In the matter of the
Berrybank Wind Farm Amendment Application

Planning Panels Victoria

Proponent: Berrybank Development Pty Ltd

Expert Witness Statement of
Christophe Frederic Delaire

Expert of Berrybank Development Pty Ltd

1 Name and address

CHRISTOPHE FREDERIC DELAIRE

Co-CEO

Marshall Day Acoustics Pty Ltd

6 Gipps Street, Collingwood.

Victoria 3066

2 Area of expertise

For over 15 years I have worked in the field of acoustics and noise control. I have a special interest in environmental noise and have gained extensive experience in the noise assessment of wind farms since 2005.

I am a member of the Australian Acoustical Society (MAAS) and the Association of Australian Acoustical Consultants (AAAC) Wind Farm Subcommittee.

My qualifications and experience are detailed in Annexure A.

I am sufficiently expert to make this statement because I have been involved in environmental noise impact assessments for major environmental projects such as power stations, wind farms and industrial plants.

My experience extends to all aspects of wind farm noise, including predictions, background noise monitoring, post-construction noise monitoring and sound power level testing. This is demonstrated by my involvement in over fifty (50) projects across Australia, providing expert witness evidence for eleven (11) Victorian wind farms and presentation of multiple papers at international conferences.

3 Scope

3.1 Instructions

The Berrybank Wind Farm has been approved for development with planning permits No. 20092820 and 20092821, for the Corangamite and Golden Plains Shire Councils respectively, issued on 24 August 2010 by the Minister for Planning (the Planning Permits).

Marshall Day Acoustics Pty Ltd (MDA) was subsequently commissioned by Berrybank Development Pty Ltd (the Proponent) to prepare an updated noise assessment for the Berrybank Wind farm.

The purpose of the updated assessment was to account for proposed amendments to the project and changes to Victorian noise assessment standards in the time since the planning permits were issued. In particular, an updated assessment was conducted in accordance with the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010), as required by the Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016 (the Victorian Guidelines).

The updated noise assessment is presented in the MDA Report Rp 001 R01 2014363ML *Berrybank Wind Farm - NZS 6808:2010 Noise Assessment* dated 13 March 2016 (the MDA Report), issued as Appendix A of the MDA letter Lt 001 R01 2014363ML dated 15 March 2016 (the MDA Letter).

The MDA Letter was exhibited in Volume 4 of the Modification Application dated March 2017.

I adopt the MDA Report as the basis for my expert witness statement and evidence.

I have been instructed by Herbert Smith Freehills (HSF) on behalf of the Proponent to prepare a witness statement and give expert evidence at the panel hearing based on the findings presented in the MDA Report.

This statement provides a summary of the noise assessment detailed in the MDA Report, together with a response to key submissions raising issues relating to noise.

3.2 Reports reviewed to prepare initial study or statement

The documents I have reviewed and referenced in the MDA Report and this statement are listed in Annexure B.

3.3 Persons assisting with this work

My colleagues Justin Adcock, Ross Leo, Alex Morabito and Jeremy Ellis have assisted with the calculations and review of calculations, reports and this statement of evidence.

4 Proposed amendments

Condition 3 of the Berrybank planning permits details the specifications of the wind farm, including the number and scale of the turbines. The permits originally specified the tower height of the wind turbines at 80 metres, with an overall height of 131 metres above ground level (AGL) and maximum blade length of 49 m.

Approval is now sought by the Proponent to further vary the turbine specifications detailed in the permits. The following amendments are proposed:

- Increase the maximum overall tip height of the turbines to 180 m, with a minimum blade ground clearance of 40 m. The selected turbine model(s) would be chosen to remain within the proposed parameters
- ground level micrositing of a number of turbines and realignment of access tracks
- Reduction of the wind farm layout from the originally approved ninety-nine (99) turbines, of which ninety-five (95) were included in the endorsed plan, to a layout with seventy-nine (79) turbines.

The proposed amendments listed above were addressed in the updated assessment presented in the MDA Report.

Approval for the proposed amendments would be facilitated via amended permits which are proposed to include updated to conditions to reflect current policy and assessment practices.

5 Noise assessment

The noise assessment for the proposed amendments to the permitted Berrybank Wind Farm presented in the MDA Report is summarised herein.

5.1 Noise criteria

5.1.1 NZS 6808:2010

At the time of approval of the subject wind farms, wind farm noise was assessed in accordance the New Zealand Standard 6808:1998 *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS 6808:1998). The existing planning permits require that compliance with the NZS 6808:1998 criteria be achieved at *any dwelling existing on land in the vicinity of the proposed wind energy facility as at the date of the issue of this permit, to the satisfaction of the responsible authority*, as detailed in Condition 18 of the Planning Permits (the Noise Limit Condition).

In the time since the planning permits were issued, the Victorian Guidelines were updated and refer to the revised version of the New Zealand standard. Specifically, the current version of the Victorian Guidelines, dated January 2016, refers to NZS 6808:2010 as the applicable assessment standard for new wind farm developments in Victoria.

Accordingly, the updated assessment presented in the MDA Report was undertaken in accordance with NZS 6808:2010. The proposed amendments to the permits for the wind farm include updating to the conditions to specify NZS 6808:2010 as the applicable standard for consistency with current Victorian Guidelines.

5.1.2 High amenity

Section 5.3.1 of NZS 6808:2010 states that the base noise limit of 40 dB L_{A90} is *appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations*. It goes on to note that high amenity areas may require additional consideration:

> […] *In special circumstances at some noise sensitive locations a more stringent noise limit may be justified to afford a greater degree of protection of amenity during evening and night-time. A high amenity noise limit should be considered where a plan promotes a higher degree of protection of amenity related to the sound environment of a particular area, for example where evening and night-time noise limits in the plan for general sound sources are more stringent than 40 dB $L_{Aeq(15\ min)}$ or 40 dBA L_{10}. A high amenity noise limit should not be applied in any location where background sound levels, assessed in accordance with section 7, are already affected by other specific sources, such as road traffic sound.*

Section 5.3 of NZS 6808:2010 provides details of high amenity noise limits that apply to noise sensitive locations that are deemed to be located within a high amenity area as defined in Sections 5.3.1 and 5.3.2 of the standard. The high amenity limit specifies that wind farm noise levels (L_{A90}) during evening and night-time periods should not exceed 35 dB L_{A90} or the background noise level (L_{A90}) by more than 5 dB, whichever is the greater, for wind speeds below 6 m/s at hub height. High amenity noise limits are not applicable during the daytime period.

In Section 5.1.2.a, the Victorian Guidelines states the following:

> *Under section 5.3 of the Standard, a 'high amenity noise limit' of 35 decibels applies in special circumstances. All wind farm applications must be assessed using section 5.3 of the Standard to determine whether a high amenity noise limit is justified for specific locations, following procedures outlined in clause C5.3.1 of the Standard. Guidance can be found on this issue in the VCAT determination for the Cherry Tree Wind Farm.*

The definition of a high amenity area provided in NZS 6808:2010 is specific to New Zealand planning legislation and guidelines. A degree of interpretation is therefore required when determining how to apply the concept of high amenity in Victoria. As recommended in the Victorian Guidelines, it is therefore appropriate to follow the guidance detailed in the Cherry Tree Wind Farm Pty Ltd v Mitchell Shire Council decisions[1].

Paragraph 53 of the Cherry Tree Wind Farm Decision states the following:

> *The Tribunal does not accept that the permit conditions need to refer to the High Amenity Area provisions of the New Zealand standard because it has not been established that any such area could reasonably be identified within the environs of this wind energy facility.* […]

Further justification for the above statement was provided in Paragraphs 107 to 109 of the Cherry Tree Wind Farm Interim Decision:

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

As detailed in Paragraph 108, for the land surrounding the wind farm to be considered a high amenity area, the zoning of the land must be identified in the relevant planning scheme as *promoting a higher degree of protection of amenity related to the sound environment*.

The area surrounding the subject wind farm is generally designated as Farming Zone with a Township Zone covering the township of Berrybank (south of the wind farm).

Consistent with the findings of the Cherry Tree Wind Farm decision, both the Corangamite and Golden Plains planning schemes, dated 3 October 2017 (the planning schemes), provide definitions relating to the Farming Zone and do *not anywhere expressly or by implication "promote a higher degree of protection of amenity related to the sound environment of a particular area"*.

[1] *Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors (Includes Summary) (Red Dot)* [2013] VCAT 521 (Interim Decision) and
Cherry Tree Wind Farm Pty Ltd v Mitchell SC (Includes Summary) (Red Dot) [2013] VCAT 1939 (Final Decision).

Similarly, in relation to the Township Zone, the planning schemes do not expressly or by implication promote a higher degree of protection of amenity. Further, the general noise limits of NZS 6808:2010 are stated to be appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations. The definition of the Township Zone in the planning schemes does not provide any indication that residential locations in this zone designation should be regarded as one of the special circumstances in NZS 6808:2010 to consider the relevance of high amenity limits. That is, there are no clauses or provisions to suggest that a residential location in a Township Zone should be protected to a higher degree than the general provisions of NZS 6808:2010 which are appropriate for protection of sleep, health, and amenity of residents at most noise sensitive locations.

Following guidance from the VCAT determination for the Cherry Tree Wind Farm, as required by the latest version of the Victorian Guidelines, the high amenity noise limit detailed in NZS 6808:2010 is therefore not considered to be applicable for noise sensitive locations in the vicinity of the subject wind farm.

5.1.3 Stakeholders

For stakeholders, it is not proposed to amend the part of the Noise Limit Conditions specifying the following:

> *Any dwelling on the subject land may be exempt from* [the Noise Limit Condition]*. This exemption will be given effect through an agreement with the landowner that must apply to any occupant of the dwelling and must be registered on title. Such dwellings will be known as 'host dwellings'*

Properties with a noise agreement would therefore be exempt from noise limits according to the Noise Limit Conditions.

A recommended base noise limit of 45 dB L_{A90} is referenced in Section 6.2 of the MDA Report for stakeholders. This base noise limit is provided for informative purposes and is consistent with recommendations from the final report by *The European Working Group on Noise from Wind Turbines* (ETSU-R-97) which is commonly referenced for wind farms in Victoria and Australia.

5.1.4 Applicable noise limits

In accordance with NZS 6808:2010, the operational noise from turbines at noise sensitive locations should not exceed 40 dB L_{A90} or the background noise (L_{A90}) by more than 5 dB, whichever is the greater.

Background noise levels were previously measured in accordance with NZS 6808:1998 at selected noise sensitive locations in the vicinity of the permitted wind farms in 2009 and 2011. However, owing to differences in the methodologies of the 1998 and 2010 version of the standard, and the time that has lapsed since these surveys were undertaken, this data is not suitable for the purpose of setting background noise related limits in accordance with the current guidelines.

Accordingly, for the purpose of this assessment, the NZS 6808:2010 base noise limit of 40 dB L_{A90} at all wind speeds has been used for all noise sensitive locations. This provides a conservative assessment since the base noise limit represents the lowest value of the noise limits which could be applied in accordance with NZS 6808:2010.

As per the conditions of the permits, and consistent with NZS 6808:2010, the noise limits do not apply when an agreement is in place between the Proponent and a neighbouring landowner. However, the proponent has advised that these noise agreements would be instated for any stakeholder locations where the predicted noise level for the final layout is between 40 and 45 dB. As such, the base noise limit of 45 dB L_{A90} has been used for noise sensitive locations within stakeholder properties.

In practice, background noise monitoring would be undertaken prior to construction. The noise limits derived from the background noise monitoring results would then be used to assess compliance with NZS 6808:2010 and be detailed in a revised Noise Compliance Testing Plan.

5.2 Site layout

5.2.1 Candidate turbine models

The final turbine model for the site would be selected after a tender process to procure the supply of turbines. The final selection would be made on account of a range of design requirements including achieving compliance with planning permits' noise limits at surrounding noise sensitive receiver locations.

Accordingly, to assess the proposed wind farm, it is necessary to consider representative candidate turbine models for the size and type of turbines being considered. The purpose of the candidate turbines is to assess the viability of achieving compliance with the applicable noise limits, based on noise emission levels that are typical of the size of the turbines being considered for the site.

The three (3) following candidate turbine models have been considered for the noise assessment in accordance with NZS 6808:2010:

- Vestas V126 with a rated power of 3.3 MW and a rotor diameter of 126 m
- Senvion 3.0M122 with a rated power of 3.0 MW and a rotor diameter of 122 m
- GE 3.2-130 with a rated power of 3.2 MW and a rotor diameter of 130 m.

In accordance with NZS 6808:2010, reference data equivalent to IEC 61400:11 emission values was sourced from the turbine manufacturers. The data for each turbine was then adjusted to account for uncertainties associated with turbine sound power level testing. The adjustments for the Vestas turbine were based on addition of the uncertainties specified in the manufacturer's test documentation, equating to values between +1 dB and +1.4 dB. An additional of +1 dB was applied to the data for the Senvion and GE turbines to account for typical values of uncertainty.

The highest sound power level for the candidate turbines, including the adjustments for uncertainty, range from 105.5 to 107.0 dB. This is considered to be representative of the typical range of noise emissions for the class of turbine that is being considered.

5.2.2 Receiver locations

The permitted Berrybank Wind Farm is located near the township of Berrybank, Victoria.

The Proponent has identified sixty-three (63) noise sensitive locations, existing in the vicinity of the permitted wind farm at the date of the issue of the planning permits, on 24 August 2010, including ten (10) stakeholders.

The proposed layout is presented in Annexure C.

5.3 Noise assessment

5.3.1 Methodology

Operational noise levels from the subject wind farms have been predicted using the international standard ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO 9613-2:1996) as implemented in version 7.4 of SoundPLAN.

The following key details are noted:

- Turbine hub height:
  - 117 m for the Vestas V126 and Senvion 3.0M122 models
  - 110 m for the GE 3.2-130 model
- Receiver heights: 1.5 m
- Ground characterisation: G = 0.5
- Atmospheric conditions: T = 10°C and RH = 70 %
- Terrain elevation in 10 m height intervals provided by the Proponent.

Further details concerning the choice and suitability of the prediction method are provided in Appendix D of the MDA Report.

5.3.2 Predicted noise levels

Predicted noise levels were calculated at all sixty-three (63) noise sensitive locations for all three (3) candidate turbines.

A summary of the results is presented in Table 1 for thirty-seven (37) noise sensitive locations which are within the 35 dB predicted contour referred to by NZS 6808:2010, based on the candidate turbine model which results in the highest noise levels.

The predicted noise levels correspond to the wind speeds which give rise to the highest noise emissions (sound power levels) for each turbine model.

Table 1: Predicted noise, L_{A90} dB

House	Vestas V126	Senvion 3.0M122	GE 3.2-130	Applicable base noise limit	Compliance with the applicable base noise limit?
9	39.2	37.7	39.9	40	✓
10	38.7	37.3	39.5	40	✓
18	37.3	35.8	38.0	40	✓
27	36.4	34.8	37.1	40	✓
28	36.0	34.4	36.7	40	✓
53	35.3	33.8	36.0	40	✓
55 (S)	39.9	38.4	40.6	45	✓
56	40.2	38.7	40.9	40	For one (1) of the three (3) candidate turbine models
57	39.5	38.0	40.2	40	For two (2) of the three (3) candidate turbine models
58	37.3	35.8	38.0	40	✓
60	35.1	33.5	35.9	40	✓
61 (S)	42.5	41.1	43.2	45	✓
62 (S)	42.5	41.0	43.2	45	✓
63	39.6	38.2	40.4	40	For two (2) of the three (3) candidate turbine models
64	37.1	35.6	37.9	40	✓
66 (S)	43.6	42.1	44.3	45	✓
67 (S)	38.6	37.1	39.3	45	✓
68 (S)	38.6	37.1	39.3	45	✓
69	38.8	37.4	39.5	40	✓
70	38.7	37.2	39.4	40	✓
71 (S)	38.4	36.9	39.1	45	✓
72	38.4	37.0	39.2	40	✓
73	36.7	35.2	37.5	40	✓
74	34.5	32.9	35.2	40	✓
78 (S)	42.2	40.7	42.8	45	✓
79	40.1	38.6	40.8	40	For one (1) of the three (3) candidate turbine models
80	40.2	38.7	40.9	40	For one (1) of the three (3) candidate turbine models
81 (S)	39.5	38.0	40.2	45	✓
83	39.0	37.5	39.7	40	✓
84	35.1	33.6	35.9	40	✓
85	34.4	32.8	35.2	40	✓
102	37.6	36.1	38.3	40	✓

House	Vestas V126	Senvion 3.0M122	GE 3.2-130	Applicable base noise limit	Compliance with the applicable base noise limit?
103	39.8	38.4	40.5	40	For two (2) of the three (3) candidate turbine models
105	34.9	33.3	35.7	40	✓
108	38.4	37.0	39.2	40	✓
109	38.4	37.0	39.2	40	✓
112 (S)	41.5	40.1	42.2	45	✓

(S) Stakeholder

In relation to non-involved receiver locations, the following conclusions can be made from the results detailed in Table 1:

- For the Senvion 3.0M122, predicted noise levels comply with the applicable NZS 6808:2010 limit at all noise sensitive locations.
- For the Vestas V126, predicted noise levels marginally exceed the applicable NZS 6808:2010 noise limit at three (3) noise sensitive locations by up to 0.2 dB
- For the GE3.2-130, predicted noise levels marginally exceed the applicable NZS 68080:2010 noise limit at six (6) noise sensitive locations by up to 0.9 dB

Predicted noise levels at all noise sensitive locations within stakeholder properties comply with the 45 dB base noise limit for all candidate turbine models.

Wind farm noise at all other noise sensitive locations not listed in Table 1 are predicted to be lower than 35 dB L_{A90} and therefore also comply with the lowest possible NZS 6808:2010 noise limit at all wind speeds.

These conclusions indicate that noise would need to be considered as part of the selection and configuration of the final turbines to be operated at the site. For example, in the event that the either the Vestas V126 or GE 3.2-130 turbine models were selected, the layout may need to be adjusted or reduced noise emission modes may need to be selected for a number of the turbines. Conversely, the selection of other commercial turbine options with emissions that are comparable to the Senvion candidate turbine model considered in this assessment could be selected.

The predicted noise levels in Table 1 therefore demonstrate that the wind farm can comply with the noise limits determined in accordance with NZS 6808:2010 as specified in the proposed amendments to the permits.

As per the requirements of the proposed amended permits, a pre-development noise assessment will need to be undertaken prior to construction demonstrating compliance with the applicable noise limits using the final turbine selection and associated layout.

5.4 Comparison of predicted noise levels

The key requirement of the Planning Permits with respect to operational noise is that the wind farm must achieve compliance with the noise criteria determined in accordance with NZS 6808:2010, irrespective of the predicted noise levels that have been presented previously for the project.

Accordingly, the predicted noise level of the wind farm may be higher or lower than presented previously as a result of differences in the noise emissions of the final turbine model selected for the site. Importantly, these differences can occur for turbine selections that fit within the permitted height envelope of the wind farm, irrespective of the height variation that is proposed. The increases or decreases in noise level that occur as a result of these types of differences are acceptable provided that the total predicted noise levels remain within the noise limits defined by the Planning Permits.

However, at the request of the Department of Transport, Planning and Local Infrastructure (now the Department of Environment, Land, Water & Planning), a comparison of predicted noise levels is presented herein for reference purposes.

The differences represent the net effect of changes in the noise emissions of the turbine models and the turbine layout considered in the assessment.

When considering the three candidate turbine models, wind farm noise levels have been predicted to change as follows depending on the turbine model and the assessed noise sensitive location:

- Reduction of up to 2.9 dB
- Increase of up to 1.9 dB.

These differences are comparable to the magnitude of variations that can be expected to occur as a result of the selection of alternative turbines that are within the existing permitted envelope of the wind farm.

5.5 Comments on amended conditions

I have reviewed the proposed amended permit conditions submitted in Volume 1 of the Modification Application.

It is my opinion that the amendments made to the existing permit conditions mainly address the change in NZS 6808 version from 1998 to 2010.

In addition to the proposed amendments, I would recommend the following additional changes:

- Title of NZS 6808 should be amended to *Acoustics – Wind farm noise*, for consistency
- Reference to the *Interim Guidelines for the Control of Noise from Industry in Country Victoria, N3/89* dated 1989 should be removed. The applicable guidance relevant to construction noise throughout Victoria, including rural areas, is now contained in EPA Publication 1254 *Noise Control Guidelines* published in 2008.

  The conditions for construction noise are therefore recommended to be amended as follows:

  > *a determination of the noise limits to be applied during construction using the methodology prescribed in the EPA Publication 1254 Noise Control Guidelines, dated October 2008.*

5.6 Conclusion

The noise assessment detailed in the MDA Report has demonstrated that predicted noise levels from the Berrybank Wind Farm can comply with the applicable noise limits at all assessed noise sensitive locations with the proposed layout.

The revised noise assessment demonstrates that the proposed amendments to the wind farm design are able to achieve the acoustic requirements of the Victorian Government's Policy and planning guidelines for development of wind energy facilities in Victoria, as detailed in the proposed amended planning permits.

As required by the proposed amended planning permits, a revised noise assessment will be required prior to the construction of the wind farm, and should be based on the measurement data for octave band sound power levels and tonality of the selected turbine model.

Adequate mechanisms are detailed in the proposed amended planning permits to assess compliance with the applicable noise limits once the wind farm is operational.

6 Response to key submissions

I have reviewed key submissions that raise issues relating to noise. These issues and my response are provided in Table 4.

Table 4: Response to key submissions

Issue raised	Comment
Increase in noise levels	The Foreword to NZS 6808:2010 states the following: *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.* As stated above, noise from the turbines may be audible at times outside noise sensitive locations in the vicinity of the subject wind farms. In terms of potential increases in noise levels, the noise limits provided by NZS 6808:2010 require the noise associated with a wind farm to be restricted to a permissible margin above background noise, except in instances when both the background and source noise levels are low. In this respect, the criteria indicate that it is not necessary to continue to adhere to a margin above background when the background noise levels are below the range of 30-35 dB.
Noise limits at stakeholder properties	NZS 6808:2010 was prepared to provide methods of assessment in the statutory context of New Zealand. Specifically, the Standard notes that, in the context of the New Zealand Resource Management Act, application of the standard will provide reasonable protection of health and amenity at noise sensitive locations. This is an important point of context, as the New Zealand Resource Act states: *(3)(a)(ii): A consent authority must not, when considering an application, have regard to any effect on a person who has given written approval to the application.* Based on the above definitions and statutory context, noise predictions are normally prepared for receiver locations that are either within the site boundary, or where the occupants have entered into a noise agreement with the proponent of the wind farm. However, the noise limits specified in the Standard are not applied to these locations on account of their participation with the project. Notwithstanding the above, an assessment of noise levels at stakeholder properties has adopted a criterion of 45 dB L_{A90} which is consistent with guidance routinely adopted for stakeholder locations throughout Australia.
Compliance at non-stakeholder properties	The proposed amended planning permits require an assessment of post-construction noise compliance with NZS 6808:2010. If noise levels are found to be non-compliant, the operator of the wind farm will be obliged to reduce the noise level in order to achieve compliance. This obligation remains in place for the duration of the wind farm's operation.
Sound proofing of dwellings and double glazing	The noise limits in NZS 6808:2010 are set at the exterior of the house and are defined on the basis of providing an appropriate level of amenity protection both outside and within neighbouring dwellings. Importantly, the noise limits for the exterior have been set at a level which the Standard considers will result in an acceptable indoor noise level when the windows of neighbouring dwellings are open (i.e. assuming no benefit from the sound insulation from the buildings envelope, since external noise ingress would be dominated by the influence of the open window). Accordingly, building sound insulation enhancements are not required to provide an acceptable internal amenity within dwellings in accordance with NZS 6808:2010.
Infrasound	Section 5.5.1 of NZS 6808:2010 states that *although wind turbines may produce some sound at (ultrasound and infrasound) frequencies considered to be outside the normal range of human hearing these components will be well below the threshold of human perception.* Additional information is provided in Annexure D.

7 Declaration

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

Signed…….

Dated 6 November 2017

Annexure A – Qualifications

Qualifications

M.Eng – Masters' Degree in Engineering (French Equivalent), France 2001

Professional associations

MAAS – Member of the Australian Acoustical Society

Member of the Association of Australian Acoustical Consultants (AAAC) Wind Farm Subcommittee

Employment history and achievements

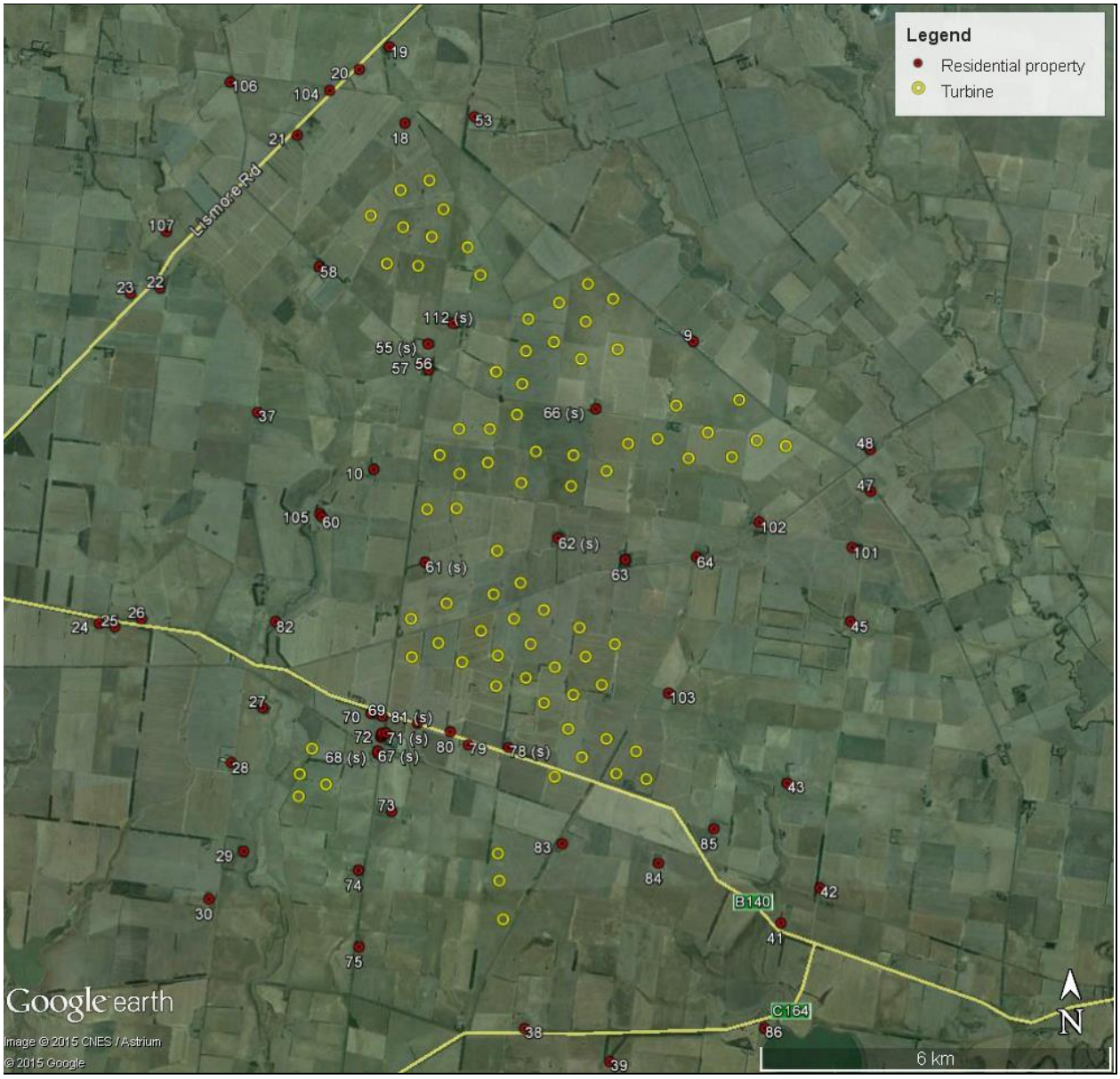
2017- Present	Co-CEO Marshall Day Acoustics Pty Ltd, Melbourne, Australia. Consultants in acoustics and noise control.
2002- Present	Associate Marshall Day Acoustics Pty Ltd, Melbourne, Australia. Consultants in acoustics and noise control. Responsibilities include consulting work in industrial noise control, environmental noise impact (including wind farms) and architectural sound insulation. Noise impact assessments of Victorian wind farm developments at Bald Hills, Berrimal, Berrybank, Challicum Hills, Chepstowe, Coonooer Bridge, Crowlands, Dundonnell, Ferguson, Golden Plains, Hawkesdale, Hepburn, Kiata, Maroona, Moorabool, Mortlake, Mt Gellibrand, Mt Mercer, Newfield, Nhill, Oakland Hill, Penshurst, Portland, Berrybank, Sidonia Hills, Spring Hill, Stockyard Hill, Timboon West, Waubra, Winchelsea, Wonthaggi, Yaloak South and Yawong.
2001	Vacation Employment Marshall Day Acoustics Pty Ltd, Melbourne, Australia

Annexure B – Reports reviewed to prepare this statement

I have reviewed the following documents that are referenced in the noise assessments and this statement of evidence:

- Victorian Government's *Policy and planning guidelines for development of wind energy facilities in Victoria* dated January 2016
- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010)
- New Zealand Standard 6808:1998 *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS 6808:1998)
- ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation* (ISO 9613-2:1996)
- EPA Publications 1411-1413 *Noise from Industry in Regional Victoria* (NIRV)
- Final report by *The European Working Group on Noise from Wind Turbines* (ETSU-R-97)
- *Cherry Tree Wind Farm Pty Ltd v Mitchell SC & Ors* [2013] VCAT 521
- Corangamite Planning Scheme dated 3 October 2017
- Golden Plains Planning Scheme dated 3 October 2017
- Berrybank Wind Farm planning permit No. 20092821 dated 24 August 2010
- Berrybank Wind Farm planning permit No. 20092822 dated 24 August 2010
- MDA Report Rp 001 R01 2014363ML *Berrybank Wind Farm - NZS 6808:2010 Noise Assessment* dated 13 March 2016, issued as Appendix A of the MDA letter Lt 001 R01 2014363ML dated 15 March 2016
- MDA Report Rp 001 R01 2011425ML dated 23 July 2013, issued as Appendix B of MDA letter Lt 001 R01 2014363ML

Annexure C – Layout



Annexure D – Additional information in response to key submissions

Effects of Wind Farm 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 personal 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 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. 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[2] 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.*

[2] Victorian Department of Health *Wind farms, sound and health: Community information* dated April 2013

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[3] and public statements[4, 5] 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.

These findings lend support to the suitability of the wind farm noise controls applied in Victoria, 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. 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.

Low frequency noise, infrasound and vibration

The limits adopted for the assessment of operational noise from wind farms represent relatively low levels which have been specified in recognition of the quieter rural environments in which wind farms are normally located.

However, consistent with noise policies applied to other forms of development, the criteria are not intended to restrict wind farm noise to inaudible levels. Accordingly, a wind farm which achieves compliance with the criteria may still be audible at surrounding noise sensitive locations on some occasions; this will depend on a range of factors such as the time of day, the speed and direction of the wind, the proximity to turbines, the extent of vegetation around the dwelling, and the degree to which the dwelling is sheltered from prevailing wind conditions. Irrespective of the relatively low levels which operational wind farm noise is restricted to, an individual's judgement of the audible noise from a wind farm is highly subjective and will be influenced by a range of contextual factors.

The subject of wind farm noise and its characteristics has attracted considerable attention. Specific attention has been directed to alleged matters relating to low frequency sound as well as infrasound and vibration. Low frequency sounds are generally regarded as sounds above 20 Hz and extending upwards into the range of 100-200 Hz. The definition of infrasound often varies in different jurisdictions, but is generally accepted to refer to frequencies of sound which lie below 20 Hz. While 20 Hz is commonly cited as the lower bound of audibility, frequencies below 20 Hz can still be audible, provided that the level of the sound is sufficiently high to exceed the threshold of audibility at those frequencies.

In common with many other sources of noise, wind turbines emit infrasound, low frequency sound and ground vibrations. However, what is often overlooked is that these types of sound and vibration are a feature of the everyday environment in which we live and arise from a wide range of natural sources such as the wind and the ocean to man-made sources such as domestic appliances, transportation and agricultural equipment. The important point in relation to wind turbines is that the levels of these types of emissions are low and therefore, in many cases, cannot generally be reliably measured amidst normal background levels.

NZS 6808:2010 provides specific advice concerning infrasound at Section 5.5 noting:

> *Although wind turbines may produce some sound at (ultrasound and infrasound) frequencies outside the normal range of human hearing these components will be well below the threshold of human perception.*
>
> *Claims have been made that low frequency sound and vibration from wind turbines have cause 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 recommend* [in the Standard].

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

[4] NHMRC Statement: *Evidence on Wind Farms and Human Health* 2015, National Health and Medical Research Council

[5] AMA Position Statement – *Wind Farms and Health* 2014, Australian Medical Association

These types of emissions have been the subject of considerable misrepresentation in media commentary. Notably, the work of Dr Geoff Leventhall, a prominent UK consultant in the field of acoustics and vibration, and researcher in the field of low frequency noise is often cited in some documents which continue to claim concerns about infrasound and low frequency noise from wind turbines. However, Dr Leventhall has regularly made clear statements to assert that there is no significant infrasound from current designs of wind turbines and very little low frequency sound, neither of which are anywhere near the sorts of levels which would represent a direct health risk for neighbouring residents of modern wind farms. An example such publication, co-authored by Dr Leventhall, was published in the UK Institute of Acoustics Bulletin in March 2009[6]. This publication was prepared as an agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed by local councils and community groups campaigning against wind farm developments. The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern.

On the subject of infrasound and low frequency noise, the article notes:

> *Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles. Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view.*
>
> *A Portuguese group has been researching 'Vibro-acoustic Disease' (VAD) for about 25 years. Their research initially focussed on aircraft technicians who were exposed to very high overall noise levels, typically over 120dB. A range of health problems has been described for the technicians, which the researchers linked to high levels of low frequency noise exposure. However other research has not confirmed this. Wind farms expose people to sound pressure levels orders of magnitude less than the noise levels to which the aircraft technicians were exposed. The Portuguese VAD group has not produced evidence to support their new hypothesis that infrasound and low frequency noise from wind turbines causes similar health effects to those experienced by the aircraft technicians.*

More recent measurements[7, 8] have demonstrated that infrasound and low frequency sound produced by regularly encountered natural and man-made sources, such as the infrasound produced by the wind or distant traffic, is comparable to that of modern wind turbines, noting that:

> *Infrasound levels in the rural environment appear to be controlled by localised wind conditions. During low wind periods, levels as low as 40dB(G) were measured at locations both near to and away from wind turbines. At higher wind speeds, infrasound levels of 50 to 70dB(G) were common at both wind farm and non-wind farm sites.*
>
> *Organised shutdowns of the wind farms adjacent to [sic: measurement locations] indicate that there did not appear to be any noticeable contribution from the wind farm to the G-weighted infrasound level measured at either house. This suggests that wind turbines are not a significant source of infrasound at houses located approximately 1.5 kilometres away from wind farm sites.*

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[6] Institute of Acoustics Bulletin – Bowdler, Bullmore, Davis, Hayes, Jiggins, Leventhall, McKenzie - *Prediction and Assessment of Wind Turbine Noise* –March 2009

[7] Sonus report for Pacific Hydro - *Infrasound measurements from wind farms and other sources* – November 2010 - see http://www.pacifichydro.com.au/media/192017/infrasound_report.pdf

[8] Evans, T., Cooper, J. & Lenchine, V., *Infrasound levels near wind farms and in other environments*, South Australian Environment Protection Authority, Adelaide, 2013

Another example of the misrepresentations made in relation to the environmental effects of wind turbines centred around work carried out by Keele University in the UK on ground vibration. Professor Peter Styles and his team at Keele University undertook a study of the effects of wind turbines on the seismic detection array at Eskdalemuir, Scotland. The results of this work were widely misinterpreted and resulted in a statement[9] from Professor Styles:

> *We are writing to clarify some misconceptions [...] about wind farm noise. Whilst it is technically correct that 'vibrations can be picked up as far away as 10km', to give the impression that they can be felt at this distance is highly misleading. The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect. The Dunlaw study was designed to measure effects of extremely low level vibration on one of the quietest sites (Eskdalemuir) in the world, and one which houses one of the most sensitive seismic installations in the world. Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health. It is, however, an issue for the Eskdalemuir seismic array, as it can detect this level of vibration. It is designed to detect explosions and earthquakes of a low magnitude from all over the world. The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect the low frequency sound. There is no scientific evidence to suggest that infrasound has an impact on human health.*

In 2010, the UK Health Protection Agency published a report[10] on the health effects of exposure to ultrasound and infrasound. The exposures considered in the report related to medical applications and general environmental exposure. The report notes:

> *Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.*
>
> *[...]*
>
> *For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects.*

Also, a recent State Government of Victorian Department of Health document[11] concludes the following in relation to infrasound from wind farms:

> *Infrasound is audible when the sound levels are high enough. The hearing threshold for infrasound is much higher than other frequencies. Infrasound from wind farms is at levels well below the hearing threshold and is therefore inaudible to neighbouring residents.*

These studies all indicate that infrasound levels from wind farms are anticipated to be comparable with existing ambient levels.

In February 2015, the National Health and Medical Research Council (NHMRC) released a statement[12] addressing human health effects of wind farms which includes consideration of noise. Based on consideration and review of over 2,500 publications, the NHMRC was not able to identify any reliable evidence of direct health impacts from wind farm noise.

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[9] *Keele University Rejects Renewable Energy Foundation's Low Frequency Noise Research Claims*. http://www.bwea.com/ref/lfn_keele.html

[10] Health Protection Agency UK – *Health Effects of Exposure to Ultrasound and Infrasound – Report of the independent Advisory Group on Non-ionising Radiation* - 2010

[11] Victorian Department of Health *Public Statement: Wind Turbines and Health - July 2010*

[12] NHMRC Statement: *Evidence on Wind Farms and Human Health* 2015, National Health and Medical Research Council