STATE OF VERMONT
PUBLIC SERVICE BOARD

Docket No. 7156

Petition of UPC Vermont Wind, LLC for a Certificate of)
Public Good pursuant to 30 V.S.A. sections 231 and 248,)
authorizing it to construct up to a 52 MW wind electric)
generation facility, and associated transmission and)
interconnection facilities, in Sheffield and Sutton, Vermont,)
and operate the same.)

PREFILED REBUTTAL TESTIMONY OF CHRISTOPHER J. BAJDEK and CHRISTOPHER MENGE

ON BEHALF OF UPC VERMONT WIND, LLC

September 25, 2006

Summary:

Mr. Bajdek and Mr. Menge respond to the concerns raised by other parties regarding noise from the Project. They also discuss how the revised project layout affects potential noise. While Mr. Bajdek and Mr. Menge disagree with a number of technical criticisms made by other parties, these criticisms have not raised issues that change their fundamental conclusions for this Project: that project sound levels will not pose undue adverse impacts.

Exhibits

UPC-CB-Reb1	Resume of Christopher Menge
UPC-CB-Reb2	Letter from Clipper re noise issues (September 21, 2006)
UPC-CB-Reb3	Revised Noise Map – with and without vegetation

Q. Please state your name and occupation.

Response. My name is Christopher J. Bajdek. I am Senior Consultant at Harris, Miller, Miller & Hanson, Inc., 77 South Bedford Street, Burlington, MA 01803.

My name is Christopher Menge. I am a Principal Consultant and Senior Vice President at Harris, Miller, Miller & Hanson, Inc., 77 South Bedford Street, Burlington, MA 01803.

Q. Have you previously filed testimony in this proceeding?

Response. I, Christopher Bajdek, did prefile direct testimony.

I, Christopher Menge, am testifying in this case for the first time. My background and experience are described in the attached resume, ***Exhibit UPC-CB-Reb1***.

Q. Please summarize your testimony.

Response. We respond to issues presented in the prefiled direct testimony of RPI/UHS witness Peter Guldberg and Town of Sutton witness Kenneth Kaliski, and present revised noise modeling results for the revised project layout. While we disagree with a number of their technical criticisms, our overall assessment is that Guldberg and Kaliski have not raised issues that change our fundamental conclusions for this Project: that the sound levels at the closest receptors will be relatively low, will be below appropriate noise standards, will not pose special problems related to low frequencies or rhythmic beating, and will not pose an undue adverse impact on aesthetics.

In connection with our rebuttal testimony, we have reviewed prefiled testimony related to noise which was filed by RPI/UHS, the Town of Sutton, the Department of Public Service, the Burringtons, and Donald Gregory. We have also reviewed discovery responses, and performed additional analyses and noise modeling (using the revised project layout described in the Cowan rebuttal testimony).

Q. UHS/RPI witness Mr. Peter Guldberg claims that your sound power data are incomplete, especially for low frequency sounds, and do not conform to International Standard IEC 61400-11 for wind turbine generator systems (Guldberg PFT pg. 2, lines 23-25). How do you respond?

Response. The only sound-level data that was available to HMMH for the proposed Gamesa turbine was the octave-band data shown in the Noise Study Report. Therefore, the analysis needed to be conducted in those octave bands. However, a different turbine has been proposed by UPC for the project, and the noise data from that turbine are in 1/3-octave bands, and cover the full frequency range recommended in the IEC standard.

We would like to point out that our analysis reported in the Noise Study Report shows that the projected wind turbine noise in the lowest frequency band that we did evaluate is below the human threshold of hearing in all of the surrounding noise-sensitive areas, and at frequencies lower than that, wind turbine noise will also be inaudible. This is because at frequencies below the range we studied, the threshold of human hearing increases at a much faster rate than does the noise emitted from wind turbines comparable to the proposed Gamesa turbine.

Q. Mr. Guldberg claims that HMMH's noise analysis did not properly assess narrow-band frequency, tonality, adverse impacts of audible tones and low frequency, or model worst-case operational conditions. How do you respond (Guldberg PFT, pages 4, 5, 9, 11, 13, and 14)?

Response. No narrow-band or tonality analysis could have been performed, because HMMH had no narrow-band data from the turbine manufacturer (Gamesa) to work with. However, HMMH would not have needed to perform a narrow-band or tonality analysis such as Mr. Guldberg suggests, since any tonal sounds created by modern wind turbines are abated so that they are not audible in the surrounding areas. Note that in response to discovery requests, Mr. Guldberg provided papers by Mr. van den Berg, (Attachment A:1.1078 (p.5)) which state "all experts say that modern wind turbines do not produce tonal sound" and in Attachment A:1.1077 p.3 "…turbulent flow is the dominant cause of (audible) sound for modern wind turbines. It is broad-band noise with no tonal components…" HMMH did not evaluate any "potential adverse effects" of audible tones for these reasons.

With respect to the Clipper turbines, Clipper is in the process of making design changes as it moves from its prototype turbine to the actual production units in order to resolve any potential tonality issues. See ***Exhibit UPC-CB-Reb2***. In addition, we understand from UPC that Clipper provides a sound warranty which will ensure that the actual turbine units delivered will meet all turbine specifications and comply with all applicable permit conditions. Consequently, we do not believe tonality will be an issue for this Project.

Low frequency noise was evaluated in detail on HMMH's analysis, in two different ways, as reported in the Noise Study Report for the Proposed Sheffield Wind Farm (February 14, 2006) on pages 34 through 36 (Exhibit UPC-CB-2). The first method evaluated the audibility of wind turbine noise, and compared projected low-frequency wind turbine noise in the 31.5 Hz octave band (which includes sound energy down to 22 Hz, the lowest-frequency information available on the Gamesa turbine) to the existing background and to the threshold of hearing. It is clear from the graphs in Figure 10 that the projected maximum noise levels from all wind turbines at any of the receivers is below the human threshold of hearing by approximately 8 dB to 30 dB in the 31.5 Hz band.

HMMH has examined the more complete spectrum shapes of other wind turbines that are comparable to the Gamesa turbine originally proposed for this study. The low-frequency characteristics of comparable GE and Clipper turbines show that sound power levels generated by these turbines in the octave band centered at 16 Hz are between about 2 dB and 6 dB higher than those in the octave band centered at 31.5 Hz. We would expect similar values for the Gamesa turbine. The threshold of hearing at 16 Hz is 24 dB higher than the threshold at 31.5 Hz, according to Mr. Guldberg's Table 1 in the Cape Wind Noise Report (supplied by Guldberg in response to discovery question "Q.UPC:UHS/RPI.2-23" and labeled "Attachment A.UPC:UHS/RPI.2-23a."). Therefore, since the Gamesa turbine noise is below the threshold of audibility at 31.5 Hz, and the threshold of hearing is much higher than the potential turbine noise at 16 Hz, the Gamesa turbine would not be audible at frequencies lower than 31.5 Hz either.

The second way that HMMH evaluated low-frequency effects is presented in Section 5.2.2 of the Noise Study Report, and addresses the potential for perceptible vibration in residential structures from turbine noise. This analysis shows the projected maximum turbine noise levels to be well below the threshold for perceptible vibration at all frequencies.

Q. Mr. Guldberg claims your audibility analysis is flawed because it did not include a proper analysis of audible tones (PFT at page 10). How do you respond?

Response. The purpose of HMMH's audibility analysis was different from what Mr. Guldberg assumes. A tonal analysis was not performed for reasons given above. The audibility analysis presented in Section 5.2.1 of our report and in Figure 10 is a perfectly reasonable approach for characterizing a range of acoustical situations that are likely to arise in noise-sensitive areas near the Project. The purpose of the discussion is to show in what frequency ranges noise from the wind turbines would be comparable to or greater than the background noise, in which cases it would contribute to the overall noise level and likely be audible. Tonal analysis is not needed for this kind of comparison. The discussion shows how the lowest-frequency noise (31.5 Hz octave band) from the wind farm and also from the background is lower than the threshold of hearing. The discussion shows in the middle frequencies how there is overlap between the range of wind turbine noise and the range of background sounds, which indicates that there are locations and circumstances where wind turbine noise will contribute enough in that frequency range to be audible above the background noise, and circumstances where it will be well below the background and therefore not be audible. The discussion and figure show that in the upper frequencies above 2000 Hz, where the ear is particularly sensitive to sound, noise from the Project is expected to be well below the background for the most part, and below the threshold of hearing at many locations, and therefore expected to be mostly inaudible.

Q. Mr. Guldberg and Mr. Kaliski each take issue with several of the inputs used in your noise modeling of the proposed project, including: the assumption of a moderate nighttime inversion, the presence of vegetation, and ground absorption. Mr. Guldberg concludes that you have likely underestimated the potential maximum sound levels by 5 to 8 decibels collectively, due to assumptions regarding "moderate downwind" condition, nighttime inversion, vegetation, and ground absorption (Kaliski PFT, Q. 7; Guldberg PFT pg. 12-14 and 16). How do you respond?

Response. HMMH's noise analysis was conducted in a manner appropriate for the proposed wind farm and the surrounding community. The thrust of the analysis was to address public health and welfare, and aesthetics. Therefore, the analysis incorporated international standards for sound propagation (ISO 9613-2), used worldwide for the study of the effects of noise from ground-based noise sources of all kinds. ISO 9613-2 has provisions for the computation of long-term average sound levels, to which public health and safety noise criteria are usually applied. The standard also incorporates computations of noise levels under "meteorological conditions favorable to propagation from sources of known sound emission." The standard goes on "these conditions are for downwind propagation, . . . or, equivalently, propagation under a well-developed temperature inversion, such as commonly occurs at night." The purpose of these calculations is to determine shorter-term noise levels under worst-case atmospheric conditions. In our analysis, HMMH used the maximum noise level output of the turbines, along with the short-term downwind/temperature inversion propagation conditions of ISO 9613-2. We are not aware of a more justifiably appropriate sound propagation model that would be more protective of the community's interests than this international standard.

HMMH's SoundPLAN model for the UPC project was run both with and without vegetation included, and we found no difference, or small differences, at all of the locations. Because people are usually most affected by noise during the summer season when they spend more time outdoors and windows are open at night, our final noise contour runs were done with the vegetation included. However, the recent model runs with the new turbines (see discussion below) showed differences between including vegetation and not including it at only 36% (17 of 47) of the receiver positions. The average difference was only 0.5 dBA.

HMMH used the "soft ground" assumption within SoundPLAN and ISO 9613 because the ground in the study area fits that classification. SoundPLAN does compute the high average heights of the sound paths traveling from the turbines to the receiver locations, based on the actual turbine and receiver heights. And, the effect of the ground absorption is reduced with increasing average path height.

In conclusion, we believe that all of the assumptions we made were reasonable and very conservative, and did not in any way underestimate the wind turbine noise levels. Our conservative approach *overestimated* the turbine noise levels with the assumptions of maximum turbine output and downwind propagation for an entire day to all of the receivers – an unlikely scenario. Then, we made the very conservative extension of comparing this worst-case *day* to the EPA's *annual average* DNL noise guideline.

Q. Mr. Guldberg claims that your baseline sound level monitoring is inadequate and fails to show how low ambient sound levels are in inhabited areas near the project (Guldberg PFT pg. 14 and 15). Likewise, Mr. Kaliski claims at A. 4 of his PFT that the levels measured at M3 and M4 are extraordinarily high for a rural area, and that they are not representative of background sound for the majority of land uses around the project. How do you respond?

Response. Mr. Guldberg states in his prefiled testimony (P16, A24), "existing sound levels are extremely low during these nighttime inversion conditions." He suggests that existing background measurements should have been conducted when temperature inversions were present. On the contrary, in our experience, and in the experience of many of the professionals at HMMH, background noise levels in rural and suburban areas, which are often controlled by distant ground-based noise sources such as highways, are usually significantly higher during nights when temperature inversions are present. This is because the inversion refracts sound downward and allows noise from ground-based noise sources to travel longer distances via higher, curved paths, without the noise-reducing effects of intervening buildings, vegetation and soft ground. ISO 9613-2 uses calculation methods for downwind/temperature inversion propagation because they generate higher, rather than lower noise levels at long distances. Mr. Guldberg's testimony is also internally conflicting because in this section he argues that sound levels are lower under the downward-refracting inversion conditions, whereas he states elsewhere (pg. 12-13, A22) that downward-refracting wind conditions cause higher noise levels.

Mr. Kaliski states that the measurements are not "typical of background noise levels in the area" because "unusual" events occurred during the measurement period relating to a recent snow fall. First, we would not characterize the sounds of snow plows and chain saws after a snowfall to be "unusual" in northern Vermont. Secondly, HMMH's noise measurement period accomplished one primary objective of measuring background noise levels during calm, quiet times when such levels reach natural lows. That is the purpose of conducting noise measurements for more than just a few hours, so that hour-to-hour and some day-to-day variation in the background noise environment can be captured. The HMMH measurement program also accomplished that broader objective, as the first day was somewhat busier and windier than the second, and the second night was calm and quiet. In fact, the levels that night (during the early morning hours of 10/28/05) were very low, with L90's in the low 20's dBA at three of the four sites. These levels are so quiet that they are near the lowest measurable levels of HMMH's precision noise measurement instrumentation, and below the lowest measurable limits of many noise meters (30 to 35 dBA). And, the calm, quiet conditions are confirmed by the repeated low and nearly constant hour-to-hour L90 and L99 levels (see original HMMH Noise Study Report, Tables 7-9). Therefore, we can say with confidence that HMMH's noise measurement program encompassed an appropriate range of noise and atmospheric conditions that are likely to be common in and typical of the study area.

Finally, we should point out that these lowest background noise levels occur during the middle of the night when people are typically indoors. This makes the background acoustical environment and its relationship to sound from the wind turbines very different. In summer with windows open, wind turbine noise will be attenuated by 10 to 20 dB relative to outside levels, while the background noise levels will consist both of noise from outside, including crickets (which were not present during the measurement period and will increase the background levels), and noise from interior sources such as fans, refrigerators and air conditioners. With windows closed, exterior sounds will be reduced by between 20 and 30 dB, and interior sources will also include heating systems. A significant point to be made is that inside most of the surrounding homes when windows are closed, noise from the turbines will be below the threshold of hearing and inaudible even if there are no interior sources of sound.

Q. Mr. Kaliski expresses concern regarding the limited amount of spectral monitoring used for audibility analysis that you collected at the background monitoring sites (Kaliski PFT, A. 4). Mr. Guldberg also expresses concern about spectral monitoring. How do you respond?

Response. The background spectral data we collected were obtained during periods characteristic of quiet daytime hours (not peak traffic hours) at three of the measurement sites. We believe that these periods are reasonable representations of the ambient daytime noise environment, and provide a valid basis to which the noise from wind turbines was compared for purposes of determining audibility. The average overall A-levels during those spectral measurements were quite low at two of the sites, in the 30s.

Periods of quiet background noise, whether during the day or night, are typically controlled by the same sources, which include distant traffic, insects and light wind in the trees. At night, the background levels in the middle and low frequencies are lower than during the day because traffic activity and wind speeds are usually lower. When insects are not present, as was the case during HMMH's measurement program, the high frequencies also follow this pattern, therefore the patterns of the A-weighted sound levels are a reasonable surrogate for full-frequency spectrum data. As a result, we believe that the spectra we measured during the quiet daytime periods would be similar during quiet nighttime periods, but would be reduced in level by amounts comparable to the A-level differences.

Q. Mr. Kaliski claims that because there is no site-specific information regarding the wind speeds at the receptor locations versus at the proposed turbines, there is no basis to consider the potential effects of wind noise masking project-generated noise (Kaliski PFT A. 9). Mr. Guldberg also notes that no modeling was done to quantify masking (Guldberg PFT pg. 11, lines 13-17, A.20). How do you respond?

Response. Our analysis and conclusions about the masking effects of ambient wind were largely based on the published studies of Rogers and Manwell and of Bolin, both cited in the Noise Report. Rogers and Manwell concluded that "wind noise from large modern turbines during constant speed operation tends to increase more slowly with increasing wind speed than ambient wind-generated noise." These studies give us the confidence to make the reasonable statement we made in the noise report: "At times, noise from the wind farm may be masked by other sources, such as wind in the trees." Note that we did not include such ambient wind noise directly in the noise modeling or computations.

Q. Mr. Guldberg suggests you failed to conduct an impulsivity analysis and that the noise criterion you selected does not address the rhythmic "beating" character that is most objectionable. He states that the Project will likely create impulse noise that will adversely impact aesthetics at sensitive receptors within 2 km of the turbines, where there are homes and a boarding school (Guldberg pg. 3, lines 1-4, pg. 8, lines 4-10). How do you respond?

Response. We have seen no evidence that a high ridgeline location of a wind farm is likely to create rhythmic beating to the same degree that it might occur in less mountainous terrain. At UPC's proposed project, the revised layout is notably less uniform and with less regular spacing than at the site where Mr. van den Berg, the researcher cited by Mr. Guldberg, measured the beating effect. Also, the terrain is less mountainous. We would also point out that the effect that van den Berg has observed, while thoroughly presented, represents one study in one location. In an e-mail message to Mr. Guldberg (provided in discovery), Mr. van den Berg states that he is not aware of measurements of this phenomenon at other locations.

Also, Mr. van den Berg stated in the dissertation he references in the August 1, 2006 e-mail message to Mr. Guldberg (provided in discovery), that turbines can be designed to eliminate the beating effect. On page 117, Mr. van den Berg states: "When the impulsive character of the sound is heightened because of the interaction of several turbines in a wind farm, this may be eliminated by adding small random variations to the blade pitch, mimicking the random variations imposed by the atmospheric turbulence in daytime when this effect does not occur." While we are unaware whether such measures could be applied to the Clipper turbines, we do not see any evidence that a beating effect would occur at this Project.

Q. Mr. Kaliski claims that the project will be clearly audible and the noise out of character with the surrounding land uses (Kaliski PFT, A. 10). How do you respond?

Response. The spectrum shape of the ambient background sound is roughly similar to that of the proposed wind turbines, therefore we believe that it will not sound "out of character with the surrounding land uses." Figure 10 in our original Noise Study Report (Exhibit UPC-CB-2) shows the range of spectra as measured under existing conditions and projected from the wind farm. The spectrum shapes are very similar in the low frequencies, up to about 250 Hz. Above that frequency, the wind turbine noise drops somewhat relative to the background, so the sound will be more muted and having less influence on the speech frequency range between 250 Hz and 2000 Hz.

We have stated in our original report that sound from the Project is expected to be audible in the surrounding area at times. However, as described above, the character of the sound is not expected to be significantly different from that of the existing environment. And significantly, we have shown that the projected noise levels are well below the EPA's guidelines for health and safety protection (including sleep disturbance).

Q. Mr. Kaliski explains that a "worst-case" turbine noise / background noise differential is found by comparing a turbine that is operating at the highest sound power with the background sound levels that are lowest (Kaliski PFT, A. 8). The highest sound level that was modeled is approximately 38 dBA and the lowest background sound level at M1 is 23 to 24 dBA. This would yield a difference of 14 to 15 dBA. Do you agree with these calculations and their implication? Please explain.

Response. Mr. Kaliski's interpretation of our data is correct. However, the implications are somewhat misleading. Comparing the highest modeled level to the lowest background only addresses a potential momentary condition, and does not represent an appropriate way to address environmental noise impact. That requires the assessment of longer term noise levels and appropriate standards for impact.

With regard to the momentary nighttime noise level comparisons and the audibility of the turbines at night, it is useful to reiterate here the point made earlier about how the lowest background sound levels occur during the middle of the night, when people are typically indoors. With windows closed, the sound from wind turbines is expected to be inaudible inside most of the surrounding homes because of the attenuation provided by the house structure. Indoor sound sources add to the masking effect of any audible noise from the wind turbines. The house structure also provides 10 dB to 20 dB of reduction to outside noises with windows open, substantially reducing the already low projected outdoor turbine noise levels in the 20's and low 30's dBA.

Finally, it is appropriate to point out that at Site M1, the projected Project noise levels are significantly lower with the revised turbine layout, since the turbines in closest proximity to M1 have been eliminated. See ***Exhibit UPC-CB-Reb3***.

Q. Given the revised project layout, have you updated your modeling and analyses? Please explain.

Response. Yes. We performed modeling for the Project assuming a revised layout that consists of sixteen (16) wind turbines manufactured by Clipper Windpower Technology, Inc. The Clipper Liberty 2.5 MW is an upwind, three-bladed, horizontal axis wind turbine, with a rated electric power output of 2.5 MW. The Clipper Liberty incorporates pitch-controlled blades that operate with rotational speeds of up to 15.5 rpm. This turbine has a hub height of 80 meters (262 feet). The new layout of the wind farm consists of a single northern array of wind turbines along the ridge from Granby Mountain extending northeasterly to Norris Mountain. The new layout of the wind farm does not include a southern array along Hardscrabble Mountain, as had the previous proposal.

Consistent with our original Noise Study Report (Exhibit UPC-CB-2), HMMH used the International Standards Organization current standard for outdoor sound propagation: ISO 9613 Part 2 – "Attenuation of sound during propagation outdoors" within SoundPLAN. We produced revised Noise Maps that show the noise contours for the Clipper layout for two cases: with and without excess attenuation due to trees. The revised Noise Maps are presented as ***Exhibit UPC-CB-Reb3***. The noise contours in the Exhibit are for the maximum A-weighted sound pressure level ($L_{A,max}$) for full operation of the wind farm under moderate downwind conditions.

Q. What effects does the revised layout have on the noise modeling results?

Response. The noise effects of the revised project layout are summarized in the table and figures on the following pages. In addition to producing noise contours, SoundPlan was used to compute sound levels at specific sites or receivers.

Table 1 summarizes the computed maximum A-weighted noise levels ($L_{A,max}$) from full operation of the wind farm at exterior locations in the community. Wind farm noise levels were computed at 50 prediction sites (receivers) representing three schools and 91 residences. As shown in the table, maximum A-weighted noise levels are expected to range from 9 to 33 dBA $L_{A,max}$ in the communities around the wind farm. These overall levels are quite low for any sound source, and are less than the noise levels produced from the wind farm layout that utilized two arrays of Gamesa G87 wind turbines as detailed in the original Noise Study Report.

As depicted in the Noise Study Maps for the Clipper layout and as shown in Table 1, the residences that would experience the highest sound levels are located to the southwest of the wind farm along New Duck Pond Road (Sites Duck Pond 1 and Duck Pond 2 and Site M3) – noise levels at these prediction sites are expected to range from 28 to 33 dBA $L_{A,max}$. To the southeast of the wind farm, noise-sensitive land use along Dareios Road would be exposed to wind farm noise levels of approximately 31 dBA $L_{A,max}$ (Site Darieos 1). To the north of the wind farm, the closest noise-sensitive land use along Route 5 would be exposed to levels ranging from 30 to 31 dBA $L_{A,max}$.

The noise levels from the Clipper layout are relatively low compared to sound levels from other common indoor and outdoor noise sources found in the built environment. Figure 1 in the original Noise Study Report provides examples of common sources and the sound levels they produce.

The noise levels for the Clipper layout, as well as the earlier layout, assume moderate downwind conditions. Under upwind conditions, A-weighted noise levels from the wind farm are likely to be significantly lower than for downwind conditions – possibly by as much as 10 to 20 dB depending on proximity to the wind farm.

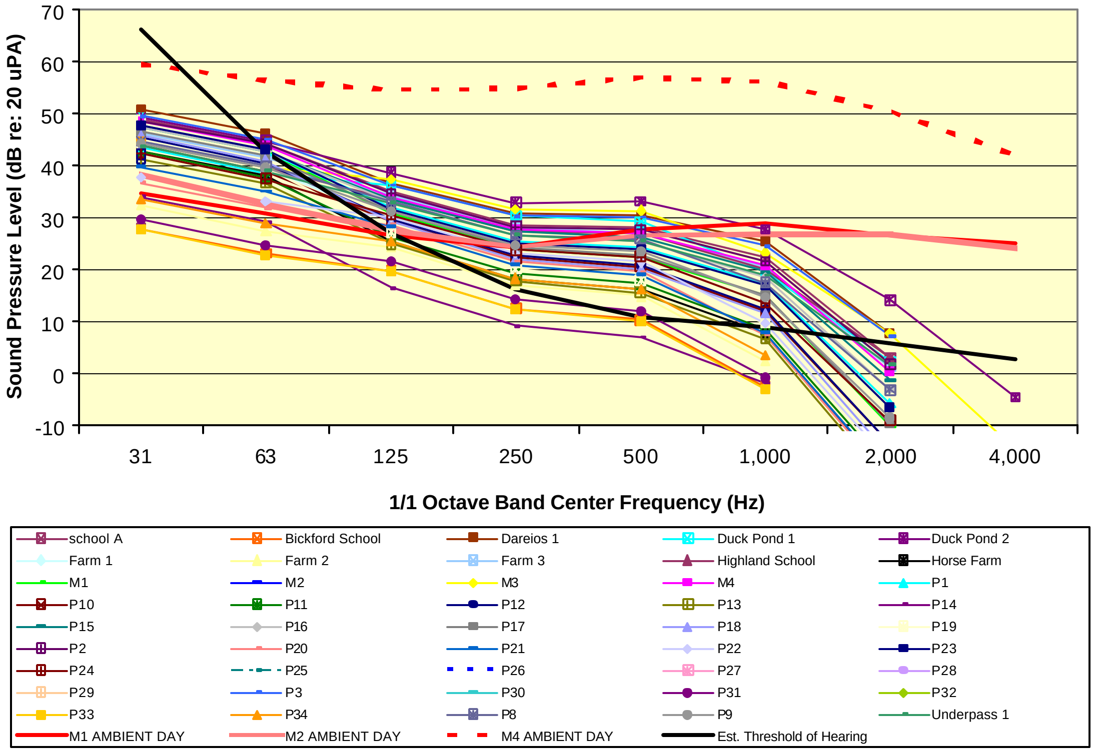
Table 1 also reports the Daily Day-Night Noise Level (DNL) from full operation of the wind farm under downwind conditions. The worse-case Daily DNL ranges from 15 to 39 dBA at exterior locations associated with noise-sensitive land use throughout the study area. The corresponding interior worse-case Daily DNL (assuming residential structures in the study area provide 20 to 30 dB of noise reduction with windows closed, as stated in a previous response above) would be less than DNL 20 dBA throughout the study area. The exterior noise exposure levels are well below the Environmental Protection Agency's (EPA) guideline value of DNL 55 dBA to protect human health and welfare with an adequate margin of safety.

Table 1 Computed Wind Farm Noise Levels at Noise-sensitive Land Uses in the Community for the Clipper Layout – No Tree Attenuation, Downwind Conditions

Receiver	Description/Location	Locality	No. of Dwellings	$L_{A,max}$ (dBA)	Daily DNL (dBA)
School A	King George School	Sutton	unknown	28	35
Bickford School	Old Duck Pond Road/ Route 122	Sheffield	0	10	16
Dareios 1	King George School dormitories	Sheffield	unknown	31	37
Duck Pond 1	New Duck Pond Road	Sheffield	1	28	35
Duck Pond 2	New Duck Pond Road	Sheffield	1	33	39
Farm1	Morey Road	Sutton	1	21	28
Farm2	Underpass Road	Sutton	1	15	21
Farm3	King George Farm Road @ TH-2	Sutton	1	27	34
Highland School	Underpass Road	Sutton	0	27	33
Horse Farm	Berry Hill Road	Sheffield	1	18	24
M1	Hardscrabble Mountain Road	Sheffield	2	23	30
M2	Berry Hill Road	Sheffield	1	--	--
M3	New Duck Pond Road	Sheffield	0	31	37
M4	South Barton Road (Route 5)	Barton	0	27	34
P1	South Barton Road	Barton	1	25	31
P10	Underpass Road	Sutton	3	21	28
P11	Underpass Road	Sutton	5	18	25
P12	King George Farm Road	Sutton	3	22	28
P13	King George Farm Road	Sutton	2	17	23
P14	King George Farm Road	Sutton	4	9	15
P15	Clark Brook	Sheffield	3	27	33
P16	Kivimae Road	Sheffield	3	26	32
P17	Union House Road	Sutton	1	24	30
P18	Union House Road	Sutton	1	21	28
P19	Berry Hill Road	Sheffield	1	20	26
P2	Lynburke Road	Barton	2	28	34
P20	Berry Hill Road	Sheffield	3	19	26
P21	Berry Hill Road	Sheffield	2	19	26
P22	Hardscrabble Mountain Road	Sheffield	1	21	27
P23	Hardscrabble Mountain Road	Sheffield	1	25	31
P24	New Duck Pond Road	Sheffield	3	22	29
P25	Route 122 north of Oregon Brook	Sheffield	2	--	--
P26	Route 122 near Oregon Brook	Sheffield	2	--	--
P27	Berry Hill Road	Sheffield	3	--	--
P28	Berry Hill Road	Sheffield	2	--	--
P29	Berry Hill Road	Sheffield	2	--	--
P3	Lynburke Road	Sutton	6	30	37
P30	Gayland Drive	Sheffield	2	--	--
P31	Blake Pond Road	Sheffield	1	12	18
P32	Berry Hill Road	Sheffield	1	--	--
P33	Berry Hill Road	Sheffield	1	10	16
P34	Gold Mine Road	Sheffield	1	16	22
P4	Lynburke Road	Sutton	2	31	37
P5	Underpass Road	Sutton	2	24	30
P6	Underpass Road	Sutton	2	25	32
P7	Underpass Road	Sutton	3	25	31
P8	Underpass Road	Sutton	1	25	32
P9	Underpass Road	Sutton	8	23	30
Underpass 1	Underpass Road	Sutton	2	27	33

Source: HMMH, 2006.

Figure 1. Wind farm maximum A-weighted noise levels at prediction sites in the community compared to <u>measured</u> <u>outdoor</u> background noise levels for quiet daytime periods in 1/1-octave bands. Source: HMMH, 2006

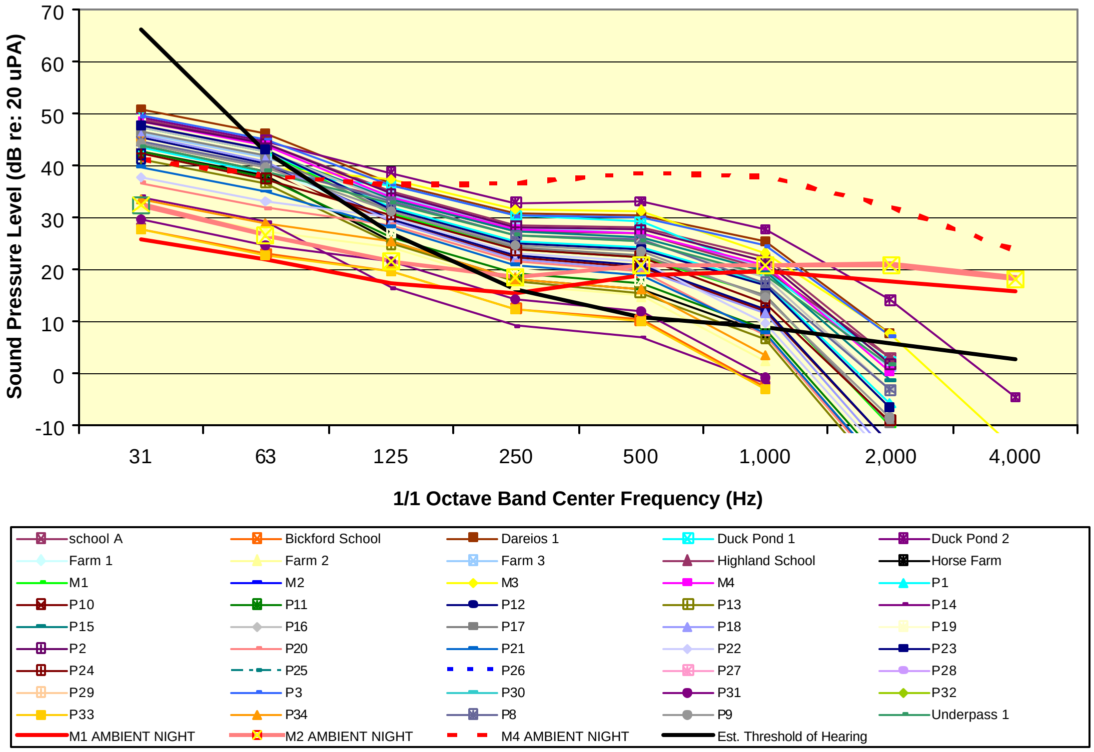


The graph of Figure 1 shows computed maximum A-weighted noise levels from full operation of the wind farm plotted against measured background noise levels for quiet daytime periods in octave bands. In the graph of Figure 1, measured background levels at M4 are represented by the upper curve in the figure – for this period the measured L_{eq} was 60 dBA and the measured L_{90} was 36 dBA. The measured background levels at M1 and M2 are represented by the two lower curves of Figure 1. At Site M1, the measured background L_{eq} was 35 dBA and measured ambient L_{90} was 32 dBA. L_{90}. At Site M2, the measured background L_{eq} was 33 dBA and measured ambient L_{90} was 32 dBA. L_{90}. The following observations are made concerning the graph of Figure 1:

- In the 31.5 Hz octave band, wind farm noise levels would be more than 10 dB below the threshold of hearing and therefore inaudible.
- In the 63 Hz octave band, wind farm noise levels would be mostly below the threshold of hearing.
- In the octave bands from 125 to 500 Hz, wind farm noise is mostly above the threshold of hearing, and depending upon the location, above background noise levels during quiet daytime periods.
- Above 1,000 Hz the wind farm would be mostly inaudible throughout the study area during quiet daytime periods.

These results are for a moderate downwind condition or for a temperature inversion. During periods when a prediction site would be located upwind of the turbines, wind farm noise levels could be much lower than the levels shown in Figure 1.

Figure 2. Wind farm maximum A-weighted noise levels at prediction sites in the community compared to <u>estimated</u> <u>outdoor</u> background spectra for quiet nighttime periods in 1/1-octave bands. Source: HMMH, 2006



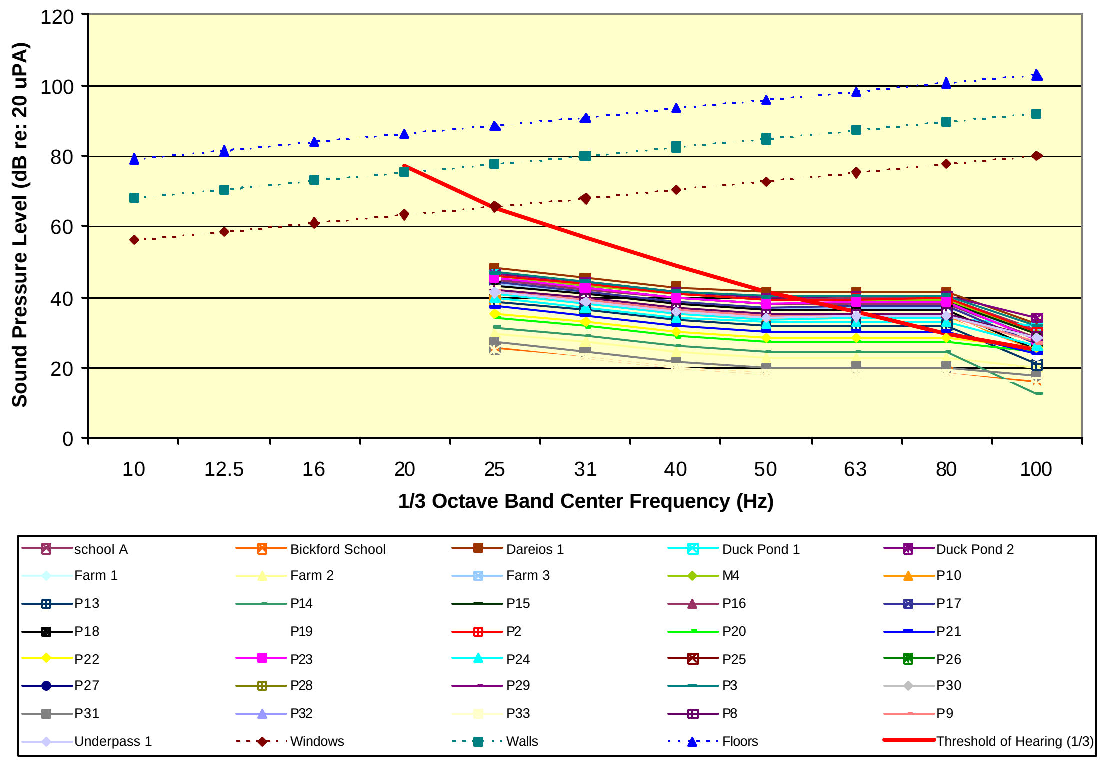
The graph of Figure 2 shows computed maximum A-weighted noise levels from full operation of the wind farm plotted against estimated background spectra for quiet nighttime periods in octave bands. The nighttime spectra were developed by applying the observed diurnal patterns of hourly noise levels within the 24-hour noise measurement data to the measured spectra obtained during quiet daytime periods.

In the graph of Figure 2, estimated nighttime background spectra at M4 are represented by the upper curve in the figure – for this quiet nighttime period the L_{eq} would be 41 dBA, and the L_{90} would range from 40 to 41 dBA. The estimated nighttime background spectra at M1 and M2 are represented by the two lower curves of Figure 2. At Site M1, the background L_{eq} was 25 dBA for a representative quiet nighttime period, and the ambient L_{90} was 23 dBA L_{90}. At Site M2, the background L_{eq}

was 33 dBA and ambient L_{90} was 32 dBA L_{90}. Figure 2 shows that for full operation of the wind farm under moderate downwind conditions noise from the wind farm would be more audible at night than during the day.

Note that under upwind conditions, noise from the wind farm may be as much as 10 to 20 dB lower than shown in Figure 1 and Figure 2, and so would be less audible during such periods.

Figure 3. Wind farm maximum A-weighted noise levels compared to thresholds of perceptible vibration in residential structures in 1/3-octave bands. Source: HMMH, 2006



The graph of Figure 3 shows wind farm noise levels compared to thresholds of perceptible vibration in residential structures, as well as the threshold of hearing in 1/3 octave bands from 20 to 100 Hz. Based on the results of this graph, HMMH concludes that below about 50 Hz noise from the wind farm will be below audible levels, and that low-frequency noise from the wind farm would not be of sufficient magnitude to generate perceptible vibration in any residences in the vicinity of the Sheffield Wind Farm.

Q. What effect would the revised layout have on the projected sound levels at the home of the Burringtons (338 Hardscrabble Mtn Road), a party in this case who has expressed concerns about noise levels?

Response. The noise effects of the Project at 338 Hardscrabble Mountain Road can be assessed by examining the projected sound levels at Sites P20 and P21. Under a moderate downwind condition and for full operation of the wind farm, the maximum A-weighted noise level for the Clipper layout would be approximately 19 dBA at Sites P20 and P21. The exterior daily DNL under these conditions would be 26 dBA at Sites P20 and P21 – nearly 30 decibels below the EPA's guideline value of DNL 55 dBA to protect against human health and welfare with an adequate margin of safety. Assuming a "windows-closed" condition, this residence would experience an interior daily DNL of less than 10 dBA. With the Gamesa layout, these prediction sites were expected to experience maximum A-weighted noise levels of 37 dBA, an exterior daily DNL of 44 dBA, and an interior daily DNL of less than 25 dBA.

Q. What effect would the revised layout have on the projected sound levels at the home of Donald Gregory (3767 Underpass Road), a party in this case who has expressed concerns about noise levels?

Response. The noise effects of the Project at 3767 Underpass Road can be assessed by examining the projected sound levels at Sites P5 and P6 and Underpass 1. Under a moderate downwind condition and for full operation of the wind farm, the maximum A-weighted noise level for the Clipper layout would be 24 to 27 dBA at Sites P5 and P6 and Underpass 1. The daily DNL under these conditions would be between 30 and 33 dBA – more than 20 decibels below the EPA's guideline value of DNL 55 dBA to protect against human health and welfare with an adequate margin of safety. Assuming a "windows-closed" condition, this site would experience an interior daily DNL of 13 dBA or less. With the Gamesa layout, these receivers were expected to experience maximum A-weighted noise levels of 29 to 30 dBA (exterior), an exterior daily DNL of 36 to 37 dBA, and an interior daily DNL of 17 dBA or less.

Q. Does that conclude your testimony at this time?

Response. Yes it does.