions of presenting A-weighting such as dBA or dB(A) are therefore not used within this report (unless referred to in quoted text).

2.0 SCHEDULE OF SUBMISSION RESPONSES

Item No.	Submission	Issue	Response
1	S002	What is a "noise descriptor"?	Environmental noise is inherently variable. To deal with this variation, there is a range of different ways to describe noise such as averages or referring to the level of sound that is exceeded for a period of time. These different methods of describing sound are referred to as noise descriptors or noise metrics. The equivalent noise level L_{Aeq} (the A-weighted equivalent noise level) and background noise level L_{A90} (the A-weighted noise level exceeded 90% of the time) are two common examples of noise descriptors. Further general information about the description of sound is provided in Appendix A.
2	S002	The local council's acoustic expert has given advice that the project should not receive approval.	The assessment has demonstrated that the proposed Mt Emerald Wind Farm can viably operate within the limits defined in the relevant and only wind farm noise standard referred to in the current Mareeba Shire Council Planning Scheme Wind Farm Code (subsequently referred to as the Mareeba Shire Wind Farm Code). This assessment was based on consideration of a range of potential turbine options using well-established noise prediction and assessment methodologies that have been used to plan wind farms throughout Australia and internationally.
3	S002	This EIS was supposed to be in a clear and concise format that could be easily understood by the average citizen. This Noise Assessment, as presented, fails these basic criteria.	An assessment of operational noise from a proposed wind farm requires careful consideration of a range of detailed information including planning policy, noise standards, turbine supplier data and noise prediction methodologies. The MDA Noise Impact Assessment has been documented to provide a complete account of all relevant input information and processes for the purposes of transparency.

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4	S018/S020	In view of the number of times the Noise Mapping Australia document 090815ND02 dated 16 March 2012 is mentioned throughout the draft EIS, it should be an appendix to the EIS. It is used to support some of the comments in the EIS. Clearly identify this gap in the information presented if it is not intended to be supplied as part of the EIS.	The Noise Mapping Australia document was referenced in the MDA Noise Impact Assessment as a source of background noise data. In the time since the MDA Noise Impact Assessment report was prepared, the background noise data measured by Noise Mapping Australia has been provided to MDA. This background data has been subsequently analysed by MDA and the results of this analysis are presented in Section 4.0 of this report.
5	S022	Based on peoples experiences across the globe who are impacted by industrial wind turbine developments one can only imagine this will be an acoustic nightmare.	The noise standards used to plan and develop wind farms around the world vary widely, in terms of both the methods used and the level of protection provided to neighbouring communities. A common theme of the most stringent policies is that noise limits are set at levels generally intended to provide a reasonable level of amenity protection for the majority of people. Genuine complaints from operational wind farm noise can and do occur for a variety of reasons. This may be due to factors such as defective turbines, the absence of robust compliance requirements in some jurisdictions around the world, or non-compliance with operating limits. Even at wind farm sites in jurisdictions with stringent noise limits, there is a residual possibility that a compliant wind farm may attract complain from some individuals; this is true of any type of new development (i.e. not just wind farms) that produces audible sound. An important fact that influences the likelihood of complaints is the complexities of individual reactions to sound. Individual attitudes and reactions to sound are highly variable, and will depend on a complex set of acoustic and non-acoustic factors. These include the level and character of the sound in question, the time of day the sound occurs, the regularity of the sound, the environment in which the sound is heard, the individuals hearing acuity, and an individual's personal opinion and perception of the sound source or development in question. (PTO)

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			Due to the complexity and range of potential responses to sound, it is not possible to define limits that will guarantee an audible sound will be acceptable to all individuals; this will always be a matter of personal judgement for each individual. Noise policies are therefore normally designed to limit noise from new development to levels that will provide a reasonable level of protection for the majority of people. This is not unique to wind farms; the same principle applies to the development of other types of industry and infrastructure.
Noise Limits			
6	S002	Remember, we live in North Queensland, where we sleep with our window open for much of the year. Using your NZS6808:2010 example, we are looking at a noise limit of 25-30 dBA. Why do you state that a direct comparison with Queensland acoustic quality objective is not possible?	There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Mareeba Shire Wind Farm Code. Further general information about the application of NZS 6808:2010 to the Mt Emerald Wind Farm is provided in Section 3.1 of this report. For reference though, the approach of NZS 6808:2010 and its application to areas zoned for rural activities such as agriculture is generally consistent with current policies in both South Australia and Victoria (i.e. 40dB outdoor base limit, or background +5dB, whichever is greater). When referring to different decibel values, it is important to define the location where the value applies, the way that the noise is being described and where the decibel values. In particular, it is important to note whether the value is an outdoor or indoor noise level, whether the value relates to an average level or some other measure, and the time period the value relates to. Refer to definition of noise descriptor and the additional information provided in Appendix A of this report. NZS 6808:2010 refers to an outdoor noise limit of 40dB $L_{A90,10minute}$ at all times on the basis of achieving an indoor night-time target of 30dB $L_{Aeq, 8hour}$ as per night-time the World Health Organization *Guidelines for Community Noise* 1999. The Environment Protection (Noise) Policy 2008 (EPP 2008) refers to both outdoor and indoor acoustic quality objectives, but for the night-time the objective only defines indoor values ranging from 30-40dB depending on the way the noise is measured over a 1-hour period.

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			These comparisons identify some important differences in the decibel values of the various guidelines. A key difference is that NZS 6808:2010 refers to a complex analysis of 10-minute lower noise levels, while the WHO refers to an average over 8 hours and the EPP 2008 refers to averages and upper noise levels over 1 hour periods. The relationship between these different types of values is complex and will depend on the specifics of each environment being considered. Accordingly, a discussion of the equivalency or otherwise of these values can only be indicative. It is for this reason that it is not possible to conduct a direct comparison of the NZS 6808:2010 guidance with the Queensland acoustic quality objective. Further discussion of the relationship between NZS 6808:2010 and the EPP 2008 is provided in Section 3.2.
7	S002	I note that the W.H.O. recommended noise levels are 30dBA inside bedrooms, and there is no justification to deliberately discriminate against rural residence living near wind turbines. This limit is also currently in the Queensland Noise Policy.	Refer to response to item number 6. Noting the technical points referred to in the response to item 6 (i.e. the differences in the noise descriptors used in different documents), the NZS 6808:2010 outdoor limit of 40dB at all times is based on achieving the indoor WHO target value of 30dB indoors. The key point here is that the NZS 6808:2010 limit is an outdoor value, while the WHO and Queensland noise policy values are indoor (for night-time – the applicable period when discussing the WHO 30dB value).
8	S002	The MEWF is proposing higher levels of noise than would be allowed for any other power station in rural Queensland – and even higher than any development in rural Queensland.	Throughout Australia, operational noise levels from planned wind farm developments are assessed using policies and limits specifically defined for the unique nature and characteristics of wind farms. Other types of power station are assessed using policies and limits applicable to general industry. It is therefore true that in Queensland, as is the case in some other jurisdictions in Australia, a power station may be required to be designed to a lower limit value than would apply to a wind farm. This would be dependent on background conditions in the area and the specifics of the development that is proposed. (PTO)

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			However, there are other forms of development which would be allowed to be designed to significantly higher limits than apply to wind farm noise levels; specifically, transport infrastructure such as new roads and railway. In relation to the differences between limits that could apply to general industry and a wind farm, it is noted that the EPP 2008 prescribes limits that are applicable to general industry that may produce noise at a receiver location at all times, 24 hours a day and 7 days a week. In contrast, a receiver in the vicinity of a wind farm will only experience wind turbine noise some of the time. When wind conditions are still, the wind turbines do not operate and therefore do not produce noise at receiver locations. In windy conditions, the likelihood of hearing noise from the wind turbines will depend on the wind direction and wind speed. In addition to the above, noise policies generally define limits on account of the ability to control the source of noise in question. Transportation noise is clearly very distinct from general industry noise or an operational wind farm, but provides a good example of a type of noise for which the limits are set much higher in order to still provide amenity protection, but not prevent new development. In relation to a power station or other type of general industry, conventional types of industrial mitigation measures can be used to significantly reduce noise levels without compromising the viability or energy yield of the project. In contrast, all forms of noise control for a wind farm (layout or noise management modes of operation) have a direct influence on the viability and energy yield of a project. Further information concerning policy and general related considerations is provided in Section 3.0.
9	S002	The proposed development does not comply with the State's Wind Farm Code, which is under development, and does not comply with Queensland Noise Regulations.	The Draft Wind Farm State Code and Draft Wind Farm State Code Planning Guideline were released by the Department of State Development, Infrastructure and Planning (DSDIP) for public consultation from 22 April 2014 to 13 May 2014. At the time of preparing this report, these consultation documents remain in draft form. The Draft Wind Farm State Code Planning Guideline proposes how the draft code would apply to the development approval process and notes:

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			The Code does not have a retrospective effect. A wind farm proposal that is already under assessment will continue to be subject to that assessment process.' In addition, DSDIP is now the relevant authority responsible for deciding the Development Application for the project. DSDIP have advised the proponent that given the timing of the application and the release of Draft Wind Farm State Code and Draft Wind Farm State Code Planning Guideline, the draft guidelines would not be applicable to the assessment of the Mt Emerald Wind Farm project.
10	S002	You do not comply with the Noise Criteria as stated in 2.1.1 (wind Farm Code), 2.1.2 (Overall Outcomes) and 2.1.3 (Specific Outcomes) of your Noise Impact Assessment, Appendix 7.	See response to item number 6 and further discussion of the relationship between NZS 6808:2010 and the EPP 2008 which is provided in Section 3.2.
11	S002	Your Noise Limit (4.4) assessment of 40dBA, is totally rejected. What gives you the right to set a compliance level higher than any other development in rural Queensland and higher than the Queensland Noise Policy?	See responses to items 6, 7 and 8 in addition to further information on policy and the effects of environmental noise in Section 3.0 of this report.

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12	S006	Noise Guidelines should not use the New Zealand Standard 6808:2010 which permits audible noise that is above the WHO recommended levels of 30 dBA inside bedrooms to be exceeded [21]. Why are rural folks used to quiet settings be forced to accept noise levels higher than those in most typical busy urban areas? The introduction of background noise level factor merely obfuscates noise regulation requirement that should simply not permit unacceptable IWT signal noise discharge. The statement in NZS6808:2010 contains this unacceptable loose loophole "this Standard does not set limits that provide absolute protection for residents from audible wind farm sound." For this reason too, it cannot be relied upon as it does not hold wind developers rightly accountable. Furthermore, the impulsive nature of the noise generated by IWT is a peculiar harmful sound signature that is very different form say, road traffic [22].	See responses to items 6, 7 and 8 for information concerning the application of NZS 6808:2010 and its relationship with WHO guidance and the EPP 2008. Further information on policy and the effects of environmental noise is also provided in Section 3.0 of this report. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Mareeba Shire Wind Farm Code. The submission correctly notes that NZS 6808:2010 does not set limits that provide absolute protection for residents from audible wind farm sound. This statement is included in NZS 6808:2010 in recognition that the standard does not require the sound of a wind farm to be inaudible, and that attitudes to any audible are highly subjective and will vary between individuals. This is true of all policies which permit audible noise from new development, and therefore true of all industry and infrastructure noise policies in Australia. This point is specifically evident in the objective of the Queensland *Environmental Protection Act 1994* (the Act) which recognises the need to protect the environment while at the same timing allowing for development. In relation to noise character, the noise of a modern upwind rotor turbine is not generally regarded as impulsive. At a limited number of sites in limited conditions, an effect described as atypical amplitude modulation has been identified, however based on the available information about its limited occurrence, this is not a common characteristic of a modern wind farm. Further discussion of this effect is provided in this report in Section 5.3. In terms of differences between wind farm noise and road traffic, it is noted that wind farms are required to achieve noise limits that are much lower than is applied to new road developments. This is due to the differences in reactions to sounds from different sources and the practical limitations of controlling road traffic noise. (PTO)

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			For reference purposes, in contrast to the 40dB limit referenced in the assessment of the Mt Emerald Wind Farm, the Queensland Department of Transport and Main Roads' code of practice defines limits ranging from 58-68dB. These decibel values relate to noise measured in different ways over different time periods, but demonstrate the significantly higher noise levels permitted for road development.
13	S006	EIS 8.3 Existing Noise Environment is yet again a totally misleading and irrelevant handling of the noise issue as it does nothing to address the infra-sounds and low-frequency noise. The surrounding rural setting of this site is as it should be regarded quiet rural primary agriculture as a norm especially at nights and therefore it is nonsense to refer to background noise as an issue and push the noise limit any higher than what is typical of rural Australia, where the rustling of leaves is the only background soothing sound to be expected once in a while but otherwise perfectly quiet and still. So quiet, you could hear a pin drop in your bedroom. Try that for background noise standard. IWT noise is typically loudest at nights [21].	An account of existing conditions is a requirement when conducting an environmental impact assessment. The available noise measurement data from the NMA surveys confirmed that background noise levels are low and therefore insufficient to warrant the adoption of increased noise limits related to background noise levels for planning assessment purposes. It is for this reason that the assessment has been based on the lowest base limit that applies under New Zealand standard referred to in the Mareeba Shire Wind Farm Code.

Item No.	Submission	Issue	Response
14	S010	Why does the EIS use New Zealand noise limit standards, rather than those we have in Queensland, for a project that is proposed for North Queensland? Since when did North Queensland become a part of New Zealand? Queensland 's Draft Wind Farm State Code have different limits to New Zealand codes.	See responses to item 6. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Wind Farm Code of the Mareeba Shire Wind Farm Code.
15	S011	The draft EIS should use the Queensland Draft Wind Farm State Code noise limits (currently 35dB or background noise level plus 5dB, whichever is higher).	See response to item 9. The Draft Wind Farm State Code is not applicable to the Mt Emerald Wind Farm. It is understood that DSDIP have confirmed this to RATCH Australia.
16	S012	Why does the EIS use New Zealand noise limit standards?	See responses to item 6. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Wind Farm Code of the Mareeba Shire Wind Farm Code.

Item No.	Submission	Issue	Response
17	S017	The proponent has focussed on the New Zealand noise standard instead of Queensland's Environmental Protection (Noise) Policy 2008, which is a statutory requirement for any development. Council's expert acoustician advised the council against approving the project because it could not comply with Queensland's noise regulations (his review was of the first noise impact assessment, which had lower noise levels than the second one, submitted with the draft EIS). The New Zealand noise standard has not standing under any statutory requirements in Queensland.	See responses to items 6, 7 and 8 for information concerning the application of NZS 6808:2010 and its relationship with WHO guidance and the EPP 2008. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Wind Farm Code of the Mareeba Shire Wind Farm Code.
18	S017	uncertainties revolve around the ability of tropical homes and farmhouses of lightweight construction to keep out the turbine noise. This has also not been studied by the proponent. Under these circumstances, demonstrate in the EIS how the requirements of Queensland's noise regulations will be achieved in practice, particularly in relation to the night time indoor maximum requirement of 30dBA.	Sound insulation characteristics of dwellings vary across Australia. It is correct that lighter weight constructions can potentially result in lower overall sound insulation than a masonry construction. However, this is dependent on the influence of other key facade elements. Importantly, if there are low sound insulation elements present, such as thin single glazing or an open window, the sound entering via these paths will tend to dominate the overall internal sound level, with limited secondary influence from elements such as the walls and roof. A key consideration here is that NZS 6808:2010, in common with all other wind farm noise policies applied throughout Australia, defines limits on the basis of the outdoor to indoor sound reduction of a partially open window. This means that relatively low sound insulation values of 10-15dB are already assumed in the assessment. The dominance of sound that enters via the open window generally means that the sound entering via other elements such as the walls and roof is a limited secondary influence. (PTO)

Item No.	Submission	Issue	Response
			Weather conditions in north Queensland may potentially result in windows being regularly opened widely and more frequently than in other areas in Australia. This could in turn result in lower outdoor to indoor differences than the 10-15dB assumed for a partially open window. This will depend on the orientation of the dwelling and the extent the windows are open. However, the Queensland EPP 2008 provides acoustic quality objectives for indoor and outdoor noise levels which are applicable throughout Queensland and does not differentiate between dwelling types or window openings of different sizes. Specifically, the EPP 2008 objectives indicate an assumed outdoor to indoor sound difference of 15-20dB; a higher level of sound insulation than the 10-15dB assumed in NZS 6808:2010 and other policies used to assess wind farm noise in Australia.
19	S018/S020	Remove all reference to the New Zealand Standard 6808:2010 Acoustics – Wind farm noise (NZS6808:2010) as it is not applicable to this project. It is mandatory for the project to be considered under Queensland's Environmental Protection (Noise) Policy 2008 (EPP Noise).	See responses to item 6. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Wind Farm Code of the current Mareeba Shire Wind Farm Code.
20	S018/S020	As shown by the tables below from Queensland's Noise Measurement Manual, a 5dB increase in noise level would result in a clearly noticeable deterioration of the acoustic environment and would result in complaints. Advise what level of noise will be acceptable to the community and protect health and wellbeing, as required by EPP Noise.	The current Queensland Noise Measurement Manual published in August 2013 provides indicative advice about the subjective impressions of different changes in noise level and the estimated community response according to the amount that the noise criterion is exceeded. It is important to note that these are indicative values only; individual reactions to sound are complex and highly subject. See response to item 5 and a discussion of the effects of environmental noise in Section 3.3 if this report. (PTO)

Item No.	Submission	Issue	Response
			In relation to perceived changes, the New Zealand Standard NZS 6808:2010 referenced in the Mareeba Shire Wind Farm Code, along with general noise policies in Queensland and all other wind farm policies applied throughout Australia, does not require the sound of a wind farm to be inaudible. It is expected that the proposed Mt Emerald Wind Farm would be audible on some occasions and the change in noise could be clearly perceptible. This will depend on many factors including wind speed, wind direction and background sound levels. In relation to the Noise Measurement Manual's advice about estimated community response, the guidance solely relates to situations where the noise exceeds the criterion. In this respect, the assessment has demonstrated that the proposed Mt Emerald Wind Farm is predicted to comply with the criterion at all applicable assessment locations. It is expected that achieving and demonstrating compliance with the criterion would be a condition of consent attached to any approval for the wind farm.
21	S018/S020	The noise levels proposed by the proponent (40dB) are higher than would be permitted anywhere else in rural Queensland for an industrial noise source at night time. By comparison, rurally located Tarong, Millmerran and Kogan Creek Power Stations have permitted noise levels of between 31 and 33dB LAeq. The turbines will make more noise at night due to higher wind speeds, when the background noise levels at residences will be at their lowest. What valid reason is there for allowing industrial noise from a wind farm at 40dBA, or even 35dBA, especially in such quiet rural areas?	See responses to items 6, 7 and 8 in addition to further information on policy and the effects of environmental noise in Section 3.0 of this report. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Wind Farm Code of the Mareeba Shire Wind Farm Code.

Item No.	Submission	Issue	Response
22	S018/S020	Both the National Health and Medical Research Council and Queensland Health have recommended a precautionary approach regarding wind turbines and health. Best practice in Australia is 35dB(A) and 2km setbacks, as adopted in Victoria and New South Wales. High Road Wind Farm (a Ratch development) was permitted by Council with a noise base level of 35dB(A) in June 2011. Ratch adopted a 35dB(A) limit and 2km setbacks for non-involved residences in its application for the Collector Wind Farm in NSW. The 40dB(A) level, as proposed for the Mt Emerald development, is a higher nighttime noise level than would normally be allowed for any other industry in quiet rural Queensland. Industrial and night time noise have been recognized by the World Health Organisation as special noise characteristics known to induce annoyance. Under these circumstances, justify the high proposed noise level and describe how 40dB(A) is a precautionary approach when 35dB(A) is considered best practice.	The latest National Health and Medical Research Council (NHMRC) findings on wind turbines and noise are documented in their consultation paper which was published in 2014 titled *draft Information Paper:* Evidence on Wind Farms and Human Health. This latest NHMRC document states: *There is no reliable or consistent evidence that proximity to wind farms or wind farm noise directly causes health effects.* The complete summary text of the review findings of this NHMRC document is reproduced in Section 3.3 of this report. In terms of current ratified wind farm polices for wind farms in other Australian states, Victoria has formally adopted NZS 6808:2010 for all new wind farm applications, and the South Australian Environment Protection Agency published its own updated policy in 2009. In both states, the applicable current policies in Victoria establish a minimum limit of 40dB for areas zoned for rural activities such as agriculture. Victoria also specifies a requirement for written consent of all residents within 2km of a proposed turbine. A lower value of 35dB is adopted in NSW on the basis of their continued reference to the superseded South Australian 2003 wind farm guidelines (a draft policy prepared in NSW in 2011 also refers to 35dB). See responses to items 6, 7 and 8 for information concerning the application of NZS 6808:2010 and its relationship with WHO guidance and the EPP 2008. Further information on policy and the effects of environmental noise is also provided in Section 3.0 of this report.

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23	S019	The proponents have also failed to mention that other industrial uses must meet the Queensland Government's noise guidelines – the same requirements the proponents seek to avoid. For instance, under the Environmental Protection Act, 1994 air conditioners and refrigeration plants are allowed no more than 3dBA above background at night and pumps are not allowed to make any audible noise at night. In contrast, the proponents believe 40dBA is an acceptable noise level, which is 10 or more decibels above background noise levels, interfering with environmental values under the State Planning Policy (Noise).	See responses to items 6, 7 and 8 in addition to further information on policy and the effects of environmental noise in Section 3.0 of this report. There is no ratified state policy in Queensland that is specific to the assessment of noise from an operational wind farm. NZS 6808:2010 is the only standard that is specifically related to wind farm noise and referred to in the Wind Farm Code of the Mareeba Shire Wind Farm Code.
Noise Modelling			
24	S002	It is impossible to accurately predict the likely turbine noise, when there are three options listed, but no understandable noise emission from any of them. There are lots of interesting figures and details, but at the end of the day, all I want to know is what noise will be heard where I live and work, and how it will impact me.	Noise predictions have been prepared using measured noise emission data for the types of turbines proposed. The emission data is based on an international standard test methodology (IEC 61400-11 Wind turbines - Part 11: *Acoustic noise measurement techniques*). This emission data has then been used in conjunction with information about the terrain profile of the area to calculate noise levels at distant receptor locations. These calculations have been made using the prediction method set out in international standards (ISO 9613 *Acoustics - Attenuation of sound during propagation outdoors*), with dedicated adjustments applied for wind farms based on validation studies conducted in Australia and internationally. The overall approach adopted for the calculations is consistent with general practice adopted internationally and is consistent with the UK Institute of Acoustics' advice about good practice for the assessment of wind farm noise.

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25	S004	There is no confirmed turbine type in the EIS, and yet we are expected to take the developers world that the noise would be acceptable, no matter what turbine type. The noise models, as presented, exceed Queensland legislation, but we wonder how a model can be presented when the actual turbine is not identified. Unfortunately for the potentially effected residence, any mitigation is highly unlikely once the turbines are operational.	The actual turbine selection would not be determined until the project planning application has been completed, and would be the subject of a commercial tendering process for the supply of turbines from a range of manufacturers. It is therefore necessary to consider a turbine type which can be considered representative of the size, power rating and noise emissions of turbines which may be considered for this site. Accordingly, at this phase in the project, the purpose of the noise study is to demonstrate that the proposed development could be viably constructed with a range of commercially available products. The normal method of demonstrating the viability of the site is to predict the noise levels for one or several turbine types that are indicative of the range of the assessment. The purpose of the assessment is not to consider every possible turbine on the market, nor is this a practical objective. The candidate turbines considered in the assessment report are representative of the normal range of emission levels achieved by commercial scale variable speed and variable pitch wind turbines. The assessment therefore demonstrates that the proposed wind farm layout can be viably constructed with commercially available turbine options for the site. Any planning consent for the project would be expected to include detailed noise compliance requirements that the operator must adhere to. It will therefore be necessary for any final turbine selection complies with these requirements. In the event that a turbine does not comply with the requirement, it would be the responsibility of the operator to implement measures to reduce the noise accordingly.
26	S006	Audible noise pollution levels produced would be far above what is normal for this rural community and therefore a transgression of the regulation clause [12]. It is also unacceptable to have these noise monitoring investigations done by the wind developer's choice of acousticians.	See responses to items 6, 7 and 8 in addition to further information on policy and the effects of environmental noise in Section 3.0 of this report.

Item No.	Submission	Issue	Response
27	S006	It is of no use to rely on acousticians under the control of wind developers to provide an objective understanding of noise generated by IWT. Noise characteristics data of various wind turbines provided by wind turbine manufacturers are only of relative value and should not be relied upon to project actual noise generation in actuality.	The noise assessment has been prepared using the noise standard (NZS 68008:2010) identified in the Mareeba Shire Wind Farm Code. This noise standard establishes detailed objective processes and limits, consistent with wind farm policies applied in other jurisdictions throughout Australia. All relevant input information and their sources have been fully disclosed in the noise assessment report, along with details of how accepted international standards have been applied to this data to provide noise forecasts. Consistent with the reporting requirements of the Australian Association of Acoustic Consultants, all relevant assessment data has been provided or described to a level of detail that is more than sufficient to enable the results to be independently verified if required. See response to item 25 concerning the range of candidate turbines considered in the noise assessment.
28	S010	If you were living within two kilometres of the project, wouldn't you want the EIS study to provide thorough information about the noise factor? This study makes a number of assumptions in order to compensate for the unavailability of data on both background noise and tonality of wind turbine models. In our opinion this should be reviewed by an independent noise expert.	The noise impact assessment provides information for all receiver locations in the vicinity of the proposed wind farm, including all receiver locations out to distances of more than 3km from the nearest proposed turbine. In recognition of the character of the area surrounding the development site, the assessment has been made on the basis of the lowest possible range of background noise conditions. Specifically, the assessment allows for the effect of background noise levels being regularly below 35dB, even at higher wind speeds. In practice, background noise levels may be higher at some locations around the wind farm, particularly at high winds speeds. Notwithstanding the above, the background noise data measured by Noise Mapping Australia has been provided to MDA. This background data has been subsequently analysed by MDA and the results of this analysis are presented in Section 4.0 of this report. (PTO)

Item No.	Submission	Issue	Response
			The available data concerning tonality for the candidate turbines has been provided in the MDA Noise Impact Assessment. Tonality should not be a feature of the audible noise of a modern correctly functioning wind farm. Accordingly, any planning consent for the project would be expected to include stringent requirements specifically related to the control of tonal noise emissions. It will therefore be necessary for any final turbine selection to comply with these requirements. Refer to response to item 25 for a discussion of candidate turbines.
29	S010	The EIS should be required to provide a tonal audibility test for whichever wind turbine model is selected, and conduct valid background noise baseline data study	See response to item 28 concerning tonality and the consideration of background noise levels in the assessment. Also refer to background noise data provided in Section 4.0 of this report.
30	S011	I believe the information provided is insufficient due to the fact that a specific turbine model has not been nominated for assessment – rather, a selection of possible choices of turbine models has been given.	Refer to response to item 25 for a discussion of candidate turbines. It is regular practice that a final turbine selection is not made until after an approval for the project has been obtained.
31	S011	A tonal audibility (annoyance factor) assessment is not yet conclusive. A tonal audibility test should be done for the selected wind turbine model. A valid background noise baseline data study should also be conducted. It appears that the study has made a number of assumptions to compensate for the unavailability of data in relation to background noise baseline data and tonality of turbine models. These should be reviewed by an additional noise expert.	See response to item 28 concerning tonality and the consideration of background noise levels in the assessment. Also refer to background noise data provided in Section 4.0 of this report. See response to item 27. Consistent with the reporting requirements of the Australian Association of Acoustic Consultants, all relevant assessment data has been provided or described to a level of detail that is more than sufficient to enable the results to be independently verified if required.

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32	S012	Tonal Audibility Testing needs to be carried out to a greater detail on the chosen turbine model	See response to item 28. Any planning consent for the project would be expected to include stringent requirements specifically related to the control of tonal noise emissions. It will therefore be necessary for any final turbine selection to comply with these requirements.
33	S012	The gaps in the EIS highlight a need to conduct a valid background noise baseline data study and ascertain which noise standards need to be used – then re-interpret the data from the noise impact assessment. This needs to be carried out by an independent expert reviewer.	See response to item 28 concerning the consideration of background noise levels in the assessment. Also refer to background noise data provided in Section 4.0 of this report.
34	S016	Your EIS claim that the turbines are 'unlikely to result in noise nuisance' is untrue. If you have not selected the model of turbine or country of manufacture, how can you make this assertion. If media reports are correct and you are planning to begin construction early in 2015, we are sure you do know your suppliers, but are withholding this information.	See response to item 5. Individual attitudes and reactions to sound are highly variable, and will depend on a complex set of acoustic and non-acoustic factors. Due to the complexity and range of potential responses to sound, it is not possible to define limits that will guarantee an audible sound will be acceptable to all individuals; this will always be a matter of personal judgement for each individual. Noise policies applied to wind farm developments in Australia, including NZS 6808:2010, are therefore designed to limit noise from new development to levels that will provide a reasonable level of protection for the majority of people. This is not unique to wind farms; the same principle applies to the development of other types of industry and infrastructure. Refer to response to item 25 for a discussion of candidate turbines. It is regular practice that a final turbine selection is not made until after an approval for the project has been obtained.

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35	S016	As stated above, there is very little noise in this area, mainly local traffic which is day time anyway. Night noise is barely audible. The constant 24/7 of working turbines is very likely to result in noise nuisance and to claim otherwise is misleading.	See response to item 34. In relation to the times of operation, a receiver in the vicinity of a wind farm will only experience wind turbine noise some of the time. When wind conditions are still, the wind turbines do not operate and therefore do not produce noise at receiver locations. In windy conditions, the likelihood of hearing noise from the wind turbines will depend on the wind direction and wind speed.
36	S017	provide background noise monitoring data for sensitive receptors as required by Section 5.14 of the EIS Guidelines.	The background noise data measured by Noise Mapping Australia has been provided to MDA. This background data has been subsequently analysed by MDA and the results of this analysis are presented in Section 4.0 of this report.
37	S018/S020	Revise the noise impact assessment predictions, addressing the shortcomings of the noise prediction method ISO9613 (as discussed below) and provide worst case scenario noise predictions, an Objective of the EIS Guidelines (Section 4.1). Provide confidence level on all revised predictions of noise impacts as required by Section 5.10(c) of the EIS Guidelines.	The ISO 9613 prediction method has been used to present typical worst case noise levels associated with operation of the wind farm. Specifically, the predictions assume that all turbines are operating simultaneously producing their maximum sound emissions, and that each residence is simultaneously downwind of every turbine associated with the project. In practice, this is unlikely to occur in the majority of instances and actual noise levels would be lower than predicted in the assessment. The use of ISO 9613 for predicting operational wind farm noise is common practice throughout the world. The use of the standard is supported by MDA's own validation and compliance work. Further, the use of this standard is specifically supported by a number of key publications including: (PTO)

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			• The UK Institute of Acoustics document *A Good Practice Guide to the application of ESTU-R-97 for the Assessment and Rating of Wind Turbine Noise, May 2013* • A comprehensive 1998 study part funded by the European Commission titled *Development of a wind farm noise propagation prediction model - Final Report* 1998 • The joint agreement between practitioners in the field of wind farm noise assessment, including consultants routinely employed on behalf of both developers and community opposition groups, published in the UK Institute of Acoustics journal dated March/April 2009 published *2009* • NZS 6808:2010 – the standard used to assess the proposed Mt Emerald Wind Farm. In addition to the above, the use of ISO 9613 is also cited in: • South Australian EPA 2009 wind farm noise guidelines, • AS4959:2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators* Full details to support the use of ISO 9613 are provided in Appendix E of the MDA Noise Impact Assessment.
38	S018/S020	Provide evidence that with these close turbine separation distances there will be no additional increase in noise levels (infrasound and audible low frequency noise, modulated and otherwise) at residences, having particular regard to the elevation of the site and the complex terrain. Alternatively, provide details of what additional noise levels can be expected at residences.	Wind farm noise policies in Australia, including NZS 6808:2010, do not require the sound of a wind farm to be inaudible and do allow an increase in noise levels. This is true of all policies which permit audible noise from new development, and therefore true of all industry and infrastructure noise policies in Australia. Section 5 of the MDA Noise Impact Assessment provides the predicted operational noise levels at all sensitive receptor locations around the project, including receivers at distances beyond 3km from the nearest proposed turbine location. (PTO)

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			In terms of existing conditions, the noise data measured by Noise Mapping Australia has been provided to MDA. This background data has been subsequently analysed by MDA and the results of this analysis are presented in Section 4.0 of this report. Further information concerning low frequency sound and infrasound is available in Section 5.5.2 and Appendix G of the MDA Noise Impact Assessment.
39	S018/S020	ISO9613 has been used as the prediction method for A-weighted sound predictions and Marshall Day states it is "the most robust and widely used international method for the prediction of wind farm noise", including several references to support this statement. Whilst these references validate the use of ISO9613 within a very restricted scope (up to 30m height, up to 1000m, wind speed up to 8m/sec), the conditions existing at the Mt Emerald site are well outside the scope of these validated parameters. Therefore, provide evidence (studies) that provide support for the reliability of ISO9613 under the conditions existing at and around the Mt Emerald site: noise source height of over 300m, distance to receptors of over 1500m, wind speeds often above 8 metres per second, complex terrain with steep concave slopes down to many receptor locations. None of these conditions are accounted for in the prediction method and it provides no guidance as to accuracy under these circumstances.	Full details to support the use of ISO 9613 are provided in Appendix E of the MDA Noise Impact Assessment. The supporting references (see response to item 37 for an abbreviated summary of supporting material) are specifically provided to support the use of the standard for source heights above 30m and beyond 1000m, including measurement studies of actual operating wind farms. It should also be noted that the source heights are specified in the standard according to their height above ground level at the position of the source, not relative to the ground height of the receiver location. The calculations then account for the variations in the height of the propagating sound waves according to changes in terrain profile. Other key points in relation to the predictions in the assessment: • The ISO 9613 method has been calculated with specific adjustments applied to account for the effect of sound propagation across valleys and the limited screening provided by terrain features. These adjustments have been applied in accordance with the studies referenced in the MDA Noise Impact Assessment, accounting for the terrain profile from each turbine to each receiver • Atmospheric conditions which enhance the propagation of sound to a receiver represent relatively stable conditions with respect to noise. This means that when a wind is present which results in enhanced sound propagation, the sound propagation remains relatively stable as the wind speed increases i.e. for a constant sound emission level, the level of sound reaching a distance downwind receiver location does not continue to increase with increasing wind speed (or more specifically, steeper sound speed profiles).

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		The Marshall Day report should have advised the stakeholders of these obvious shortcomings and the unsuitability of the prediction method. The community has been misled and the Minister can have no confidence that the noise predictions presented will be accurate in practice.	
40	S018/S020	Provide evidence that the following conditions will not increase noise levels (infrasound, audible low frequency, A-weighted, tonal, amplitude modulation) received at residences, or, alternatively provide details of additional (worst case day/night) noise impacts which can be expected at residences: Atmospheric (meteorological) variations: Temperature inversions Wind shear, vertical and horizontal, revised as per (4) below Complex terrain and ambient turbulence Wake and turbulence effects, including effects propagated by multiple turbines Drainage flow winds and other wind effects Synchronicity effects of turbines in phase due to turbine placement and wind direction (as identified by Van den Berg – a single turbine operating at high speed into a stable atmosphere can give rise to fluctuation increases in turbine sound power level of approximately 5 dB; two or more turbines may	See responses to items 38 and 39, in addition to further discussion of atmospheric effects in Section 5.0 of this report. In terms of the submission comments concerning Van den Berg and the potential for increased turbine sound power levels in stable atmospheres and high winds, this is an effect specifically related to noise assessments based on wind speeds measured at 10m heights and turbine sound power levels related to wind speeds at 10m heights. Based on these factors, the effect reported Van den Berg was primarily related to the wind speed at the hub of the turbine being underestimated, due to the limitations of 10m height wind speed measurements and conditions of increased wind shear. This was of particular importance to and older fixed or two-speed stall regulated turbines for which the sound emissions continued to increase with increasing wind speed (due to deeper stall conditions of the blades as the wind speed increased). The factors referred to above do not apply to the Mt Emerald wind farm assessment on the basis that: • All assessments have been made on the basis of data referenced to hub-height wind speeds. • Modern wind turbine designs that now almost exclusively utilise variable speed and variable pitch blades which provide the mechanism for regulating both the power and sound emissions of each turbine, meaning that the turbine sound power levels do not continue to increase significantly once the rated power of the turbine has been achieved.

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		increase the sound power level by 9dB; in-phase beats caused by the interaction of several turbines increases the pulse height by 3 to 5 dB).	The phenomenon of 'beating' referred to in submission relates to synchronous sound sources for which the emissions combine on an alternating coherent and coherent basis. This type of effect can be observed for some types of closely spaced industrial plant that are controlled to operate at nearly identical speeds, however the effect is not applicable to the operation of a wind farm. The source to receiver distances for each turbine vary significantly, Further, the wind speeds and resulting turbine rotational speeds and sound emissions will vary significantly across a wind farm site, as supported by the studies presented in Appendix E of the MDA Noise Impact Assessment. Notwithstanding the above, a sound characteristic referred to as atypical amplitude modulation has been identified as on occasional feature at some international sites. This effect is addressed in the NZS 6808:2010 compliance assessment requirements. Further information on this specific point is provided in Section 5.3 of this report.
41	S018/S020	The noise impact assessment assumes that maximum noise levels will be generated when the turbines are operating at wind speed of rated power. Provide evidence that at wind speeds above rated power there will be no additional noise (A-weighted, audible low frequency, infrasound) at residences.	Section 3.1.2 of the MDA Noise Impact Assessment provides sound power level information for the three candidate turbines at different wind speeds. This data indicates sound power levels at and above rated power (note the data is available in both 10m height and hub-height reference wind speeds). Specifically, the data demonstrates that the emissions of the turbine reach a maximum level and then remain relatively constant with increasing wind speed. This is a common characteristic of modern wind turbine designs that now almost exclusively utilise variable speed and variable pitch blades which provide the mechanism for regulating both the power and sound emissions of each turbine. This is very distinct from older types of turbines whose emissions continued to increase with increasing wind speed, owing to the fixed speeds and blade pitch of older turbine designs. In terms of sound propagation, atmospheric conditions which enhance the propagation of sound to a receiver represent relatively stable conditions with respect to noise. This means that when a wind is present which results in enhanced sound propagation, the sound propagation remains relatively stable as the wind speed increases i.e. for a constant sound emission level, the level of sound reaching a distance downwind receiver location does not continue to increase with increasing wind speed.

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42	S018/S020	Wind shear is the term used to describe the change in wind speed with height above the ground level. Page 1 of the Wind Resource and Energy Yield Assessment provides wind shear figures based on wind speeds at Tower 9530 at heights of 81 and 50.2 metres, a difference in height of 30 metres; and at Tower 9531 at heights of 49.6 and 29.9m, a difference in height of 20 metres. However the turbine blades are over 100m in diameter, with the blade rotation heights ranging from 30m height to 130m height. Provide corrected wind shear figures (showing calculations) to reflect the actual wind shear which will occur in practice. Show corrected figures for both day and night (worst case) in order to assist with assessment of acoustic impact at residences.	Wind shear is an important factor to account for when assessing the operational noise of a wind farm, specifically when considering background noise levels and changes to noise limits with increasing wind speeds. In recognition of the character of the area surrounding the development site, the MDA Noise Impact Assessment was undertaken on the basis of the lowest possible range of background noise conditions. Specifically, the assessment allows for the effect of background noise levels being regularly at or below 35dB, even at higher wind speeds. In practice, background noise levels may be higher at some locations around the wind farm, particularly at high winds speeds. Accordingly, the assessment has been made on the basis of the lowest applicable limit which does not vary with wind speed; increased limits at higher wind speeds have not been applied. As a result, variations in wind shear and wind speed, as they specifically relate to wind speed differences at turbine and receiver locations, will not directly influence the outcome of the compliance assessment.
43	S018/S020	Provide turbine manufacturers specifications showing that the candidate turbines can operate both at worst case wind shear identified in (4) above and at the close turbine spacings identified by the Energy Yield Assessment. There is no point in gaining approval for a turbine layout which is not possible in practice, as only micrositing of turbines is normally permitted after approval. If not these candidate turbines, which turbine will be suitable for such extreme conditions?	This is an operational reliability query not related to operational noise associated with the wind farm.

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44	S018/S020	Provide information on the existing acoustic environment, which is a preliminary requirement for setting appropriate noise goals to protect environmental values. Section 5.10(b)(xii) requires that the EIS contains "baseline conditions based on monitoring results".	The noise data measured by Noise Mapping Australia has been provided to MDA. This background data has been subsequently analysed by MDA and the results of this analysis are presented in Section 4.0 of this report.
45	S018/S020	Because the correlation was poor, has the proponent simply decided to abandon any assessment of noise impacts in relation to the existing acoustic environment? Examination of the data analysis provided in the Noise Mapping Australia report dated 16 March 2012 referred to above (but also not included with this draft EIS and no longer available on the Ratch website) reveals background noise levels at sensitive receptors below 20dBA LA90. Is it reasonable to set a noise limit without first having regard to the existing acoustic environment?	In the time since the MDA Noise Impact Assessment report was prepared, the noise data measured by Noise Mapping Australia has been provided to MDA. This background data has been subsequently analysed by MDA and the results of this analysis are presented in Section 4.0 of this report. The data does exhibit a poor correlation indicating a weak relationship between background noise levels and wind speeds at the survey locations. This is believed to be attributable the receiver locations being relatively sheltered from prevailing wind conditions in the area when compared to the reference mast position used to represent wind speeds for the proposed turbine locations. In recognition of the character of the area surrounding the development site, the MDA Noise Impact Assessment was undertaken on the basis of the lowest possible range of background noise conditions. Specifically, the assessment allows for the effect of background noise levels being regularly at or below 35dB, even at higher wind speeds. In practice, background noise levels may be higher at some locations around the wind farm, particularly at high winds speeds. The standards applied to the assessment of wind farm noise in Australia, including NZS 6808:2010, recognise the need to restrict wind farm noise levels to an acceptable margin above background. However, these types of standards also specify minimum limit values on the basis that it is not necessary to continue to maintain this margin above the background noise level in instances when both the background and source noise levels are low. (PTO)

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			In the case of NZS 6808:2010, the value of 35dB is chosen as the background value below which it is not necessary to continue to adhere to a margin of 5dB above background. Accordingly, a minimum limit value is defined as 40dB is applied. This approach and base limit is consistent with the approach that has been applied to significant wind farm developments in other jurisdictions in Australia. Specifically, it is consistent with current policies applied to wind farm development in Victoria and South Australia in areas primarily zoned for rural agricultural activities. See responses to items 6, 7 and 8 in addition to further information on policy and the effects of environmental noise in Section 3.0 of this report.
46	S018/S020	Provide an assessment of the community reaction to the project operating at 40dBA, including at night, having regard to Tables 5 & 6 below and the low background noise levels experienced at residences at night (some under 20dBA LA90). The Noise Impact Assessment provides no assessment of the noise impact and neglects to advise the community that the turbine noise will be clearly noticeable when it is only 5dB above normal background noise levels. Provide details of under what circumstances the turbines will be audible – provide details in the EIS.	See response to item 45.

Item No.	Submission	Issue	Response
47	S018/S020	It is noted there has been no assessment of amplitude modulated or impulsive noise as required by Section 5.10(b)(ii) of the EIS Guidelines. Modulated and impulsive noise have been recognized by the World Health Organisation as special noise characteristics known to induce annoyance. Provide details of possible impacts and the extent to which this omission may influence the conclusions of the assessment.	The noise of a modern upwind rotor turbine is not generally regarded as impulsive. At a limited number of sites in limited conditions, an effect described as “atypical” amplitude modulation has been identified, however based on the available information about its limited occurrence, this is not a common characteristic of a modern wind farm. Further discussion of this effect is provided in this report in Section 5.3.
48	S018/S020	The TLPI requires assessment of audible and inaudible noise. “Noise” under the Environmental Protection Act 1994 is defined as being both audible and inaudible noise. Provide evidence that operation of one or more turbines will not enhance indoor noise levels by way of structure-borne noise.	Information relating to low-frequency sound, infrasound, and ground-borne vibration has been provided in Section 5.5.2 and Appendix G of the MDA Noise Impact Assessment.

Item No.	Submission	Issue	Response
49	S018/S020	It is noted that 10km is increasingly being acknowledged as the “acoustic impact zone” for large wind turbines, such as those proposed for Mt Emerald. We note that the Marshall Day Acoustics Noise Impact Assessment refers to 10km in the context of cumulative impacts from other wind developments in Section 5.6 as follows: *“Separate wind farm developments that are in close proximity to each other have the potential to impact on the same receiver. It is therefore necessary to assess any potential cumulative noise impact on receivers, where such circumstances exist. We understand that there are no other wind farm developments currently planned or operating within 10km of the proposed MEWF. On this basis, cumulative impacts of noise from more than one operating wind farm are not considered further.”* From this it is clear that acoustic impacts can extend to 10km. The only Australian document considered worthy of review by the NHMRC Reference Committee documented the adverse impacts on residents up to 10km from a large scale wind farm development in South Australia. Provide details in the EIS of what resident surveys have been conducted out to 10km from large scale turbine developments and what impacts have been reported.	The statement reproduced in the submission from the MDA Noise Impact Submission was not included as a definition of the area of potential effects. The 10km referred to in the MDA Noise Impact Assessment solely relates to the statement of proximity of other wind farms in the area. The assessment has demonstrated compliance with the applicable criterion at the nearest sensitive receptor locations. Operational noise levels at more distant locations will be lower and therefore also comply with the applicable criterion. The latest National Health and Medical Research Council (NHMRC) findings on wind turbines and noise are documented in their consultation paper which was published in 2014 titled *draft Information Paper:* Evidence on Wind Farms and Human Health. This latest NHMRC document states: *There is no reliable or consistent evidence that proximity to wind farms or wind farm noise directly causes health effects.* The complete summary text of the review findings of this NHMRC document is reproduced in Section 3.3 of this report.

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		These potential impacts, whether direct or indirect, need to be considered in the EIS.	
50	S018/S020	The building attenuation figures provided in the NIA are calculated or assumed and do not actually relate to residences around the wind farm site. Acoustic testing by Les Huson has revealed attenuation of only 1-3dB(A) in lightweight Queensland residences, not the 10-20dB(A) assumed in the EIS. Accurate attenuation figures are critical to the assessment of indoor noise impacts at residences. Provide attenuation figures (dBZ, dBG, dBA) for dwellings most likely to be impacted by the wind turbine development and reassess the noise impact in the EIS.	See response to item 18.
51	S018/S020	As noise propagation from turbines is affected by external factors such as topography and meteorological effects, provide evidence that the use of active noise control functions at the turbines, across all wind speeds, will reduce noise (infrasound, audible low frequency, tonal, amplitude modulated and A-weighted) experienced at/in residences and to what degree. This assessment is required by Section 5.11(b)(ii) of the EIS Guidelines.	Full details of the prediction method and supporting references for the use of ISO 9613 are provided in Section 5.1 and Appendix E of the MDA Noise Impact Assessment. Further advice is also available in the response to item 37. Key points of confirmation are: • the predictions have been made accounting for a 3-dimensional model of the terrain around the site • the modelling includes specific adjustments to account for the presence of valleys • the modelling assumes typical worst case conditions, based on all turbines operating simultaneously at the their maximum sound emission levels and each dwelling being simultaneously downwind of every turbine associated with the proposed Mt Emerald Wind Farm.

Item No.	Submission	Issue	Response
			Information concerning other considerations (e.g. low frequency, infrasound and amplitude modulation) is provided in Section 5.5 of the MDA Noise Impact Assessment, supported by further information provided in Section 5.0 of this report.
52	S019	Relevant impacts to be considered include noise impacts, with a requirement to provide baseline conditions based on monitoring results, but this has not been provided. The noise prediction methods have not been validated for conditions existing at the project site (over 1km to sensitive receptors), nor has propagation of noise to residences due to meteorological effects (such as turbulence, wind shear and wake effects from multiple turbines) been considered. The council's noise expert advised that the noise predictions could be inaccurate by up to 10 decibels (10 decibels is a perceived doubling of the noise level). These shortcomings in the draft EIS need to be addressed.	The information referred to in the submission is provided in the MDA Noise Impact Assessment. See responses to items 37 and 51, supported by further information provided in Section 5.0 of this report.
53	S022	Can the community surrounding the proposed Mt Emerald Wind Farm have confidence in the noise predictions presented as to their accuracy?	See response to item 51.

Item No.	Submission	Issue	Response
54	S022	What guarantees are there that the noise and vibration will have no impact on this community?	See response to item 5. Individual attitudes and reactions to sound are highly variable, and will depend on a complex set of acoustic and non-acoustic factors. Due to the complexity and range of potential responses to sound, it is not possible to define limits that will guarantee an audible sound will be acceptable to all individuals; this will always be a matter of personal judgement for each individual. Noise policies applied to wind farm developments in Australia, including NZS 6808:2010, are therefore designed to limit noise from new development to levels that will provide a reasonable level of protection for the majority of people. This is not unique to wind farms; the same principle applies to the development of other types of industry and infrastructure. The above relates to audible noise levels. Vibration associated with the operation of a wind farm would be well below perception thresholds. Related information is provided in Section 5.5.2 of the MDA Noise Impact Assessment.
Cumulative Impacts			
55	S011	I also note that the cumulative assessment only considers noise from other wind farms. This assessment should consider any other sources of noise which impact the identified receivers.	Wind farm noise policies applied throughout Australia, including NZS 6808:2010 referenced in the Mareeba Shire Wind Farm Code, specifically apply solely to the contribution of operational wind farm noise to the environment. It is for this reason that the cumulative operational noise assessment is concerned with the proximity of any other existing or proposed wind farms in the surrounding area.

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Low Frequency Noise			
56	S002	Low frequency noise (e.g. boom, boom music) will travel many kms, with most residence hearing turbine noise when they live 5-10km away.	Low frequency noise of any type of source will travel further than higher frequency sounds, owing to the reduced effect of atmospheric absorption and screening on low frequency sounds. The MDA Noise Impact Assessment provides information specific to low frequency sound in Section 5.5.2 and Appendix G.
57	S018/S020	No attempt has been made to predict indoor noise levels according to the 50dBZ criteria of the Queensland draft Guideline – Low Frequency Noise Assessment. It is noted that the Noise Mapping Australia report mentioned in (8) above did provide such assessment. Provide evidence that the 63 turbine layout will meet this requirement of the LFN guideline. If this information will not or cannot be provided, discuss the extent to which this omission may influence the conclusions of the environmental assessment.	The Queensland EPA Ecoaccess draft document *Guideline: Assessment of low frequency noise* (draft LFN Guideline) is referenced and considered in Appendix C and Appendix G of the MDA noise impact assessment. The MDA Noise Impact Assessment considers audible and 'inaudible' sound separately on the basis of NZS 6808:2010 and the draft LFN Guideline respectively. In relation to audible low frequency noise, Section 5.5 of NZS 6808:2010 states: *Claims have been made that low frequency sound and vibration from wind turbines have caused illness and other adverse physiological effects among a very few people worldwide living near wind farms. The paucity of evidence does not justify at this stage, any attempt to set a precautionary limit more stringent than those recommended in 5.2 and 5.3.* The assertions of NZS 6808:2010 are supported by the latest National Health and Medical Research Council (NHMRC) findings on wind turbines and noise that is documented in their consultation paper which was published in 2014 titled *draft Information Paper: Evidence on Wind Farms and Human Health* which states: *There is no reliable or consistent evidence that proximity to wind farms or wind farm noise directly causes health effects.* (PTO)

Item No.	Submission	Issue	Response
			The complete summary text of the review findings of this NHMRC document is reproduced in Section 3.3 of this report. Further information concerning low frequency sound is provided in Section 5.5.2 of the MDA Noise Impact Assessment. In relation to 'inaudible' sound, reference has been made to the G-weighted assessment method presented in the draft LFN Guideline, included predicted internal noise levels. This information is available in Appendix G of the MDA Noise Impact Assessment.
58	S018/S020	Tonal audibility levels discussed in the Noise Impact Assessment refer only to the sound power level of a turbine under IEC61400-11 (ie at the turbine). The IEC61400-11 Standard does not provide any detailed methods of analysis or assessment. It does state, however: It should be noted that certain aspects of infrasound, low frequency noise, impulsivity and amplitude modulation are not fully understood at present. Thus it may prove that measurement positions farther away from the wind turbine than those specified may be preferable for the determination of these characteristics. Provide details of what tonal noise will be experienced inside and outside residences from multiple turbines, especially having regard to meteorological and site variables raised in section (2) above.	The available data concerning tonality for the candidate turbines has been provided in the MDA Noise Impact Assessment. IEC 61400-11 emission data is an essential reference in controlling the emissions of an operational wind farm. However compliance requirements in Australia are ultimately focused on evaluating the level and character of noise that occurs at surrounding receiver locations. In this respect, tonality should not be a feature of the audible noise of a modern correctly functioning wind farm. Accordingly, any planning consent for the project would be expected to include stringent requirements specifically related to the control of tonal noise emissions, and these requirements will apply at the location of surrounding houses. It will therefore be necessary for any final turbine selection to comply with these requirements.

Item No.	Submission	Issue	Response
59	S018/S020	Low frequency tones discussed at NIA appendix G4 (page 58) refers only to the sound power level of a turbine. Provide details of what audible low frequency tonal noise will be experienced inside and outside residences, especially having regard to meteorological and site variables raised in section (2) above. Both low frequency and tonal noise have been recognized by the World Health Organisation as special noise characteristics known to induce annoyance.	See response to items 57 and 58.
Construction Noise			
60	S006	Impact Assessment - Construction and Decommissioning falsely declares that noise nuisance would not be a serious problem for all residences within 5 km and gives a ludicrous explanation that dominant E/SE local wind direction could somehow blow this problem away. All that thumping, blasting, jack-hammering and massive earthworks plus heavy vehicle transportation ceaseless rumbling along the normally quiet rural roads would drive the residents nearby to maddening desperation and push some to the brink of nervous breakdown. Totally unacceptable to allow this level of vulgar noise pollution for many months even if only in daytime.	See assessment provided in Section 6.1 and Section 0 of this report. The assessment has demonstrated that predicted noise levels associated with on-site activities and construction traffic are within related criteria applicable in Queensland.

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61	S006	Mitigating Measures - Construction and Decommissioning cannot mitigate enough the overwhelming degree of noise generated and compensate residents for the harm and distress caused.	See assessment provided in Section 6.1 and Section 0 of this report. The assessment has demonstrated that predicted noise levels associated with on-site activities and construction traffic are within related criteria applicable in Queensland.
62	S010	No mention is made of blasting in the noise assessment , which we would certainly expect to impact on the many human residents in the area as well.	It is understood that blasting is not preferred as part of the construction of the proposed Mt Emerald Wind Farm. Should it be required it would be conducted in accordance with the relevant standards and guidelines. Aggregate material for the site is proposed to be sourced from offsite quarries and site excavation work is to be carried using mechanised plant.
63	S011	In relation to the noise and vibration impact of blasting during construction, I note that vibration is considered "not likely to impact surrounding residences" (Volume 1 page 78). However this has not been studied. There is no mention of the effect of blasting in the Noise Assessment.	See response to item 62.
64	S016	Furthermore, construction noise nuisance was not adequately considered. To state that no blasting will be required to remove rock is ludicrous.	See response to item 62.
65	S017	provide construction noise modelling, including noise and vibration impact of blasting during construction of turbine pads.	See response to item 61.

Item No.	Submission	Issue	Response
66	S018/S020	It is noted the Noise Impact Assessment contains no assessment of the impacts on residents/residences of drilling and blasting (include also "hydraulic rock breaking") during construction as required by Section 5.10(b)(ix) of the EIS Guidelines. Provide details of possible impacts.	See response to item 61.
Compliance			
67	S006	Impact Assessment - Operation is an exercise in pure fantasy of noise predictions based on modelling that bases itself in wind industry manipulated analysis and own pronouncements of supposed noise generation of various wind turbines. Nothing claimed here can even be remotely trusted. For actual real world assessments look at the documented factual evidence of people all over the world reporting persistently of intolerably high audible noise emissions from IWT including of course the far more dangerous, higher decibel and harmful infra-sounds and low-frequency impulsive noise that is totally ignored [23].	All relevant input information and their sources have been fully disclosed in the MDA Noise Impact Assessment, along with details of how accepted international standards have been applied to this data to provide noise forecasts. Consistent with the reporting requirements of the Australian Association of Acoustic Consultants, all relevant assessment data has been provided or described to a level of detail that is more than sufficient to enable the results to be independently verified if required. In terms of community response to the sound of operational wind farms, see response to item 5. Refer also to the latest National Health and Medical Research Council (NHMRC) findings on wind turbines and noise that is documented in their consultation paper which was published in 2014 titled *draft Information Paper:* Evidence on Wind Farms and Human Health. This latest NHMRC document states: *There is no reliable or consistent evidence that proximity to wind farms or wind farm noise directly causes health effects.*

Item No.	Submission	Issue	Response
68	S006	Mitigating Measures - Operation wants us to believe that a difference in wind turbine models is the magic answer to IWT noise. This is highly deceptive and pretends to offer a solution where none exists. And just what is this "active noise control function of turbines"? Shutting it down completely is the answer. It is an insult to residents to be asked to follow "acoustic treatment of receiver dwellings", as who likes to be told something like shut all your windows tight if you don't want the noise?	Any planning consent for the project would be expected to include detailed noise compliance requirements that the operator must adhere to. Specifically, these compliance requirements would apply to the level and character of noise occurring at surrounding dwelling locations. It will therefore be necessary that any final turbine selection complies with these requirements. In the event that a turbine does not comply with the requirement, it would be the responsibility of the operator to implement measures to reduce the noise accordingly. The form of measure needed to reduce the noise could include active control measures or shutting down turbines, depending on the circumstances for which the mitigation is required. In terms of active noise control, this is a mechanism to alter the pitch and rotational speed of the turbines. These types of measures result in reduced power generation by the turbine, but can provide effective and significant noise reductions when required.
69	S002	I am unable to find in your EIS where you refer to Compliance of the correct Noise Limit. Is there a continual noise monitoring system that impacted residence can view on line, and in a real time? Better still, what happens when there is Non-Compliance? Is there a procedural policy document, where the wind turbines are required to be shut, down to suit local social issues?	Section 6.0 of the MDA Noise Impact Assessment provides information about operational noise compliance and notes that Item 6.3(h) of the Mareeba Shire Wind Farm Code requires the operation of the wind farm to be controlled and monitored by a site specific management plan which is to include turbine noise. Methods for monitoring noise at an operational wind farm are provided in NZS6808:2010. These methods could be incorporated into the proposed Mt Emerald Wind Farm operational management plan to facilitate the measurement of operational noise as may be required. The specific form and extent of compliance monitoring that is included in the final operational management plan would be defined by the conditions attached to the consent for the project. These conditions, in conjunction with the operational management plan, would also outline the steps and procedures that would apply in the event that the compliance monitoring indicates noise levels above the NZS 6808:2010 limits.

Item No.	Submission	Issue	Response
70	S018/S020	It is clear that noise levels at residences post construction will be significantly more than is indicated in the proponent's noise predictions. A much more conservative approach is required. Further discussion on the suitability of ISO9613-2 below will give an indication of the possible additional noise impacts.	The use of ISO 9613 for the prediction of operational noise levels is supported by extensive validation work and key international publications including advice from the UK Institute of Acoustics good practice guide on wind farm noise assessment. See response to item 37 for further information.
71	S018/S020	Noise mitigation strategies are limited to the use of active noise control functions of the turbines, rectifying manufacturing defects and acoustic treatment of receiver dwellings. As required by Section 5.11(b)(iv) of the EIS Guidelines, provide the cost of these mitigation measures. If the costs are unknown, this needs to be clearly stated in the EIS.	See response to item 68. The conditions attached to the consent for the project would be expected to include a requirement to demonstrate compliance with the external noise criteria at surrounding sensitive receptor locations. In the event of a non-compliance, it would be the responsibility of the operator of the Mt Emerald Wind Farm to implement mitigation measures that enable compliance to be achieved. The noise predictions in the MDA Noise Impact Assessment demonstrate compliance with the applicable operational noise criteria is expected to be achieved without the need for noise management strategies (i.e. active noise control functions related to varying the pitch of the blades and speed for rotation of the blades) or turbine shut downs. These measures are however available to the operator if required.

Item No.	Submission	Issue	Response
72	S018/S020	Failing the success of active noise control and rectifying manufacturing defects in reducing noise levels at homes, the only noise mitigation strategy remaining is the acoustic treatment of resident dwellings. The success of acoustic treatment relies on the resident living inside their home with doors and windows shut. Provide details of the acceptability or otherwise to the community of hermetically sealing their homes to keep out industrial noise, particularly having regard to tropical outdoor lifestyles. This is an unreasonable mitigation measure and further measures must be provided. What else will residents be asked to endure? In any event, provide evidence to show the success of acoustic treatment in reducing noise indoors, particularly in relation audible low frequency noise and structure-borne noise caused by wind turbines. Section 5.11 requires specific and detailed descriptions of proposed measures and information must be substantiated based on best available practices. Section 5.11(b)(ii) also requires the assessment of the predicted effectiveness of this mitigation measure.	See response to item 71. In referring to 'active noise control' associated with operational wind turbines, it is important to note that this relates to active variation in blade pitch angles and turbine rotational speed. It is not related to other forms of active noise control referred to in other industries which are based on the principles of noise cancelling systems. The active noise control systems utilised for variable speed turbines are a key basis for the reduced noise emissions of modern wind turbine designs, and provide the opportunity to significantly reduce noise emissions when required. In the unlikely event that additional measures are required to reduce noise levels at the exterior of neighbouring sensitive receivers, other options include selective turbine shut down strategies if and when required.

Item No.	Submission	Issue	Response
73	S018/S020	Securing compliance with noise limit controls at wind farms, in the event of a breach, is not as straightforward as with most other forms of noise generating development. Windy Hill Wind Farm noise complaint took 2 years to investigate and there is still uncertainty around compliance due to the omission of amplitude modulation from the compliance assessment. As the noise prediction method has not been validated, and does not account for the impact of meteorological conditions, it is very likely there will be noise exceedances which cannot be successfully addressed by the proposed noise mitigation strategies. For these reasons, provide more reliable and robust mitigation strategies in the EMP, eg turning off turbines.	The specific form and extent of compliance monitoring that is included in the final operational management plan would be defined by the conditions attached to the consent for the project. Predicted noise levels in the MDA Noise Impact Assessment account for typical worst case meteorological conditions by assuming that all turbines are operating simultaneously at their maximum emission level and that each receiver is simultaneously downwind of every turbine associated with the proposal. The use of ISO 9613 for the prediction of operational noise levels is supported by extensive validation work and key international publications including advice from the UK Institute of Acoustics good practice guide on wind farm noise assessment. See response to item 37 for further information.
74	S018/S020	The Preliminary EMP for Noise (5.6) only provides for noise monitoring within three months of commencement. Given the strong likelihood that the noise predictions will be exceeded in practice, provide for ongoing regular noise monitoring, eg annually, or when there is a reasonable complaint. The Policy for 5.6 Noise should contain mention of Operational impacts, including during the commissioning phase and refer to EPP Noise. The Performance Indicators should refer to the protection of Environmental Values, as required by EPP Noise.	See response item 69.

Item No.	Submission	Issue	Response
75	S018/S020	Due to the difficulty in measuring wind turbine noise in the presence of other noises in the environment, a robust method of noise monitoring should be provided. Provide a commitment in the Noise Management Plan to turning turbines on and off during noise testing, and the provision of wind speed, wind direction and power generation data. This must be part of the Minister's approval conditions.	See response to item 69. The submission correctly notes that measurement of operational noise from wind farm is complicated by the difficulties of measuring in the presence of other sources. Compliance measurement methodologies will need to be robust to address these issues. Depending on the specifics of each site in question, this can involve a range of measurement techniques which may include on-off testing when required in some instances.
76	S019	As Tableland residents and Council are well aware from the Windy Hill Wind Farm, predicted noise levels often fail the 'real life' test and there are no reliable noise mitigation measures after construction apart from turning turbines off, which has proven extremely difficult to achieve here and in wind farms elsewhere in Australia. In southern states, local Councils have repeatedly found that noise permit conditions for wind farms are not enforceable. Non-compliance can be very difficult to prove when you don't control the turbines, and wind speed and turbine information is not made available by wind farm companies. The proponents have not even adhered to minimum setback distances of at least 2km as required in other states.	See response to item 69 and item 75.

Item No.	Submission	Issue	Response
		The Preliminary Environmental Management Plan must provide for automatic and immediate shutdowns of offending turbines when noise breaches occur.	

3.0 NOISE POLICY

3.1 Application of NZS 6808:2010 to the Mt Emerald Wind Farm Proposal

A review of state and local planning policy considerations was outlined in Section 2.0 of the MDA Noise Impact Assessment. A summary of the key findings is presented here.

There is currently no ratified state policy in Queensland specifically intended for the assessment of operational noise from a proposed wind farm.

At the local planning level, the current applicable guidance is provided by the Tablelands Regional Council (TRC) Planning Scheme Amendment *01/11 – Wind Farms - Mareeba Shire Planning Scheme 2004* (PSA 01/11) which commenced on 30 September 2013. Division 23 of PSA 01/11 outlines the Wind Farm Code for the Mareeba Shire (referred to subsequently as the *local Wind Farm Code*).

The local Wind Farm Code identifies operational noise from a wind farm and ancillary infrastructure as a relevant consideration for the planning and design of a wind farm. Specifically, the local Wind Farm Code notes that wind farm turbines and associated infrastructure should be located, designed, constructed and operated in accordance with recognised standards with respect to noise emissions. The local Wind Farm Code then notes that development should:

> *consider the Environment Protection (Noise) Policy 2008 and New Zealand Standard Acoustics – Wind farm noise (NZS6808:2010).*

Accordingly, in the absence of ratified state policy, NZS6808:2010 has been used to assess the proposed Mt Emerald Wind Farm on the basis that:

- NZS6808:2010 is specifically designed to address the unique assessment considerations relevant to operational wind farms; and
- consideration of NZS6808:2010 is specifically recommended in the current applicable local Wind Farm Code.

The EPP which is also recommended in the local Wind Farm Code provides relevant guidance that is directly applicable to ancillary infrastructure associated with the proposed wind farm (ancillary infrastructure discussed in Section 6.0 of this report). In addition to the direct application of the EPP to ancillary infrastructure noise, qualitative consideration is given to the consistency of the objectives of the EPP and NZS 6808:2010 (see next section).

3.2 EPP 2008

This section provides a discussion of the objectives of the EPP 2008 and how these are addressed by the use of NZS 6808:2010 to assess noise associated with the proposed Mount Emerald Wind Farm.

3.2.1 Purpose of the EPP 2008

The purpose of the EPP 2008 is stated in Part 2 of the policy as follows:

> *The purpose of this policy is to achieve the object of the Act in relation to the acoustic environment.*

In turn, the *Environmental Protection Act 1994* (the Act) states the following:

> *The object of this Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).*

An important aspect of the objective of the Act is the concept of balancing the protection of the environment with the need for beneficial development. This is an approach adopted in noise management policies throughout Australia.

The way in which the purpose of the EPP 2008 is achieved is detailed in Part 2, Item 6 of the policy, titled *How purpose of policy is achieved,* which states:

> *The purpose of this policy is achieved by—*
>
> *(a) identifying environmental values to be enhanced or protected; and*
>
> *(b) stating acoustic quality objectives for enhancing or protecting the environmental values; and*
>
> *(c) providing a framework for making consistent, equitable and informed decisions about the acoustic environment.*

Item 7 from Part 3 of the EPP2008 identifies the environmental values for the acoustic environment, noting:

> *The environmental values to be enhanced or protected under this policy are—*
>
> […]
>
> *(b) the qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following—*
>
> *(i) sleep;*
>
> *(ii) study or learn;*
>
> *(iii) be involved in recreation, including relaxation and conversation; and*
>
> *(c) the qualities of the* acoustic *environment that are conducive to protecting the amenity of the community.*

3.2.2 Consistency of NZS 6808 with the Purpose of EPP 2008

The foreword of NSZ 6808:2010 outlines the overall purpose of the document as follows:

> *The purpose of this Standard is to provide suitable methods for the prediction, measurement, and assessment of sound from wind turbines. These methods may be applied during the processes of planning and developing a wind farm, then for confirming compliance with resource consent conditions covering sound levels, and also for the investigation and assessment of noise complaints about operating wind farms.*

The foreword of NZS 6808:2010 provides further explanation of the intentions of the assessment methodology as follows:

> *Wind farm sound may be audible at times at noise sensitive locations, and this Standard does not set limits that provide absolute protection for residents from audible wind farm sound. Guidance is provided on noise limits that are considered reasonable for protecting sleep and amenity from wind farm sound received at noise sensitive locations.*

The foreword of the Standard then goes on to note that the consensus view of the committee responsible for the development of NZS 6808:2010, including representatives from New Zealand's Ministry of Health and Institute of Environmental Health Inc, was that the Standard provides a reasonable way of protecting health and amenity at nearby noise sensitive locations, without unreasonably restricting the development of wind farm.

In terms of the types of sensitive uses that the NZS 6808:2010 was designed to protect, the Standard defines the criteria which are applicable to locations termed *noise sensitive locations*. The definition of noise sensitive locations is stated to include the following:

> *The location of a noise sensitive activity, associated with a habitable space or education space in a building not on the wind farm site. Noise sensitive locations include:*
>
> *a) Any part of land zoned predominantly for residential use in a district plan;*
>
> *b) Any point within the notional boundary of buildings containing spaces defined in (c) to (f);*
>
> *c) Any habitable space in a residential building including rest homes or groups of buildings for the elderly or people with disabilities …*
>
> *d) Teaching areas and sleeping rooms in educational institutions …*
>
> *e) Teaching areas and sleeping rooms in buildings for licensed kindergartens, childcare, and day-care centres; and*
>
> *f) Temporary accommodation including in hotels, motels, hostels, halls of residence, boarding houses, and guest houses.*
>
> *In some instances holiday cabins and camping grounds might be considered as noise sensitive locations. Matters to be considered include whether it is an established activity with existing rights.*

Based on the above stated purpose, intent and scope of NZS 6808, the following points of similarity with the EPP 2008 are noted:

- NZS 6808:2010 is intended to provide a reasonable level of protection for the environment, consistent with the EPP 2008 and parent Act's objective to protect the environment while allowing for beneficial development;

- NZS 6808:2010 sets out values of the environment to be protected; these values are the acoustic amenity for a range of residential and educational sensitive uses, which are comparable to the EPP 2008's statement of acoustic qualities (see Item 7 from Part 3 of the EPP2008) that are conducive to human health; and
- NZS 6808:2010 sets out objective criteria specifically intended for the reasonable protection of amenity for recreation, rest and conversation, as per the environmental values of the EPP 2008.

Operational wind farms are a unique type of noise source that require dedicated assessment methodologies; in particular, methods that are suited to the quiet rural locations in which wind farms are usually developed, and methods that account for the complicating influence of wind speed on background and source noise levels. In the absence of an endorsed state-wide assessment procedure that is specific to wind farms, and in recognition of the reference to NZS 6808 in the local Wind Farm Code, the use of NZS 6808:2010 represents an assessment procedure which is consistent with, and therefore achieves the objectives of, Part 2 and 3 of the EPP 2008.

3.3 Effects of Environmental Noise

Sound is an important feature of the environment in which we live; it provides information about our surroundings and is a key influence on our overall perception of amenity and environmental quality. Sound is therefore an environmental quality that must be considered as part of any proposal to develop new infrastructure that could influence the sound environment of neighbouring communities.

Excessive or unwanted sound is commonly referred to as noise and can have a range of effects on people, depending on a range of physical and contextual factors. The *Guidelines for Community Noise* 1999 prepared by the World Health Organisation (WHO) provides a health-based framework of guideline limits and values to address the broad definition of health given as:

> *A state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity*

This broad definition means that effects ranging from community annoyance, sleep disturbance and speech interference, through to direct physiological impacts such as hearing damage, are all identified as potential health considerations. An important aspect of this range of considerations is that some effects will be highly dependent on the listener's perception and attitude to the noise in question, such as annoyance, while other effects are primarily related to the level of sound and the direct physiological risks these may represent, such as hearing damage.

Environmental noise policies, including those applied to wind farms, establish objective noise criteria to address these health considerations. In particular, environmental noise policies define criteria which are chosen to prevent direct physiological risks of sound, and minimise as far as practically possible adverse health considerations such as annoyance and sleep disturbance.

Practically minimising the risks of noise effects related to annoyance and sleep disturbance requires the potential range of responses to sound to be considered. In this respect, it is important to note that individual attitudes and reactions to sound are highly variable, and will depend on a complex set of acoustic and non-acoustic factors. These include the level and character of the sound in question, the time of day the sound occurs, the regularity of the sound, the environment in which the sound is heard, the individuals hearing acuity, and an individual's opinion and perception of the sound source or development in question. The latter will in turn depend on other complicating factors such as visual impressions of the source in question and the perceived community benefit, or otherwise, of the source in question.

Due to the range and complexity of potential responses to sound, it is not possible to define limits that will guarantee an audible sound will be acceptable to all individuals; this will always be a matter of personal judgement for each individual. Further, it is usually not feasible or practical to design new development or infrastructure to inaudible noise levels. As a result, minimising the risks of noise effects involves setting criteria which prevents the majority of people from being disturbed. This requires regulatory authorities to strike a balance between amenity and development, setting noise limits which are as stringent as can be practically achieved without preventing new development.

This type of approach to noise policy was outlined by the Victorian Department of Health in their 2013 publication on wind farm sound and health which states:

> *Noise standards are used not only for environmental noise (such as wind farms and traffic noise) but also for industry and even household appliances.*
>
> *Noise standards are set to protect the majority of people from annoyance. The wide individual variation in response to noise makes it unrealistic to set standards that will protect everyone from annoyance. A minority of people may still experience annoyance even at sound levels that meet the standard. This is the case not only for wind farms, but for all sources of noise.*

The subject of health effects related to operational wind farms in Australia has been extensively considered by the Commonwealth Government's National Health and Medical Research Council (NHMRC) and the Australian Medical Association; in particular, the NHMRC has undertaken and coordinated a systematic review of evidence related to wind farms and health. The research reviews[1] and public statements[2, 3] produced by these peak health bodies support that, as with any audible sound, wind farm noise can represent a potential source of annoyance or sleep disturbance for some individuals. Their findings did however indicate that there was no reliable evidence to support a relationship between wind farm noise and direct adverse effects on human health. The summary of findings presented in the most recent NHMRC Draft Information Paper are reproduced here:

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1 *Systematic review of the human health effects of wind* farms 2013, Adelaide University, commissioned by the NMRC

2 NHMRC Draft Information Paper: *Evidence on Wind Farms and Human Health* 2014, National Health and Medical Research Council

3 AMA Position Statement – *Wind Farms and Health* 2014, Australian Medical Association

- *There is no reliable or consistent evidence that proximity to wind farms or wind farm noise directly causes health effects.*
- *There is consistent but poor quality evidence that proximity to wind farms is associated with annoyance and, less consistently, with sleep disturbance and poorer quality of life. Finding an association between wind farms and these health-related effects does not mean that wind farms cause these effects. These associations could be due to selection or information bias or to confounding factors.*
- *There is no direct evidence that specifically considered possible health effects of infrasound or low-frequency noise from wind turbines.*
- *It is unlikely that substantial wind farm noise would be heard at distances of more than 500–1500 m from wind farms. Noise levels vary with terrain, type of turbines and weather conditions.*
- *Noise from wind turbines, including its content of low-frequency noise and infrasound, is similar to noise from many other natural and human-made sources. There is no evidence that health or health-related effects from wind turbine noise would be any different to those from other noise sources at similar levels.*
- *People exposed to infrasound and low-frequency noise in a laboratory (at much higher levels than those to which people living near wind farms are exposed) experience few, if any, effects on body functioning.*

These findings lend support to the suitability of the wind farm noise standards such as NZS 6808:2010 which are intended to provide reasonable protection of health and amenity at noise sensitive locations. This is consistent with the objectives of NZS 6808:2010 discussed earlier in this section. Importantly, the Standard notes that the consensus view of the committee responsible for the development of NZS 6808:2010, including New Zealand representatives from the Ministry of Health and Institute of Environmental Health, was that the Standard provides a reasonable way of protecting health and amenity at nearby noise sensitive locations, without unreasonable restricting the development of wind farm.

4.0 BACKGROUND NOISE MONITORING DATA

Background noise monitoring data measured by Noise Mapping Australia (NMA), as documented in the prior NMA report for the Mt Emerald Wind Farm, has been supplied to MDA by RATCH Australia.

The background noise monitoring data has been re-analysed according to the procedure defined in NZS6808:2010 which involves:

- *Correlation of measured background noise levels with wind speeds referenced to hub height.*
  The NMA report provided background noise measurement data referenced to wind speeds measured at 10m above ground level (AGL). The use of hub height wind speeds is consistent with the NZS 6808:2010.
- *Consideration of wind speeds between cut-in and rated power*
  Consistent with the above guidance documents, our reassessment excludes data below cut-in wind speed (nominally 3m/s at hub height for the two candidate turbine models detailed in the MDA Noise Impact Assessment) and above rated power (nominally 12m/s at hub height for the two turbines). Data outside of this range is presented in the figures in grey, and is not included in the assessment of regression curves.
- *Use of 2nd and 3rd order regression curves*
  The use of non-linear regression curves is consistent with the above guidance documents. For reference, the NMA Report documents linear regression curves.

Figure 1 through Figure 6 present the results of this re-analysis. It should be noted that these figures also include an indication of the background related limit line which could be established on the basis of the measured background noise levels. These background related limits are however shown for reference purposes only and have not been used in the MDA Noise Impact Assessment.

As noted in the NMA Report, the background monitoring at House R5 appears to be significantly affected by a local, mechanical noise source. The likely affected data has been removed from the analysis. The majority of affected data was collected during the evening period.

It is common for assessments of background noise level data for wind farms to exclude known periods of rainfall and periods where wind speeds at the microphone are comparatively high (typically greater than 5m/s). We have not been provided with rainfall data or local wind speed information for the period of the noise monitoring. Accordingly, no corrections have been made to account for these weather conditions.

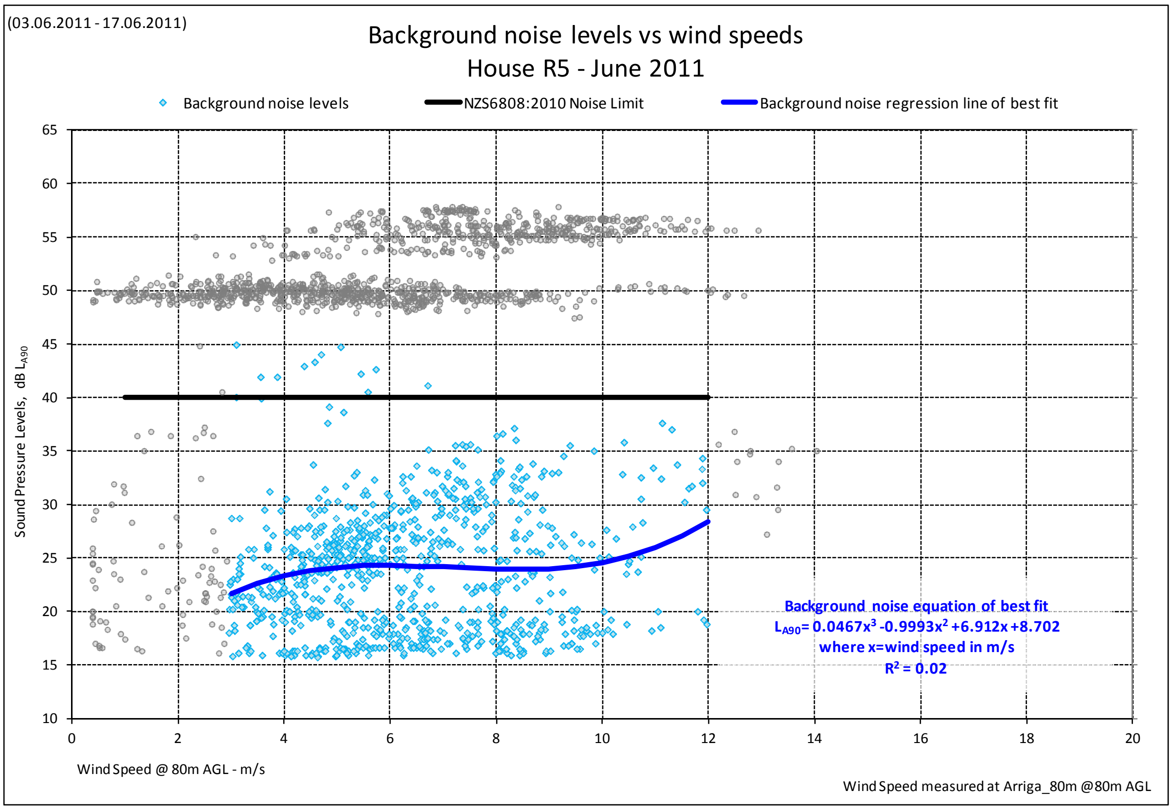

Figure 1: House R5 24 hour data

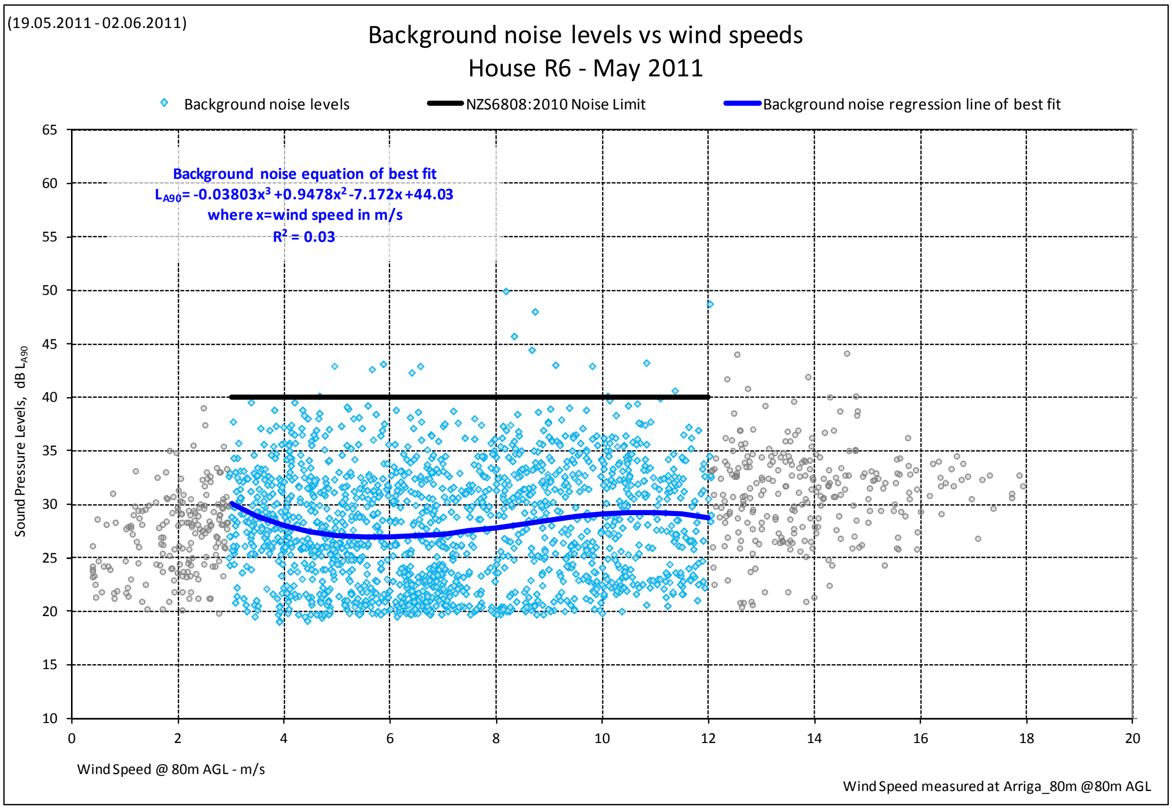

Figure 2: House R6 24 hour data

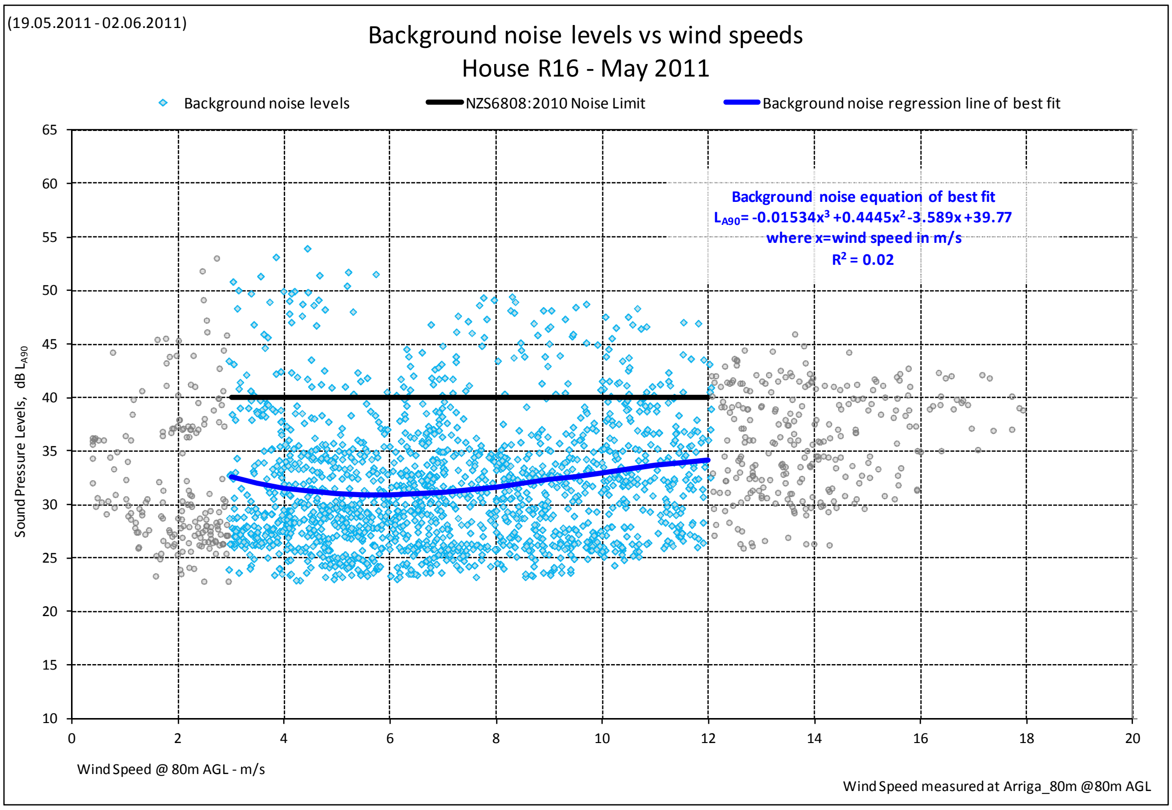

Figure 3: House R16 24 hour data

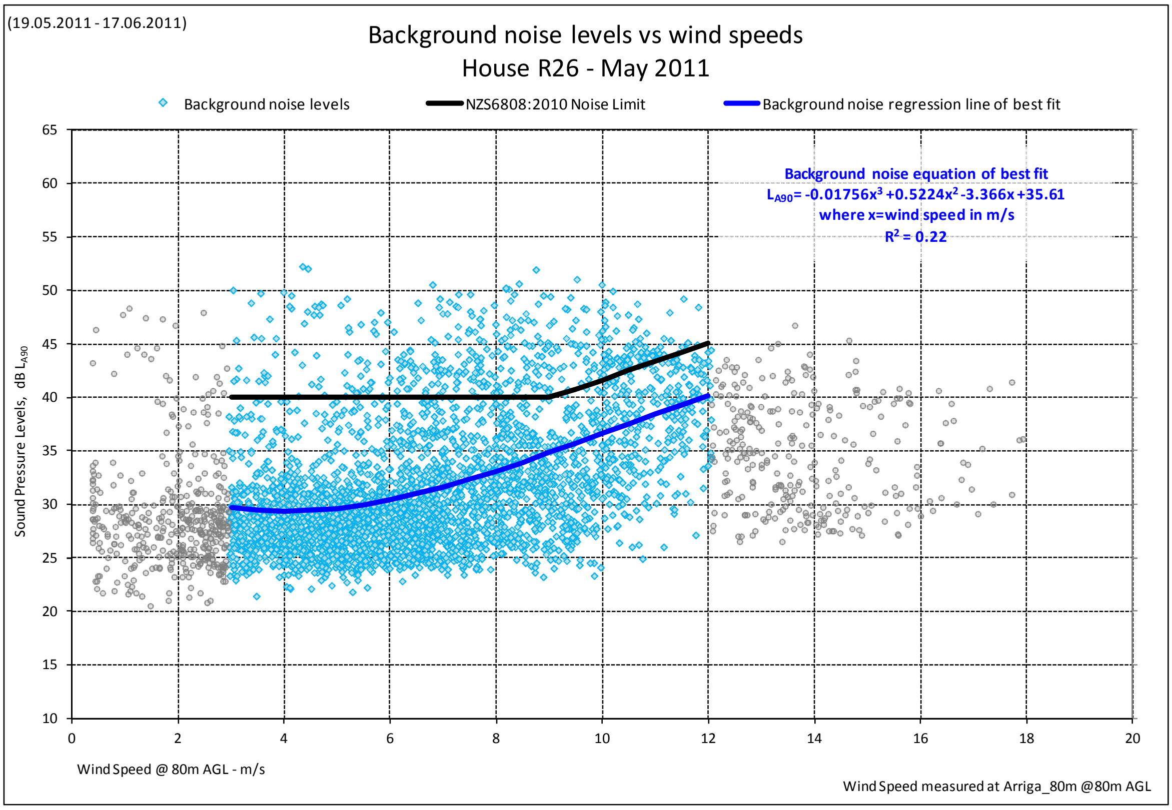

Figure 4: House R26 24 hour data

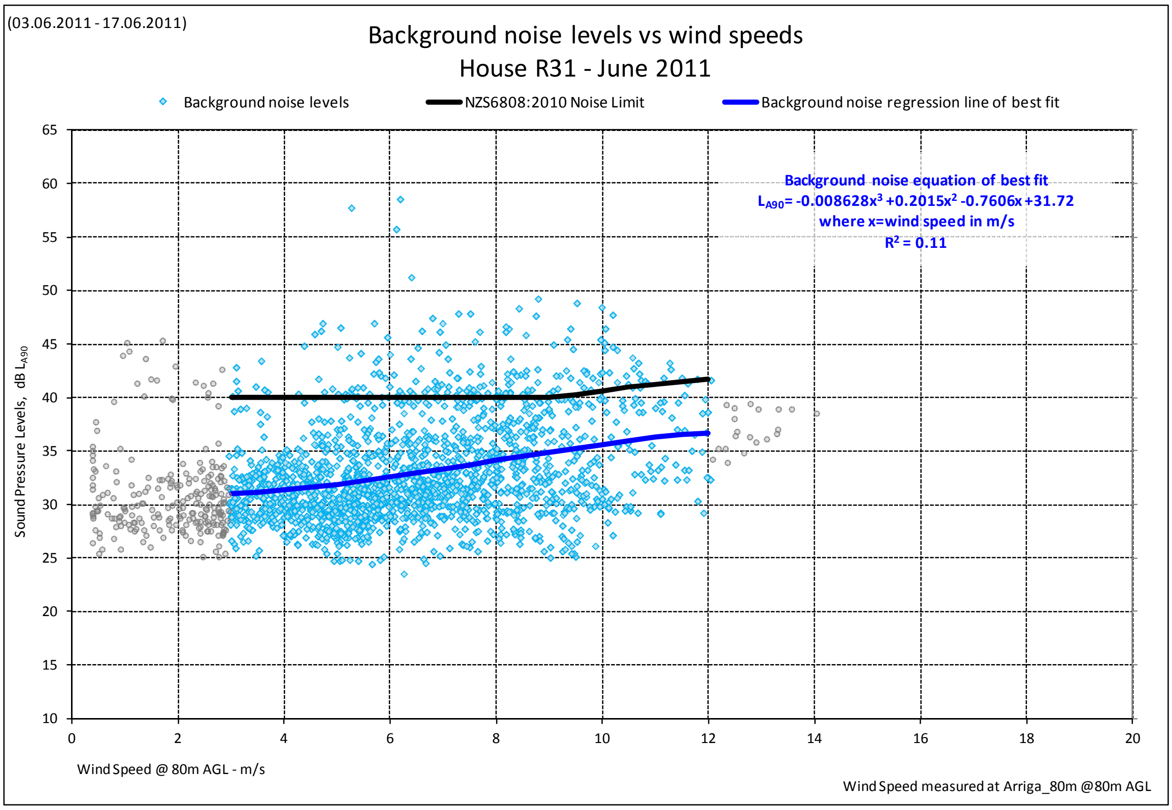

Figure 5: House R31 24 hour data

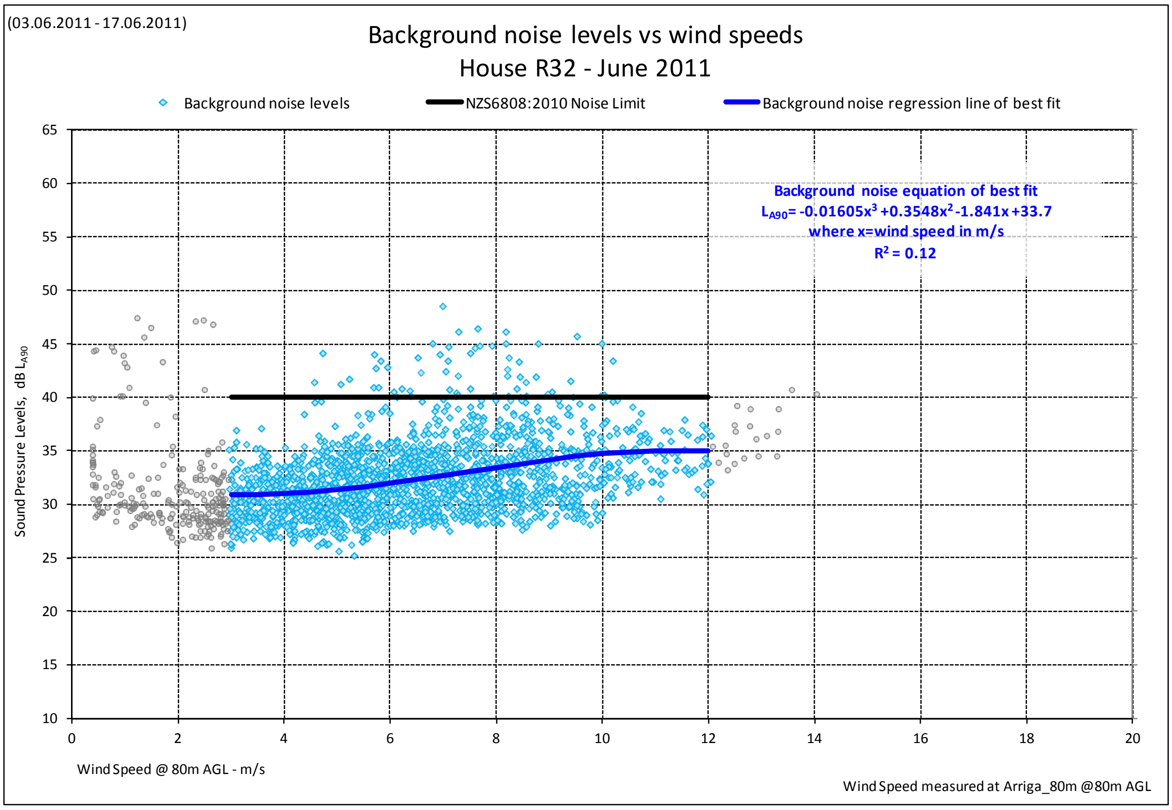

Figure 6: House R32 24 hour data

5.0 ATMOSPHERIC EFFECTS

5.1 Sound Propagation

The noise predictions presented in the MDA Noise Impact Assessment are based on the assumption that each receiver location is simultaneously downwind of every turbine associated with the proposed Mt Emerald Wind Farm. In terms of the noise expected to occur under alternative conditions which reduce the noise, the following points are noted on the basis of the range of supporting information cited in Section 5.1 and Appendix E of the MDA Noise Impact Assessment:

- Due to the increased wind speeds in which the wind turbines operate, downwind noise propagation can occur over a range of wind directions approaching cross-wind conditions.
- Under cross-wind conditions (wind in the direction perpendicular to the line between a turbine and a receiver), noise levels will be marginally lower, but the reduction in noise level (relative to the predicted noise level) may be as little as 2-3dB depending on wind speed
- Under upwind conditions (wind directed from a receiver to a turbine), noise levels may be as much as 10-15dB lower than predicted. Noise levels under these conditions are however highly variable as a result of the effects of atmospheric turbulence, and the resultant scattering of the propagating sound wave.

In relation to changes in temperature with height above ground, Inversions are not considered to be a significant factor influencing the propagation of noise from wind turbines. Specifically, the wind speeds that are required for the turbines to operate do not favour the development of thermal inversions throughout the propagation path from the source to the receiver.

Atmospheric conditions which enhance the propagation of sound from a wind farm are primarily related to varying sound speed profiles associated with wind direction and wind speed. Regions of reduced air movement in sheltered locations may experience thermal inversions whilst the turbines are operating, however this type of localised inversion is not representative of the overall noise propagation path, and will not refract sound that propagates upwards of the turbines. These types of conditions are also likely to only occur during low wind speed conditions when the turbines rotate slowly.

Other atmospheric conditions relevant to the assessment of noise from wind farms are stable air conditions in which there is an increased difference between wind speeds near the ground and at the proposed height of the turbine rotors. The key consideration for stable air is not the way it influences sound propagation, but is the potential for lower background noise levels as a result of there being less wind near the ground to disturb vegetation in the vicinity of surrounding houses. Current practice for addressing this consideration is to correlate measured background noise levels with wind speeds referenced to the hub-height of the proposed turbines. All assessment information provided in the MDA Noise Impact Assessment is based on wind speeds referenced to the hub-heights of the proposed turbines.

5.2 Wake Effects

Turbine wake effects are an important consideration for wind farm layout designers to factor into the arrangement and spacing of proposed turbine locations. Specifically, wake effects can potentially reduce the efficiency and reliability of the turbines. Turbine arrangements and separation are therefore chosen to reduce these effects.

To consider wake effects and their relevance to environmental noise from an operational wind farm, the following provides an overview of the way total noise levels from wind farms are modelled and occur in practice.

The prediction of environmental noise levels from an operational wind farm requires a representation of the sound emission characteristics of each wind turbine that forms part of the wind farm. This representation, referred to as the sound power level of the wind turbines, provides the basis for estimating corresponding noise levels at a distance from the turbine.

In the case of the Mount Emerald Wind Farm noise assessment[4], the sound power level data has been sourced from manufacturers and we understand that it is consistent with test standard *IEC 61400-11 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques*. The sound power level data represents the sound emission characteristics of a single wind turbine for a stated hub-height across a range of wind speeds.

To predict environmental noise levels from the proposed Mount Emerald Wind Farm, it has been assumed that all of the turbines of the proposed wind farm simultaneously experience the same inflow wind speed. Subsequently, it has been assumed that all turbines simultaneously emit sound power levels equivalent to the manufacturers test data. This method is consistent with the NZ 6808:2010 standard adopted in the noise impact assessment, and accepted international practice for the assessment of predicted operational wind farm noise levels.

In practice, wind speeds across the wind farm would inevitably vary, and the inflow air conditions at each turbine location will vary from the conditions in which the manufacturers test sound power data was derived. These variations may lead to changes in the sound emission characteristics of the turbines. For example, an increase in air turbulence as a result terrain, atmospheric conditions or upwind turbines can potentially give rise to an increase in the sound emission characteristics of an individual turbine when compared to the assumed value. Conversely, the effect of upwind turbines can result in reduced wind speed at the downwind turbines compared to the assumed wind speed across the wind farm. This in turn may lower the sound emission characteristics of an individual turbine compared to the assumed value.

[4] Refer to our report RP 001 R02 2012376ML dated 16 April 2014.

In considering the implications of these variations in conditions across a wind farm layout, the key point to note is that the predicted noise levels at neighbouring dwellings are the result of the combined influence of a number of turbines. The types of variations described above are unlikely to equally apply simultaneously to all of the turbines. In practice, some of the wind turbines could experience wind conditions which result in a slight increase above the assumed sound power level, whilst others could experience wind conditions which result in a slight reduction below the assumed sound power level. Accordingly, a change in the emission characteristic of any individual turbine would therefore generally not give rise to an equivalent change in the total operational noise level of the wind farm. Specifically, the balance of slight increases and decreases in turbines emissions across the wind farm reduces the likelihood of the variations of individual turbine emissions translating to equivalent variations in the total combined noise level of the wind farm.

While there is no precise method or recommended procedure to evaluate the likelihood or magnitude of these types of effects on individual turbine emissions, post-construction measurements of operational wind farms have demonstrated that the assumptions of constant wind speed and manufacturers sound power test data provides a reliable basis for estimating total operational wind farm noise levels. An example of this type of study[5], which considered the effect of variations in wind conditions across a commercial scale wind farm layout, indicated that the effect of reduced wind speed at turbines located downwind of other turbines tended to reduce the total noise levels at downwind receptor locations.

Notwithstanding the above, operational noise levels from the proposal would normally be controlled by way of standard conditions which accompany a wind farm planning consent, in combination with the performance specifications normally incorporated into the procurement contracts for wind turbines. These conditions normally include requirements to conduct commission noise testing to demonstrate that the noise limits have been achieved. In the unlikely event that noise emissions varied significantly from the assumptions made in this assessment, the operator and their suppliers would be required to undertake all steps necessary to offset the variation and enable continued compliance with environmental noise requirements.

5.3 Amplitude Modulation

Amplitude modulation is a normal feature of a correctly functioning wind turbine, described as the rise and fall in broadband noise level corresponding to the rotation of the blades. This characteristic is typically most evident in close proximity to the turbine.

Other reported characteristics of modern wind farm noise relate to an effect sometimes referred to as ‘atypical’ or ‘other’ amplitude modulation which relates to the rhythmic rise and fall in the level of noise, over and above the normal variation in noise associated with a wind farm. If present, atypical levels of amplitude modulation can attract a special audible characteristics’ penalty to compliance testing results. In this respect, Section 5.4.2 of NZS 6808:2010 states the following:

5 A.Bullmore, J.Adcock, M.Jiggins, M.Cand *Wind Farm Noise Predictions: The Risks of Conservatism*. Second International Meeting on Wind Turbine Noise, France 2007

> *Wind turbine sound levels with special audible characteristics (such as tonality, impulsiveness and amplitude* modulation*) shall be adjusted by arithmetically adding up to +6dB to the measured level at the noise sensitive location.*

A study[6] released by Renewable UK in December 2013 presents the findings of a detailed research programme by an international consortium into atypical amplitude modulation of wind farm noise. The UK study found that situations can arise where the modulation of wind farm noise is sufficient to lead to increased annoyance from wind farm noise. However, based on the evidence available at sites where it was identified, its occurrence may be relatively infrequent.

Importantly, the study found that the factors which give rise to the effect are multiple and complicated, rather than a single phenomenon such as wake effects.

As a result, the study determined that it is not feasible to reliably predict the likelihood of atypical amplitude modulation occurring at a particular site. While the NZ standard (NZS 6808:2010) used to assess Mount Emerald Wind Farm requires that wind farms be designed with no special audible characteristics at nearby residential properties, the standard concurrently recognises that these types of effects cannot always be predicted. Specifically, Section 5.4.1 of the standard notes:

> […] *as special audible characteristics cannot always be predicted, consideration shall be given to whether there are any special audible characteristics of the wind farm sound when comparing measured levels with noise limits.*

In terms of commission monitoring, an important outcome of the UK study is a new method proposed for objectively measuring and assessing atypical amplitude modulation during post-construction monitoring. Further, the UK study determined that if atypical modulation were to arise from a scheme, turbine management systems can be used to control the individual turbines responsible so that the impacts are mitigated under the particular conditions where they occur, on a case by case basis.

In recognition of the limited apparent extent of this reported matter, the subject of enhanced amplitude modulation has not altered the current approach to assessing wind farm noise in Australia. Specifically, current noise policies continue to represent a suitable basis for designing and assessing new wind farm developments.

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6 Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects (http://tinyurl.com/RUK-OAM-Report - 12.6MB)

6.0 CONSTRUCTION AND ANCILLARY INFRASTRUCTURE NOISE

This section presents noise criteria and predicted noise levels for:

- Construction activities occurring on the site of the proposed wind farm
- Temporary increases in road traffic generated by construction of the proposed wind farm
- Ancillary infrastructure associated with development of the proposed wind farm.

6.1 Site Construction Noise

6.1.1 Criteria

To provide an assessment of noise associated with construction activities, reference has been made to related guidance provided by the Queensland Department of Transport and Main Roads publication titled *Transport Noise Management Code of Practice Volume 2 – Construction Noise and Vibration* dated September 2014 (the Code). While the Code is specific to the construction of transport infrastructure, in the absence of alternative Queensland construction noise criteria, the document is referenced for the purposes of the present assessment.

The Code outlines different work periods according to the type of construction work. The work periods defined by the Code for general construction activity and traffic are reproduced in Table 1.

Table 1: Work periods for construction activities

Work Period	Days	Times
Standard hours	Monday-Friday	7:00am to 6:00pm
	Saturday	8:00am to 1:00pm
Non-Standard hours – evening	Monday-Friday	7:00am to 6:00pm
	Saturday	1:00pm to 10:00pm
	Sunday	7:00am to 10:00pm
Non-Standard hours – night-time	Monday-Sunday	10:00pm to 7:00am

The Code defines noise criteria for general construction activities in terms of external facade corrected noise levels at dwelling locations (including hotels and motels). The criteria account for pre-development noise conditions on the basis of a Rating Background Level (RBL); a parameter derived from measurement and analysis of background noise levels $L_{A90,15min}$ in the vicinity of the development site. The Code states that the noise criteria should be used to manage construction noise as follows:

- Standard hours – work within the Standard hours should be encouraged where possible. All reasonable and practicable measures should be implemented to achieve the lower limit. Exceedance of the upper limit requires immediate action and community consultation to determine further mitigation measures.
- Non-Standard hours – all reasonable and practicable measures should be implemented to achieve the lower limit. If exceeded, community consultation should be conducted for further mitigation measures.

The noise criteria outlined in the Code are reproduced in Table 2.

Table 2: External construction noise criteria

Work Period	External Noise Level $L_{Aeq,15minute}$ [4] dB	
	Lower Limit	Upper Limit
Standard	RBL + 10 [1][2][3]	75 where: RBL > 55 70 where: 40 < RBL ≤ 55 65 where: RBL ≤ 40
Non-Standard: evening and night-time	RBL + 5 [3]	Not applicable

[1] RBL + 5dB should be considered where a facility, equipment and long-term earthworks are required in an area for greater than 6 months

[2] Where the lower limit value exceeds the upper limit value, the lower limit is taken to equal the upper limit value

[3] Minimum lower limit are 50dB for Standard hours and 45dB for Non-Standard hours. A maximum lower limit of 75dB applies to Non-Standard hours

[4] Noise contribution from construction activity

Construction of the wind farm will generally occur within the Standard hours defined in the Code. Works may need to occur outside of standard working hours on some limited occasions. Examples of activities where this may be required include delivery of oversize plant or structures, including turbine nacelle, blades and tower in addition to erection of these structures based on weather constraints.

In terms of the Rating Background Level (RBL) required to establish the guideline lower and upper limit values for construction, reference is made to the background noise monitoring conducted as part of the assessment of the operational noise associated with the Mount Emerald Wind Farm. Consistent with the rural location of the development site, the monitoring demonstrated background noise levels were regularly below 40dB L_{A90}, particularly during low-wind speed conditions relevant to the assessment of construction noise impacts.

Based on the above, the applicable limits referred to in this assessment relate to Standard working hours and RBLs below 40dB. Accordingly, the following construction noise criteria are considered herein:

- Lower limit: 50dB $L_{Aeq,15minute}$
- Upper limit: 65dB $L_{Aeq,15minute}$

6.1.2 Construction Activities

Construction tasks associated with the project include the following:

- Access road and turbine hardstand construction
- Associated Infrastructure construction, such as the substation & site facilities
- Turbine tower foundation construction
- Trench digging to accommodate underground cabling
- Assembly of turbine towers, nacelles and rotor blades.

Equipment required to complete the tasks outlined above include:

- Bulldozers, graders, excavators, dump trucks, rollers, concrete trucks, front end loaders, cranes, pneumatic jack hammers etc
- All wheel drive vehicles and flat-bed delivery trucks.

6.1.3 Construction Equipment Noise Data

It is anticipated that a variety of construction equipment would be used for this project.

Sound power levels for the proposed construction equipment have been determined based on guidance and data sources including Australian Standard AS 2436:2010 Guide to noise and vibration control on construction, demolition and maintenance sites (AS 2436:2010), and noise level data from previous projects of a similar nature.

Table 3 summarises the noise emissions used to represent key items of plant associated with construction.

Table 3: Construction noise sources sound power data, L_{WA} dB

Noise source	Sound Power Level
Excavator fitted with pneumatic breaker	118
Excavator (100 to 200kW)	107
Tracked loaders	115
Crane (200t)	105
Crane (500t)	110
Crane (1200t)	115
Delivery Trucks	107
Concrete trucks	108
Dump truck	117
Concrete pump	108
Generator	99
Grader	110
Bulldozer	108
Front end loader	113
Rock crusher	120
Batching Plant	110

Overall sound power levels for equipment items that are likely to operate simultaneously have been estimated for each of the major construction phases, as detailed in Table 4.

Table 4: Overall sound power levels of major construction phases, LWA dB

Construction phase	Plant/Equipment	Total sound Power Level
Access roads	2x Excavator (100 to 200kW), 1x Tracked loaders, 2x Dump truck, 1x Grader, 1x Bulldozer	120
Substation	1x Excavator (100 to 200kW), 1x Crane (500t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	115
Site Compound	1x Excavator (100 to 200kW), 1x Crane (200t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	115
Turbine foundations	1x Excavator fitted with pneumatic breaker, 1x Excavator (100 to 200kW), 1x Crane (200t), 1x Delivery Trucks, 1x Concrete trucks, 1x Concrete pump, 1x Generator, 1x Bulldozer	120
Cable trench digging	1x Excavator (100 to 200kW), 1x Dump truck, 1x Generator, 1x Bulldozer	120
Turbine assembly	2x Crane (200t), 2x Crane (500t), 1x Crane (1200t), 1x Generator	120

6.1.4 Predicted Construction Noise Levels

Noise levels during construction have been predicted at the nearest noise sensitive locations during the construction phase to provide an indication of potential noise associated with regular working areas.

The predictions have been determined using the method outlined in AS 2436 Appendix B (the reference standard for the source emission data noted in the preceding section). The predictions account for a mix of soft and hard ground conditions which is considered to be consistent with the type of ground cover typically encountered in rural regions of eastern Australia.

The predictions also assume direct line of sight between all source and receiver locations. Accordingly, in some instances where intervening terrain obscures line of sight in practice, actual construction noise levels would be lower than predicted.

Our assessment of construction noise has been divided up into the six (6) main components during this phase of the development, namely:

- Site compound construction
- On-site substation construction
- Access road construction
- Turbine foundation preparation
- Cable trench digging
- Turbine delivery and assembly

To be conservative, it has been assumed that cable trench digging could occur anywhere along the proposed tracks within the site.

Furthermore, predicted noise levels are based on equipment being operational simultaneously for a full 15 minute assessment period.

Table 5 details the predicted noise levels at the nearest receptor locations for each of the construction activities outlined above. Given that the precise equipment selections and methods of working would be determined during the development of a construction plan, and that the noise associated with construction plant and activity varies significantly, the predicted noise levels are provided as an indicative range of levels which may occur in practice.

Table 5: Indicative range of construction noise predictions, $L_{Aeq, 15minute}$ dB

Construction phase	Nearest property	Predicted level range
Access road construction	R78	45-50
On-site substation	R05	35-40
Site Compound	R05	35-40
Turbine foundations	R78	45-50
Cable trench digging	R78	45-50
Turbine assembly	R78	45-50

The results presented in Table 5 demonstrate that the construction noise levels are predicted to achieve the lower limit values provided by Code. The predicted noise levels have been determined for the nearest receiver location to each activity. Accordingly, predicted noise levels at other receiver locations will be lower than presented in Table 5, and will therefore also achieve the lower limit of the Code.

6.2 Construction Traffic Noise

6.2.1 Criteria

To provide an assessment of noise associated with construction traffic, reference is again made to the Queensland Department of Transport and Main Roads publication *Transport Noise Management Code of Practice Volume 2 – Construction Noise and Vibration* dated September 2014 (the Code).

The code notes that haulage/transportation associated with construction activities on public roads within the project area or beyond has the potential to create traffic noise issues for existing sensitive receptors. Accordingly, the Code proposes that construction traffic should not increase the pre-construction traffic noise level $L_{A10,1hour}$ by more than 3dB.

6.2.2 Assessment

An assessment of noise associated with construction traffic has been prepared on the basis of the existing and forecast traffic information presented in the SKM (now Jacobs) reports:

- *Mount Emerald Wind Farm Traffic Impact Assessment Report dated 8 August 2011.*
- *Mount Emerald Wind Farm Traffic Impact Assessment Report – Technical Note – Traffic Impact Assessment Engineering Response dated December 2012.*

The forecast traffic information has been used in conjunction with the prediction methodology detailed in the UK publication Calculation of Road Traffic Noise to determine the expected increase in noise levels for comparison with the guideline criterion provided by the Code.

The predictions have been prepared for two proposed traffic routes; Kennedy Highway and Hansen Road. For both route options, noise calculations have been based on the Average Annual Day Traffic (AADT) increasing by seventy-nine (79) vehicles. These vehicles will comprise a mix of heavy goods and passenger vehicles. A conservative assessment has been made by assuming that all 79 additional construction vehicles are heavy goods vehicles.

Based on the above, Table 6 and Table 7 provide details of the reference traffic information and predicted noise level changes for the two construction traffic routes.

Table 6: Construction traffic on Kennedy Highway – noise levels $L_{A10,\ 1hour}$ for receivers at Walkamin

Period	AADT	%HGV	Speed (km/hr)	Distance (m)	Estimated $L_{A10,1\ hour}$
Existing (estimated 2012)	5670	5.9	100	35	66
Existing plus construction	5749	7	100	35	66

Table 7: Construction traffic on Hansen Road – noise levels $L_{A10,\ 1hour}$ for receiver R111

Period	AADT	%HGV	Speed (km/hr)	Distance (m)	Estimated $_{LA10,1\ hour}$
Existing (estimated 2012)	1440	0	90	45	57
Existing plus construction	1519	5	90	45	58

The results presented in Table 5 and Table 6 demonstrate that traffic noise levels are predicted to increase by less than 1dB and approximately 1dB for the Kennedy and Hansen Road route options respectively. These predicted increases are provided for the nearest representative receiver locations along the proposed construction traffic routes, however the predicted changes are applicable for all other receiver locations along the routes. The predictions therefore demonstrate that the change in traffic noise as a result of construction meets the Code guideline criterion for all receiver locations.

6.3 Ancillary Infrastructure Noise

6.3.1 Criteria

The Queensland *Environmental Protection (Noise) Policy 2008* (the EPP) provides legislation relevant to the control of noise from noise sources of a commercial or industrial nature.

The purpose of the EPP is to achieve the objectives of the Environment Protection Act 1994, and the purpose of the policy is stated to be achieved by:

a) Identifying environmental values to be enhanced or protected; and

b) Stating acoustic quality objectives for enhancing or protecting the environmental values; and

c) Providing a framework for making consistent, equitable and informed decisions about the acoustic environment.

Schedule 1 sets out acoustic quality objectives relevant to residential dwellings and these are reproduced below in Table 8.

Table 8: EPP Schedule 1 acoustic quality objectives for dwellings

Sensitive receptor	Time of day	Acoustic quality objectives dB (measured at the receptor)			Environmental value
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$	
dwelling (for outdoors)	daytime & evening	50	55	65	health and wellbeing
dwelling (for indoors)	daytime & evening	35	40	45	health and wellbeing
	night-time	30	35	40	health and wellbeing, in relation to the ability to sleep

6.3.2 Assessment

Ancillary infrastructure associated with the development of a wind farm includes power transmission networks and electrical substations and.

The wind farm is proposed to be connected to existing power transmission infrastructure that passes through the wind farm site layout. The new connection to the network will also occur within the wind farm site. Accordingly, the proposed wind farm will not introduce any new power transmission lines in the vicinity of noise sensitive receptor locations. Further consideration of noise associated with power transmission infrastructure is therefore not required.

An electrical substation is proposed to be developed as part of the project, located within the proposed wind turbine layout of the site. We understand that the specific installation location and arrangements are yet to be finalised. However, the planned location for the substation is illustrated on the following figure which is an extract of the map PR100246-170 provided from RATCH by email on 2 September 2014.

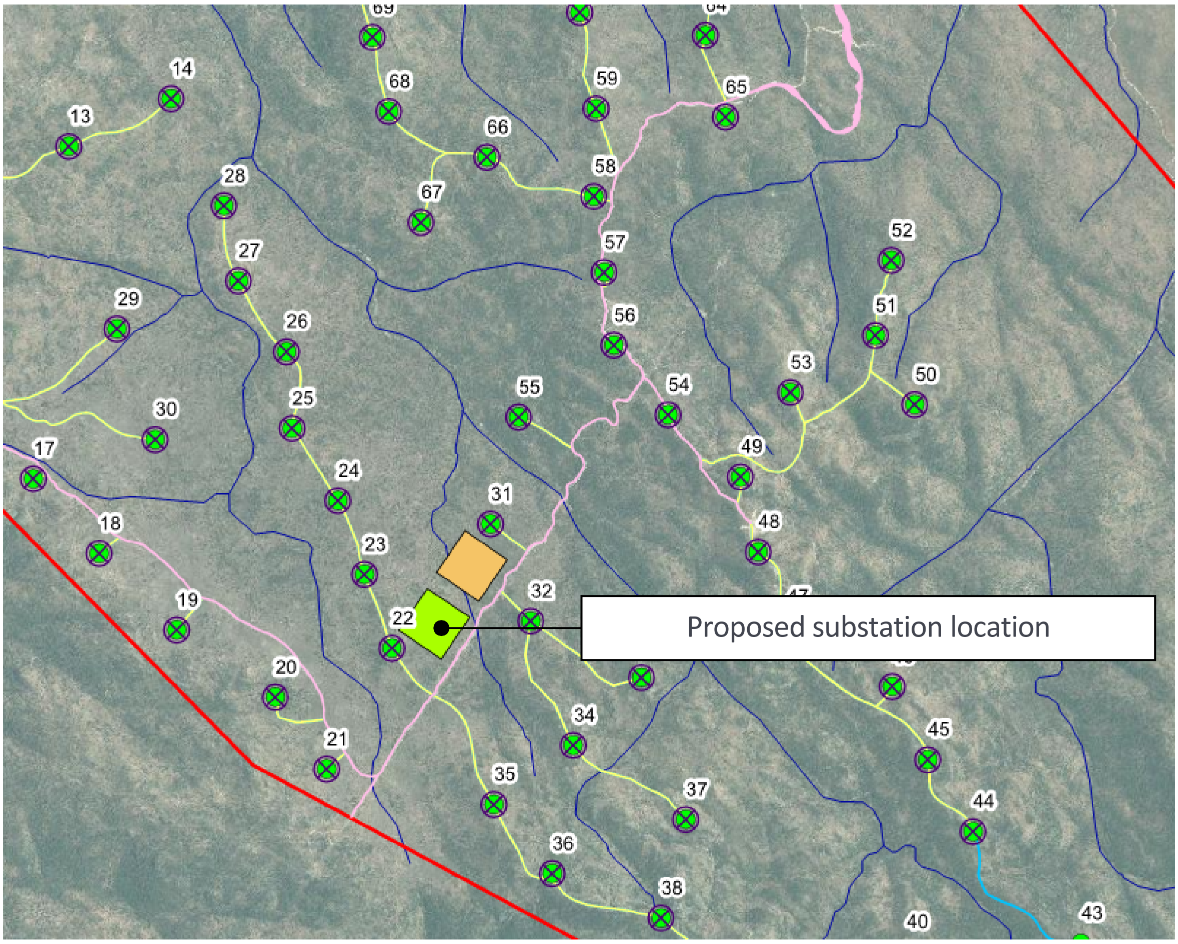


Figure 7: Planning location for wind farm substation

Based on this plan, approximate GPS coordinates as detailed Table 9 have informed the current assessment of transformer noise.

Table 9: Approximate substation location

	GPS Coordinates (GDA94 Zone 55)	
	Easting	**Northing**
Substation	327812	8099863

The nearest receiver location to the substation is receiver R05 at a distance of approximately 2.7km.

Specific details of transformer selections are yet to be made, however noise emissions associated with this type of electrical plant are commonly in the range of 95-100dB L_{Aw}. While the specific transformers selections would not be finalised until the detailed design phase of the project, the typical emission ranges and separating distances are sufficient to determine that operational noise levels associated with transformers would be below 30dB externally at surrounding residential receiver locations.

The noise of the transformers is therefore expected to be well within the acoustic quality objectives noted by the EPP for the day and evening and external, even accounting for any adjustments (if applicable at the receptor) for the potential tonal characteristics associated with transformers . Further, accounting for the typical outdoor to indoor reduction of 10-15dB for a partially open window, the internal acoustic quality objectives of the EPP are also expected to be met for night-time operation.

APPENDIX A DESCRIPTION OF SOUND

A.1 Introduction

Sound is usually composed of complex and varied patterns of pressure changes. As a result, a number of attributes are used to describe sound. Two of the most fundamental sound attributes are:

- sound pressure
- sound frequency

Each of these attributes is explained in the following sections, followed by a discussion about how each of these attributes varies.

A.2 Sound Pressure

The compression and expansion of the air that is associated with the passage of a sound wave results in changes in atmospheric pressure. The pressure changes associated with sound represent very small and repetitive variations that occur amidst much greater pressures associated with the atmosphere.

The magnitude of these pressure changes influences how quiet or loud a sound will be; the smaller the pressure change, the quieter the sound, and vice versa. The perception of loudness is complex though, and different sounds can seem quieter or louder for reasons other than differences in pressure changes.

To provide some context, Table 10 lists example values of pressure associated with the atmosphere and different sounds. The key point from these example values is that even an extremely loud sound equates to a change in pressure that is thousands of times smaller than the typical pressure of the atmosphere.

Table 10: Atmospheric pressure versus sound pressure – example values of pressure

Example	Pascals (Pa)	Bars	Pounds per Square Inch (PSI)
Atmospheric pressure	100,000	1	14.5
Pressure change due to weather front	10,000	0.1	1.5
Pressure change associated with sound at the threshold of pain	20	0.0002	0.003
Pressure change associated with sound at the threshold of hearing	0.00002	0.0000000002	0.000000003

The pressure values in Table 10 also show that the range of pressure changes associated with quiet and loud sounds span over a very large range, albeit still very small changes compared to atmospheric pressure. Owing to the wide range of these fluctuations, the way we hear sound is more practically described using the decibel (dB). The decibel system serves two key purposes:

- Compressing the numerical range of the quietest and loudest sounds commonly experienced.

  As an indication of this benefit, the pressure of the loudest sound that might be encountered is around a million times greater than the quietest sound that can be detected. In contrast, the decibel system reduces this to a range of approximately 0-120 dB.

- Consistently representing sound pressure level changes in a way that correlate more closely with how we perceive sound pressure level changes.

  For example, a 10dB change from 20-30 dB will be generally be subjectively perceived as a similar to a 10dB change from 40-50 dB. However, expressed in units of pressure as Pascals, the 40-50 dB change is ten times greater than the 20-30 dB change. For this reason, sound pressure changes cannot be meaningfully communicated in terms of units of pressure such as Pascals.

Sound pressure levels in most environments are highly variable, so it can be misleading to describe what different ranges of sound pressure levels correspond to. However, as a broad indication,

Table 11 provides some example ranges of sound pressure levels, expressed in both dB and units of pressure.

Table 11: Example sound pressure levels that might be experienced in different environments

Environment	Example Sound Pressure Level	
Outside in an urban area with traffic noise	50-70 dB	0.006-0.06 Pa
Outside in a rural area with distant sounds or moderate wind rustling leaves	30-50 dB	0.0006-0.006 Pa
Outside in a quiet rural environment in calm conditions	20-30 dB	0.0002-0.0006 Pa
Inside a quiet bedroom at night in still conditions	<20 dB	0.0002 Pa

The impression of how much louder or quieter a sound is will be influenced by the magnitude of the change in sound pressure. Other important factors will also influence this, such as the frequency of the sound which is discussed in the following section. However, to provide a broad indication, Table 12 provides some examples of how different changes in sound pressure levels can be perceived.

Table 12: Perceived changes in sound pressure levels

Sound pressure level change	Indicative change in perceived sound
1dB	Unlikely to be noticeable
2-3dB	Likely to be just noticeable
4-5dB	Clearly noticeable change
10dB	Distinct change - often subjectively described as halving or doubling the loudness

The example sound pressure level changes in Table 12 are based on side by side comparison of a steady sample of sound heard at different levels. In practice, changes in sound pressure levels may be more difficult to perceive for a range of reasons, including the presence of other sources of sound, or gradual changes which occur over a longer period of time.

To illustrate the pressure variation associated with sound, Figure 8 shows the repetitive rise and fall in pressure of a very simple and steady sound. This figure illustrates the peaks and troughs of pressure changes relative to the underlying pressure of the atmosphere in the absence of sound. The magnitude of the change in pressure caused by the sound is then described as the sound pressure level. Since the magnitude of the change is constantly varying, the sound pressure may be defined in terms of:

- Peak sound pressure levels: the maximum change in pressure relative to atmospheric pressure i.e. the amplitude as defined by the maximum depth or height of the peaks and troughs respectively; or
- Root Mean Square (RMS) sound pressure levels: the average of the amplitude of pressure changes, accounting for positive changes above atmospheric pressure, and negative pressure changes below atmospheric pressure.

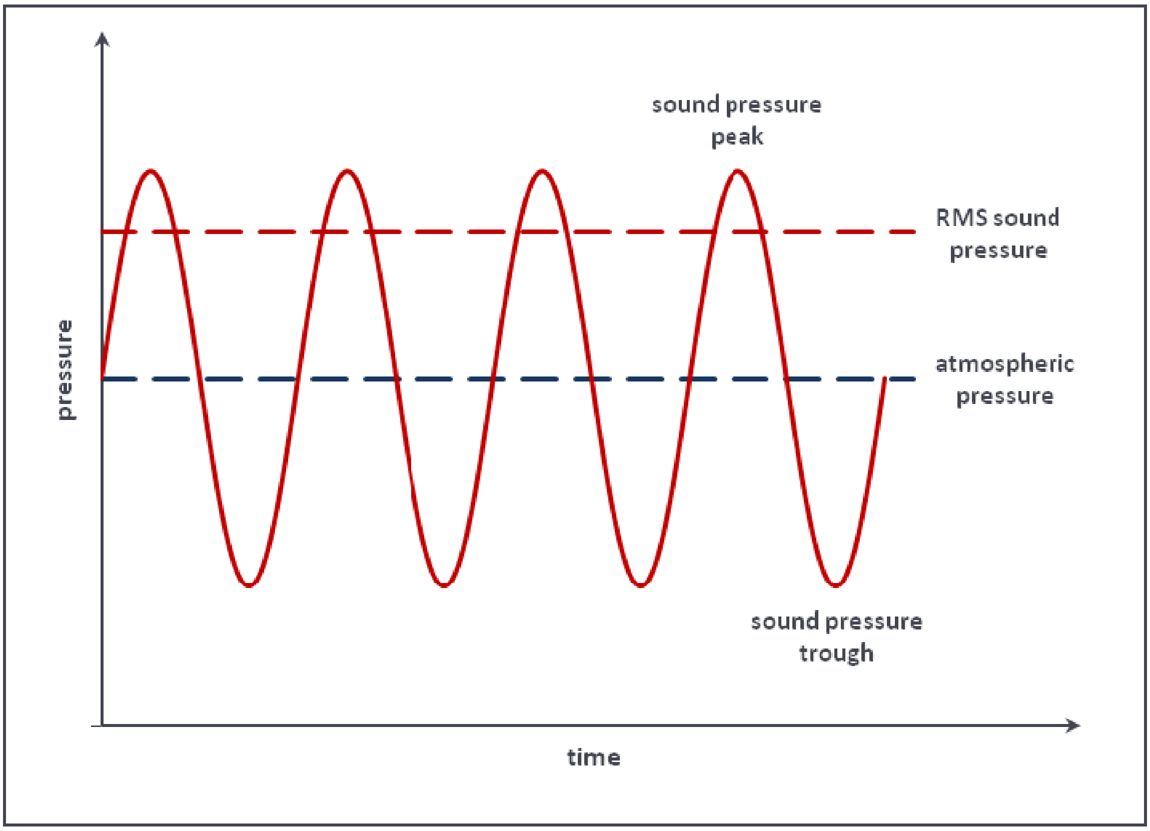


Figure 8: Pressure changes relative to atmospheric pressure associated with sound

A.3 Frequency

Frequency is a term used to describe the number of times a sound causes the pressure to rise and fall in a given period of time. The rate of change in pressure is an important feature that determines whether it is able to be perceived as a sound by the human ear.

Repetitive changes in pressure can occur as a result of a range of factors with widely varying rates of fluctuation. However, only a portion of these fluctuations are able to be perceived as sound. In many cases, the rate of fluctuation will either be too slow or too fast for the human ear to detect the pressure change as a sound. For example, local fluctuations in atmospheric pressure can be created by someone waving their hands back and forth through the air; the reason this cannot be perceived as a sound is the rate of fluctuation is too slow.

At the rates of fluctuation that can be detected as sound, the rate will influence the character of the sound that is perceived. For example, slow rates of pressure change correspond to rumbling sounds, while fast rates correspond to whistling sounds.

The rate of fluctuation is numerically described in terms of the number of pressure fluctuations that occur in a single second. Specifically, it is the number of cycles per second of the pressure rising above, falling below, and then returning to atmospheric pressure. The number of these cycles per second is expressed in Hertz (Hz). This concept of cycles per second is illustrated in Figure 9 which illustrates a 1Hz pressure fluctuation. The figure provides a simple illustrate of a single cycle of pressure rise and fall occurring in a period of a single second.

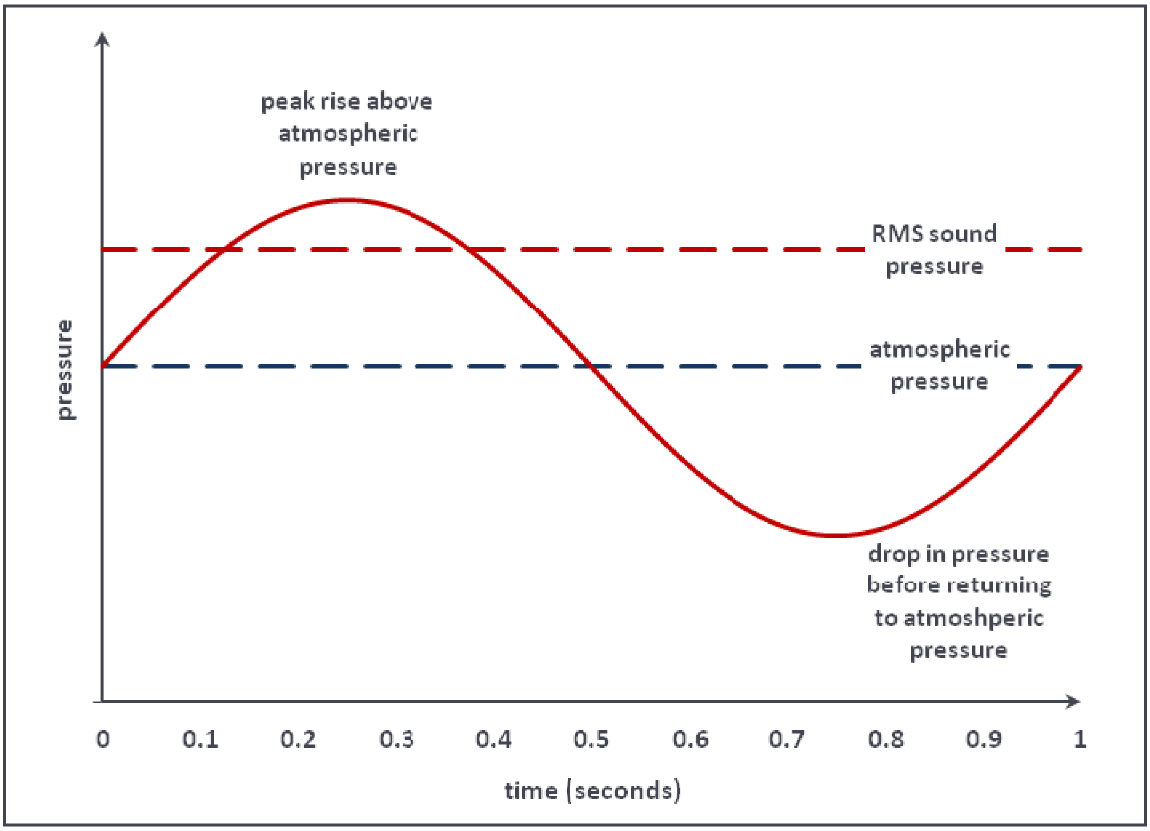
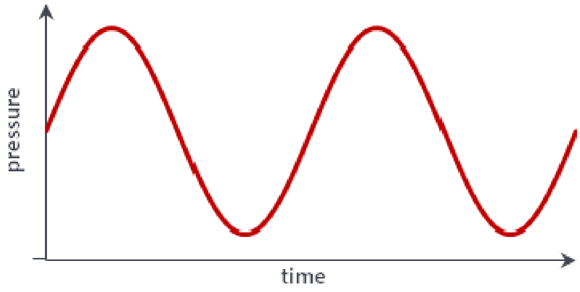


Figure 9: Illustration of a pressure fluctuation with a frequency of 1Hz

The rate that sound pressure rises and falls will vary depending on the source of the sound. For example, the surface of a tuning fork vibrates at a specific rate, in turn causing the pressure of the adjacent air to fluctuate at the same rate. Recalling the idea of pressure fluctuations from someone waving their hands, the pressure would fluctuate at the same rate as the hands move back and forth; a few times a second translating to a very low frequency below our hearing range (termed an *infrasonic* frequency). Examples of low and high frequency sound are easily recognisable, such as the low frequency sound of thunder, and the high frequency sound of crashing cymbals. To demonstrate the differences in the patterns of different frequencies of sound, Figure 10 illustrates the relative rates of pressure change for low, mid and high frequency sounds. Note that in each case the amplitude of the pressure changes remains the same; the only change is the number of fluctuations in pressure that occur over time.

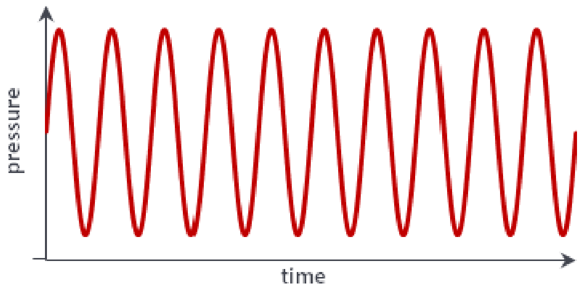
Low frequency sounds:

20 to 200 Hz



Mid-frequency sounds:

200 to 800 Hz



High frequency sounds:

greater than 800 Hz

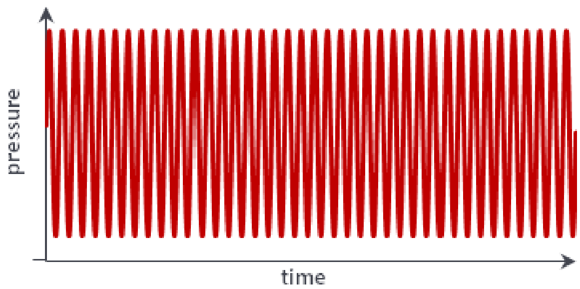


Figure 10: Examples of the rate of change in pressure fluctuations for low, mid and high frequencies

A.4 Sound Pressure and Frequency Variations

The preceding sections discuss important aspects of the nature of sound, the changes in pressure and the changes in the rate of pressure fluctuations.

The simplest type of sound comprises a single constant sound pressure level and a single constant frequency. However, most sounds are made up of many frequencies, and may include low, mid and high frequencies. Sounds that are made up of a relatively even mix of frequencies across a broad range of frequencies are referred to as being ‘broad band’. Common examples of broad band sounds include flowing water, the rustling of leaves, ventilation fans and traffic noise.

Further, sound quite often changes from moment to moment, in terms of both pressure levels and frequencies. The time varying characteristics of sound are important to how we perceive sound. For example, rapid changes in sound level produced by voices provide the component of sound that we interpret as intelligible speech. Variations in sound pressure levels and frequencies are also features which can draw our attention to a new source of sound in the environment.

To demonstrate this, Figure 11 illustrates an example time-trace of total sound pressure levels which varies with time. This variation presents challenges when attempting to describe sound pressure levels. As a result, multiple metrics are generally needed to describe sound pressure, such as the average, minimum or maximum noise levels. Other ways of describing sound include statistics for describing how often a defined sound pressure level is exceeded; for example, typical upper sound levels are often described as an L_{10} which refers to the sound pressure exceeded for 10% of the time, or typical lower levels or lulls which are often described as an L_{90} which refers to the sound exceeded for 90% of the time.

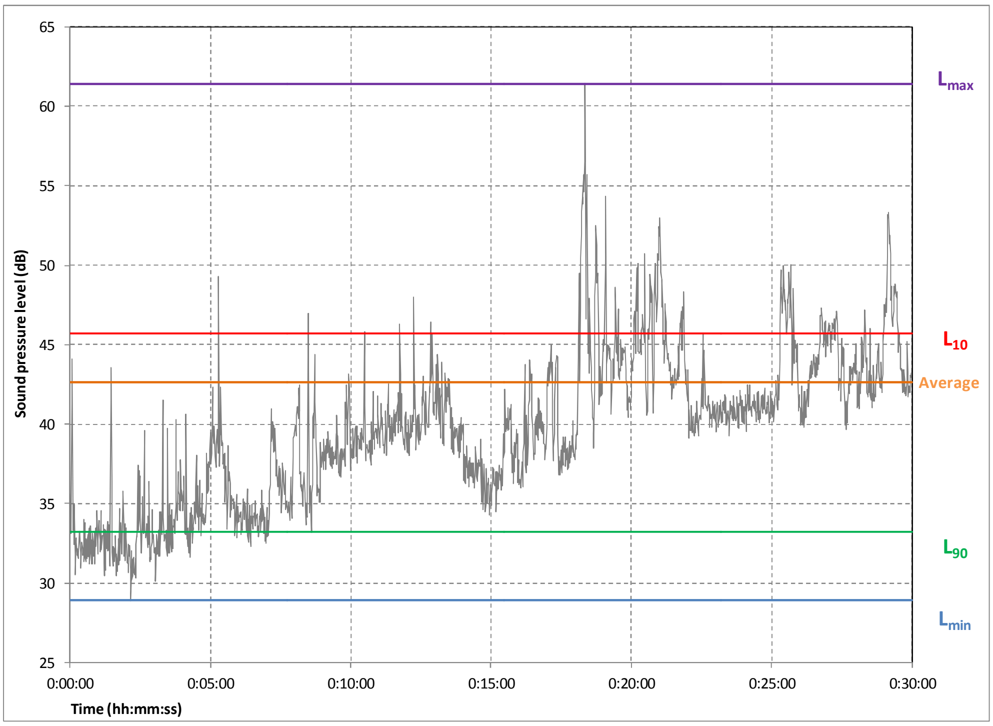


Figure 11: Example of noise metrics that may be used to measure a time-varying sound level

This example illustrates variations in terms of just total sound pressure levels, but the variations can also relate to the frequency of the sound, and frequently the number of sources affecting the sound.

These types of variations are an inherent feature of most sound fields and are an important point of context in any attempt to describe sound.