BEFORE THE COMMISSIONER ON BEHALF OF THE DUNEDIN CITY COUNCIL

UNDER	the Resource Management Act 1991
IN THE MATTER	an application for resource consent of LUC-2015-469
BY	Blueskin Energy Limited
	Applicant

BRIEF OF EVIDENCE OF STEPHEN GORDON CHILES

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Introduction

1. My full name is Dr Stephen Gordon Chiles. I am an acoustics engineer and independent hearings commissioner, and am self-employed by my company Chiles Ltd. I am separately employed half-time by the NZ Transport Agency as a Principal Environmental Specialist, responsible for state highway noise and vibration. I am also a visiting academic at the University of Canterbury Acoustics Research Group.

2. I have qualifications of Doctor of Philosophy in Acoustics from the University of Bath, and Bachelor of Engineering in Electroacoustics from the University of Salford. I am a Chartered Professional Engineer (NZ), Chartered Engineer (UK), Fellow of the UK Institute of Acoustics, and Member of the Resource Management Law Association. I have been employed in acoustics since 1996, as a research officer at the University of Bath, as a consultant for the international firms Arup, WSP, and URS, and for the specialist firms Marshall Day Acoustics and Fleming & Barron.

3. My experience includes acoustics assessment for numerous wind farms including: four distributed generation wind farms for Energy3 in Marlborough; Flat Hill wind farm; Mt Stuart wind farm; Hurunui wind farm; Mill Creek wind farm; Butoni wind farm in Fiji; peer reviews for Mahinerangi, Kaiwera Downs and Te Rere Hau wind farms; monitoring of the Windflow 500 prototype wind turbine at Gebbies Pass; review of the Te Rere Hau Extension for a neighbouring landowner; and assessing cumulative noise effects from the Long Gully wind farm. I was summoned by the Board of Inquiry to give evidence for the Turitea wind farm and I recently gave evidence to the Environment Court relating to declarations on the Te Rere Hau wind farm. I assisted in the preparation of guidelines for the Environment Protection Authority in Victoria for applying NZS 6808:2010[1]. I am advising the Christchurch City Council for appeals on reconsenting the Gebbies Pass wind turbine.

4. I am convenor of the New Zealand industry reference group for the international standards committee ISO TC43 (acoustics) and its

[1] New Zealand Standard 6808:2010 Acoustics – Wind farm noise

subcommittees SC1 (noise) and SC2 (building acoustics), which is responsible for approximately 200 published 'ISO' standards relating to acoustics. I was Chair of the 2012 Standards New Zealand acoustics standards review group; Chair for the 2010 wind farm noise standard revision (NZS 6808); and a member for the 2008 general environmental noise standards revision (NZS 6801[2] and NZS 6802[3]).

Scope of Evidence

5. My evidence addresses potential acoustics effects from the proposed Blueskin wind cluster. I will discuss acoustics fundamentals, provisions of the district plan, criteria and methodology provided by NZS 6808, predicted sound levels at relevant locations, and compliance monitoring. I will also address comments made by submitters, the peer review of my assessment commissioned by the Council and the section 42A report.

6. Data, assumptions, modelling and results that I have relied on in my evidence are detailed in my acoustics assessment dated 13 September 2013. I conducted my assessment on a desk-top basis using modelled sound levels provided by Blueskin Resilient Communities Trust (BRCT). In addition to these details I have prepared my evidence on the basis of my experience assessing wind farm sound at other sites, and my review of international literature during the revision of NZS 6808 and subsequently.

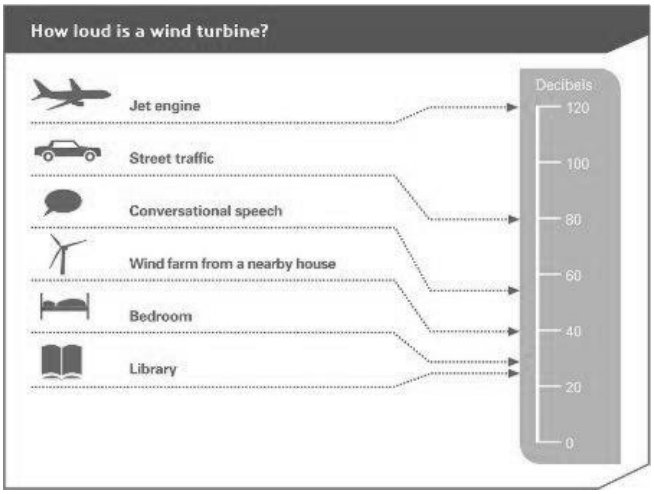
7. I confirm I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence is within my area of expertise except where I state that I am relying on facts or information provided by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Acoustics fundamentals

8. Sound sources cause changes in air pressure which are detected by human ears and can also be measured by a sound level meter. The pressure changes are expressed in decibels (dB), which is a logarithmic

[2] New Zealand Standard 6801:2008 Acoustics – Measurement of environmental sound
[3] New Zealand Standard 6802:2008 Acoustics – Environmental noise

parameter used to condense a wide range of pressures into a convenient scale. Being a logarithmic scale, normal mathematical rules for addition do not apply, for example, 35 dB + 35 dB = 38 dB. An increase of 3 dB is therefore a doubling of sound energy. However, a 3 dB increase is only just perceptible to the human ear, when listening to two sounds in succession. As a rule-of-thumb a 10 dB increase corresponds approximately to a doubling of perceived loudness; that is 50 dB sounds roughly twice as loud as 40 dB. I have copied the following figure from the New Zealand Wind Energy Association website, which shows examples of different sound levels.



9. The main source of sound from wind turbines is aerodynamic sound, which is created as air passes around the blades. This sound is heard as a swishing or whooshing near to the turbines. Turbines can also produce mechanical sound from the generator and gear box, and adjacent to the turbine the electrical transformer can be heard. At the distance of houses from a wind farm the overall sound is generally a bland indistinct low level sound sometimes compared to the sound of waves on a beach.

10. There have been occasions where wind farms have had more noticeable 'special audible characteristics' such as a prominent whine. These sounds should not manifest themselves with modern wind turbines, and the turbines proposed for this project have been tested to demonstrate the absence of such special audible characteristics. If alternative wind turbines are used my recommended consent conditions require them to also be tested prior to installation.

11. A key feature of wind farm sound is that it only occurs when there is wind. Under these conditions there will also be 'background' sound created by vegetation moving in the wind, and at high wind speeds it can be hard to distinguish the wind farm sound from the background sound. From inspection of aerial photographs it appears there are trees and other vegetation near most neighbouring properties to this site, which will contribute to background sound.

District Plan

12. The proposed wind cluster is in the rural zone of Dunedin City. There is no specific reference to wind farm noise within the district plan. Rule 21.5.1 of the district plan sets general noise limits for permitted, controlled and restricted discretionary activities with reference to Noise Maps. From these maps the noise limits at the nearest neighbours are 50 dB L_{A10} during the day and 40 dB L_{A10} at night. These noise limits are typical of many district plans and I consider they are generally appropriate for rural areas, albeit more stringent than guidance in NZS 6802.

13. I note the district plan uses a non-standard definition of 'notional boundary' for assessment locations as being 50 metres from houses, rather than 20 metres from houses as defined in NZS 6802, NZS 6808 and all other district plans I have referenced. The area around the wind farm is not identified in the district plan as having high acoustic amenity.

14. The L_{A10} parameter used in the district plan represents the sound level exceeded for 10% of the time during a measurement. Thus it measures the peaks of sound, which for many activities correlates well with the source being assessed. However, when it is windy the level measured as being exceeded for 10% of the time is generally determined by the sound of vegetation moving or other transient sounds. It does not correlate well with steady sound from wind turbines. For this reason sound level measurements are generally not made in windy conditions.

15. Rule 21.5.1 does not allow for measurement in significant wind, which is inherently present when a wind turbine is operating. Therefore these noise limits cannot be applied to the proposed wind cluster. Due to these

technical constraints, for my assessment I have applied the wind farm specific methods and recommended noise limits from NZS 6808. The proposed second generation district plan includes this noise limit for wind turbines from NZS 6808.

New Zealand Standard NZS 6808

16. NZS 6808 provides an assessment methodology for wind farm sound and recommended noise limits. Unless adopted in a district plan or consent condition, consideration of this standard is not mandatory, but it has been used for all recent wind farm projects in New Zealand and has been accepted by the Environment Court. The fundamental methodology is also well accepted internationally. The Standard includes a recommended noise limit of 40 dB L_{A90}, which can increase at higher wind speeds to 5 dB above the background sound level.

17. A key feature of NZS 6808 compared to the district plan noise limits is that the L_{A90} metric is used, which avoids undue effects of wind. The L_{A90} parameter represents the sound level exceeded for 90% of the time during a measurement. Thus it measures the 'background sound' which is always present and is not affected by peaks of sound.

18. For a constant sound source with no other sounds affecting measurements the values of the L_{A10} and L_{A90} parameters could be within 1 dB. However, for most measurements the L_{A10} is higher than the L_{A90}. For wind turbine sound it is not practical to directly correlate the L_{A10} noise limits in the district plan for general sources with the L_{A90} noise limits in NZS 6808 for wind turbines. However, in broad terms they should result in consistent noise outcomes.

19. The noise limits in NZS 6808 have been designed to provide protection from sleep disturbance and to maintain reasonable residential amenity. I consider this is the appropriate basis for assessing potential noise effects from the proposed Blueskin wind cluster.

20. NZS 6808 includes model consent conditions, which provide a clear and efficient way to give effect to the recommended noise limits. My acoustics assessment included proposed conditions based on the model conditions from NZS 6808.

Sound level predictions

21. In accordance with my directions, BRCT provided modelled sound levels around the wind cluster, based on a Gamesa G58 wind turbine. This included predictions for all noise sensitive locations in the vicinity of the site, as identified by BRCT. The predictions used the ISO 9613-2[4] propagation algorithm, as referenced by NZS 6808, implemented in WindFarmer software. This prediction method gives results for light downwind conditions in all directions simultaneously. While this is not physically possible, it provides a conservative assessment.

22. From the acoustics assessment, the predicted sound levels at the nearest neighbours are as follows:

Address	**Closest turbine**	**Predicted sound level, L_{A90}**
22 Pryde Road	679 m	37 dB
90 Pryde Road	471 m	41 dB
139 Pryde Road	917 m	34 dB
2197 Waikouaiti-Waitati Road	1073 m	33 dB
2142 Waikouaiti-Waitati Road	1172 m	31 dB
2100 Waikouaiti-Waitati Road	1134 m	32 dB
110 Porteous Road	551 m	39 dB
58 Reservoir Road	1456 m	29 dB

23. All predicted wind farm sound levels comply with a 40 dB L_{A90} noise limit, other than an exceedance of less than 1 dB at one location. From my experience at other wind farms, it is likely the daytime background sound will be at least 36 dB L_{A90} during this wind farm operation, which would result in compliance with the 'background + 5 dB' noise limit. Therefore, at all locations it is expected the wind cluster would comply with the NZS 6808 noise limit.

24. If following background sound level measurements it was found there would not be compliance, such as at night, the wind turbines could be programmed to reduce the sound levels (at the expense of power output) to maintain compliance with the noise limits. Such programming would adjust the angles of the wind turbine blades, or stop the wind

[4] ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors. Part 2 General method of calculation.

turbine altogether. The ability to make this programming is standard technology for many modern wind turbines.

25. I understand that Enercon wind turbines are now being considered for this site. In terms of sound levels they have essentially the same sound power (103.5 dB) as the Gamesa G58 turbine (103.6 dB) so can be used interchangeably without altering potential noise effects. Enercon has provided sound level predictions for their turbines on this site in slightly different (optimised) positions to those modelled previously, and include scenarios for several different turbine variants and heights. However, otherwise the predictions use the same methodology applied for the Gamesa turbines discussed above in paragraph 21.

26. I have attached example modelling results for the Enercon turbines as **Appendix A** to my evidence. The first result sheet shows predicted sound levels similar to those in the table in paragraph 22 above. This includes one location (90 Pryde Road) with a predicted sound level between 40 dB and 41 dB, when all three turbines are operating at 800 kW. The second sheet shows how a standard control setting, capping the power of one of the turbines at 600 kW, reduces the predicted sound level to below 40 dB. On this basis I am confident the proposed wind farm can comply with the noise limits in NZS 6808.

27. The modelling results in Appendix A are for Enercon turbines with a 50 metre hub height. I have used this data as it demonstrates the effect of the control settings as discussed above. I have also reviewed modelling for Enercon turbines with a 60 metre hub height, which results in marginally lower predicted sound levels at the nearest houses. Therefore, a turbine option with a 60 metre hub height and 53 metre rotor diameter would also comply with the noise limits in NZS 6808.

28. As the noise limits have been set in NZS 6808 to provide protection from sleep disturbance and maintain reasonable residential amenity, I therefore consider the predicted wind farm sound levels will result in acceptable noise effects.

Compliance Monitoring

29. I have recommended consent conditions based on NZS 6808. This includes a requirement for a 'compliance assessment report' to be submitted to the Council within 3 months of the wind cluster becoming operational. Extensive sound level measurements will be required at the nearest three houses to establish the background and wind farm sound levels under a representative range of wind speeds and directions. I have previously directed this commissioning process for the Mt Stuart and Mill Creek wind farms and consider it is a robust and reliable method to confirm compliance with the noise limits.

Submissions

30. I have reviewed submissions that BRCT has identified as raising acoustics issues. I will now address specific issues raised by submitters, but will not make further comment on individual submissions which only raised 'noise' in a general manner.

Denis Albert

31. Mr Albert raises several points relating to my assessment. Firstly with respect to the modelling Mr Albert highlights that BRCT provided the sound level contours. I confirm that I have checked these contours; they have been produced using an appropriate method and inputs; and the results are in accordance with my expectations.

32. Mr Albert has questioned the confidence limits and sensitivity of the predicted sound levels. Practical application of the method used has shown such predictions to be conservative for wind farms with measured levels normally below predicted levels, and if above predicted levels typically by no more than 1 dB. The main inputs used are the locations of the turbines and houses, and the sound power of the wind turbines. These inputs are set out in my assessment and in my opinion do not require any sensitivity analysis. For other parameters conservative values have been used. Critically, regardless of the predicted sound levels, compliance is to be demonstrated through extensive commissioning sound level measurements.

33. The submission also discusses meteorological and topographic effects. I confirm that modelling light downwind propagation provides a conservative assessment and this will not be further enhanced in the prevailing wind directions. Furthermore, sound reflections from the topography of the area are not able to significantly enhance sound levels at houses more distant than those considered in my assessment. By assessing and measuring the sound levels at the nearest houses I am confident that levels will also be controlled at all houses in the wider area. This approach is standard for all environmental sound sources.

34. Mr Albert makes reference to unnamed research into infrasound effects from wind turbines. Numerous researchers have in fact demonstrated that wind turbines do not generate significant infrasound. A recent study conducted in New Zealand[5], published in a peer reviewed international journal, has again shown that infrasound from wind farms is below perception thresholds.

Mecaela Baird

35. Ms Baird submits there will be constant noise from the wind cluster and health issues. The sound of the wind turbines will vary depending on the wind speed and direction. For much of the time, including during quiet still evenings, the turbines will not be operating and there will be no wind farm sound. At locations beyond the nearest neighbours the wind farm is unlikely to be audible most of the time. I have recently directed the commissioning sound measurements for the Flat Hill wind farm near Bluff, where I understand the wind turbines are not audible in the surrounding area.

36. The noise limits recommended by NZS 6808 are set in line with World Health Organisation guidelines to protect health. My recommended consent conditions require compliance with these limits and extensive commissioning measurements to ensure ongoing compliance.

[5] Botha, P. *Ground vibration, infrasound and low frequency noise measurements from a modern wind turbine*. Acustica (99), pp 537-544. 2013

Jillian Borrie

37. Ms Borrie asserts there will be noise and vibration effects. As I have set out in my evidence, wind farm sound will be within acceptable limits at all nearby houses, and while some wind farm sound is likely to be audible it will be at a reasonable level. The study I referenced on infrasound[5], also included measurements of ground vibration and showed it to be substantially below thresholds of perception.

Thomas Cardy and Jamie Pickford

38. These submitters live at 139 Pryde Road, which is predicted to have a wind farm sound level of 34 dB. The submitters have questioned the assumption of light downwind propagation with respect to effects at higher wind speeds and under the prevailing wind directions. The modelled propagation takes account of the prevailing wind direction, and all other directions by assuming all houses are downwind of the wind farm. The predictions are for the maximum sound output of the wind turbines which represents high wind speeds. However, at higher wind speeds, sound propagation to houses is disrupted by air turbulence. Therefore, the assumption of light downwind conditions is appropriate. This is also the basis on which all other wind farms in New Zealand have been assessed.

39. The submitters are concerned about the effects of wind farm sound at their house. The wind farm is likely to be audible at times but at a reasonable level. During the daytime the wind farm sound will be substantially below the general district plan noise limit for permitted activities. It will also be below the general district plan noise limit for permitted activities at night.

Philip Clarke

40. Mr Clarke raises issues with wind farm sound. He references 'large wind turbines' but I note those proposed in the Blueskin wind cluster are only of modest size, similar to the Mt Stuart and Flat Hill wind farms. He also references large numbers of noise complaints made with respect to Meridian Energy Ltd's Te Apiti wind farm. I have made enquiries

regarding this and I understand from Meridian that it has not received any complaints about that wind farm in the last seven years.

Lyndon and Kirsty Clayton

41. Mr and Ms Clayton live at 22 Pryde Road, which is predicted to have a wind farm sound level of 37 dB.

42. Paragraph 4.2 of the submission references the potential exceedance of the 40 dB L_{A90} component of the noise limit at 90 Pryde Road. However, it does not acknowledge the integral "background + 5 dB" component of the recommended noise limits in NZS 6808. It is incorrect to infer non-compliance on the basis of just part of the noise limit.

43. Paragraph 4.3(a) refers to potential changes to the wind turbine type and locations. I agree this is an issue that needs to be addressed and I have therefore recommended a consent condition requiring a prediction report to be submitted to Council if there are any changes to the turbine types or locations.

44. Paragraph 4.3(b) refers to existing background sound levels at the property. I note that in terms of the noise limits, as the wind farm sound is predicted to comply with 40 dB L_{A90}, the "background + 5 dB" component of the noise limit should not be relevant in this location. As I have discussed for other nearby properties, it is likely that wind farm sound will be audible at times but at a reasonable level.

45. Paragraph 4.3(c) asserts there has been no assessment of whether a more stringent noise limit should be applied in accordance with clause 5.3 of NZS 6808. This is incorrect. I have reviewed the district plan and, as set out in my acoustics assessment, the noise limits for permitted activities are standard (40 dB L_{A10} at night) and there is nothing that identifies the area around the proposed wind cluster as having unusual or special acoustic amenity. On this basis, clause 5.3.1 of NZS 6808 is clear that a more stringent 'high amenity noise limit' is not appropriate.

46. Paragraph 4.3(d) questions why the district plan noise limits have not been applied. As I have set out in my acoustics assessment and above, compliance with the district plan noise limits cannot be assessed in the

presence of significant wind. Therefore it is not technically possible to apply them to a wind farm. Contrary to the submission, I am not aware of any other wind farms in New Zealand that use the district plan noise limits. The noise limits adopted from NZS 6808 result in noise outcomes consistent with those provided by the district plan noise limits for other sound sources.

47. Paragraph 4.3(e) notes there is an additional dwelling at 22 Pryde Road that has not been explicitly listed in the table of predicted sound levels. In terms of assessing wind farm sound effects, both dwellings will be exposed to similar levels. I have recommended that 22 Pryde Road should be one of three locations used for compliance monitoring, if access is allowed by the owners. By default the measurement location should be 20 metres towards the wind farm from the nearest of the two dwellings, unless that location is subject to screening or excessive background sound. This would be standard practice when conducting the monitoring in accordance with NZS 6808.

48. Section 5 of the submission raises a question about potential vibration effects. As I have stated above, evidence[5] shows there will be no perceptible wind turbine ground vibration or adverse vibration effects at 22 Pryde Road.

49. Section 9 discusses construction effects including construction noise. Due to the separation distances involved, construction noise effects from wind farms are usually straight-forward to manage. Construction noise is exempt from the district plan noise limits, but with standard construction practices the wind farm should be able to comply with the recommended noise limits in NZS 6803[6]. While there may be some temporary disturbance from construction noise this should remain at a reasonable level.

Gareth Hughes (15 Bay Road, Warrington)

50. Mr Hughes asserts that infrasound from the wind farm would cause health problems for people with sensitive ears. As I have stated with respect to other submissions, evidence[5] shows that infrasound will be

[6] New Zealand Standard 6803:1999 Acoustics – Construction noise

below perception thresholds. There is commonly infrasound in the environment from a range of sources, including the wind and waves, at levels higher than generated from wind farms.

Ross Jackson

51. Mr Jackson also raises concerns with infrasound, and for the reasons set out above this is not an adverse effect that would arise from the proposed wind cluster.

Paul Jouanides

52. Mr Jouanides notes that information found on the internet links wind farm sound with various health effects. It is correct that a large number of assertions have been made relating to wind farm sound and published online. However, international scientific studies, generally initiated by government health agencies, have consistently shown these assertions to be incorrect. A summary of studies that show these assertions to be incorrect has been compiled by Professor Simon Chapman of Sydney University School of Public Health and Teresa Simonetti, Sydney University Medical School[7]. Further discussion of these issues has been published in a paper led by researchers at the University of Auckland[8].

Lorna McMullan

53. Ms McMullan raises concerns about ground vibration from wind turbines. As I have set out above, vibration from the wind cluster will be substantially below thresholds of perception at neighbouring properties.

Rachel Ozanne

54. Ms Ozanne raises numerous concerns with respect to wind farm sound. In paragraph 1.3 she notes that no background sound measurements have been conducted and discusses sound levels that might currently exist. It is agreed that under still conditions many rural areas have relatively low sound levels in the evening and at night. At times wind

[7] Chapman, S. and Simonetti, T. *Summary of main conclusions reached in 25 reviews of the research on wind farms and health*. University of Sydney working paper http://hdl.handle.net/2123/10559, accessed 2 Jan 2016.
[8] Crighton, F. et. al. *The Link between Health Complaints and Wind Turbines: Support for the Nocebo Expectations Hypothesis*. Frontiers in Public Health 2(220). 2014.

farm sound levels may be higher than existing background sound and would be audible. However, the aim of NZS 6808 is not to result in inaudibility but to restrict wind farm sound to a reasonable level.

55. Ms Ozanne references a comment relating to a sound level of 40 dB providing a distraction to learning, but this would relate to the environment inside a classroom and not outside a rural dwelling, although even then, classroom sound levels are generally higher.

56. In paragraph 1.4 Ms Ozanne asserts my conclusion that sound levels will result in acceptable noise effects is 'flippant'. My conclusion is firmly based on compliance being achieved with the noise limits in NZS 6808, which have been explicitly set to *"provide reasonable protection of health and amenity at noise sensitive locations"*[9].

57. In paragraphs 1.5 and 1.6 Ms Ozanne refers to studies promoting set-back distances to control wind farm sound. The potential noise effects of wind farms are dependent on the turbine types, layout, topography, and the existing environment, as well as the distance between a turbine and a house. All of these factors are included in an assessment under NZS 6808 but would be omitted by just considering a set-back distance. I therefore consider the use of a set-back distance is not appropriate as it does not relate to the actual noise effects experienced at a receptor. The issues raised by Ms Ozanne have previously been put before the Environment Court, and a distance based criterion was rejected[10].

58. In paragraphs 1.7 to 1.9 Ms Ozanne refers to infrasound and low frequency sound effects. As I have previously set out, it has been repeatedly shown[5] that all parts of the frequency spectrum are appropriately controlled by the noise limits in NZS 6808.

59. In paragraphs 1.10 to 1.12 Ms Ozanne quotes extracts from World Health Organisation guidance. I confirm that NZS 6808 explicitly takes this guidance into account and it is addressed through the recommended noise limits.

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[9] NZS 6808:2010, Outcome statement
[10] 2013 NZEnvC 59, para 297

60. In paragraphs 1.13 and 1.14 Ms Ozanne criticises the sound modelling undertaken by BRCT. In my opinion the modelling is appropriate for the acoustics assessment, and use of more complex software would not increase predicted sound levels or alter my conclusions.

Simon Ryan and Jennifer Ashby

61. The submitters live at 90 Pryde Road, which is predicted to have a wind farm sound level of 41 dB. The submission details several matters, which are the same as those in the submission of Mr and Ms Clayton. I will not repeat the comments I have already made with respect to the submission of Mr and Ms Clayton, where the same issue is raised.

62. Paragraph 4.3(b) refers to existing background sound levels at the property. It is stated the wind farm sound may exceed both the 40 dB L_{A90} and the "background + 5 dB" components of the noise limit. This is not correct as if the wind farm cannot comply with one of these components of the noise limit then as set out in my acoustics assessment the operation of the turbines will need to be constrained by the control system. Measurements of the existing background sound at this location will be required before the wind farm is commissioned, if the owner agrees to access.

63. Paragraph 4.3(e) states that topographic features may increase the sound levels experienced at 90 Pryde Road. While reflections from hillsides are sometimes audible, due to a proportion of sound being diffracted and the increased distance sound has to travel across a valley and back, the contribution of such reflections to predicted wind farm sound levels is minimal. In any event, any contribution of reflected sound will be included when sound levels are measured during commissioning.

Friederike Schmaltz

64. Mr Schmaltz submits that sound from wind farms is unpredictable. I disagree as sound levels from the proposed wind farm have been predicted. While the predictions are generally conservative, they are appropriate for assessing the potential effects.

Cathrin Stewart

65. Ms Stewart raises concerns about ground vibration from wind turbines. As I have set out above, vibration from the wind turbines will be substantially below thresholds of perception at neighbouring properties.

Geraldine Tait

66. Ms Tait submits there is no information on wind turbines to allow an assessment of noise. In my acoustics assessment I have clearly set out the basis for the sound level predictions including an assumed wind turbine. If a different turbine is used I have recommended a consent condition that would require a prediction report to be submitted to the Council. This methodology is in accordance with NZS 6808.

Thomas and Linda Thompson

67. Mr and Ms Thompson submit that low frequency noise may be an issue. For the reasons I have detailed with respect to other submitters, low frequency noise will be appropriately controlled by the noise limits taken from NZS 6808.

Peer review

68. The Dunedin City Council commissioned a peer review of my acoustics assessment by Malcolm Hunt Associates (MHA). The review was provided in a report dated 30 November 2015. In general, the MHA peer review has confirmed the approach I have adopted in my assessment, but it has raised an issue around the timing of the measurement of background sound levels.

69. MHA has confirmed my interpretation of the district plan and agrees NZS 6808 should be used for the assessment.

70. In section 3.1 of the review MHA notes that alternative turbines could be used. As I have stated previously, I consider any change to the turbine type should be subject to a prediction report being submitted to Council in accordance with NZS 6808 (clause 8.4.2).

71. In sections 3.3 and 4 MHA notes that background sound level measurements are required to set noise limits. I agree. MHA also notes that 'on/off' measurements should not be used in this instance. I agree that full background sound level measurements are required at the three nearest receivers prior to the wind farm construction. It might have been preferable for these background sound measurements to have been conducted prior to the resource consent application having been made, but in my opinion this is not essential for the acoustics assessment.

72. For other projects I have found that background sound level measurements have only provided limited value in the acoustics assessment, and often they need to be repeated due to the delay between initial investigations and wind farm construction. For example, if I had conducted background sound measurements at the time of my assessment in 2013, they would probably need to be repeated prior to the wind farm construction at some point in the future. I consider this to be an unnecessary duplication that can be avoided by conducting the measurements closer to the time of construction. In the interim, conservative assumptions can be made about the nature of the existing environment.

73. I agree with MHA that compliance with noise limits should not be obtained or demonstrated on the basis of 'trial and error'. There should be certainty prior to construction of the wind farm that the noise limits will be achieved. Prior to construction a prediction report should be prepared for the final turbine type and locations in accordance with clause 8.4.2 of NZS 6808, and background sound levels should be measured in accordance with section 7.4 of NZS 6808. This report should set out any requirements for turbines to operate in reduced power modes if necessary to maintain compliance with the noise limits.

74. I did not previously recommend a consent condition explicitly requiring background sound measurements, but these would have been required to fulfil the other conditions. However, in response to the findings of MHA, I recommend an additional condition to those set out in my acoustics assessment, as follows:

X. Prior to the construction of the wind farm, a background sound level report shall be submitted to the Dunedin City Council in accordance with section 8.2 of NZS 6808:2010. Background sound shall be measured at the three assessment positions specified in condition X. If access to these locations is not granted then alternative positions may be used subject to approval by the Dunedin City Council.

75. Section 5 of the MHA report briefly discusses wind turbine ground vibration. As discussed above, published data shows that vibration outside the wind farm site will be negligible.

76. Section 6 of the MHA report discusses wind farm construction noise and vibration effects. I agree with MHA that construction noise should be managed in accordance with NZS 6803.

Section 42A Report

77. The s42A report includes a memorandum from the Environmental Health Officer Carlo Bell, discussing wind turbine sound. Mr Bell has undertaken background sound level measurements at the three nearest houses to the proposed wind cluster. He measured relatively low sound levels under calm conditions, under which wind turbines would probably not operate, and higher background sound levels when it was windy. These measurements are typical for a rural area and are in accordance with my expectations.

78. Mr Bell asks a number of questions in his memorandum, for which I have the following responses:

Q1. Are predicted noise levels created by the wind turbines and the 35 dB L_{A90} contour likely to be a realistic estimation?

Yes, the predictions have been made using an internationally standardised method that has been used for numerous wind farms and consistently shown to provide a realistic estimation.

Q2. Is the estimated background daytime noise level of 36 dB L_{A90} realistic and how will this relate to the night-time background?

As indicated by Mr Bell's measurements, the background sound level might be lower than estimated. If this is the case the wind turbine programming will be adjusted to meet a 40 dB L_{A90} noise limit as I have discussed above.

Q3. The acoustic assessment suggests there is not likely to be any effects from low frequency noise or tonality associated with these turbines. Is this likely to be the case?

Yes, the certification testing of the turbines includes analysis of tonality and as this is not shown to be present near the turbine it will not occur at the nearest houses. The standard noise limits will appropriately control low frequency sound.

Q4. NZS 6808 refers to a limit of 40dB LA90 for noise received at sensitive dwellings. Is this an appropriate limit in this location or could the area be considered to be high amenity as per 5.3 of NZS 6808 given low background sound levels and if so what limit would be appropriate?

Mr Bell's memorandum sets out the standard district plan noise limits for other sources, and these do not provide for greater protection of this area than other rural areas in New Zealand in terms of noise. In my opinion, in accordance with section 5.3.1 of NZS 6808 this is therefore not a high amenity area and the standard noise limits from NZS 6808 are appropriate.

Q5. To what degree is the effect of wind likely to 'mask' the noise of the wind turbines? Could the turbines perhaps only cause a noise nuisance at certain wind speeds meaning that wind-speed limits on the operation, at certain times of the day may be required?

When operating the wind turbines will often be audible at the nearest houses. However, the sound will be at a reasonable level that should not cause undue disturbance or nuisance. As alluded to by Mr Bell, the extent to which the wind turbines are audible will vary, but the sound levels should always remain reasonable.

Q6. Would the conditions suggested by the applicant to address any noise nuisance be adequate? Are any other conditions considered necessary?

I will discuss conditions below.

79. In the Section 42A report itself, Darryl Sycamore, largely adopts the advice provided by Mr Bell and Mr Hunt. I will not repeat my comments already set out above with respect to their reports.

80. I note that in paragraph 71 of the Section 42A report Mr Sycamore attributes a statement to my acoustics assessment relating to the risk of non-compliance with the noise limits. This statement was not made in my assessment, and in fact my opinion is the opposite. With the conditions I recommend I am confident that the wind cluster will comply with the noise limits.

Conditions

81. Mr Sycamore recommends four conditions to control wind turbine sound levels, numbered 19 to 22. I agree with the intent of all of the conditions proposed by Mr Sycamore. The only correction that would be essential to those conditions is that three instances of "L_{95}" should be changed to "L_{90}" in accordance with NZS 6808.

82. While I agree with the intent of the conditions proposed by Mr Sycamore, there are various technical issues they do not address, which would be resolved by referring to NZS 6808 as I have done in the conditions proposed in my assessment. I recommend that conditions 19 to 22 in the Section 42A report should be replaced with the following:

19. The consent holder shall ensure that, at the assessment positions in condition 21, at any wind speed, wind farm sound levels do not exceed the greater of 40 dB $L_{A90(10\ min)}$ or the background sound level $L_{A90(10\ min)}$ plus 5 dB.

20. Wind farm sound shall be measured and assessed in accordance with NZS 6808:2010.

21. The assessment positions shall be outside at the noise sensitive locations, defined in accordance with NZS 6808:2010, at:
(a) 22 Pryde Road
(b) 90 Pryde Road
(c) 110 Porteous Road

22A. Prior to the construction of the wind farm, a background sound level report shall be submitted to the Dunedin City Council by email to rcmonitoring@dcc.govt.nz, titled 'LUC-2015-469 Background Sound Data', in accordance with section 8.2 of NZS 6808:2010. Background sound shall be measured at the assessment positions in condition 21. If access to these locations is not granted then alternative positions may be used subject to approval by the Dunedin City Council.

22B. A prediction report shall be submitted to the Dunedin City Council by email to rcmonitoring@dcc.govt.nz, titled 'LUC-2015-469 Sound Level Predictions', in accordance with section 8.4.2 of NZS 6808:2010, unless the selected wind turbine layout is the same as a layout for which predictions were provided in the application, and the selected wind turbines have sound power levels no greater than the levels used in those predictions.

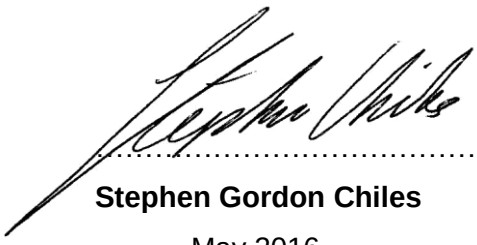
22C. A compliance assessment report shall be submitted to the Dunedin City Council by email to rcmonitoring@dcc.govt.nz, titled 'LUC-2015-469 Sound Level Compliance', in accordance with Section 8.4.1 of NZS 6808:2010.

Conclusions

83. I have conducted a detailed acoustics assessment for the proposed Blueskin wind cluster. On the basis that predicted wind farm sound levels can comply with the recommended noise limits in NZS 6808, which have been set to protect health and reasonable amenity, I consider the acoustics effects of the proposed wind cluster are acceptable.

84. I have reviewed all submissions made relating to noise effects. I have also considered the peer review by MHA. None of the issues raised in submissions alter the conclusions I previously reached. I have clarified

issues raised by submissions, and recommended an addition to the consent conditions I previously proposed to address the issue of background sound level measurements raised by MHA.



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Stephen Gordon Chiles

May 2016

Appendix A

Sound level predictions for Enercon wind turbines

Project:
Dunedin (NZ)

IC16020PO
Blue Skin

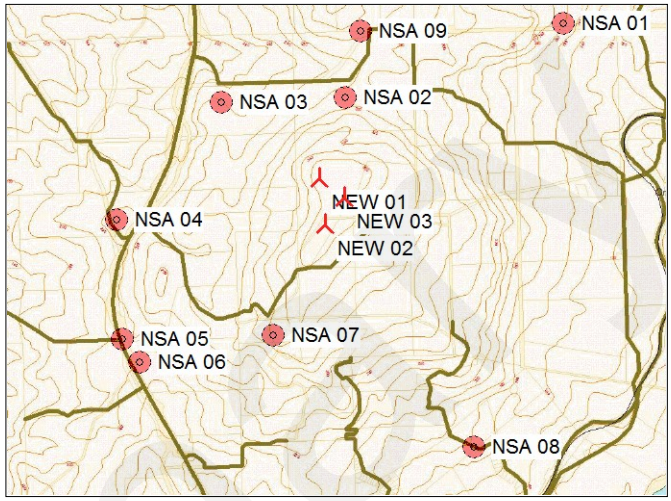
Description:
Please notice, that the sound power level of the ENERCON turbines demonstrate the official value by ENERCON GmbH. The adjusted octave band sound power levels are scaled to fit the declared sum level. Only the sum level at 95% rated power is the official value, not the individual octave band levels! This calculation was made without visiting the site and is based on information provided by the customer. In case of discrepancies of site coordinates, ENERCON does not take any responsibility for calculated sound pressure values at considered noise sensitive areas (NSA). The calculation did not include an elevation model. The results represent a calculation for the customer only and are not meant to be submitted to planning authorities.

Licensed user:
ENERCON GmbH Aurich
Dreekamp 5
DE-26605 Aurich
04941/927-0
Henriette Labsch / Site Assessment
Calculated:
18.02.2016 13:00/3.0.639

DECIBEL - Main Result

Calculation: Additional/Total Noise Impact: B01 - 3x ENERCON E-48 (50m hh)

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, fixed, Ground factor: 0,5
Meteorological coefficient, C0:
0,0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are mean values (Lwa) (Normal)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
1,5 m Allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0,0 dB(A)



Scale 1:40.000

New WTG Noise sensitive area

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
NEW 01	170°34,9390' E	-45°41,3550' S	390,0	ENERCON GmbH E-48 800 48.0 !O!...	Yes	ENERCON GmbH	E-48-800	800	48,0	50,0	USER	SPL official OM I Rev. 1.0 (800 kW) + 1 dB safety margin	(95%)	103,5	No
NEW 02	170°34,9570' E	-45°41,4860' S	390,0	ENERCON GmbH E-48 800 48.0 !O!...	Yes	ENERCON GmbH	E-48-800	800	48,0	50,0	USER	SPL official OM I Rev. 1.0 (800 kW) + 1 dB safety margin	(95%)	103,5	No
NEW 03	170°35,0380' E	-45°41,4120' S	386,3	ENERCON GmbH E-48 800 48.0 !O!...	Yes	ENERCON GmbH	E-48-800	800	48,0	50,0	USER	SPL official OM I Rev. 1.0 (800 kW) + 1 dB safety margin	(95%)	103,5	No

Calculation Results

Sound Level

Noise sensitive area No.	Name	Longitude	Latitude	Z [m]	Imission height [m]	Demands Noise [dB(A)]	Sound Level From WTGs [dB(A)]	Demands fulfilled ? Noise
NSA 01	139 Pryde Road	170°35,9670' E	-45°40,9340' S	172,8	1,5	40,0	29,5	Yes
NSA 02	90 Pryde Road	170°35,0600' E	-45°41,1250' S	294,4	1,5	40,0	40,6	No
NSA 03	22 Pryde Road	170°34,5530' E	-45°41,1290' S	235,3	1,5	40,0	37,1	Yes
NSA 04	2197 Waikouiaiti-Waitati Road	170°34,1040' E	-45°41,4550' S	230,0	1,5	40,0	32,9	Yes
NSA 05	2142 Waikouiaiti-Waitati Road	170°34,1060' E	-45°41,7960' S	215,0	1,5	40,0	31,3	Yes
NSA 06	2100 Waikouiaiti-Waitati Road	170°34,1740' E	-45°41,8630' S	197,9	1,5	40,0	31,3	Yes
NSA 07	110 Porteous Road	170°34,7240' E	-45°41,7970' S	345,9	1,5	40,0	37,3	Yes
NSA 08	58 Reservoir Road	170°35,5210' E	-45°42,1350' S	137,4	1,5	40,0	29,9	Yes
NSA 09	Quarry on Pryde Road	170°35,1380' E	-45°40,9390' S	303,4	1,5	40,0	35,5	Yes

Distances (m)

	WTG		
NSA	NEW 01	NEW 02	NEW 03
NSA 01	1545	1662	1496
NSA 02	454	682	532
NSA 03	653	844	819
NSA 04	1099	1108	1215
NSA 05	1355	1245	1403
NSA 06	1368	1233	1398
NSA 07	865	650	821
NSA 08	1630	1407	1478
NSA 09	812	1040	885

Project:
Dunedin (NZ)

IC16020PO
Blue Skin

Description:
Please notice, that the sound power level of the ENERCON turbines demonstrate the official value by ENERCON GmbH. The adjusted octave band sound power levels are scaled to fit the declared sum level. Only the sum level at 95% rated power is the official value, not the individual octave band levels! This calculation was made without visiting the site and is based on information provided by the customer. In case of discrepancies of site coordinates, ENERCON does not take any responsibility for calculated sound pressure values at considered noise sensitive areas (NSA). The calculation did not include an elevation model. The results represent a calculation for the customer only and are not meant to be submitted to planning authorities.

Licensed user:
ENERCON GmbH Aurich
Dreekamp 5
DE-26605 Aurich
04941/927-0
Henriette Labsch / Site Assessment
Calculated:
18.02.2016 12:59/3.0.639

DECIBEL - Main Result

Calculation: Additional/Total Noise Impact: B02 - 3x ENERCON E-48 (50m hh) red. power

Noise calculation model:
ISO 9613-2 General
Wind speed:
Loudest up to 95% rated power
Ground attenuation:
General, fixed, Ground factor: 0,5
Meteorological coefficient, C0:
0,0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are mean values (Lwa) (Normal)
Pure tones:
Pure and Impulse tone penalty are added to WTG source noise
Height above ground level, when no value in NSA object:
1,5 m Allow override of model height with height from NSA object
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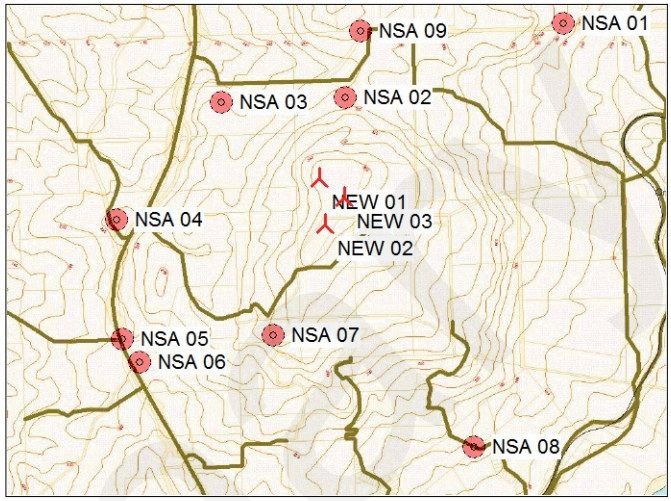

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New WTG Noise sensitive area

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			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
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NEW 02	170°34,9570' E	-45°41,4860' S	390,0	ENERCON GmbH E-48 800 48.0 !O!...	Yes	ENERCON GmbH	E-48-800	800	48,0	50,0	USER	SPL official OM I Rev. 1.0 (800 kW) + 1 dB safety margin	(95%)	103,5	No
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