WASCO COUNTY BOARD OF COMMISSIONERS

SPECIAL SESSION / AGENDA TUESDAY, MARCH 20, 2012

LOCATION: Wasco County Courthouse, Circuit Courtroom #301

511 Washington Street, The Dalles, Oregon

NOTE: This Agenda is subject to last minute changes. **Meetings are ADA accessible.** For special accommodations please contact the Administrative Services Office in advance, (541) 506-2550. TDD 1-800-735-2900. Wasco County does not discriminate against individuals with disabilities.

9:00 a.m. **CALL TO ORDER**

CONTINUATION OF PUBLIC HEARING to consider the adoption of amendments to the Wasco County Land Use and Development Ordinance.

ADJOURN

WASCO COUNTY BOARD OF COMMISSIONERS
CONTINUANCE OF PUBLIC HEARING
MARCH 20, 2012

PRESENT: Rod L. Runyon, Chair of Commission
Scott C. Hege, County Commissioner
Sherry Holliday, County Commissioner
Tyler Stone, County Administrator
Sue Stephens, Executive Assistant

At 9:00 a.m. Chair Runyon reopened the Public Hearing to consider the adoption of amendments to the Wasco County Land Use and Development Ordinance. He asked those wishing to speak to sign in on the sheet provided. He went to explain that this is a legislative hearing regarding PLALEG 09-06-0003, recommending amendments to the Wasco County Land Use and Development Ordinance relating to energy production, consumption and conservation, reformatting, modernizing language that is out of date or incorrect, creating consistency with State regulations and making other amendments appropriate for Wasco County. The hearing is a continuance from the February 15, 2012 Public Hearing. The procedure for today's hearing is as follows: Planning Department presentation which includes additional changes to what was presented at the February 15, 2012 Public Hearing, the Board may then ask staff for further clarification or explanation regarding the proposed regulations or public comments, and finally public testimony will be taken. Public comment is limited to three minutes per person unless extended by the Chair. The BOCC will choose how to proceed, whether they will continue to another date or close the hearing and take a vote today.

The rules of evidence are as follows: No person shall present irrelevant, immaterial or unduly repetitious testimony or evidence. Evidence received shall be of a quality that reasonable persons rely upon in the conduct of their daily affairs. Testimony and evidence must be directed toward the hearing subject.

Chair Runyon then asked Board members for any disclosure of interest that might disqualify them from participation. There were none. He then asked the audience if anyone wished to challenge the right of any Commission member to hear this matter. There were none. He then asked if any member of the audience wished to challenge the jurisdiction of Wasco County to act in this matter. There were none.

Chair Runyon asked for a show of hands for those intending to speak. He then explained that he would prefer to hear first from those who had not spoken at the previous hearing and then from those who had already spoken. He encouraged those who had already spoken to come forward only if they had something new to add that they had not previously expressed.

Planning Department Presentation

John Roberts, Planning Director, came forward to review additional changes made to the Wasco County Land Use and Development Ordinance. He began by pointing out that materials were available for the public – the staff report and ordinance changes – if they wanted to take advantage of them.

The project began 2 ½ years ago, kick-started by State Representative John Huffman. The purpose of the project was to address both commercial and non-commercial energy, not limited to wind energy. The process has been thorough and included two working advisory committees which brought forward recommendations to the Planning Commission. The Planning Commission reviewed and digested that information and held two public hearings after which they forwarded their final recommendations to the Board of County Commissioners.

Changes to Chapter 19 triggered amendments to Chapters 1, 3, 4 and 9; however, the substantive changes are all found in Chapter 19. The regulations will be used in two ways – it will allow more responsiveness to both commercial and non-commercial energy projects and it will also allow the Planning Department to review smaller scale energy projects.

Although, Mr. Roberts did not want to interfere with the process and work that had already been done, he did feel that some additional revisions were warranted. His suggested changes are outlined in the staff report included in the Board packet. While some of the changes are not substantive, there are six he felt that were.

1. There is a mandatory change that will bring the ordinance in compliance with State regulations.

2. A second change adjusts language to be more flexible in regards to radar triggered lighting, a technology which is still evolving.

3. A change to the provision requiring County Commissioners to conduct a public comment period for all EFSC reviewed projects. He explained that while in theory it is a good idea, in practice, it cannot work. EFSC requires response in thirty days which is not enough time to notice, receive, and review public comment before providing a response to EFSC. He cited a recent instance where they had 36" referral from EFSC; it came with eight binders of information to review and a 30 day response time. It is not reasonable to expect that the County would be able to review the material and then receive and review public comment in time to respond in thirty days. He reminded everyone that EFSC has built into their process the opportunity for the public to comment on proposed projects.

4. A change pertaining to section 19.030 (c)(4) Visual Impact. He explained that public comment revealed that the section was confusing. Mr. Roberts' predecessor reworked the section in an effort to clear up the confusion. Based on comments from the February public hearing, Mr. Roberts made further revisions to the section.

5. A change pertaining to section 19.030 (c)(9) Transportation Section. These changes were suggested by the Public Works Director to ensure that applicants work closely with the Road Master in the approval process – allowing for a road impact assessment when appropriate.

6. A change regarding setbacks for wind turbines. This is the issue that elicits the most public reaction. The original recommendation was for three different setbacks:

    a. A ¾ mile setback from the city limits or urban growth areas.

    b. A 1 mile setback for non-resource lands – essentially, residentially zoned properties. This setback is measured from property lines rather than from a residence.

c. A 2/3 mile setback for agricultural and forest lands. This setback regulation included a waiver process to reduce the setback.

Mr. Roberts explained that Umatilla County had created a waiver process to reduce their 2 mile setback. LUBA determined that it is unconstitutional to have a waiver provision in regard to setbacks. He said that the Planning Commission really likes the flexibility of offering a waiver provision and so began to explore how they might incorporate that without being in conflict with LUBA. The Planning Department has created an adjustment process with steps and criteria based on issues raised by LUBA. This provision will replace the existing waiver provision and will apply to shadow flicker, non-project boundaries, residences in agricultural and forest lands, and urban growth boundaries or city limits. The adjustment provision will not apply to residentially zoned properties because the original intent was to allow no waiver for residential properties.

What is not shown in this process is that the State has no setbacks for wind turbines. They do have setbacks for noise; their noise standards range from 36-50 DbA. To be closer than 36 DbA a property owner has to sign a noise easement. Regardless of what Wasco County establishes, the State noise regulations will still have to be met.

Mr. Roberts said that other changes he is proposing do not change the intent of the ordinance but are formatting changes or changes to make language more clear. He also outlined some areas that he has received public comment but has not responded with any changes to the ordinance. He then outlined the Board's choices to adopt the amendments, continue the hearing to a future date or reject the amendments.

Further discussion outlined the State policy to allow review of any energy source generating under 105 megawatts to remain at the county level.

Public Testimony

SHEILA DOOLEY
816 E. 13th Street, The Dalles, OR.
Ms. Dooley stated she has owned a house and property in the F280 Resource Zone since the 1970's. The proposed ordinance states that the applicant may be required to submit a qualified expert's noise analysis. If the wind turbines are going to be located anywhere near residences, it should state that the applicant

should be required to pay for a noise study. Having accurate noise measurements is critical as the applicant is going to have to meet the DEQ noise standard. If the setback is not adequate to meet it, they will need a waiver or variance. The applicant should not be the one supplying the noise measurements or any other required survey results such as wildlife surveys. A consultant hired by a company can spin the results for whoever hires them. This was the case with UPC's Cascade Wind Project. UPC did not follow the State regulations. They took measurements when the wind was 18 miles an hour instead of the limit of 10 miles an hour. They took measurements at Brown's Creek and tried to apply them to the forest zone and the Vensel/Ketchum Road area, which is a much quieter area located several miles away with a ridge top between them. If this project had gone through as proposed, there would have been wind problems for residents according to Curry Stanley who is the noise analyst the State contracts with. The noise analysis needs to be done by an independent third party, not selected by the developer. Allowing the developer to submit their noise measurements is like letting them hire their own building inspector; County Planning doesn't operate on the honor system. It places the burden of proof on the adjoining landowner to prove that noise won't be a problem. Citizens will assume that the adopted setback is adequate. When a development with an inadequate setback is proposed near residents who know enough to do so and can afford it will be forced to hire their own noise analyst and attorney, at a cost of thousands of dollars, in order to contest it and protect the livability of their homes.

Once the turbines are installed, they are not going to be moved. We know that the 2/3 mile proposed setback for the resource zone will not be adequate for those of us with homes in the Vensel/Ketchum Road area. This is based on where turbines were proposed in the UPC Cascade Wind Project. There are currently different rules applied to forest and ag zones. Different rules should apply for wind turbines also. With forest lands there are three considerations: soil, habitat and how noise travels. Placement of turbines on ridge tops can amplify the noise. Hilly terrain can cause wind turbines to be heard at a greater distance than on flat land. We've seen how sound can echo down the ridge top and get louder as it travels down the ridge. Our neighbors complain of our dogs barking when we can barely hear them but it sounds like an echo if you're down below us. I can imagine what a wind turbine above us would sound like. When UPC proposed its project on 7 Mile Hill, one of the impacts that could not be mitigated was the loss of the pine oak habitat. This is a unique and important habitat that needs to be protected and wind turbines should not be permitted in

these areas. When wind turbines are installed on uneven terrain such as the hilly areas in the forest zone the land is blasted and the hills leveled to create a huge flat area to site the turbines on. (At this point, Chair Runyon told Mr. Dooley that she was nearing 3 minutes and should wrap up.) This destroys the soil and habitat value, taking out resources for a lifetime. With the EFSC review, you should hear all points of view and not just the developer's viewpoint. In closing, the wind industry continues to deny that noise is a serious problem. They deny the validity of any noise complaints in spite of rising evidence to the contrary. At the same time, people living near wind turbines who sign waivers, agree not to complain. If the wind turbines are so benign, why do residents have to sign gag orders as part of the waiver? EFSC will never hear from these people because they are accepting hush money and will not complain. Thank you.

BLAINE CARVER
91443 Hinton Road, Maupin, OR
My wife and I just purchased a small farm in the Bake Oven area of South Wasco County. We both work outside our personal farming operation to support our goal of living and raising a family in rural South County. Growing up in Wasco County, I've watched the businesses and farms come and go. I attended school through the years when the timber tax revenue dried up. It is very exciting that there is a new green and sustainable industry that is interested in our incredible wind resource. The wind energy business has an incredible track record for the environment and human health. This is the opportunity that will help me and others stay on the land and in our county. The added tax revenue will benefit all public services and the county economy as a whole. It will ensure that our children will receive a better education and have more opportunities than they currently do. It will inspire other young people to stay and build businesses and families. Wind development will provide additional jobs in a sustainable green industry as well as an added influx of revenue into the local economy. What is not to love about this opportunity? Wind turbines do alter the landscape; and yes, if you stand next to one and listen carefully, you can hear it. We currently derive our electricity from fossil fuels and hydro dams. I would like someone to look me in the eye and tell me that does not alter the landscape. It is astounding to me that anyone thinks wind turbines are more obtrusive or dangerous than pollution or dams. The issue at hand boils down to does the county want wind turbines and the benefits that come with them? Modern wind turbines have only one factually proven effect at distances beyond the state mandated setbacks – you can see them. A site setback that is greater than the State standard puts wind development in jeopardy. Our county cannot afford to jeopardize this opportunity.

My family, future children and community cannot afford to pass this up. This opportunity is right here, right now. Let's quit stalling and trying to prove that we know something that the State doesn't. Development is not going to wait on us and I am sure the wind blows in other counties. As a taxpaying landowner and concerned citizen, I request that you secure the future of this county by adopting the 1,320 foot setback for rural residences and the 3,520 foot setback for non-resource zone boundaries and city limits. Failing to do so is possibly taking a pass on this opportunity and waiting for the next. It might be a long wait. Thank you.

LARRY ASHLEY
Bake Oven, OR
I am a lifetime resident out in Bake Oven. I've got ranch land in Bake Oven and the Shaniko area. My feeling is on this wind energy – I think the landowners can benefit from it and also the county. I think one of the biggest benefits is the county where they have lost timber tax. It not only benefits South County but it will benefit North County, too. I feel that at times North County is trying to regulate what South County does on their land. I feel there needs to be a different set of rules for South County because we're spread out out there. My feeling is we probably need ¾ mile from property line and ¼ mile from dwellings. And I feel that we're going to miss a good opportunity if we don't go ahead with this; and if they make the restrictions too much it eliminates too much of the wind energy for the county. Thank you.

MARK WOMBLE
Seven Mile Hill
Good morning. In the interest of brevity I would like to submit some complete written comments to John if I could. My particular niche is the protection of existing residences and I know that there are a lot of aspects to this energy ordinance. My niche is on setbacks; it's what I'm interested in. There's no question that the impacts of industrial wind facilities on nearby residences can be life-changing. Very recent medical and scientific studies have now confirmed and explained long-standing anecdotal reports of sleep deprivation, migraine headaches, dizziness, unsteadiness, nausea, exhaustion, anxiety, anger, irritability, depression, memory loss, cognitive problems with concentration and learning, and ringing in the ears. It is important to note that complaints of sound from neighbors and the medical and scientific studies tend to focus on the nighttime hours when people are inside their homes trying to sleep and nothing's masked by the wind when they're inside. The question has been asked by folks

at the last meeting – Why not just rely on EFSC? Why even have setbacks? And I think there are several things to consider. First of all, EFSC laws were last updated in 2007. DEQ was last updated in 2004. All the wind-specific studies that have emerged and caught up now with the anecdotal reports really came to the fore in 2009, 2010, 2011 and 2012. So EFSC did not have access to the same state of medical and scientific research that you folks now have. Another reason to have setbacks is that they are easily understood by citizens in the County, including Ma & Pa Kettle. You can understand how far a mile or a mile and a half or two miles is easily if you're a property owner. If, on the other hand, you're approached by someone from the wind company who has a box and some complicated computer noise modeling, you really don't know what to believe. I think we're all impressed with Iberdrola, but frankly, the wind industry in the past has had a very poor reputation for telling people the truth in order to get facilities sited. A setback is something that regular folk can understand and apply. Also, EFSC is not in charge of implementing our comprehensive plan which among other things, under goal ten housing is to protect residential development from encroachment by incompatible land uses. Some of the studies that have come out in the last three years include the Draft Oregon HIA, January 3, 2012, stating, "The potential impacts from wind turbine sound range from moderate disturbance to serious annoyance sleep disturbance, decreased quality of life. Chronic stress and sleep disturbance could increase risk for cardio-vascular disease, decreased immune function, endocrine disorders, mental illness and other effects." They also reference the nighttime wind turbine sound. The LUBA decision in Cosner clearly found an adequate factual basis for two mile setbacks. You're not bound by Umitilla County decisions; you're governing Wasco County. But, I think it's instructive that that whole process, LUBA looked at those findings and said, yes – two mile setbacks are justified by the facts. The Bruce McPherson Infrasound and Low-frequency Noise Study, dated December 14, 2011, just three or four months ago, you can see how all this has evolved over the last several years since EFSC updated their laws. There is a report by Dr. Sarah Laurie of Australia to the Australian Federal Senate in March, 2011, recommending 6 mile setbacks pending further understanding of infrasound, inaudible low-frequency, and sound pressure caused by turbines. And of course, Dr. Nina Pierpont's book, *Wind Turbine Syndrome*, published in 2009 – she recommends at least a mile and a half, two to three miles in hilly or mountainous terrain. Even the draft study submitted by Iberdrola says that wind turbines cause "annoyance and sleep deprivation." The important thing to understand is the definition of "annoyance" cited by the authors on page 15 includes distress and aversion which, if

maintained, can lead to a deterioration of health and well-being. (At this point Chair Runyon called time and asked Mr. Womble to wrap it up.) I want to just point out in my written materials, I think the landowners in South County, some of which are my dear friends, have nothing to worry about; if you take these circles where there are residences, and incorporate the waiver concept, virtually all of this land is not excluded. In my materials there are three families who have testified against setbacks, property tax records indicate they have about 70,000 acres and nine residences; they will all sign waivers. A setback in Wasco County is not going to keep these folks from getting paid by the wind companies. Their bigger worry is the DEQ noise standard. I also have detailed objections to Mr. Roberts, I don't want to see him fall on his sword, but EFSC doesn't have specific time limits to respond to applicable, substantive criteria. And the most important thing I want to close with is that the waiver or adjustment – I've added additional language, one sentence which clarifies that in all cases the waiver must be signed by the landowner. That was not clear in John's draft language, it lists it as a factor, but it must be signed by the landowner. Thank you very much for allowing me this time.

Commissioner Hege asked Mr. Womble to clarify his statement regarding EFSC time limits. Mr. Womble: As I understand and read 345.022-0030, it says two points "if the special advisory group recommends applicable substantive criteria, the council shall apply them." In the law "shall" means mandatory. I don't think the public has a right to comment on what the applicable criteria are to EFSC. Under this administrative rule, EFSC gets it from you good folks and that's it. And so the public criteria where the County sends it to EFSC, that's under 345.021-0050(4)(b). It does not set a specific time frame for response as I read it. Now, everybody always wants it yesterday and EFSC is no exception, but I don't think the County's locked into a time frame. So, I don't think the advantage to having public comment is outweighed by a time constraint. I don't think there's a specific time constraint there. Thank you very much.

ROBIN MOATS
45500 Main Street, Antelope, OR
Public speaking is not my forte, so excuse me if I wobble. First off, I am totally in agreement with alternative energy sources. When I lived in California I was one of the first to sign up for them and did until I moved to Wasco, where it is not available. I appreciate the Commission taking its due time to go over all the issues; you're in a no-win situation. You are going to <expletive deleted> everybody off one way or the other. But, I would also like to continue that thought

and ask that you take it a little more slowly and consider everyone, not just those who will benefit directly. There is a trickledown effect for the County that will eventually get money to spend, but it's going to be a long time before the rest of the people are affected in any substantial way. There are lots of considerations. We won't have a lot in our view, maybe only a few, but we are out in the middle of nowhere and for some of us that's why we are there. I would like to ask the Commission to at least not lessen the setbacks, if anything, increase them a little bit and to seriously consider the radar lighting for the top of the towers. Yes, from a far distance they're kind of cool to watch at night, but if you drive amongst them it's a little surreal. And if you have to live amongst them that's another thing, they are glowing off and on all night. Health issues are still a hotly debated issue. Pros and cons, I guess it depends which side of the forum you're on. I don't have a lot of scientific stuff to say, so I think that will be it. Thank you.

Commissioner Holliday asked Ms. Moats if she would be able to see the proposed towers from her home. Ms. Moats said that it's kind of hard to tell by the map. It would appear that – and it is also hard because we are down in the valley – but looking at the map the nearest one's on Mr. Kelly's property and may very well be in view especially if you're on East Street and at the south end of town. I would like to state that Mr. Kelly, while he may own that particular piece of property, is not a resident. In eight years of living there – almost eight years – I have never seen him there. So, his interest is different, if I may state. And I also think that maybe the removal of probably a few towers will not necessarily invalidate the projects altogether. They're here, which is a good thing in many ways. Thank you.

Commissioner Hege asked if there are any towers she can see from her home now. Ms. Moats: No, there is nothing out there currently, and again we are down in a little valley. However when I do come up top and drive out to Maupin way, you can see them in the distance when you're out on Bake Oven or go up 97. Commissioner Hege asked if her primary concern is visual. Mr. Moats: It's somewhat visual. I mean, I was born and raised in the burbs. I'm here for a reason and it was to get away from the destruction of what was really a nice little place to live as I grew up and I was third generation from San Jose. So, I have my mother's stories and grandmother's stories. Growth is a great thing in moderation just like anything else. I think also to the health issue and aspects that yes, there has been more information. I think the jury's still out on that. I know that I've been driving down to California quite a bit recently due to family health issues and I go through the Bay area. When I cross the Martinez Bridge

and look out toward the delta, that's all you can see these days. And same if you're out in the Altamont Pass area, they are just going up everywhere. It's kind of hard, but change is coming and like it or not, it's here.

JANA WEBB
3825 Cherry Heights Road, The Dalles, OR
I have been a resident of Wasco County most of my life. This, in my estimation, is a basic property rights issue. I don't feel that a small group of people in one area of the county should say what the group of people do in the other. It's kind of like the Willamette Valley controlling what goes on in Eastern Oregon. We're two different zones, two different things. The Scenic Overlay controls a lot of what would happen in the north half of the county already. I think that the proposed setbacks for the south end are too restrictive for the commercial wind projects. And I guess that I would just like to say we can find a scientific study to support anything. We should probably not be using our cell phones; the latest one that has been in the news a lot lately is what we breathe when we drive in our car; we're not supposed to use our laptops on our lap – so we can find scientific studies, and anybody can pay for one, as Sheila said, for anyway they want. But we do have to live in today's world; we have to exist with electricity in today's world; and so that all has to be weighed equally. I guess what I want to say – I did send you a letter. I know Rod got it. I didn't get a response from anyone else. And I would just like to say that future wind development projects can provide commercial development and fiscal security for this county. Please do not restrict our county's chances for that. Thank you.

ROCKY WEBB
3825 Cherry Heights Road, The Dalles, OR
I would just like to go on record as supporting and agreeing with Jana Webb's letter and her comments. Thank you.

BRIAN WALSH
4824 NE 21st Ave, Portland, OR
Good morning, Commissioners. I have four points to cover here really quickly and two of them will take a little more time. I work for Iberdrola Renewables. I have participated in all the Planning Commission meetings and have been here for all these meetings as well. Thank you very much for the opportunity to speak and all the work that you've put into this. So, two quick points and then two longer points; the longer ones have to do with DEQ noise standards and I'd like to explain to you how they work in practice and in real life and how we apply

them because I think that can be enlightening for both sides. And also, talk about decommissioning security – something that we haven't really talked about, but DEQ is the most important one. The first two quick points - I want to just make a quick correction or clarification that John made about EFSC. He stated that EFSC doesn't have actual setbacks. I think what he meant is that they don't have a fixed setback for residential homes. They have public safety and health setbacks. But John was speaking specifically, I think, about homes and residential setbacks. There is no fixed distance, but there are other health and public safety setbacks that EFSC has.

Commissioner Hege asked what those setbacks are. Mr. Walsh: They are specific distance setbacks. There are public roads setbacks; most of them are based on height because a tower and wind turbines height can vary as well as the tower size and blade diameter. They are setbacks that are easily quantitative based on the turbine size proposed to be used. They are safety – so it is falling down height or size and a half. There are varying setbacks from roads, from above-ground power lines – there are various setbacks that are in there for public safety through the EFSC process.

Two – and I don't want John to impale himself either, falling on his sword – I get the point in sitting through the Planning Commission that I think it's responsible to give the County residents a voice in the EFSC process and I think it's responsible for the Commissioners to notify the people. Already through the EFSC process, we're required or an applicant is required to publish it in the paper. There is a public comment period. I think it is at least twice during the public comment period that it runs in the paper consecutively. But anything else that you can do - and you can decide on that – on how to publically notify the residents of Wasco so that they're aware that they can participate in the commenting process, I would recommend, whether it be John's newsletter or any other way you can notify the public. But I agree that it's problematic to hold a public meeting with the County Commissioners and the timing issues. Anything else that you can bring attention to the residents so that they can participate in the process, I would recommend.

On to DEQ noise standards. Right now with the DEQ noise setbacks, you cannot emit a noise that reaches a house, designated by the State as a receptor, beyond 36 decibels. This bright yellow line is a 36 decibel model. The way this contour is decided is each turbine is emitting a noise power level that's rated by the turbine manufacturer and it varies on commercial turbines these days

from104 dbe to 109, depending on the size and the manufacturer. Roughly, what that equates to is a mile and a half setback or a mile and three-quarters on the noisiest of modern turbines. What you're seeing here in this yellow line, the green receptors are homes and the orange one is a 50 db. With a noise easement from DEQ you can reduce the distance on the setback from 36 decibels to 50 decibels, which basically reduces it down to 1,320 or 1,350 and that's where that number comes in within the setbacks they way they are (at this point Chair Runyon asked Mr. Walsh to take only 30 seconds more). The setback is greater unless someone waives or signs a noise easement and reduces it. Otherwise the landowner has the right at that particular residence to enforce a mile and half to a mile and three-quarters setback. That is regardless of whatever the County adopts; you can go through the County process and the State process – it still applies for DEQ setbacks. I think it's important to understand that neither one of these projects would have been built without the waiver provision. If you had to follow this all the way through, most of the turbines fall within homes and there would only be a few turbines. I could go over it in more detail, but neither one of these projects would be able to be permanently built without the noise setback.

For Sheila's question about measurements, how DEQ is actually done and how we model it. It's not a question of modeling it when the wind is blowing a certain speed; we have to model when we do the noise standard at the maximum sound power rating for that turbine. So when it's going full-bore, that is the noise level that we model. It takes in the topography; it takes in the height of the turbine, and the topography. You can't measure it like it's a set standard. We are always measuring it at that maximum sound rating. There's no way to get around that or cheat the system, I guess. And anyways, more to my point is that we as the owner and operator of the wind farm do not want to be appealed; we do not want to have our project curtailed which would happen if those turbines were found to be exceeding the noise standard. So when you make a four-hundred-million dollar investment in a wind farm, you do a risk analysis. You hire the best sound expert possible that you have and that's what we do at Iberdrola to make sure that we are not curtailed and that we're building it responsibly so that we're not found, if somebody were to file an appeal, and that we'd have to shut down those turbines. We don't make money unless they are turning. And if we have to shut them off because we are exceeding that noise level, it's a risk our financers, our company would not take that risk. In practicality, we get the best noise analysis that money can buy so that we're not put into a position where we could be appealed.

Chair Runyon stopped Mr. Walsh, saying that that was what the open house was all about – to have an opportunity to go through these. He added that the Board may want to call him back later in the hearing.

Commissioner Hege asked if there was anything in the setbacks proposed by Wasco County that would cause the specific project being considered by Iberdrola to not be built. Mr. Walsh: It's no secret that we're developing around the town of Shaniko. So one, there's a setback – the one mile setback from the town of Shaniko. It's a pretty great resource around the town of Shaniko. We have four land owners that would lose a total of 13-14 wind turbines around Shaniko with a one-mile setback or if there isn't a variance to reduce that setback from the town of Shaniko. The town of Shaniko signed a petition that they were open to reducing it down to 1,320 feet. Fred Justesen has a petition that he will submit when he gets up next that was signed by all the residents. So that one's a big one just because those higher resource turbines, if we're not able to build them, it might affect the overall economics of the project and therefore the wind farm might not be built.

Commissioner Hege pointed out that the setback is ¾ of a mile and at least in the proposal that John put forward, it does allow for adjustments around those cities. Those provisions could actually mitigate the issue.

Mr. Walsh: Even if we have a waiver or a provision that we could reduce it from ¾ of a mile, there are at least 13 residences within the town of Shaniko. We individually have to go to those landowners and get a noise easement. They are all within a few hundred yards of each other, so even if one doesn't sign it, it will create a mile and a half or a mile and three quarter setback from the town of Shaniko. If one single resident doesn't want it, they have the power then to eliminate 14 turbines. I don't like to broadcast that, but the burden is on the developer to make sure that it's all right. I don't see it as hush money or anything like that; it's a noise easement and we don't pay our landowners to sign a noise easement. I'll leave it at that.

To clarify, Commissioner Hege asked that even if Wasco County had a zero setback, wouldn't DEQ noise standards still be the issue. Mr. Walsh: Right, right. We would have to get a noise easement – otherwise we would have to assume the mile and three quarters.

Commissioner Hege asked if there are any issues related to the mile setback from non-resource lands that you think would impact any projects they are looking at. Mr. Walsh: I've looked at it and I think we can live with the mile from the non-resource zones. As a developer, and I can probably speak on behalf of my company but I probably shouldn't, but as a developer in the use of my experience, no one is ever going to build near Seven Mile. You have the opposition – they have successfully fought a wind project. On top of that there is a tight cluster of homes, a lot of homes, that all have a mile and a half, mile and three quarter setback from them. All of those individual property owners hold the right to stopping a wind turbine farm from being developed near their home. I mapped out all the petitions that were submitted by Gary Cassidy and collectively together, that accounts for a lot of the homes up there. And so nothing would ever be built on Seven Mile as long as the homeowners never signed a noise easement. And so they have the power, already in the DEQ noise law, to prevent a wind farm from their area. I don't think another setback, if it were up to me, the setback for any residence would just be the DEQ noise standard. I think it's there and it's protective and anything else is redundant but that's your prerogative if you want to identify it.

FRED JUSTESEN
Grass Valley, OR
I am a landowner in Wasco County. First I'd like to thank the Commission for offering this hearing today for people to give their comment, and also for the informative session we had earlier. It was very helpful. I would cede some more of my time to Brian Walsh if he would want it. I think he did a fairly good job of explaining something about the setbacks. To reiterate, I think it's very important that we have those issues in there that they are in the language that we can have a waiver or whatever you want to call it. Because like he explained, if I can use this over here again, I don't know if everyone knows it, but this is a project that's already been permitted in the County. This would not be here today if we went with the standards that were being proposed. Is that the way I understand it? Is that correct? You see, this is what I am concerned about – where is the language? Can we see it about a waiver or adjustments? It's very important we have this going forward – an adjustment to these setbacks. Where individuals, communities, cities, whatever – that they have the right to make that adjustment. Because if we don't have that we're not going to have projects in this county as I see it. I have a lot of things to say here in this. I'm glad we have this because people don't understand what's going on, I don't think. Because if you don't have the setbacks, John assured me it's there but I haven't seen that language, and so

if it's not written properly, all this stuff we're talking about isn't going to matter cause we're not going to have the projects. We all know, it's all been stated about the employment and so forth. There's a lot of people in this county my age, in their fifties, haven't had a steady job, a good steady job, since the mills went out in Wasco, in Maupin, in Tygh Valley. The other thing I might want to relate to is the DbA rating and what that sounds like. There are lots of studies and there's lots of ways to relate that, what that sounds like and I'll ask Brian – How do you relate to it, 36 DbA; what does that sound like?

Mr. Walsh: It's inaudible.

Mr. Justesen: You know you can't hear it. I'm going to submit some stuff here, some studies that shows you what that sounds like. Then the lady that talked about their dog barking. The dog, yes, is louder than the windmill. That's the way it is. I go ahead and support all the pro wind power testimony that's been given today. And with that I would just, I can't express enough that we have to have those setbacks; something that we can deal with and understand and see what the setbacks are. We have to have that in the language of your regulations. Thank you.

Commissioner Holliday asked about the previously mentioned petition Mr. Justesen was to have from Shaniko. Mr. Justesen: I attended a town council meeting at Shaniko before the last hearing – the night before. I submitted a petition to them. Everyone that was there signed the petition that called for lesser setbacks. Commissioner Holliday explained that she had thought it was new information, but that they had already seen that.

Commissioner Hege asked if what he was saying is that he wants a provision that allows the setback to be reduced. Mr. Justesen: Correct. Commissioner Hege wanted to make it clear that that language does exist in the currently proposed ordinance amendments.

A brief discussion ensued reinforcing the point made by Commissioner Hege.

ROY JUSTESEN
89720 Wagontire Road, Wamic, OR
I came to the meeting last time and the hearing this time and I've learned some scary things about wind mills but, I'm thinking that I could find some scary things about anything if I looked on the internet. The basic facts of the matter seem to

me that any proposed setbacks from the County are going to present difficulties for the wind projects. The wind projects, as we all know, will create economic opportunity and tax revenue for the County. Basically it seems like they're not going to put anything on Seven Mile anyway, so why not let us be out there at the south end? That's about all.

GARY CASSIDY
2500 Badger View Drive, The Dalles, OR
I thank you for the opportunity to testify and for your diligent, attentive work and for your thorough consideration of these ordinances before us here today. My introduction to county ordinances began in 2003 when a commercial wind facility was proposed on Seven Mile Hill. I was shocked that such a facility would even be considered on such a site. At that time I knew next to nothing about land use and development ordinances. In the next several years I became thoroughly acquainted with Wasco County LUDO and these ordinances were woefully inadequate having been designed 32 years ago – prior to the awareness of how these wind turbines would impact land and peoples. They opened the door for unwise consideration of improperly sited wind facilities. They did throw us all into turmoil that resulted in wasteful use of finances and personnel and costly appeals all the way to the State Supreme Court. The Planning Department wisely decided to throw these out and do a total rewrite of Chapter 19. When I was asked to be a member of the Commercial Energy Advisory Group rewriting this ordinance I wholeheartedly accepted, thinking I could be a part of a good process that could help the County as a whole. As you know this group was composed of people from every sector and I personally spent hours in monthly meetings, scores of hours for nearly a year and hundreds of hours poring over ordinances from several counties and states. I believe the proposed ordinances before us today are very good in most places. The setback of one mile from boundaries of non-resource zones appears to be good in terms of all people and developers as well. The setbacks proposed in resource zones need a slight adjustment to make them good and serving for all parties. So, I repeat, the proposed wording with a little adjustment that I previously submitted online, and is in section 19.030(D)(1)(c)(3) Setbacks Resource Zone Dwellings. Wind turbines shall be setback a minimum of 1.5 miles from all resource zone approved dwellings utilized as permanent residence for individuals and families. If it is deemed that a particular project requires adjustment provision in order to be viable, such adjustment provision may be requested. It is totally possible to write acceptable language for adjustment provisions in the setback portion of these ordinances. And it will not be a difficult task to acquire adjustment provision to make a project

viable. I believe this proposal will satisfy lease ease, make the ordinance clear as to where the development is responsible, and protect land and residents for decades to come. It is a reasonable, sustainable and durable way forward and will satisfy all parties and protect us all from wasting time and finances in costly appeals. There are no State ordinances or ordinances in any county in the State addressing the important issue of cumulative effect of multiple energy projects. I believe a 1.5 mile setback helps address this issue in a practical way and still allows appropriate development. I call your attention, once again, to the petition I submitted online. Note that I inadvertently failed to submit page 10 but I submitted that in what I have submitted now. You've read the comments so I won't repeat those but I do ask you to imagine 181 more people in this room who all say that they agree that a 1.5 mile setback is good with the adjustment provision to make a project viable. I appreciated Mr. Justesen's comments and I agree with him that the adjustment provision and setback must be very clear so that we all can understand that. Thank you very much.

JILL BARKER
3375 Vensel Road, Mosier, OR
I'm commenting today on the setback issue specifically and I fully support 2 mile setbacks as LUBA had ruled was necessary in Umatilla County. I think there should be two mile setbacks between legal residences for wind turbines in all resource and non-resource zones. This would include no waivers in non-resource zones and a variance, waiver or adjustment option allowed in resource zones. In a recent 2011 Oregon Land Use Board of Appeals case, Cosner vs. Umatila County, evidence was revealed that these 2 mile setbacks are necessary to protect the people in these residences from impacts of the noise produced by these huge industrial wind turbines. LUBA ruled that there is more than sufficient testimony and factual evidence to prove that there is indeed significant noise impact for at least a 2 mile radius around each industrial wind turbine and that these 2 mile setbacks are absolutely necessary to protect residents from the noise and health threats. The ruling sets an important precedent statewide concerning wind turbine setbacks and clearly needs to be observed and implemented by all counties in Oregon. The noise impact on health is the same issue no matter where the turbines might be. So this ruling of the Oregon LUBA on this issue must be adhered to by everyone equally. Since it's the goal of Wasco County's Land Use and Development Ordinance to protect health, safety and welfare of Wasco County citizens and to protect resources identified by the comprehensive plan as well as to protect property values, investments and preventing conflicts and incompatible uses, then providing these 2 mile setbacks

would ensure that all these goals were met. It is totally inconsistent and incompatible to place such intrusive and negatively impacting industrial operations within 2 miles of any rural residences. Property values plummet where there is even a suggestion of an industrial wind power project. And often land and homes adjacent to the industrial wind power projects cannot be sold at any price. And I had some experience; I went to Mars Hill, Maine, one of the first projects on the east coast that was talked about widely. The sound issues there were the same as they are here. And the people that had originally wanted to have the turbines were completely against them after they were built. They couldn't sleep at night; they had health issues; they had all the problems that have been talked about. Then the Oregon Public Health Division's Office of Environmental Public Health – The Strategic Health Impact Assessment on Wind Energy Development in Oregon it was stated that the sound from wind energy facilities in Oregon could potentially impact people's health and well-being if it is increased by levels of more than 10 decibels. There is some evidence that turbine sound is more noticeable, annoying and disturbing that other community or industrial sounds at the same level of loudness. This was stated earlier so I'll be brief. The potential impact from wind turbines' sound could range from moderate disturbance to serious annoyance – sleep disturbance, decreased quality of life, and chronic stress. Sleep deprivation could increase risk for cardiovascular disease, decreased immune function, endocrine disorders, mental illness and others. Now that's pretty serious language, I would say. Mental illness – all this is potential. I'm just asking Wasco County to take time. It's better to be safe than sorry. These rules are going to be set right now and to have a wider setback with the adjustment option would be more prudent and would prevent Wasco County from being sued at a later date if people can prove that their health has been affected by wind turbines that are too close to their homes. The wind turbine syndrome is a real, present health threat to humans; this is well-known throughout the world now. It is an established fact that can no longer be debated or ignored by the wind power industry and their lawyers, but can be conclusively observed and understood with only a mere five minutes research on the subject. If a resident chooses to have a wind turbine less than 2 miles from their home then a waiver option should be available for them to do so only if all the affected neighbors within the 2 mile radius also agree to such a waiver. I feel certain that Wasco County does not want to put itself in the position of facing many future costly lawsuits from people who can prove that their health has been adversely affected by the noise from these turbines. I also expect Wasco County Commissioners to support strong protection for the scenic area in all respects –

it's vital to the well-being, integrity and prosperity of Wasco County to defend this value and stated provisions. Thank you.

AUSTIN JUSTESEN
303 3rd Street, Grass Valley, OR
I wasn't at the first hearing, I was told about it by my uncle and Brian. And since I've sat here, I'm having a hard time gathering what we're doing here. DEQ is already protecting people from the noise and you already have the right to sign a waiver to say that you will accept the noise if you want it closer than a mile and three quarters from your home. This project here, everyone there signed a waiver saying they don't mind having the noise and anyone outside that yellow line – that's 36 decibels. Thirty decibels is leaves rustling; that's what thirty decibels is. So, I don't know why we need any setbacks anywhere because everyone already has the DEQ right to keep a wind tower a mile and three quarters away from their home. If you want a wind tower closer than that, sign a waiver; if you don't, don't sign the waiver. Shaniko's protected, The Dalles is protected, Mosier's protected – everyone's protected by the DEQ already. I just wanted to say that. Thank you.

RICK TILL, CONSERVATION LEGAL ADVOCATE
ON BEHALF OF THE FRIENDS OF THE COLUMBIA GORGE
522 SW 5th, Suite 720, Portland, OR
Thank you for the opportunity to comment again and I appreciate the County's deliberative process for the last year or two adopting these rules. I think we are getting close to a very workable solution that addresses everyone's concerns. I have a couple of comments in a few different areas. First I wanted to comment about the rules for the special advisory group which is on page 10 of the most recent draft ordinance. Friends would support ensuring some opportunity for public comment to the advisory group. I recognize John's concerns about the timing and how to best do that. There might be some compromise language that could be used. One if the issues is that the County advisory group will get deference at EFSC and so commenting to EFSC won't give the public the same opportunity to influence the County's recommendation. That deference is really important and there's only one chance for the public to speak to its publically elected representatives and that's when the special advisory group is convening. Finding some opportunity to do that is very important. One solution might be to explicitly limit the special advisory group's scope of review to just identifying the applicable standards but not attempting to determine whether a project is consistent with those standards. That kicks it to EFSC to make that consistency determination and doesn't leave the County exercising as much discretion as far

as what would apply. Language that might do that would be just to add at the end of Section C on page 10, "The Special Advisory Group shall not make a recommendation on project consistency with applicable land use rules without providing an opportunity for public comment." That might be a compromise position that would work for John. I also note that the County did convene at least one or two public hearings when giving advice on the Cascade Wind project on 7 Mile Hill and was able to provide that public process.

One comment about the modifications to a project that's at the bottom of page 11 and the top of page 12. The modifications to facilities could be pretty dramatic if they stay within the footprint; it could still affect neighboring property owners or important resources. I would recommend adding a requirement for an amendment that if turbines within the facility boundary are relocated by more than 100 feet in the project parameter - if turbines are being moved around inside there substantially there should be an amendment process for that just so neighbors and the affected community has an opportunity to know what's going on there.

And then some comments on setbacks. I think we're getting a lot more clarity here. It seems like the real choice is, is there going to be a uniform setback that is easy to understand with a waiver process or a DEQ process that is kind of obscured through a lot of noise analysis and creating these contour maps which is just harder for everyone to understand and which I think has led to a lot of the confusion here. A lot of people advocating for that don't want to stop Summit Ridge, they don't want to stop a project near Shaniko; they just want clear rules that are understandable. I think one mile or one and a half mile setback is clear, understandable and an adjustment process would allow projects to go forward. I did want to note that on page 23, the non-resource boundary setback – the Planning Commissioner originally did not recommend an adjustment process for non-resource zones. That was going to be a one mile flat set back without a provision to allow that to be reduced. The version you have in front of you does add that in. That may be appropriate. It seems like Shaniko would like the ability to reduce it and I've heard people in Antelope say they want to keep it larger. So maybe it's keep the adjustment process but increase the actual default setback from cities from ¾ of a mile to a mile or a mile and a half. Plus that adjustment process would allow communities to determine the extent to which they want to allow development to approach their boundary lines.

One more recommendation, I think Mark Womble had recommended some language to clarify the adjustment process for resource zone dwellings to make sure getting property owner consent is required and not just one discretionary element. One way to do that is in the first sentence on the top of page 23 would be to say that "factors to support an adjustment *shall* include," and I think that would get to the point quickly that land-owner consent is required.

One more issue with the DEQ noise standards, the 36-decibel contour line - developers can use a default ambient noise level of 26 decibels and not measure the actual ambient noise levels on the ground. And the ambient degradation tests which generates that 36 decibel line is based on that default, assumed 26 decibel ambient noise level. Actual ambient noise levels may be less than that and the DEQ standards require that you not degrade or increase ambient noise levels by more than 10 decibels. If you have a 23 decibel ambient noise at your home then the DEQ standards would require a 33 decibel noise contour setback. The only way landowners are going to be able to do that is if they hire their own expert to do it. A way to protect them would be to have the larger setback so they don't have to hire and expert to protect themselves from noise and then include the waiver provision that allows development to go forward and protect individual property rights.

One more point that EFSC and Shepherds Flats adopted a 1320 foot minimum setback for safety based on the risk for towers collapsing while their spinning and parts being thrown hundreds of feet. Any waivers should not allow going under a quarter of a mile, but there's a minimum safety setback is applied in at least one case. I don't know if that's fixed across the board but you might want to include that in the adjustment process. That is all I have. Thank you very much for the opportunity to comment.

ELAINE ALBRICH ON BEHALF OF IBERDROLA RENEWABLES
900 SW 5th, Suite 2600, Portland, OR 97204
I just wanted to be quick to respond to a few things that I've heard today that I think will provide clarification for the Board. First off are procedural issues with respect to the EFSC process versus the County process. I would just point you to State Statute ORS 469.350 and 469.370. Those are two State Statutes that outline procedures that EFSC must follow when processing an application for a site certificate. It goes to the timing for public comments, the SAG providing recommendations, things like that. So, just point you to that if you are interested to help clarify some of those questions that came up.

Another point that I wanted to discuss briefly is the distinction between EFSC standards and conditions of approval on EFSC projects. There have been a lot of questions about what actually amounts to an EFSC standard. EFSC standards for wind energy facilities are found in OAR 345 Division 22 and Division 24. There is a specific standard that requires an applicant demonstrate the wind project is designed, operated and decommissioned so as not to adversely impact public health and safety. That's in Division 24. EFSC ensures that that standard is met then by imposing a condition of approval which has a hard setback distance. So there is not specific hard setback distance in the OARS for wind energy facilities but it's a process whereby the standard is met through a condition that imposes a hard distance. So I just wanted to clarify that relationship a little bit because it seem like that has been a topic of conversation over the last several hearings.

The third point in response to testimony today has to do with health. We could debate this topic all day long. It actually was debated before the Planning Commission. We submitted a volume of material in response to comments about public health impacts and so that is already in your record. A lot of the studies that were discussed today are internet researched, self-published, unsubstantiated, and not peer-reviewed. So I would just point that out, that that is already in the record and that we can respond to that further if you like.

Getting to the staff report, I want to make sure that you guys have my comment letter. (The Board indicated that they did.) We have reviewed the staff report with the recommended revisions to the code and I think, for the most part, they are great. We are very close to a very workable code that will take it to a balance of allowing developers to take advantage of wind resource areas in the County while also ensuring responsible wind development and the protection of the County citizens.

There are a few points that I think need to be hit on and I think we need to discuss a little bit further, the first point being FAA lighting requirements. Although the intent of staff's recommended revisions is to allow for more flexibility in determination of lighting on a case by case basis, the language does not go far enough and it's just not workable based on the FAA's current process for reviewing acceptable lighting, also taking into account individual companies' ability to carry risk. And so in the letter I have recommended revised language that essentially requires and applicant to minimize the amount of lighting to the

extent feasible under law and company safety protocols. And then the County can exercise its discretion on a case by case, project by project basis to determine what amounts to minimize to the extent feasible. And if it wants to it can exercise its discretionary authority to require an applicant to investigate FAA approval for radar lighting not necessarily required as part of the code.

The next point to talk about is setbacks, a topic that everybody has been talking about today. We propose an alternative to the staff report for resource dwelling setbacks. There has been continued discussion about creating a distinction between those who want wind projects, those who don't, the north, the south . . . and so the recommended language you will find on page 4 of the letter creates a distinction between participating landowners and non-participating landowners for the purposes of setting setbacks. That then accounts and gives more flexibility to those landowners that are participating or in other words have landownership within the energy facility project area versus those who are not landowners in the energy facility project area but may be in proximity to a proposed project; and associated with that our recommendation is participating landowners at 1320 feet for a hard setback or the distance that's required to comply with DEQ regulations. And then for non-participating landowners it would be the Planning Commission's recommendation of 2/3 of a mile whatever's necessary to comply with DEQ noise regulations. While it would be my preference to simply rely on DEQ noise regulations I think, having heard testimony, that's probably not an acceptable approach for the County. So, I think there is a compromise by having both a hard setback so it's clear in the code and then also allowing for DEQ compliance. We could speak all day about how those two things actually interact, from a legal perspective it allows flexibility for landowners who want the project and it provides protection for those landowners who want a greater distance away. We do agree with the staff's recommended adjustment provisions; we think that's appropriate for resource zone dwellings. I think the factors that are outlined in staff reports, language for those factors evaluating adjustment are appropriate. It would also be appropriate to include landowner consent as a factor that the County considers when determining whether to grant the requested adjustment. I think just for clarification of process as I view it from a process standpoint, that adjustment would actually be a determination the County makes when it's granting a conditional use permit for a wind project and then it would have findings in the conditional use permit decision that justifies how the applicant has demonstrated that the adjustment factors have been met. I think that process addresses those issues that were

raised in Cosner and would provide the County with a more defensible decision when it's moving forward.

The second has to do with non-resource boundaries. While we have not recommended a change for the Planning Commission's recommended distances for these setbacks, I think it's very, very important that it's clear in the code and also in the County's record that there is a distinction between non-resource property boundaries like rural residences or rural residence five or rural residence ten, those types of zones that are not protected by goal three and goal four versus those lands that are actually within the city limits, the UGB, or an urban reserve of an incorporated city. There are some legal nuances that I don't want to go into about zoning and what a non-resource zone could actually be considered. I have just recommended some language on page five for your consideration that kind of further explains this distinction so there can't be interpretation arguments down the road saying that the one mile should actually apply to all non-resource zone properties whether or not it is in an incorporated city.

Those were the key points that I wanted to mention to you. We also have some minor language recommendations having to do with the natural resource section, the cultural resources, and termination and decommissioning. You'll find those suggestions in the letter and they really are intended to go toward creating more consistency with the State process. With that, I am happy to answer any questions.

Further discussion ensued regarding the 30-day turn around for the County to provide comment to EFSC for a proposed project. Ms. Albrich assured the Board that the public already has many opportunities to comment directly to EFSC up to and including challenging the County's recommendations.

PHIL SWAIN
Wasco Butte, Vensel Road, Mosier, OR
Good morning. Thanks for letting me appear before you again today. I want to address the issue of setbacks proposed in the resource zone. Three-thousand five-hundred and twenty feet, two-thirds of a mile is a distance from turbines to a boundary zone line used in Gilliam County. Iberdrola's Juniper II project has had to secure about a dozen waivers from residents in Arlington to comply with the DEQ noise regulations. Sarah Parsons, the Project Director, said she had no problem with doing that set-up to make that comply.

On June 7, 2011, Wasco County Planning Commission was influenced by an opinion presented as fact from industry representatives that the State Energy Facility Siting Council had a quarter mile setback standard as related to the noise ordinance. This clouded the final recommendation because two commission members did not want to be more restrictive than State rules. Before the vote four members supported three quarters of a mile setback, but lost in converting fractions to feet. Three-thousand five-hundred and twenty feet was the distance settled upon, but only after a follow-up email vote. The issue of a State EFSC setback standard has not allowed a fair discussion of what is a safe setback. As people claim, Wasco County's rewrite of Chapter 19 is proposing greater setbacks than what the State requires. From my first encounter with EFSC in 2007 in the public meeting in the Civic Auditorium until my last encounter on February 3, 2012, EFSC staff has always stated there is no setback standards but for the DEQ noise regulations. Ninety-percent of the time wind turbines will be over the DEQ noise regulations with the setback of three-thousand five-hundred and twenty feet. At three quarters of a mile proposed for urban boundaries, still the DEQ noise regulations will not be met in most instances, especially with the larger turbines of 2.3 or 3 megawatts. Over time setback distances have increased in wind-friendly Sherman County. The city of Wasco has a one mile setback and not everyone out there likes living in the red light district. With an adjustment process to allow closer setbacks of turbines to residents, a greater setback distance should not be a problem. I haven't had the opportunity to fully process Attachment A, page 23, concerning the adjustments. What is proposed concerning adjustments seems ambiguous and open to interpretation. The conditions need to definitively state that an adjustment to establish a waiver for lesser setback distances is mandated by specific written permission from the affected property owner before any other conditions or factors be pursued. The two following paragraphs that are in Section A on page 23, that have been struck through present a clear understanding of intent and meaning and should be left in the ordinance.

Please keep these points in mind and consider the evidence in the studies from Minnesota, New Zealand, Great Britain, and Europe that all conclude greater setbacks eliminate the conflict and issues of wind turbine noise within the community. Thank you.

BRIAN WALSH – RETURNING

Two quick points that I wanted to talk about again - DEQ and then decommissioning security that I didn't get to before. I'd just like to add to what Elaine said about the importance of participating and non-participating dwelling setbacks. I want to give you two examples of why we should adopt the lesser setback for participating landowners. For instance, Dan Carver who was our first landowner to sign up, owns thirty-two thousand continuous acres of property. There isn't any home that is located less than a mile and a half or maybe even two miles from an exterior property boundary. So he is no closer than anyone of those homes. Right now, if we assume a greater set back than one-thousand three hundred and twenty feet, we'll have to wait for a variance. Dan seven homes are located on his property within the interior of the ranch. For us to have to assume that we're going to have a greater setback and wait until we get a conditional use permit and to get a variance on that. It just seems a little bit ridiculous and it gets into landowner's basic property rights. He's already agreed to have it and he signed a lease that he wants wind turbines on his property. I would advocate for a smaller setback or whatever the 15 decibel sound distance is and if you need a hard setback using the 1320 or the 1350, roughly a quarter mile setback for participating landowners which ensures safety, as Rick Till talked about. We'd be amenable to that – we already have to meet fewer than 50 decibels in the noise standard. If you were going to establish a setback for participating landowners, I'd make it that 1320 or 1350 – quarter mile.

Then on to decommissioning security, we haven't talked about this much at all. From the developers stand point, decommissioning security under the EFSC rules you have to apply for security, provide a letter of credit; guarantee a bond for it on day one before you can build your project which means you're carrying the cost of decommissioning for the life of the project. In reality you're not going to decommission that project 6 months after you build it or likely anywhere within the first ten years especially when you get a production tax credit. Making you post the full decommissioning amount on day one is just unrealistic and it's a financial burden on the project that sometimes has made the difference or whether you build it or not. We submitted into the record some of the decommissioning plans that are used in practice in Klickitat County, across the way, in which they start making you fund decommissioning in your seven and as the facility gets older they make you fund it on a straight line until it is fully funded in your twenty which is realistic. The turbine manufacturers rate that their turbines will at least last twenty years. We believe it's thirty years and that's why we execute a lease, anyway full security would be provided by them. Second, in

determining the amount of decommissioning security that needs to be posted, take into account the salvage value of the wind farm. As you know, these things are made of steel, they have copper wire. They have a lot of salvage value. Through the six decommissioning plans we submitted into the record from Klickitat County, the salvage value done by a third party independent analysis all exceeded the cost of decommissioning by almost half. There was more than enough salvage value to cover the cost of decommissioning. We ask that the County recognize part of the salvage value into the decommissioning estimate. Thanks.

Fred Justesen came forward to suggest that the County consider having two sets of standards, one for the southern portion of Wasco County and one for eh northern portion of Wasco County. Chair Runyon replied that they would talk about that.

Chair Runyon called a 10 minute recess at 11:10 a.m.

The hearing resumed at 11:20 a.m.

Mr. Roberts returned to say that he had no concerns regarding the suggested changes to the decommissioning language.

Commissioner Holliday asked if Mr. Roberts thought the change from "waiver" to "adjustment" would be enough to prevent appeals such as the one in Gilliam County. Mr. Roberts responded that more had actually changed than just the term for the process; they had looked at the specifics sited in the Cosner appeal and addressed those issues when writing the adjustment provisions. Commissioner Holliday expressed concern that through the adjustment process, the County would get bogged down in a public hearing process. Mr. Roberts replied that the process includes a thorough staff review of the adjustment provisions of the application to ensure it complies with the ordinance.

Commissioner Hege asked if the idea of separate north/south regulations had already been considered. Mr. Roberts said that he had heard some discussion around that and that it could be a viable solution. In considering today's suggested provisions of a different setback for those within the project boundaries, that seems like a more practical solution.

Commissioner Hege moved to close the oral public testimony portion of the hearing and continue to receive written testimony until the day of the continuation

of the hearing. Commissioner Holliday seconded the motion which passed unanimously.

Commissioner Hege moved to continue the public hearing until April 4, 2012, at 9:30 a.m. in Court Room 202, asking staff to review today's testimony and return with a revised staff report. Commissioner Holliday seconded the motion which passed unanimously.

Chair Runyon adjourned the session at 11:35 a.m.

WASCO COUNTY BOARD
OF COMMISSIONERS

Rod L. Runyon, Chair of Commission

Sherry Holliday, County Commissioner

Scott Hege, County Commissioner

Wasco County Board of Commissioners
Staff Report
PLALEG-09-06-0003

Amendments to the
Wasco County Land Use & Development Ordinance

Note: This staff report has been written to address ONLY the amendments to the Wasco County Land Use and Development Ordinance, NOT the amendments to the Wasco County Comprehensive Plan. The amendments to the comprehensive plan were adopted by the Board of Commissioners on January 4, 2012. The staff report and attachment was prepared for the March 20th public hearing and addresses issues raised at the February 15, 2012 public hearing.

More information available at: http://co.wasco.or.us/planning/Energy_updates_Main.html

Date:	Prepared for March 20, 2012 Public Hearing (Continued from February 15, 2012)
Request:	Amend the Wasco County Land Use and Development Ordinance (LUDO) 1. Amend language related to where and how commercial and non-commercial energy development is allowed. 2. Modernize language that is not compliant with state law, incorrect, or out of date. 3. Reformat all zones and add similar uses to create as much consistency between the zones as possible.
Prepared by:	John Roberts, Planning Director Jeanette Montour, Senior Planner
Prepared for:	Wasco County Board of Commissioners
Applicant:	Wasco County Planning Department
Planning Commission Hearing Dates:	May 3, 2011 and June 7, 2011
PC Recommendations:	LUDO: On a vote of 7 – 0 the planning commission recommended the Board of Commissioners adopt the proposed amendments as presented at the 7 June 2011 hearing and further amended during deliberation.
Applicable Properties:	All properties in Wasco County outside of the National Scenic Area and outside of urban growth areas.
Procedure Type:	Legislative

Attachments: Attachment A: Additional Suggested Changes to the Wasco County Land Use and Development Ordinance, Chapters 1, 3 & 19 (Focused on Chapter 19 – Standards for Energy Facilities)

I. OPEN HOUSE – March 20th

An Open House has been noticed and will be hosted on March 20th from 8:00 a.m. to 9: a.m. (just before the scheduled 9:00 a.m. hearing) on the third floor of the Court House. The Open House was organized in response to public comments and feedback received and recognizing the need to be available to the public. At the Open House all planning staff will be onsite and available to:

- Explain how the proposed setback regulations would affect properties in each zoning district differently (i.e., differences between non-resource and resource lands).
- Illustrate proposed setbacks with maps and visuals.
- Provide explanations and answers to all related issues and concerns.

II. ADDITIONAL CHANGES PROPOSED TO CHAPTERS 1, 3 & 19

The first Board of Commissioner public hearing on the proposed amendments to the Wasco County Land Use and Development Ordinance (LUDO) was held at the Northern Wasco PUD on February 15, 2012. The amendments focus on Chapter 19 (Energy Facilities & Related Uses). The hearing was well attended and many comments were solicited through both written and public testimony.

The following breaks down additional changes proposed by staff to the draft LUDO amendments and are primarily in response to comments received before or at the February 15th public hearing. The comments are categorized as either non-substantive or substantive. These changes are identified through Track Changes: ~~strikethrough~~ and underline in Attachment A.

Examples of "Non-Substantive" Changes Made to Chapters 1 and 19:

- Headers pertaining to four definitions.
- Capitalization and reformatting of tables where necessary or appropriate.
- Elimination of the word "ministerial" throughout and replaced with "Type I."
- Basic or common sense provisions related to color, visibility or odor were modified.
- Headers and language to explicitly clarify review process and review authority were inserted.
- Reorganizing provisions to make them flow better (e.g., section on County Decision Options: Tentative and Final Approval).
- Sentences eliminated to reduce redundancy.
- Specifics eliminated to allow for more flexibility (e.g., section on Decommissioning Plan).

It is felt it is not necessary to provide details on these changes as they were intended to provide additional clarity and did not change the intent of any specific provisions.

Substantive Changes Made to Chapter 3 and 19:

Chapter 3

The following changes were made to Section 3.210(D)(12) – EFU Zone:

- EFU Zone – Section 3.210(D)(12): Utility facilities "necessary" for public service, including wetland waste treatment systems and Electrical Transmission Facilities under 200 feet in height, but not including commercial utility facilities for the purpose of generating electrical power for public use by sale, or Electrical Transmission Facilities ~~transmission towers~~ over 200 feet in height, subject to Section J(8), Additional Standards below ~~and the applicable provisions of Chapter 20, Site Plan Review~~.

  ~~A Transmission Facility under 200 feet in height subject to J(8)(a)(1) – (6) below and the applicable Subject to Standards criteria of Chapter 19.~~

  Staff Comment: Electrical Transmission is divided into three categories: (1) Distribution/Utility Facility Service Lines under 200' in height which are allowed without review; (2) Related and accessory transmission which are allowed accessory to a new energy generation facility if owned by the developer and are not a separate use; and (3) New transmission facilities. ORS 215.283 only allows Electrical Transmission Facilities over 200' to be reviewed as a CUP. So, while other zones require all Electrical Transmission Facilities to be reviewed as a CUP, this zone must be consistent with ORS.

Chapter 19

- Section 19.020.B(2)C(2) - Lighting ~~the top of the tower~~ - Lighting of towers is only allowed if required by the Oregon Department of Aviation or Federal Aviation Administration. If lighting is required by Oregon Department of Aviation or Federal Aviation Administration the applicant shall seek approval of radar triggered lighting~~and radar triggered lighting is on the list of approved lighting, it shall required~~.

  Staff Comment: There were multiple concerns about lighting at night submitted. The current proposal required radar triggered lighting if it is allowed by the FAA. The suggested changes allows more flexibility in requiring radar triggered lighting or not based on specific circumstances. These changes are also applicable to Section 19.030(D)(1)(A)(3) – Visual Impact.

- Section 19.030.A.1.C.1 - EFSC:
  (1) EFSC has regulatory authority over all energy facilities designated by ORS 469.300. However, pursuant to ORS 469.480 EFSC shall designate the BOCC as a Special Advisory Group which may participate in the siting process pursuant to the role established in ORS 469 and OAR 345 which includes recommending substantive criteria applicable to the proposed energy facility. ~~Prior to submitting recommended applicable substantive criteria to EFSC the BOCC shall provide newspaper notification to citizens of Wasco County about the meeting where they will take action to establish the applicable substantive criteria. At this meeting the BOCC will take public testimony on~~

~~the applicable substantive criteria. Recommendations of the Planning Department to the BOCC will be available to the public 7 days prior to the BOCC hearing~~.

Staff Comment: Staff believes this provision as originally proposed is a good idea. However, it is felt that in light of very tight or short timelines established in the EFSC (Energy Facilities Siting Council) process (i.e., typically 30 days) it would be difficult to make such referrals from the Board of Commissioners through the above described referral process a reality. Moreover, there is ample opportunity for the public to comment directly to EFSC as part of the referral process. In short, going through the recommended Board referral process could take a long time and such provision could open up the county to challenges. The suggested changes would align the provision with the realities of the EFSC siting process.

- Section 19.030.C.4. – Visual Impact

a. Scenic Resources – To issue a conditional use permit for an energy facility, the county must find that the design, construction and operation of the facility, taking into account mitigation, are not likely to result in significant adverse impact to scenic resources or values identified as significant or important in the Wasco County Comprehensive Plan.

~~a.~~b. Protected Areas: Except as provided in subsections (b) and (c) below, an energy facility shall not be located in the areas listed below~~following areas~~:

~~i. Areas identified as significant or important visual resources in the Comprehensive Plan;~~

(1) National recreation and scenic areas, including but not limited to the Columbia River Gorge National Scenic Area;

(2) Scenic waterways designated pursuant to ORS 390.826, wild or scenic rivers designated pursuant to 16 U.S.C. 1271 et seq., and those waterways and rivers listed as potentials for designation;

(3) State parks and waysides as listed by the Oregon Department of Parks and Recreation;

(4) State wildlife areas and management areas identified in OAR chapter 635, division 8.

(5) National and state fish hatcheries or national and state wildlife refuges;

(6) State natural heritage areas listed in the Oregon Register of Natural Heritage Areas pursuant to ORS 273.581;

(7) Wilderness areas established pursuant to The Wilderness Act, 16 U.S.C. 1131 et seq. and areas recommended for designation as wilderness areas pursuant to 43 U.S.C. 1782; and

~~(8) Bureau of Land Management areas of critical environmental concern, outstanding natural areas and research natural areas.~~

~~b.~~ 1. Exceptions to Protected Areas - Except where the following uses are regulated by federal, state or local laws, including but not limited to the Columbia River Gorge National Scenic Area Act and implement land use ordinances, t~~T~~he following may be approve in a protected area identified in subsection (b~~a~~) above if other alternative routes or sites have been studied and been determined to have greater impacts

~~(9)~~(8) An electrical transmission line;

~~(10)~~(9) A natural gas pipeline; or

~~(11)~~(10) An energy facility located outside a protected area that includes an electrical transmission line or natural gas or water pipeline as a related or supporting facility located within a protected area.

~~c.~~ 2. Transmission Line & Pipeline Exception - The provisions of subsection (b~~a~~) above do not apply to electrical transmission lines or natural gas pipelines routed within 500 feet of an existing utility right-of-way containing at least one transmission line or one natural gas pipeline.

~~b.~~c. Additional Visual Mitigation Impacts for all Facilities - The design, construction and operation of the energy facility, taking into account mitigation, are not likely to result in significant adverse impact to scenic resources and values identified in subsection (a) above. Methods to mitigate adverse visual impacts could include but are not limited to:

(1) Building the energy facility near the edge of contiguous timber areas or using the natural topography to obscure the energy facility;

(2) Using materials and colors that blend with the background unless otherwise required by the Federal Aviation Administration or the Oregon Department of Aviation; and

(3) Retaining or planting vegetation to obscure views of the energy facility.

Staff Comment: Based on public comments this section was reorganized to try and provide more clarity. For example, the comprehensive plan language is proposed to be removed as it could create duplication and confusion with Goal 5 in the County's Comprehensive Plan. It is felt the four headers should create more distinction between scenic resources, protected areas and what exceptions pertain to protected areas.

- Section 19.030.C(9) – Transportation Plan

Staff Comment: This section is proposed to be amended to stress that a transportation plan shall be developed and implemented in consultation with the Wasco County Road Department and/or the Oregon Department of Transportation. In this context two specific provisions amended or added include:

(c) Restoring the natural grade and revegetating all temporary road cuts, used during construction of the energy facility. The applicant shall specify the type and amount of

native seed or plants used to revegetate the disturbed areas and a timeline to complete this work.

(d) A Road Impact Assessment/Geotechnical Report for roads to be used by the project. Said report should include an analysis of project-related traffic routes to be used during phases of construction, project operation and decommissioning. The report and any subsequent amendments shall be used as a discipline study and shall be incorporated into the Road Use Agreement between the Applicant and the County.

- 19.030(D)(1)(c) - Setbacks

Staff Comment: The issue of setbacks received a lot of attention at previous Board of Commissioner and planning commission public hearings. A provision was included in the original draft regulations to allow a "waiver" to the proposed 2/3 mile setback for dwellings in agriculture and forest lands. For example, a property owner could provide permission for a turbine to be sited closer than 2/3 of a mile and possibly within a ¼ mile of their dwelling if a waiver was signed by them the property owner.

The waiver provision has been deemed unconstitutional by the Oregon Land Use Board of Appeals (LUBA). However, it is felt the need for waivers as it relates to setbacks is very important to provide flexibility to landowners and applicants. Thus, in light of the LUBA decision an approach similar to a waiver provision has been proffered.

This approach is called an "adjustment" and addresses the issues raised in the recent LUBA case (i.e., Cosner vs. Umatilla County). The adjustment process avoids legalities as it is a factors based determination in process, safety, resource management and preservation.

The proposed "adjustment process" could be applied to: shadow flicker, non-project boundaries, and setbacks for cities/urban growth boundaries, non-resource zone lands (i.e., rural residential properties) and resource zoned lands (i.e., agricultural and farm lands). It is proposed to incorporate the adjustment provision into all the aforementioned, except "non-resource" zoned properties. The reason for this is because a waiver provision was not originally proposed for non-resource zoned properties, which has a proposed setback of 1 mile.

The following is the proposed language to address "adjustments" (i.e., akin to a waiver process) to dwellings located in agricultural and forest lands:

An applicant may request an adjustment to the resource dwelling setback described above without being subject to the variance processes in Chapters 6 or 7 and authorized pursuant to the Administrative Action process of Section 2.060(A). As part of the permitting process the request shall demonstrate safety factors have been considered and a lesser setback is warranted. Factors to support an adjustment include, but are not limited to:

(a) The property owner's support or consent of a lesser setback.
(b) Applicant's ability to comply with DEQ noise regulations.
(c) Site specific conditions of the site.
(d) Avoiding or minimizing potential environmental or resource impacts.

Staff Comment: Note, wind turbines would still be required to meet the underlying zone setback requirement unless a variance is granted pursuant to either Chapter 6 or 7.

Other Comments Received But Not Incorporated:

The following identifies specific sections of Chapter 19 that have been identified by the public, through the public commenting process, as areas in need of substantive change. The suggested changes as it relates to these sections were not incorporated into Attachment A by staff. Proposed changes to these sections could be brought to the Board's attention at the public hearing. Staff is willing to expand on any of these sections and respective comments or issues at the public hearing and explain why suggested changes offered by the public were not incorporated.

- 19.010 – Purpose
- 19.030(A)(1)(c) – Tentative Approval and Final Approval
- 19.030(C)(5) – Natural Resource/Wildlife Protection
- 19.030(C)(6) – Cultural Resources
- 19.030(C)(11) – Onsite Access Roads and Staging Areas
- 19.030(C)(12) – Dust Control

III. OPTIONS & RECOMMENDATIONS

The Board of Commissioners have three options on how to proceed. In deciding how to move forward the following are factors to weigh, balance and consider:

- Public comments and feedback from the March 20th public hearing.
- Need for additional public testimony.
- Comfort level with the proposed regulations.
- Desire for more research or details on specific issues.
- Need to explore more options.
- Recent adoption of the Wasco County Comprehensive Plan on January 4, 2012.

The three options to consider are as follows:

1) Continue Public Hearing: If the Board of Commissioners need more time to take more public comment, address issues or explore options, Planning Case PLALEG 09-06-0003 should be continued to a date, place and time certain for additional information necessary to make a decision (and if necessary, direct staff to provide additional information). This would also involve leaving the public hearing open. It would be suggested to schedule the continuance within two to three weeks.

2) Adopt Proposed Regulations: If the Board of Commissioners are ready to adopt the proposed regulations, the Board can approve the proposed amendments to Chapters 1, 2, 3, 4, 15 and 19 of the Wasco County LUDO as: recommended by the planning commission; in light of the applicable criteria and findings presented in the staff report to the Board dated February 15, 2012; with additional amendments generated from public comment and from staff as presented; as well as any additional amendments made by the Board (Note: additional amendments made by the Board must be specifically worded). With this approval

the Board shall also grant staff the authority to make non-substantive changes throughout the documents to ensure consistency.

It is recommended such an adoption would be similar to the updates to the Wasco County Comprehensive Plan adopted on January 4, 2012. After adoption staff would prepare a final order (i.e., resolution) with all applicable changes to all chapters clearly identified in an accompanying document. It would be the goal to tie this final order together with the updates to the Wasco County Comprehensive Plan. This could realistically happen in April.

3. Deny the amendments as proposed

Attachment A

Additional Suggested Changes to Wasco County Land Use and Development Ordinance Chapters 1, 3 & 19 (Focused on Chapter 19 – Standards for Energy Facilities)

PLALEG-09-06-0003

"Working Draft"

Recommended new language and changes are identified by Track Changes: ~~strikethrough~~ and underline

Prepared by: John Roberts, Planning Director
Prepared for: March 20, 2012 Public Hearing

CHAPTER 1 DEFINITIONS

BO~~C~~C - Wasco County Board of ~~County~~ Commissioners.

Road Department – Wasco County Public Works Department.

Wind Turbine Horizontal Axis ~~Wind Turbine WECS~~ - A wind turbine ~~WECS~~ on which the rotor axis substantially is parallel to the ground.

Wind Turbine Vertical Axis ~~Wind Turbine WECS~~ - A wind turbine ~~WECS~~ where the rotor axis is vertical.

CHAPTER 3 BASIC PROVISIONS

EFU Zone – Section 3.210(D)(12): Utility facilities "necessary" for public service, including wetland waste treatment systems and Electrical Transmission Facilities under 200 feet in height, but not including commercial utility facilities for the purpose of generating electrical power for public use by sale, or Electrical Transmission Facilities ~~transmission towers~~ over 200 feet in height, subject to Section J(8), Additional Standards below ~~and the applicable provisions of Chapter 20, Site Plan Review~~.

~~A Transmission Facility under 200 feet in height subject to J(8)(a)(1) – (6) below and the applicable Subject to Standards criteria of Chapter 19.~~

CHAPTER 19 STANDARDS FOR NON COMMIERCIAL ENERGY FACILITIES, COMMERCIAL ENERGY FACILITIES & RELATED USES

SECTION 19.010 Purposes

This chapter describes the requirements for establishing non-commercial energy facilities, commercial energy facilities and related uses (as included) in Wasco County. The goals of this chapter are to:

- Encourage renewable energy production;
- Utilize clear and objective standards;
- Establish a clear, consistent and accountable application process;
- Collaborate and coordinate with agencies and other stakeholders;
- Minimize conflict with other permitted uses through compatibility review;
- Protect resources identified in the Wasco County Comprehensive Plan; and
- Protect the public health, safety and general welfare of the citizens of Wasco County.

The uses described in this chapter are only allowed if listed in the zoning section in Chapter 3 applicable to the subject property.

SECTION 19.020 Non-Commercial/Stand Alone Power Generating Facilities & Related Uses Review Processes & Approval Standards

A. Review Processes - Non-commercial/Stand Alone Power Generating Facilities & Related Uses (energy facilities) shall be reviewed pursuant to the following. Where standards are less restrictive than comparative standards in other sections, the more restrictive shall govern.

1. Towers - This shall include free standing (Wind Turbine & Meteorological) or roof mounted towers/turbines.

Tower Height	Property Size			
	<2 Acres	2 - < 5 Acres	5 - < 10 Acres	> = 10 Acres
Non-Resource Zones				
< = 35'	*Type I ~~Ministerial~~	*Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I~~Ministerial~~
> 35' - < 50'	Type II - STS	Type II - STS	Type I~~Ministerial~~	Type I ~~Ministerial~~
50' - < 100'	Type II - CUP	Type II - STS	Type II - STS	Type II - STS
100' - 150'	Type II - CUP	Type II - CUP	Type II - CUP	Type II - STS
Resource Zones				
< 35'	*Type I~~Ministerial~~	*Type I ~~Ministerial~~	Type I~~Ministerial~~	Type I ~~Ministerial~~
35' - < 50'	Type II - STS	Type II - STS	Type I ~~Ministerial~~	Type I ~~Ministerial~~
50' - < 100'	Type II - CUP	Type II - STS	Type II - STS	Type II - STS
100' - < 200'	Type II - CUP	Type II - CUP	Type II - STS	Type II - STS
> = 200'	Type II - CUP	Type II - CUP	Type II - CUP	Type II - CUP

*The 4th tower sited on the property shall elevate the review from a Type I~~Ministerial~~ to

an STS.

Wind turbines that are attached to other lawful uses (excluding roof mounted turbines) including but not limited to street lamps and telephone poles are not subject to the standards of chapter 19. They shall be subject to the same standards and review process as the use to which they are attached as outlined in the applicable zone.

2. Solar Systems

System Size	Property Size				
	<2 Acres	2 - < 5 Acres	5 - < 10 Acres	10 - < 40 Acres	> = 40 Acres
Roof Mounted < = 35' in height	Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I ~~Ministerial~~
*Roof Mounted > 35' in height	STS	STS	STS	Ministerial	Ministerial
**Ground Array < 500 sq. ft.	Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I ~~Ministerial~~	Type I ~~Ministerial~~
**Ground Array 500 - < 1,500 sq. ft.	Type II – STS	Type II - STS	Type II - STS	Type II - STS	Type I ~~Ministerial~~
**Ground Array > = 1,500 sq. ft.	Type II – CUP	Type II - CUP	Type II - CUP	Type II - CUP	Type II - STS

*Roof mounted systems exceeding 35' in height shall be allowed without a variance pursuant to either Chapter 6 or 7.
**Ground Arrays are limited to 35' in height. Ground Arrays exceeding 35' in height will be required to apply for a variance pursuant to either Chapter 6 or 7.

Small solar systems (less than 10 square feet) that are accessory to other lawful uses including but not limited to gates, electric fences & lights are not subject to the standards of chapter 19. They shall be subject to the same standards and review process as the use to which they are accessory as outlined in the applicable zone.

Multiple panels, multiple arrays and supporting equipment providing energy to the same structure or use shall be considered one (1) system in determining the applicable review process. If a portion of the system is already installed and the permit holder is creating an addition to the system, the applicable review process shall be based on the total size of the system.

3. OWRD -Hydroelectric Facilities:

a. Not Located within an Area of Special Flood Hazard - Hydroelectric energy projects not located within an Area of Special Flood Hazard are not required to meet property development standards within the zone they are being located. If located in a non-resource zone they are allowed without any review by the Planning Department as long as they are being reviewed by the OWRD. If located in a resource zone they are required to be reviewed as a "utility facilities necessary for a public use", "reservoir", or water impoundment".

b. Located within an Area of Special Flood Hazard – In addition to a. above,

hydroelectric energy facilities located within an Area of Special Flood Hazard are subject to Section 3.740, Flood Hazard Overlay by the Planning Department even if they are being reviewed by the OWRD.

4. Additional Non-Commercial/Stand Alone Power Generating Facilities - The review process for energy facilities other than those previously described will be decided by the Planning Department based on an evaluation of the primary purpose of the zone, the size of the subject property and surrounding properties, the proposed location of the use and its potential impact to adjacent properties. Impacts include but are not limited to noise, vibration, smell, emissions, visibility, or physical footprint.

B. ~~Ministerial/~~Type I Review Standards - The following are applicable to energy facilities in addition to meeting the property development standards of the zone, unless otherwise specified, and any other listed or referenced standards.

1. General Standards for all Energy Facilities:

a. Lawful Use - Power will be for a lawfully established use or use that is in the process of being reviewed by the Planning Department.

b. Interconnect Agreement (Net Metering Only) - The applicant shall provide an interconnect agreement with a local utility or copy of a submitted application requesting an interconnect agreement with a local utility.

c. Closed System (Non-Commercial Stand Alone Only) - The applicant shall provide a plan or diagram that proves the proposal is a closed system and will not tie into a utility.

d. Setback/Buffers - Unless otherwise specified in this chapter, all energy facilities shall meet the property line setbacks of the zone in which they are located, natural resource buffers, as well as any additional setbacks required below.

e. Height - Unless otherwise specified in this Chapter, Pursuant to Section 4.070, General Exceptions to Building Height Requirements, energy facilities shall be exempt from the height limits of the zone in which they are located.

f. Color/Visibility - Energy facilities and their accessory electrical control equipment shall be ~~either the stock color from the manufacturer or painted in~~ a non-reflective, unobtrusive color that blends in with the surrounding environment unless otherwise required by the Federal Aviation Administration or Oregon Department of Aviation.

g. Noise – Manufacturer's sound power level ~~as defined by XXXXXX~~ shall not exceed 60 db(A).

h. Air Quality - Manufacturer's emissions estimate shall be in compliance with Oregon Department of Environmental Quality in OAR Chapter 340, Division 200.

i. Vibration - Vibrations shall not be produced which are humanly perceptible beyond the property on which the energy facility is located.

j. Odor — To the extent practicable, oOdors shall not be produced which are humanly perceptible beyond the property on which the energy facility is located.

k. Health & Safety:

(1) All uses or structures shall be designed and constructed to limit access.

(2) Warning and safety signs, up to three square feet in area, are allowed.

(3) All ground mounted electrical and control equipment shall be labeled or secured to prevent unauthorized access.

(4) The manual electrical and/or overspeed shutdown disconnect switch(es) shall be clearly labeled.

(5) Utility facility service lines, electrical lines and other wires associated with the energy facility that are not underground shall be kept clear along the route and have a single point of access to the building to the maximum extent practicable while still complying with local, state, and federal electrical codes.

(6) Uses and structures shall be designed and constructed to not impair emergency response. Contact your local emergency responder for specific requirements and guidance.

(7) Energy facilities shall be kept and maintained in good repair and condition at all times and shall not pose a potential safety hazard.

l. Advertising - No commercial or advertising markings shall be allowed except those of the manufacturer & installer.

m. Interference with Communication - Energy facilities shall not create any material signal interference with communication systems such as, but not limited to, radio, telephone, television, satellite, microwave or emergency communication systems. Should any material interference occur, the property owner must develop and implement a mitigation plan in consultation with the Planning Department.

n. Decommissioning/Removal - Any facility that is inoperable for more than 12 months shall be deemed discontinued. Removal of the equipment and facilities shall occur within six (6) months of the discontinuance time frame or other time frame approved by the Planning Department unless all or a portion of the equipment and facilities are converted to an approved use within this same time frame.

o. Other Authority - All necessary local, state and federal authorizations/permits shall be obtained prior to constructing the use.

2. Specific Standards:

a. Tower Standards

(1) Setbacks

(a) The base of the tower shall be set back from all property lines, public-rights-of-ways, and above ground public utility lines a distance equal to the height of the tower (i.e., fall height). The setback shall be measured to the center of the tower's base.

(b) ~~Towers shall be allowed closer to a property line, public right-of-way, or above ground public utility line than the height of the tower without a variance pursuant to either Chapter 6 or 7 if granted written permission from the affected property owner, road authority, or utility. Said written permission shall be made part of the deed records to any private property.~~

Notwithstanding receiving permission from an affected property owner(s), road authority or utility, towers shall still be required to meet the property lines setbacks of the zone in which they are located and all natural resource buffer requirements unless a variance is granted pursuant to either Chapter 6 or 7.

(c) Any guy wires associated with a tower shall be required to meet the property and buffer setbacks of the zone in which they are located unless a variance is granted pursuant to either Chapter 6 or 7.

(2) Safety:

(a) Minimum Height - The lowest extension of any exposed blade or other exposed moving component shall be at least fifteen (15) feet above the ground (at the highest point of the grade level within fifty (50) feet of the base of the tower) and, in addition, at least fifteen (15) feet above any outdoor surfaces intended for human occupancy, such as balconies, that are located directly below the blade.

The minimum height may be reduced if a safety fence is installed around the area of the exposed blade or other moving component that would prevent access and direct contact with the exposed blade or other moving component. The minimum height may also be reduced through the Type II /STS review process in subsection C below.

(b) Wind turbines shall be equipped with an automatic braking, governing or feathering system to prevent uncontrolled rotation, over-speeding and excessive pressure on the tower structure, rotor blades and other wind energy components unless the manufacturer certifies that a braking system is not necessary.

(c) Towers shall be equipped with lightning protection.

(d) Towers shall be designed and installed so as to not provide step bolts or a ladder readily accessible to the public for a minimum height of 8 feet above the ground.

(e) "Danger" signs shall be posted at the height of five feet on the tower if it has a climbing apparatus.

(f) Permit holders are encouraged to sheath guy wires in a covering that would increase their visibility from a height of three feet above ground to eight feet above ground.

(3) Avian Protections - Perch deterrents shall be placed on all surfaces that would attract birds to a location where they could be struck by a moving component on the tower such as the sweep of a wind turbine blade.

(4) Lighting - Lighting of towers subject to only a ~~Ministerial/~~Type I review is not allowed.

b. Solar System Standards:

(1) Safety

(a) Roof mounted solar panels shall be installed in a manner that maintains adequate fire department access to the roof, with an unobstructed path from the structures eaves to structure components located on the roof (i.e., chimney, stove pipe, other roof mounted appliances). Contact ~~your~~ local fire official for specific requirements and guidance.

(b) Ground arrays shall maintain a ten feet (10') perimeter of fire fuel break. Refer to Section 10.120 of the Fire Safety Standards for a description of a fire fuel break.

(2) Solar Access Rights - The establishment of a solar system consistent with the requirements of this ordinance shall not constitute solar access rights that are protected by this ordinance.

C. ~~STS/~~Type II Review Standards - The following are applicable to energy facilities in addition to meeting the ~~Ministerial/~~Type I Review Standards in subsection B above, the property development standards of the zone, unless otherwise specified, and any other listed or referenced standards.

1. General Standards for all Energy Facilities

a. General Compatibility - The proposed use is compatible with adjacent surrounding properties taking into consideration the following:

(1) Scale
(2) Odors
(3) Vibration

b. Noise - If the manufacturer's sound power level exceeds 60 db(A) or there is no manufacturer's stated sound power level, the applicant shall submit an ~~qualified expert's~~ analysis from a qualified consultant or individual and written report to prove operation of the energy facility shall be in compliance with sound pressure noise regulations established by the Oregon Department of Environmental Quality in OAR Chapter 340, Division 35 with regard to any existing dwellings on non-participating landowners property. These regulations shall govern notwithstanding the energy facility is neither a commercial or industrial use.

2. Specific Standards:

a. Tower Standards:

(1) Aviation Notification - Planning staff shall notify the following groups or agencies as to the location of the proposed tower(s). Comments received regarding safety may be included as safety features required in subsection (2) below.

(a) Aerial Sprayers and operators who have requested to be notified - All towers over 50' in height.

(b) Oregon Department of Aviation (ODA) & Federal Aviation Administration (FAA) - All towers over 200 feet in height or as prescribed by OAR 738-070-0110.

(2) Aircraft Safety Plan - A safety plan shall be submitted that will ensure aircraft safety is maintained for all towers 50' in height or greater. Unless a determination of no hazard is made, safety features will be required as necessary to ensure aircraft safety based on the location, height, and type of tower. Any safety features required as part of an approval shall be completed at the time the tower is installed. Safety features, if required, could include but are not limited to the following:

(a) Placing an aviation device, or equivalent visible marker at each of the outermost guy wire anchors.

(b) Painting the top 30 feet of each tower with 5 foot bands of alternating colors of Aviation Orange and Aviation White.

(c) Lighting ~~the top of the tower~~ - Lighting of towers is only allowed if required by the Oregon Department of Aviation or Federal Aviation Administration. If lighting is required by Oregon Department of Aviation or Federal Aviation Administration the applicant shall seek approval of radar triggered lighting~~and radar triggered lighting is on the list of approved lighting, it shall required~~.

(3) Minimum Height - The lowest extension of any exposed blade or other exposed moving component may be allowed less than (15) feet above the ground as required by subsection B(2)(a)(2) if based on the proposed location and site specific circumstances, the tower will not represent a safety hazard.

(4) Shadow Flicker~~ing/Flicker~~ ~~—~~ Upon the non-participating owner's request, t~~T~~he applicant shall demonstrate that the wind turbines, taking into account mitigation measures, will have no significant adverse impact of shadow flicker on an existing dwelling of a non-participating landowner within ¼ mile (1,320 feet) from a turbine, measured from the centerline of the turbine to the centerline of the dwelling~~, upon the non-participating owner's request~~.

Towers shall be allowed to create an adverse shadow flicker impact to an existing dwelling on a non-participating landowner's property if written permission from the property owner and an adjustment is granted under Section

19.030(D)(1)(c). Said written permission shall be made part of the deed records of the non-participating landowner's property.

b. Solar Standards:

(1) Ground Leveling - The solar energy facility shall be designed and constructed to minimize ground leveling and to the extent reasonably practicable, limit ground leveling to those areas needed for effective solar energy collection.

(2) Misdirection of Solar Radiation - The solar energy facility shall be designed, constructed, and operated to prevent the misdirection of concentrated solar radiation onto nearby properties, public roadways or other areas accessible to the public.

(3) Glare - The solar energy facility shall be designed, constructed and operated such that any significant or prolonged glare is directed away from any nearby properties or public roadways.

(4) Cleaning Chemicals and Solvents - During operation of the solar energy facility, all chemicals or solvents used to clean solar panels or heliostats shall be low in volatile organic compounds and to the extent reasonably practicable, the permit holder shall use recyclable or biodegradable products.

D. CUP/Type II Review Standards - Energy facilities subject to conditional use review shall meet the standards of Chapter 5, Conditional Use Review, the ~~Ministerial/~~Type I Review Standards in subsection B above, the ~~STS/~~Type II Review Standards in subsection C above, the property development standards of the zone, unless otherwise specified and any other listed or referenced standards.

SECTION 19.030 Commercial Power Generating Facilities Review Processes & Approval Standards

A. Review Processes - Commercial Power Generating Facilities & Related Uses (energy facilities) shall be reviewed pursuant to the following. Where standards are less restrictive than comparative standards in other sections, the more restrictive shall govern.

1. Review Authority:

a. Planning Commission Review — Notwithstanding applications reviewed by EFSC and u~~U~~nless otherwise specified all energy facilities reviewed pursuant to this section shall be initially heard and decided upon by the Planning Commission in a public hearing.

b. Planning Department Review:

(1) Small Scale Commercial Power Generating Facilities - A commercial power generating facility shall be considered small scale if it falls within either the tower or solar matrix listed in Section 19.020, Non-Commercial Power Generating Facilities and shall be reviewed by the Planning Department pursuant to the standards of Section 19.020 and not this section.

For non-resource zones, solar arrays shall be limited to ¼ acre and towers to no more than 150' in height and no more than 4 towers per property. For resource zones solar arrays shall be limited to ½ acre and towers to under 200' in height and no more than 4 towers per property shall be reviewed by the Planning Department. Beyond these limits the energy facility will not be considered small scale and will only be allowed pursuant to the standards in this section.

(2) Community Projects - Renewable projects of 10MW or less which include a partnership between a local land owner and a community (public) organization such as Wasco County, Mid-Columbia Council of Governments, a city, or a school district, shall be reviewed ~~initially heard and decided upon~~ by the Planning Department.

(3) Post EFSC Review - Pursuant to ORS 469.401, after issuance of a site certificate by EFSC pursuant to subsection c. below, and subject to receiving the proper fees, Wasco County will issue in an expedited manner ~~must promptly issue~~ any permits, licenses and certificates addressed in the site certificate subject only to conditions set forth in the site certificate but without hearings or other proceeding (i.e., Type I review).

(4) Hydroelectric Energy Facilities - See subsection d. below.

c. EFSC Review:

(1) EFSC has regulatory authority over all energy facilities designated by ORS 469.300. However, pursuant to ORS 469.480 EFSC shall designate the BO~~C~~C as a Special Advisory Group. As such and at their discretion the BOC ~~which~~ may participate in the siting process pursuant to the role established in ORS 469 and OAR 345, which includes recommending substantive criteria applicable to the proposed energy facility. ~~Prior to submitting recommended applicable substantive criteria to EFSC the BOCC shall provide newspaper notification to citizens of Wasco County about the meeting where they will take action to establish the applicable substantive criteria. At this meeting the BOCC will take public testimony on the applicable substantive criteria. Recommendations of the Planning Department to the BOCC will be available to the public 7 days prior to the BOCC hearing.~~

(2) Pursuant to ORS 469.320(8), notwithstanding the threshold limits in ORS 469.300, an applicant can elect to have EFSC review an energy facility that may otherwise be subject to Wasco County's jurisdiction.

(3) If for any reason the BO~~C~~C desires, they may defer regulatory authority of energy facility to EFSC notwithstanding it is less than the threshold designated by ORS 469.300.

d. OWRD Review - Hydroelectric Energy Facilities:

(1) Not Located within an Area of Special Flood Hazard - Hydroelectric energy facilities not located within an Area of Special Flood Hazard are not required to meet property development standards within the zone they are being located. If located in a non-resource zone they are allowed without any review by the

Planning Department as long as they are being reviewed by OWRD or FERC. If located in a resource zone they are required to be reviewed as a "utility facilities necessary for a public use".

(2) Located within an Area of Special Flood Hazard - In addition to d.(1). above, hydroelectric energy facilities located within an Area of Special Flood Hazard are subject to Section 3.740, Flood Hazard Overlay by the Planning Department even if they are being reviewed by the OWRD or FERC.

e. FERC Review - FERC has regulatory authority over all energy or related projects of a size, scale or interest to the federal government pursuant to Title 18, Conservation of Power and Water Resources, of the Code of Federal Regulations.

2. County Decision Options - As part of the application materials the applicant shall indicate if they are requesting tentative or final ~~or tentative~~ approval. For facilities sited through EFSC, this section does not apply.

a. Tentative Approval - A tentative approval may be issued when the applicant has submitted most of the required application materials but defers completion of one or more required discretionary elements such as the wildlife plan and all of its required baseline studies. Any deferred discretionary elements will be the only elements reviewed and decided upon during the final approval process.

A tentative approval shall specify a time limit or expiration date within which all deferred discretionary review elements or plans shall be reviewed for final approval. Pursuant to Section 2.125, Time Limits for Permits and Extensions of Time, the combined time for both the tentative and final approval shall be limited to 2 years with the opportunity for a onetime 2 year extension. This time frame shall start on the date of the tentative approval.

~~a.~~b. Final Approval - Final approval occurs when the applicant has submitted all of the required application materials, Wasco County has issued a decision which includes ~~only non-discretionary~~ conditions of approval that can be submitted for staff review and verification, and the appeal period has concluded.

~~b. Tentative Approval - A tentative approval may be issued when the applicant has submitted most of the required application materials but defers completion of one or more required discretionary elements such as the wildlife plan and all of its required baseline studies. Any deferred discretionary elements will be the only elements reviewed and decided upon during the final approval process.~~

~~A tentative approval shall specify a time limit or expiration date within which all deferred discretionary review elements or plans shall be reviewed for final approval. Pursuant to Section 2.125, Time Limits for Permits and Extensions of Time, the combined time for both the tentative and final approval shall be limited to 2 years with the opportunity for a onetime 2 year extension. This time frame shall start on the date of the tentative approval.~~

3. Modifications - ~~Energy facility requirements shall be facility specific, but can be modified as long as the facility does not exceed the boundaries of the Wasco County conditional use permit where the original facility was constructed.~~ An amendment to the conditional

use permit shall be required if the proposed facility changes would:

a. Require an expansion of the established facility boundaries where the original facility was sited or constructed;
b. Increase the number of towers; or
c. Increase generator output by more than 25 percent relative to the generation capacity authorized by the initial permit due to the repowering or upgrading of power generation capacity.

~~No amendment would be required if an expansion of power-generating capacity is due to technology upgrades installed within the existing boundaries of the established energy facility. Notification by the permit holder to the Planning Department of changes not requiring an amendment are encouraged, but not required.~~

B. Non-Resource Zone Standards:

1. Small Scale Commercial Power Generating Facilities - Pursuant to Subsection A(1)(b)(1) above, commercial power generating facilities that are considered small scale will be allowed in non-resource zones subject to the standards of Section 19.020.

2. Large Scale Commercial Power Generating Facilities - Except for related or supporting facilities, large scale commercial power generating facilities shall not be allowed in non-resource zones.

3. Related or Supporting Facilities (Reasonable Alternatives Analysis) - Related or supporting facilities to a commercial power generating facility may~~shall~~ be allowed in non-resource zones subject to Conditional Use Review upon a showing that such related or supporting facilities are necessary for siting the commercial power generating facility. Any related or supporting facilities must be consistent in size, scale, and impact as other existing or allowed use sin the non-resource zone. Related or Supporting Facilities shall be reviewed as part of the Commercial Power Generating Facility and not subject to a separate Conditional Use Review. To demonstrate the related or supporting facilities are necessary within the meaning of this section, an applicant must show that reasonable alternatives have been considered and that the related or supporting facilities must be sited in a non-resource zone after considering the following factors:

~~a. The related or supporting facilities will be consistent in size scale and impact as other existing or allowed uses in the non-resource zone;~~

~~b.~~a. Technical and engineering feasibility of siting the energy facility as a whole;

~~c.~~b. Availability of existing rights-of-~~-~~ways and public roads and proximity to transmission lines and interconnections;

~~d.~~c. Environmental impacts associated with avoiding non-resource zoned land; and

~~e.~~d. Protection of farm and forest resources.

C. General Standards - The following standards apply to energy facilities as outlined in Section A above, in addition to meeting the Conditional Use Standards listed in Chapter 5:

1. Air Safety - All structures that are more than 200 feet above grade or, exceed airport imaginary surfaces as defined in OAR Chapter 738, Division 70, shall comply with the air hazard rules of the Oregon Department of Aviation and/or Federal Aviation Administration. The applicant shall notify the Oregon Department of Aviation and the Federal Aviation Administration of the proposed facility and shall promptly notify the Planning Department of the responses from the Oregon Department of Aviation and/or Federal Aviation Administration.

Aerial Sprayers and operators who have requested to be notified will receive all notifications associated with the energy facility as required by Chapter 2, Development Approval Procedures.

2. Interference with Communications - The energy facility shall be designed, constructed and operated so as to avoid any material signal interference with communication systems such as, but not limited to, radio, telephone, television, satellite, microwave or emergency communication systems. Should any material interference occur, the permit holder must develop and implement a mitigation plan in consultation with the Planning Department.

3. Noise - The energy facility shall comply with the noise regulations in OAR Chapter 340, Division 35. The applicant may be required to submit a qualified expert's analysis and written report.

4. Visual Impact

a. Scenic Resources – To issue a conditional use permit for an energy facility, the county must find that the design, construction and operation of the facility, taking into account mitigation, are not likely to result in significant adverse impact to scenic resources or values identified as significant or important in the Wasco County Comprehensive Plan.

~~a.~~b. Protected Areas: Except as provided in subsections (b) and (c) below, an energy facility shall not be located in the areas listed below~~following areas~~:

~~(1) Areas identified as significant or important visual resources in the Comprehensive Plan;~~

~~(2)~~(1) National recreation and scenic areas, including but not limited to the Columbia River Gorge National Scenic Area;

~~(3)~~(2) Scenic waterways designated pursuant to ORS 390.826, wild or scenic rivers designated pursuant to 16 U.S.C. 1271 et seq., and those waterways and rivers listed as potentials for designation;

~~(4)~~(3) State parks and waysides as listed by the Oregon Department of Parks and Recreation;

~~(5)~~(4) State wildlife areas and management areas identified in OAR chapter 635, division 8.

~~(6)~~(5) National and state fish hatcheries or national and state wildlife refuges;

~~(7)~~(6) State natural heritage areas listed in the Oregon Register of Natural Heritage Areas pursuant to ORS 273.581;

~~(8)~~(7) Wilderness areas established pursuant to The Wilderness Act, 16 U.S.C. 1131 et seq. and areas recommended for designation as wilderness areas pursuant to 43 U.S.C. 1782; and

~~(9) Bureau of Land Management areas of critical environmental concern, outstanding natural areas and research natural areas.~~

~~b.~~ 1. Exceptions to Protected Areas - Except where the following uses are regulated by federal, state or local laws, including but not limited to the Columbia River Gorge National Scenic Area Act and implement land use ordinances, t~~T~~he following may be approve in a protected area identified in subsection (b~~a~~) above if other alternative routes or sites have been studied and been determined to have greater impacts

~~(1)~~(8) An electrical transmission line;

~~(2)~~(9) A natural gas pipeline; or

~~(3)~~(10) An energy facility located outside a protected area that includes an electrical transmission line or natural gas or water pipeline as a related or supporting facility located within a protected area.

~~c.~~ 2. Transmission Line & Pipeline Exception - The provisions of subsection (b~~a~~) above do not apply to electrical transmission lines or natural gas pipelines routed within 500 feet of an existing utility right-of-way containing at least one transmission line or one natural gas pipeline.

~~d.~~c. Additional Visual Mitigation Impacts for all Facilities - The design, construction and operation of the energy facility, taking into account mitigation, are not likely to result in significant adverse impact to scenic resources and values identified in subsection (a) above. Methods to mitigate adverse visual impacts could include but are not limited to:

(1) Building the energy facility near the edge of contiguous timber areas or using the natural topography to obscure the energy facility;

(2) Using materials and colors that blend with the background unless otherwise required by the Federal Aviation Administration or the Oregon Department of Aviation; and

(3) Retaining or planting vegetation to obscure views of the energy facility.

5. Natural Resource/Wildlife Protection - Taking into account mitigation, siting, design, construction and operation the energy facility will not cause~~has been designed and will be constructed and operated without~~ significant adverse impact to important or significant natural resources identified in the Wasco County Comprehensive Plan,

Wasco County Land Use and Development Ordinance or by any jurisdictional wildlife agency resource management plan adopted and in effect on the date the application is submitted. As appropriate, t~~T~~he permit holder agrees to implement monitoring and mitigation actions that Wasco County determines appropriate after consultation with the Oregon Department of Fish and Wildlife, or other jurisdictional wildlife or natural resource agency. Measures to reduce significant impacts may include, but are not limited to the following:

a. Providing information pertaining to the energy facility's potential impacts and measures to avoid impacts on:

   (1) Wildlife (all potential species of reasonable concern);
   (2) Wildlife Habitat;
   (3) Endangered Plants; and
   (4) Wetlands & Other Water Resources.

b. Conducting biologically appropriate baseline surveys in the areas affected by the proposed energy facility to determine natural resources present and patterns of habitat use.

c. Selecting locations to reduce the likelihood of significant adverse impacts on natural resources based on expert analysis of baseline data.

d. Utilizing turbine towers that are smooth steel structures that lack features that would allow avian perching. Where horizontal surfaces cannot be avoided, anti-perching devices shall be installed where it is determined necessary to reduce bird mortality.

e. Designing and installing all aboveground transmission line support structures following the current suggested practices for avian protection on power lines published by the Avian Power Line Interaction Committee.

f. Utilizing towers and transmission line support structures designed so the foundation area and supports avoid the creation of artificial habitat or shelter for raptor prey.

g. Controlling weeds to avoid the creation of artificial habitat suitable for raptor prey such as spreading gravel on turbine pad.

h. Avoiding construction activities near raptor nesting locations during sensitive breeding periods and using appropriate no construction buffers around known nest sites.

~~i. Using suitable methods such as coloration or sound producing devices to discourage birds from entering areas of concentrated solar energy near solar thermal mirrors or other devices that concentrate solar radiation.~~

~~j.~~ Locating transmission lines or associated transmission lines with the energy facility to minimize potential impacts (e.g., ~~at least~~ 50 feet from the edge of the nearest wetland or water body except where the line is required to cross the wetland or water body; or separating transmission lines or associated transmission lines with the energy facility from the nearest wetland or water body by topography or substantial vegetation to the extent practical, except where the line is required to cross the

wetland or water body).

~~k. Separating transmission lines or associated transmission lines with the energy facility from the nearest wetland or water body by topography or substantial vegetation to the extent practical, except where the line is required to cross the wetland or water body~~.

~~l.~~i. Locating transmission towers or associated transmission towers outside of Class I or II streams unless:

(1) Adjoining towers and conductors cannot safely and economically support the line(s) that span the stream without an in-stream tower; and

(2) The lines cannot be safely and economically placed under the water or streambed.

~~m.~~ j. Developing a plan for post-construction monitoring of the facility site using appropriate survey protocols to measure the impact of the project on identified natural resources in the area.

6. Protection of Historical and Cultural Resources - The applicant shall complete a cultural resources survey of areas where there will be temporary or permanent disturbance. During construction, cultural resources included in the Wasco County Comprehensive Plan shall be flagged and avoided in areas of potential temporary or permanent disturbance, and construction activities monitored to ensure all cultural resources in such areas are avoided, unless appropriate permits are obtained from the Oregon State Historic Preservation Office. Prior to construction an Inadvertent Discovery Plan (IDP) shall be developed that must outline the procedures to be followed in the case previously undiscovered archeological, historical or cultural artifacts are encountered during construction or operation of the energy facility, in compliance with ORS 358.905-358.955 and any other applicable local, state and federal law.

7. Fire Protection & Emergency Response - A fire protection and emergency response plan shall be developed and implemented in consultation with the applicable fire district or department and/or land management agency to minimize the risk of fire and respond appropriately to any fire or emergency that occurs onsite for all phases of the life of the facility. In developing the plan the applicant shall take into account, among other things, the terrain, dry nature of the region, address risks on a seasonal basis, and identify the locations of fire extinguishers, nearby hospitals, telephone numbers for emergency responders, and first aid techniques.

8. Public Safety - A public safety plan shall be developed and implemented to exclude members of the public from hazardous areas within the Energy Facility Project Area.

9. Transportation Plan - A transportation plan shall be developed and implemented in consultation with the Wasco County Road Department and/or the Oregon Department of Transportation (ODOT). The plan shall be consistent with any applicable requirements from the Wasco County Transportation System Plan and shall also provide or address:

a. The size, number, and location of vehicle access points off of public roads.~~;~~

b. Use of existing roads to the extent practical to minimize new access roads.~~; and~~

c. Restoring the natural grade and revegetating all temporary road cuts, used during construction of the energy facility. The applicant shall specify the type and amount of native seed or plants used to revegetate the disturbed areas and a timeline to complete this work.

d. A Road Impact Assessment/Geotechnical Report for roads to be used by the project. Said report should include an analysis of project-related traffic routes to be used during phases of construction, project operation and decommissioning. The report and any subsequent amendments shall be used as a discipline study and shall be incorporated into the Road Use Agreement between the Applicant and the County.

d~~c. Restoring the natural grade and revegetating all temporary road cuts, used during construction of the energy facility. The applicant shall specify the type and amount of native seed or plants used to revegetate the disturbed areas and a timeline to complete this work.~~

10. Road Use Agreement - Where applicable, the Wasco County Road Department ~~County~~ shall~~may~~ require the applicant to enter into a Road Use Agreement with the County to ensure ~~-~~that any ~~unusual~~ damage ~~or~~ to county roads that is caused by the construction of the energy facility or its related or supporting facilities is repaired by the applicant, and such county roads are restored to pre-construction conditions or better (this includes a weed plan and providing for re-vegetation).

11. Onsite Access Roads and Staging Areas - The impact of onsite access roads and staging areas within the Energy Facility Project Area shall be limited by:

    a. Constructing and maintaining onsite access roads for all-weather use to assure adequate, safe and efficient emergency vehicle and maintenance vehicle access to the site;

    b. Using existing onsite access roads to the extent practical and avoiding construction of new on-site access roads as much as possible; and

    c. Restoring the natural grade and revegetating all temporary access roads, road cuts, equipment staging areas and field office sites used during construction of the energy facility. The applicant shall specify the type and amount of native seed or plants used to revegetate the disturbed areas and a timeline to complete this work.

12. Dust Control - All approved non-paved temporary or permanent roads and staging areas within the Energy Facility Project Area shall be constructed and maintained to minimize dust, which ~~-~~may be addressed through the Road Use Agreement. If roads and staging areas are not construct with material that would prevent dust, the permit holder must regularly water roads and staging areas as necessary or apply an approved dust suppression agent such as Earthbind 100 to minimize dust and wind erosion.

13. Erosion and Sediment Control - All ground disturbing activities shall be conducted in compliance with a National Pollutant Discharge Elimination System (NPDES) permit as may be required by Oregon Department of Environmental Quality. Where applicable, an NPDES permit must be obtained. The plan must include best management practices for erosion control during construction and operation and permanent drainage and erosion

control measures to prevent damage to local roads or adjacent areas and to minimize sediment run-off into waterways.

14. Weed Control - A weed plan shall be developed in consultation with the Wasco County Weed Department and implemented during construction and operation of the energy facility.

15. Signs - Outdoor displays, signs or billboards within the energy facility project boundary shall not be erected, except:

    a. Signs required for public or employee safety or otherwise required by law; (e.g., OSHA or compliance with the Manual of Uniform Traffic Control Devices (MUTCD) administered through the County Road Department); and

    b. No more than two signs relating to the name and operation of the energy facility of a size and type to identify the property for potential visitors to the site, but not to advertise the product. No signs for advertising of other products are permitted.

16. Underground Systems - Where reasonably practicable, power collector and communication systems shall be installed underground, at a minimum depth of 3 feet. Shallower depths may be authorized where notification and safety measures are taken and wires are placed in schedule 40 conduit. The cable collector system shall be installed to prevent adverse impacts on agriculture operations and natural resources.

17. Operation & Maintenance Buildings - Permanent maintenance/operations buildings shall be located in the same zone as the principal energy facility, except that such buildings may be constructed in a separate zone if:

    a. The building is designed and constructed generally consistent with the character of similar buildings used in the surrounding area; and

    b. The building will be removed or converted to another approved use upon decommissioning of the energy facility consistent with the provisions of this ordinance.

18. Coordination and Documentation - Prior to commencement of any construction, all other necessary permits shall be obtained, e.g. building permit, rural address, road approach, utility and other permits from the Wasco County Public Works Department, and/or from ODOT as well as any other applicable local, state or federal permits or approvals.

19. Termination and Decommissioning. For an energy facility sited through EFSC, compliance with EFSC's financial assurance and decommissioning standards shall be deemed to be in compliance with these requirements.

    a. Through the approval process t~~T~~he applicant shall prepare a decommissioning plan that describes the actions to restore the site to a useful, non-hazardous condition, including options for post-dismantle or decommission land use, information on how impacts on fish, wildlife and the environment would be minimized during the dismantling or decommissioning process, and measures to protect the public against risk or danger resulting from post-decommissioning site conditions in compliance with the requirements of this section.

b. As part of the decommissioning plan t~~T~~he applicant shall provide a detailed cost estimate, a comparison of that estimate with funds to be set aside, in the form of a financial assurance (bond or ~~, letter of credit, insurance policy or~~ other such form of guarantee acceptable to Wasco County), ~~for dismantling or decommissioning,~~ and a plan for assuring the availability of adequate funds for completion of dismantling or decommissioning. The cost estimate can be requested for review and update by Wasco County at their discretion (e.g., every 5 years). ~~will be reviewed and be updated by the permit holder on a 5 year basis~~.

c. The following shall be required as conditions of the Wasco County approval:

(1) If operation of the energy facility ceases or begins construction of the project, but does not complete it, the permit holder shall restore the site according to a plan approved by Wasco County. A plan shall be submitted that ensures the site will be restored to a useful, non-hazardous condition without significant delay, including but not limited to the following:

(a) Removal of aboveground and underground equipment, structures and foundations to a depth of at least three feet below grade (four feet if cropland). Underground equipment, structures and foundations need not be removed if they are at least three feet below grade and do not constitute a hazard or interfere with agricultural use or other resource uses of the land. Restoration of the surface grade and soil after removal of aboveground structures and equipment.

(b) Removal of graveled areas and access roads and restoration of surface grade and soil.

(c) Revegetation of restored soil areas with native seed mixes, plant species suitable to the area, consistent with Wasco County's weed control plan.

(d) For any part of the energy facility on leased property, the plan may incorporate agreements with the landowner regarding leaving access roads, fences, gates or buildings in place or regarding restoration of agricultural crops or forest resource land. Said landowner will be responsible for maintaining said facilities for purposes permitted under applicable zoning.

(e) The underground power collector and communication lines need not be removed if at a depth of three feet or greater. These cables can be abandoned in place if they are deemed not a hazard or interfering with agricultural use or other consistent resource uses of the land.

(f) The plan must provide for the protection of public health and safety and for protection of the environment and natural resources during site restoration.

(e) The plan must include a schedule for completion of site restoration work.

(2) Before beginning construction of the energy facility, the permit holder must submit in a form and amount satisfactory to Wasco County, assuring the availability of adequate irrevocably committed funds to restore the site to a

useful, non-hazardous condition naming Wasco County as beneficiary or payee. The form may include~~, but not be limited to~~ posting a bond~~, issuing an irrevocable letter of credit, purchasing a paid up insurance policy,~~ or by other means ~~as may be proposed by the permit holder and found~~ acceptable by Wasco County and shall ensure continuity between owners.

(3) The amount of the financial assurance (bond~~, letter of credit, insurance policy~~ or other such form of guarantee) shall be annually adjusted for inflation using the U.S. Gross Domestic Product Implicit Price Deflator, Chain-Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast," or by any successor agency (the "Index"). The permit holder (including possible successor if sold or transferred) shall increase the amount of the financial assurance ~~(bond, letter of credit, insurance policy or other such form of guarantee)~~ annually by the percentage increase in the Index and shall pro-rate the amount within the year to the date of retirement. If at any time the Index is no longer published, Wasco County shall select a comparable index for adjusting the amount. The amount of the financial assurance shall be prorated within the year to the date of decommissioning.

(4) Per the request of Wasco County, t~~T~~he permit holder (including possible successor if sold or transferred) shall describe the status of the financial assurance in a~~n annual~~ report (e.g., annual update report submitted to Wasco County)~~submitted to Wasco County~~.

(5) The financial assurance shall not be subject to revocation or reduction before retirement of the energy facility site.

20. Final Location - The actual latitude and longitude location or Oregon State Plane NAD83 HARN (international feet) coordinates of the energy facility and related or supporting facilities shall be provided to the County GIS Department once commercial electrical power production begins. Alternatively, this information could be provided in GIS layer consistent with the datum referenced above or any other datum deemed acceptable by the Wasco County GIS Department.

21. Power Production Reporting - The County may require a report of nonproprietary power production for any time frame after the energy facility first begins production if permitted through the County. If requested, the permit holder shall have 180 days to produce said report.

D. Specific Standards - The following standards apply to specific types of energy facilities as described, in addition to the General Standards in Section C above.

1. Wind Energy Facilities:

a. Visual Impact - To the extent practical, the proposed wind energy facility has been designed to minimize visual impact upon open space and natural landscape by:

(1) Using underground communication and power collector lines (transmission lines that connect each turbine to a substation);

(2) Using turbine towers of uniform design, color and height;

(3) Lighting - Lighting of towers is only allowed if required by the Oregon Department of Aviation or~~f~~ Federal Aviation Administration. If lighting is required by Oregon Department of Aviation or Federal Aviation Administration the applicant shall seek approval of radar triggered lighting.~~and radar triggered lighting is on the list of approved lighting, it shall required~~.

(4) Using existing roads within the Energy Facility Project Area to provide access to the site, or if new roads within the Energy Facility Project Area are needed, minimizing the amount of land used for new roads and locating roads to reduce visual impact;

(5) Using existing substations, or if new substations are needed, minimizing the number of new substations; and

(6) Shadow Flicker ~~—~~ Upon the non-participating owern's request, t~~T~~he applicant shall demonstrate that the wind turbines, taking into account mitigation measures, will have no significant adverse impact of shadow flicker on an existing dwelling of a non-participating landowner within ¼ mile (1,320 feet) from a turbine, measured from the centerline of the turbine to the centerline of the dwelling~~, upon the non-participating owner's request~~.

Towers shall be allowed to create an adverse shadow flicker impact to an existing dwelling on a non-participating landowner's property if written permission from the property owner and an adjustment is granted under Section 19.030(D)(1)(c). Said written permission shall be made part of the deed records of the non-participating landowner's property.

b. Public Safety - The wind energy facility shall be designed, constructed, and operated to protect the public by measures that may include, but are not limited to, the following:

(1) Installing the tower so at the closest point, the sweep of any exposed blade or other exposed moving component is at least 20 feet above the tallest existing or foreseeable obstruction to blade movement unless based on the proposed location and site specific circumstances, the tower will not represent a safety hazard; and

(2) Designing, constructing and operating the energy facility to exclude members of the public from close proximity to turbine blades and electrical equipment, including installing locks on turbine tower access doors; and

(3) Designing, constructing and operating the energy facility to protect against structural failure of the turbine tower or blades that could endanger members of the public's safety, including having adequate safety devices and testing procedures designed to warn members of the public of impending failure and to minimize the consequences of such failure.

c. Setbacks:

(1) Project Boundaries - If the wind energy project encompasses ~~constitutes~~ more

than one parcel ~~property~~ neither the wind turbine setback to non-project boundaries ~~abutting properties not part of the project below~~ nor the property line setbacks of the underlying zone in which the project is~~they are~~ located are applicable to any internal property lines within the~~boundaries of the~~ project area.

(2) Non Project Boundaries - Wind turbines ~~and their above ground parts~~ shall be set back from the property line of any abutting property not part of the project (non-project boundaries), the right~~-~~ of~~-~~way of any dedicated road, and any above ground major utility facility line a minimum of 1.5 times the height of the wind turbine tower (i.e., fall-height). Wind turbines ~~and their above ground parts~~ shall be set back from any above ground minor utility facility line a minimum of 1.1 times the height of the wind turbine tower.

~~Wind turbines and their above ground parts shall be allowed closer to a property line of any abutting property not part of the project, the right of way of any dedicated road, or any above ground utility facility line than the distances cited above without a variance pursuant to either Chapter 6 or 7 if granted written permission from the abutting property owner, road authority, or utility. Said written permission shall be made part of the deed records to any private property.~~

An applicant may request an adjustment to non-project boundaries described above without being subject to the variance processes in Chapters 6 or 7 and authorized pursuant to the Administrative Action process of Section 2.060(A). As part of the permitting process the request shall demonstrate safety factors have been considered and a lesser setback is warranted. Factors to support an adjustment include, but are not limited to:

(a) The permission from abutting property owners, road authority, or utility.
(b) Applicant's ability to comply with DEQ noise regulations.
(c) Site specific conditions.
(d) Minimizing conflicts with existing infrastructure.
(e) Avoiding or minimizing potential environmental or resource impacts.

~~Notwithstanding receiving permission from the abutting property owner, road authority or utility, w~~Wind turbines ~~and their above ground parts~~ shall still be required to meet the underlying zone ~~property line~~ setback requirement ~~of the zone in which they are located~~ unless a variance is granted pursuant to either Chapter 6 or 7.

(3) Resource Zone Dwellings - Wind turbines shall be setback from all approved resource zone dwellings a minimum of 2/3 mile (3,520 feet), measured from the center line of the turbine tower to the edge of the dwelling or the distance required to comply with the DEQ noise standard (OAR 340-035-0035) in Subsection D(3) above, whichever is greater unless a noise easement is obtained under OAR 340-035-0035.

An applicant may request an adjustment to the resource dwelling setback described above without being subject to the variance processes in Chapters 6 or 7 and authorized pursuant to the Administrative Action process of Section 2.060(A). As part of the permitting process the request shall demonstrate safety factors have been considered and a lesser setback is warranted. Factors to

support an adjustment include, but are not limited to:

(a) The property owner's support or consent of a lesser setback.
(b) Applicant's ability to comply with DEQ noise regulations.
(c) Site specific conditions of the site.
(d) Avoiding or minimizing potential environmental or resource impacts.

~~Wind turbines shall be allowed closer to an approved resource zone dwelling if granted written permission from the owner of the property where the approved resource zone dwelling is located. Said written permission shall be made part of the deed records to any private property.~~

~~If the location of the wind turbine(s) would not comply with the DEQ noise standard (OAR 340-035-0035) required in Subsection D(3) above, a waiver would only be allowed pursuant to the same standard.~~

(4) Non-Resource Boundaries - Wind turbines shall be setback:

(a) A minimum of 1 mile (5,280 feet) from all non-resource zoned property boundaries.~~;~~ (The adjustment provision does not apply to non-resource zoned property.)

(b) 3/4 mile (3,960 feet) from the established city limit, urban growth boundary or urban reserve boundary of any incorporated city (whichever is the more restrictive applies); or

(c) The distance required to meet the DEQ noise standard (OAR 340-035-0035) in Subsection D(3) above, whichever is greater unless a noise easement is obtained under OAR 340-035-0035.

An applicant may request an adjustment to the non-resource boundary setback in subsection (b)-(c) above without being subject to the variance processes in Chapters 6 or 7 and authorized pursuant to the Administrative Action process of Section 2.060(A). As part of the permitting process the request shall demonstrate safety factors have been considered and a lesser setback is warranted. Factors to support an adjustment include, but are not limited to:

(a) The property owner's or local jurisdiction's support or consent of a lesser setback.
(b) Applicant's ability to comply with DEQ noise regulations.
(c) Site specific conditions of the site.
(d) Avoiding or minimizing potential environmental or resource impacts.

(5) Downwind Properties - The establishment of a commercial wind energy facility consistent with the requirements of this ordinance shall not constitute wind access rights that are protected by this ordinance beyond the following setback requirement.

If a wind turbine 200' in height or taller has been previously placed on a downwind property that is not part of the project, the closest tower on the upwind property shall be set back a minimum of fifteen rotor diameters from the downwind tower

location or any lesser distance agreed to by the downwind and upwind property owners or those authorized to act on their behalf.

2. Solar Energy Facilities:

   a. Ground Leveling – The solar energy facility shall be designed and constructed to minimize ground leveling and to the extent reasonably practicable, limit ground leveling to those areas needed for effective solar energy collection.

   b. Misdirection of Solar Radiation - The solar energy facility shall be designed, constructed, and operated to prevent the misdirection of concentrated solar radiation onto nearby properties, public roadways or other areas accessible to the public, or mitigated accordingly.

   c. Glare - The solar energy facility shall be designed, constructed and operated such that any significant or prolonged glare is directed away from any nearby properties or public roadways, or mitigated accordingly.

   d. Cleaning Chemicals and Solvents - During operation of the solar energy facility, all chemicals or solvents used to clean solar panels or heliostats shall be low in volatile organic compounds and to the extent reasonably practicable, the permit holder shall use recyclable or biodegradable products.

   e. Wildlife - Measures to reduce wildlife impact may include using suitable methods such as coloration or sound producing devices to discourage birds from entering areas of concentrated solar energy near solar-thermal mirrors or other devices that concentrate solar radiation.

3. Cogeneration Facilities:

   a. The cogeneration facility would supply thermal energy to an existing or approved industrial or commercial use.

   b. Except as allowed in this section, an electric transmission line or natural gas or petroleum pipeline necessary for the cogeneration facility must be an upgrade to an existing transmission line or pipeline or must otherwise be constructed in an existing right-of-way or utility easement. If the proposed electric transmission line or natural gas or petroleum product pipeline necessary for the proposed cogeneration project is not an upgrade to an existing transmission line or pipeline, the transmission line or pipeline must comply with the standards in subsection 4 or 5 below.

4. Electrical Transmission Facilities:

   a. Use of Existing Routes/Co-Locating - The development uses available developed or approved road and utility rights-of-way, easements or transmission facilities that can accommodate the proposed facility. New routes are permitted if more adverse energy, environment, economic, and social consequences would result from using an existing route than development of other rights-of-way or easements.

b. Adjacent to Existing Routes - To the extent practical, any part of the proposed transmission or distribution line outside an existing route would be adjacent to an existing public road or utility right-of way or easement.

c. New Routes - If all or part of the proposed transmission line is outside an existing route or not adjacent to an existing route:

(1) The proposed new route would serve an existing or proposed electric generation project that is not adjacent to an existing right-of-way or easement, or

(2) The proposed new route would result in less adverse energy, environmental, economic and social consequences than would result from using an existing route.

d. Setbacks to dwellings - Unless sited within a public road right-of-way, new electrical transmission lines shall not be constructed closer than 500 feet to an existing dwelling without prior written approval of the owner. Said written approval shall be made part of the deed records to that property.

5. Natural Gas or Petroleum Product Pipelines:

a. Use of Existing Routes - To the extent practical, the proposed pipeline would use developed or approved road and utility rights-of way or easements that can safely accommodate the proposed line.

b. Adjacent to Existing Routes - To the extent practical, any part of the proposed pipeline outside an existing route would be adjacent to an existing public road or utility right-of-way or easement.

c. New Routes - If all of part of the proposed pipeline is outside an existing route or not adjacent to an existing route:

(1) The proposed new route would serve an existing or proposed electric generation project that is not adjacent to an existing right-of-way or easement, or

(2) The proposed new route would result in less adverse energy, environmental, economic and social consequences than would result from using an existing route.

d. Stream crossings: If the proposed pipeline would cross a stream or river that is important habitat for a state or federally-listed threatened or endangered species, the permit holder must use a crossing technique or method approved by the Oregon Department of Fish and Wildlife.

From: Columbia River Properties <rocky@columbiariverproperties.com>
Date: Thu, Mar 15, 2012 at 10:19 AM
Subject: Chapter 19 Ordinance
To: rodr@co.wasco.or.us, ScottH@co.wasco.or.us, sherryh@co.wasco.or.us
Cc: johnr@co.wasco.or.us

March 15, 2012

Wasco County Board of Commissioners

RE: Comments regarding the proposed changes to Chapter 19 of the Wasco County LandUse and Development Ordinance

Commissioners:

I am a land owner, and have been a citizen of Wasco County most of my life, therefore I have been directly involved with and affected by Land Use regulations in the County. I was here when the National Scenic Area Act took affect and watched as hundreds of acres of my husband and my investment land turned from an asset to a liability overnight. I've dealt with overly restrictive and or inapplicable regulations in the County Resource zones for decades, and am weary and long since disillusioned.

I have a few comments to share, and a few questions that I would like to have answered.

It seems to me that the County has an existing energy ordinance with criteria that are based on site specific review of a proposed project. This ordinance is largely based on the State's ordinance, and where the State's ordinance is more restrictive than ours, it supersedes Wasco County's. The State's Ordinance seems to be based on well-established scientific study and research. Furthermore, Wasco County's ordinance has worked in the past by allowing the Summit Ridge Wind Farm while denying the Seven Mile Hill project.

Over the last several years, we have heard over and over from County government how tight the budget is and how many cut backs we have to make. It seems odd that we had the resources of time, people and money to spend three years developing this new Energy Ordinance that stands on the verge of being more restrictive than the our existing ordinance & the states. This is especially true since we were told that the goal of this process was to create an Ordinance that is easier to understand, implement and review, and I would hope, reduce the cost of time and money for review of new projects.

As a private business owner, my first questions are always what will it cost? Is it an efficient use of time and money? And what are the benefits? Can I afford it at this time?

My specific questions:

1) How many Staff Hours did it take to develop the proposed changes to the LUDO?

2) How many Staff Hours did it take to develop the proposed changes to the Comp Plan?
3) If the county has an existing Energy ordinance with site specific review, that worked to allow Summit Ridge Wind Farm and deny Seven Mill Hill, why was it necessary to spend three years rewriting the ordinance?
4) The state has an ordinance that they have adopted, with scientific study & research that is pretty well done, why did we not adopt theirs? Would this not have been more cost effective under our budgetary constraints?
5) In simple terms, what are the benefits of this new ordinance?
6) It is my understanding that a draft of the new purposed ordinance was completed in September of 2010. Where has it been since then and now, March 2012?
7) It seems that the proposed setback of two thirds of a mile is arbitrary. How did the advisory group and later the Planning Commission come to their conclusions for static setbacks?
8) What scientific data was used to set the static setback? Is there any scientific justification for their proposal?

Finally, the Wasco County Planning Department website indicates that some members of the Commercial Advisory Group were also land owners who objected to the Seven Mile Hill wind energy project. In fact, one of our commissioners opposed the Seven Mile Hill project and was appointed to the Advisory Group because of his personal experiences. Is that a conflict of interest? Even if it isn't, shouldn't the Commissioner have disclosed his personal interests in the project?

Health effects due to wind turbines are unsubstantiated, and studies have not proven any connection. Remember the controversy when microwave ovens came out, the cell phone, lap top computers, our cars and the dangers of interior fumes we breathe in them? All have supposed health risks. Bet most everyone that came to the first hearing came in a car, used a lap top or tablet to prepare for the hearing, talk on their cell phone daily, and used a microwave at some point everyday.

Commissioners, the proposed static setbacks to energy projects are arbitrary. They would not likely offer more protection to the home owner because the impacts are already evaluated based on scientific parameters. The only thing that static setbacks would provide is an even more hostile environment for future Energy Development projects.

Future wind development projects could provide economical development & fiscal security for this county. Please do not restrict our County's chance for that opportunity.

Thank you,

Jana Webb
www.ColumbiaRiverProperties.com
541.296.1026

Cary Lowe

From: William Simpson [wcsimpson@mac.com]
Sent: Wednesday, February 15, 2012 2:04 PM
To: Cary & MaryEllen
Subject: Fwd: Siting Wind Turbines

Begin forwarded message:

From: William Simpson <wcsimpson@mac.com>
Date: February 15, 2012 1:49:41 PM PST
To: William Simpson <wcsimpson@mac.com>
Subject: Siting Wind Turbines

I have been living on Seven Mile Hill near Wasco Butte for over 27 years. The last proposed Cascade wind turbine project would have placed five wind turbines within one mile of my home; three of those would have been less than 1/2 mile away. Other proposed sites would have been less than 1/4 mile from other homes. This is unacceptable to me and the residents of our rural community. Turbines should be at least 2 miles from all dwellings. Recent studies have raised concerns about a Pandora's box of health problems associated with living near wind turbines. This includes a greater risk for certain cancers. Dr. Keith Stelzer, Chair of the Cancer Committee, Mid-Columbia Medical Center, has written numerous letters to the powers that be, expressing concern about the Cascade Wind Project sites. Studies have recommended that wind turbine sites be at least 2 miles away from homes. These site standards have been adopted in California and in other countries such as France, Denmark and England. Low frequency sound waves, also very loud noise levels (Oregon recently changed noise level standards to allow wind turbines), brightly flashing strobe lights and overhead transmission lines have caused people to abandon their homes at Mars Hill, a similar UPC project in Maine.

Our property values would fall and some families could lose their homes. Others would have to sell at a terrible loss of money.
The visual impact of forty, 413-foot tall wind turbines, less than 2 miles from my home and from most of The Dalles, or anywhere from our treasured Columbia Gorge National Scenic and Recreation area, wilderness areas, and wildflower Preserves is totally unacceptable to me and a growing number of concerned people.
The proposed wind turbine sites need to consider the flight paths of low-level Tactical Military Training Routes. For example, Route IR344, which is on all air maps passes right over my house.

I know this route has been in use for over 30 yrs and may date back to World War 2. There is a civilian website dedicated to Mission Planning.
From that website, I obtained the following information about activities practiced on that route:

Flying Low to practice avoiding radar; flying 480 miles per hour and 500 feet above the ground. Using ground-following instrumentation, it is o.k. to fly route IR344 in any weather, day or night. AND it is o.k. to stray four miles to the right or left of route IR344. It is an active route; jets often roar over my house at treetop level. In just the last two months, two huge, swept-wing, jet cargo planes have flown in formation up Mosier Creek valley at low elevation.

Also, Some proposed sites could be in conflict with the instrument flight approach to The Dalles Airport. Thus, the windmills would be a hazard to aviation and another source of danger to local residents.

Our rural community is forrest, farms and agricultural. It is our home. When siting wind turbines, there needs to be regard for the impact on people's lives; destruction of our beloved scenic vistas; and endangerment of the local residents.

I am not against wind turbine electrical power production. I have worked For the Army Corps of Engineers in Power Plant Operations for 30 years. However, Oregon Department of Energy needs to adopt wind turbine site restrictions of at least 2 miles from people's homes, and never site wind turbines In military training flight paths or where they are visible from our beloved Columbia Gorge National Scenic and Recreation areas.

Please feel free to contact me if you have any questions.

Sincerely, William Simpson PO Box 88, The Dalles, Or. 97858 Wcsimpson@mac.com

e·on | Climate & Renewables

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Mike Greczyn
T (512)419-8569
F (303)297-3464
michael.greczyn@eon.com

VIA HAND DELIVERY

Board of County Commissioners
Wasco County
511 Washington Street, Suite 302
The Dalles, Oregon 97058

February 15, 2012

Dear Commissioners:

E.ON Climate and Renewables, North America ("E.ON") is a leading developer, builder and operator of renewable energy facilities in the United States. E.ON currently operates 11 utility-scale wind farms in the United States with a total nameplate capacity of over 2,000 megawatts, consisting of more than 1,200 wind turbines.

On October 21, 2011, E.ON submitted a Notice of Intent to file an application for a site certificate for a proposed wind energy facility with the Oregon Energy Facility Siting Council ("EFSC"). The proposed facility, Brush Canyon Wind Energy Project, would be located entirely on private land within Wasco and Sherman Counties. E.ON has been actively pursuing development opportunities in Wasco County since 2009, and has contributed to the County's economic base through land lease payments and property taxes, as well as through the purchase of local goods and services.

Although E.On applauds Wasco County's efforts to update its energy ordinance and generally believes the changes are a positive step towards the responsible development of the County's energy resources, there are several issues that E.ON urges the Board of Commissioners to address in order to protect the rights of participating landowners and to provide regulatory certainty and consistency to developers like E.ON.

The following comments and suggestions are provided in response to the proposed land use code amendments to the Wasco County Land use and Development Ordinance ("WCLUDO") Chapter 19:

Lighting, WCLUDO 19.030.D.1.a(3)

WCLUDO 19.030.D.1.a(3) provides that if RADAR-triggered lighting is on the list of approved lighting, it shall be required. RADAR-triggered lighting systems are very new and relatively untested. Although these systems may be appropriate for certain wind energy facilities, they may not be practicable for other facilities, even if such systems are approved by the FAA.

Given these concerns, E.On recommends that the language requiring RADAR-triggered lighting be stricken from Chapter 19 and that such systems be evaluated on a case-by-case basis.

Setbacks, WCLUDO 19.030.D.1.c

WCLUDO 19.030.D.1.c(3) provides that wind turbines shall be setback from all approved resource zone dwellings a minimum of 2/3 mile (3,520 feet) or the distance required to comply with the Department of Environmental Quality ("DEQ") noise standard, whichever is greater. WCLUDO 19.030.D.1.c(4) provides that wind turbines shall be setback a minimum of 1 mile (5,280 feet) from all non-resource zoned property, 3/4 mile (3,960 feet) from an established city limit, urban growth boundary or urban reserve boundary, or the distance to meet the DEQ noise standard, whichever is greater.

Thus far, the County has failed to articulate a rational basis for imposing these setbacks. Although there has been a great deal of discussion surrounding issues of public health and safety, wildlife, and public services during the code amendment process, there is simply no evidence in the record to support setbacks that are greater than those imposed by EFSC (1,320 feet for rural residences and 3,520 feet for non-resource zone boundaries and city limits).

Not only is there no evidence to support the proposed setbacks, barring some sort of variance or adjustment process (discussed below), the proposed setbacks will adversely affect area landowners that already have wind leases on their properties. These participating landowners stand to benefit greatly from the leasing agreements and should not be barred from developing their properties simply because certain County residents disfavor development. Indeed, these leases were developed with the reasonable expectation that the County would not act to limit such development without a rational basis for doing so.

Further, the proposed setbacks have the potential to severely curtail the development of wind facilities in the County, depriving the County of family-wage jobs and tax benefits associated with the development of wind energy. As currently proposed, the setback provisions would put the County at a competitive disadvantage to other counties for future wind energy investment.

E.ON recommends that the County adopt setback standards consistent with what EFSC has already found to be protective of public health and safety: namely, a setback of 1,320 feet from resource zone dwellings and a setback of 3,520 feet from non-resource boundaries.

Availability of Waivers

WCLUDO 19.030.D.1.c provides that wind turbines may be allowed within the setbacks applicable to non-project boundaries and resource zone dwellings provided the

property owner grants permission. Although E.ON fully supports the ability of the County to approve lesser setbacks and believes that the County's ability to modify those setbacks is essential, E.ON is concerned about the proposed waiver language given the uncertainty surrounding the recent LUBA decision in *Cosner v. Umatilla County*, LUBA Nos. 2011-070, 2011-071, and 2011-072, 63 OR LUBA ___ (Jan. 12, 2012).

Given recent LUBA case law, E.ON recommends that the County adopt a variance or adjustment process specific to wind facility setback provisions. Specifically, E.ON supports Iberdrola Renewables, Inc.'s recommended adjustment language outlined in the February 6, 2012 letter and accompanying redline from Elaine Albrich of Stoel Rives.

E.ON appreciates the opportunity to comment on the proposed land use code amendments and looks forward to discussing these issues with the Board at the February 15, 2012 hearing.

Very truly yours,

Mike Greczyn
West Region Development
E.On Climate & Renewables

Wind farms boost rural coffers

Most NW residents favor green-energy turbines

6:00 PM Jan. 21, 2012 | Comments

AA

Views from many routes in Sherman County indicate wind farms. The county pays each resident $990 each year to compensate for the change in landscape. / Courtesy Flatt of EarthFix and Northwest Public Ra

Written by
Contributed by Courtney Flatt Northwest Public Radio / EarthFix

FILED UNDER

News
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Oregon And Washington
Mount Hood

SHERMAN COUNTY — Most Pacific Northwest residents say they wouldn't mind views of a wind farm from their back yard. That's according to an environmental survey commissioned by EarthFix.

Davis, Hibbitts & Midghall Research recently asked 1,200 residents in Washington, Idaho and Oregon how they felt about wind farms, describing the turbines as 10- to 20-stories tall with three 200-foot-long blades. Seventy-five percent of poll respondents said they wouldn't mind living near rotating turbine blades.

The survey found far less tolerance among Northwest residents for nuclear power plants. Twenty-three percent of survey respondents said they would favor building a nuclear power plant within 50 miles of their homes and 72 percent said they would be opposed. Idaho residents were more favorable than Oregon and Washington

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State Street Flooding
Jan. 19, 2012

residents to a nearby nuclear plant; 32 percent there told the pollster they would favor such a development, compared to 19 percent in Oregon and 23 percent in Washington.

Money makes wind go 'round

While most Northwesterners say they would welcome clean-energy wind turbines to their sightlines, in some communities, actual wind farm projects have drawn opposition. Residents in Union are deeply divided over the issue. Last spring, the Idaho legislature considered a moratorium on wind farms because people disliked the view. But there's one county in Oregon where, it seems, almost everyone is happy.

In Sherman County, if you stand on John Hildebrand's porch, you'll see spinning turbine blades dotting the horizon in almost any direction you look. The 84-year-old farmer says he doesn't mind the new view. In fact, residents say Sherman County may have found a way around turbine woes: money for each household.

"When I was young, they used to have a machine at the fair. It had a big flywheel you'd turn by hand, and you gave the guy a quarter. Then you put a penny in it, and it smashed that penny out. I look out there and I see those wind turbines blades turning and I think of that big wheel. Every time it goes around, it just chunks out a coin," Hildebrand says.

Sherman County Judge Gary Thompson describes the horizon more bluntly. "I see it as ca-ching, ca-ching," he says.

Every household in Sherman County receives around $590 each year, regardless of whether they have turbines on their property. Because this is one of Oregon's poorer counties, that money can go a long way. The extra money helps residents who are not directly profiting from the turbines but still have their views disturbed. The system is modeled after Alaska's compensation for oil pipelines, with payments coming from tax revenue.

Everyone benefits

Inside Hildebrand's farmhouse, a model wind turbine adorns his coffee table. The real thing is visible from the bay windows in his living room.

Hildebrand was one of the first farmers in Sherman County to allow turbines on his property. Seventeen turbines now tower over his fields. They've generated income for about 10 years now.

"They've helped out my pocketbook," he says. "We got more access to fields, through the roads, although we do have to farm around 'em, and that creates somewhat of a problem."

Most of the 1,700 people living in the area are retired, on fixed incomes. Thompson says paying every household helps those residents who aren't directly profiting from the farms but still have their views disturbed.

PHOTO GALLERIES

Cartoon gallery: Feb 14

Bomb threat at Chemeketa

"They're farmers that have been struggling over the years to make a living off the farm, and what this does is it guarantees their retirement," Thompson says.

Helping out schools

At night, red lights methodically blink off and on over Sherman County's wheat fields, making their presence known even in the dark. Superintendent Ivan Ritchie can see towers from his back yard. Though Ritchie says the wind farms lose their uniqueness overtime, he says the school district would be in big trouble without them.

Money from the county's five wind farms also has benefited students. The school district receives 20 percent of the wind farm revenue each year. Over the past three years, that's afforded computer upgrades and staffed several elective classes at the high school, including a pre-law and pre-veterinary class.

"Prior to about three or four years ago, there was severe budget cutting that eliminated most of the elective programs at the high school, and with the advent of the wind dollars, we have been able to bring back in some art and drama into the program," Ritchie says.

The county also has paid for a new green-energy teacher. Each of the four cities in Sherman County — Wasco, Moro, Rufus and Grass Valley — also receives $100,000 each year. The no-strings-attached money really has benefited the rural towns, Thompson says.

Keeping businesses running

The wind farms also have helped many small businesses in the area. Kathy Neihart owns the Lean-to Cafe and Goose Pit Saloon, the only restaurant in Wasco — "the best and worst," Hildebrand jokes. An "I heart wind" bumper sticker hangs near her cash register. She says business from wind-farm workers has helped her pay off loans and hire new employees.

"I really was afraid that we would not be able to make it," Neihart says. "Since we got to be kind of debt-free, it's easier to run now, which is due to the fact that they came in and dropped a lot of money here. ... This seemed to be the best thing that ever happened to this county."

With five wind farms in the area, Thompson says the county is about half built out right now. Another large-scale farm is permitted but must wait several years to obtain a power purchase agreement.

Thompson says the county is looking at installing solar panels alongside the turbines to help with the wind farm's indeterminacy. Developing that idea is still years down the road.

Driving around the area, Mount Hood and Mount Adams peek over the turbine-lined horizon. Mount Rainer is visible on a clear day. Thompson says, for now, pretty much all Sherman County residents are thankful the wind farms came to town.

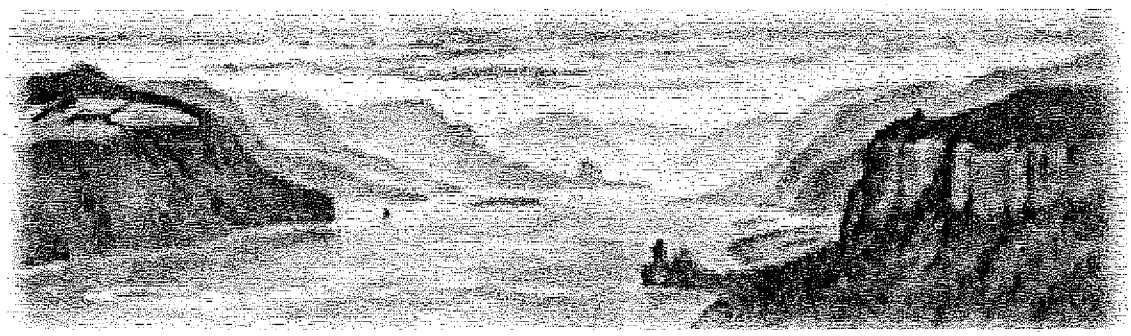
Comments

Chapter 19 Energy Update

Friends of the Columbia Gorge

Submitted by: Rick Till

January 17, 2012



FRIENDS OF THE COLUMBIA GORGE

SUBMITTED VIA E-MAIL AND FIRST-CLASS MAIL

December 17, 2011

Wasco County Board of County Commissioners
c/o Wasco County Department of Planning and Economic Development
2705 East Second Street
The Dalles, Oregon 97058

Re: Wasco County's proposed Energy Ordinance Updates (PLALEG-09-06-0003).

Dear Commissioners:

Friends of the Columbia Gorge (Friends) has reviewed and would like to comment on the proposed updates to Chapter 19 of Wasco County's Land Use and Development Ordinance (Energy Ordinance). Friends is a non-profit organization with approximately 5,000 members dedicated to protecting and enhancing the resources of the Columbia River Gorge. Our membership includes hundreds of citizens who reside within the Columbia River Gorge National Scenic Area.

Friends supports responsibly planned renewable energy development and land use rules that ensure that energy facilities are sited appropriately to ensure protection of the environment and the community. Friends provides the following specific recommendations to improve the proposed energy ordinance and provide adequate protection for the community and the environment.

Citations refer to the specific Draft LUDO section and the page number in Staff Report Attachment A ("Att. A").

Recommendations for new language are **underlined.**

Recommended deletions are identified by **~~strikethrough~~.**

/////

A. ***Purposes.***
Draft LUDO § 19.010, Att. A at 19-7.

The Planning Commission's recommended revisions to Chapter 19 (Draft Energy Ordinance) include several goals for siting non-commercial and commercial energy facilities. The first proposed goal is: "Encourage renewable energy development." Draft LUDO § 19.010, Att. A at 19-7. Friends recommends revising this goal to state that Wasco County supports appropriately sited renewable energy development that avoids and minimizes adverse impacts to the community and the environment.

Friends recommends the following revision:

> Draft LUDO § 19.010, Att. A at 19-7:
>
> Encourage renewable energy development that is appropriately sited to avoid and minimize adverse impacts to the community and environment."

B. ***Commercial Power Generating Facilities Review Processes & Approval Standards. Draft LUDO § 19.030, Att. A at 19-24–19-38.***

1. **BOCC to serve as Special Advisory Group to EFSEC.**
Draft LUDO § 19.030(A)(1)(c), Att. A at 19-24–19-25.

The Draft Energy Ordinance includes language describing how the BOCC would serve as the Special Advisory Group for projects that are within the Oregon Energy Facility Siting Council's ("EFSC") jurisdiction. Draft LUDO § 19.030(A)(1)(c), Att. A at 19-24–19-25. Under EFSC regulations, the Special Advisory Group identifies applicable local land use regulations and recommends substantive criteria and conditions to comply with those criteria. The proposed language would require the BOCC to provide an opportunity for public comment on any recommendations of the Special Advisory Group.

Since EFSC gives the BOCC's recommendation deference, it is important that the public have an opportunity to comment on matters of significant local concern. Friends strongly supports affording the public an opportunity to submit comments to the Special Advisory Group. The BOCC, acting as the Special Advisory Group, is in a unique position to convey the concerns of the local community to EFSC during the permitting process and ensure that all local land use regulations are enforced.

2. **County Decision Options: Tentative Approval and Final Approval.**
Draft LUDO § 19.030(A)(2), Att. A at 19-25.

The Draft Energy Ordinance creates a two-tier process for issuing decisions on applications for commercial energy facilities. The "tentative approval . . . defers completion of one or more required discretionary elements such as the wildlife plan and all of its required baseline studies. Any deferred discretionary elements will be the only elements reviewed and decided upon during the final approval process." Draft LUDO § 19.030(A)(2)(b). The "Final Approval" is issued

when all of the deferred application materials have been approved and "the appeal period has concluded." Draft LUDO § 19.030(A)(2)(a). The proposed ordinance does not explain what County review process would apply for each type of approval.

To avoid confusion Friends recommends providing a single decision making process rather than an unclear and untested two-step process. To achieve this outcome, the County should abandon the "Tentative Approval" and require one application process for the entire project.

Alternatively, if the County prefers the two-tier process, it should specify which administrative review process would be used for each type of approval. Friends recommends requiring conditional use review for both "tentative approval" and "final approval"

Friends proposes the following revision:

> Draft LUDO § 19.030(A)(2), Att. A at 19-25:
>
> County Decision Options - As part of the application materials the applicant shall indicate if they are requesting final or tentative approval. Both tentative and final approval are subject to conditional use review and appeal procedures.

The Draft ordinance lists the final approval first and the tentative approval second. If the County retains the two-tier process it should reverse this order. Listing the decisions in chronological order would provide more clarity to the ordinance.

3. Modifications to Permits.
Draft LUDO § 19.030(A)(2), Att. A at 19-26.

The Draft Energy Ordinance would allow for modifications of commercial energy facilities without any opportunity for public review or comment so long as the number of turbines does not increase and the modification does not require an expansion of the approved facility boundaries. Draft LUDO § 19.030(A)(2), Att. A at 19-26. The ordinance would not require notice to the Planning Department: "Notification by the permit holder to the Planning Department of changes not requiring an amendment are encouraged, but not required." Draft LUDO § 19.030(A)(2), Att. A at 19-26.

Friends strongly opposes these provisions. Wind energy facilities often extend across miles of land and cover hundreds of acres. Relocating or changing the height of turbines within a project boundary, even if the total number of turbines does not change, has the potential to create significant new impacts that may not have been addressed through the conditional review process.

To ensure project modifications stay within the scope of impacts considered during conditional use review, Friends recommends that the County require that all modifications to project designs be submitted to the Planning Department for review and approval through an amendment process.

Friends recommends the following revisions:

Draft LUDO § 19.030(A)(2), Att. A at 19-26:

Modifications - ~~Energy facility requirements shall be facility specific, but can be modified as long as the facility does not exceed the boundaries of the Wasco County conditional use permit where the original facility was constructed.~~

An amendment to the conditional use permit shall be required if the proposed facility changes would:

a. Require an expansion of the established facility boundaries;
b. Increase the number of towers; or
c. Increase generator output by more than 25 percent relative to the generation capacity authorized by the initial permit due to the repowering or upgrading of power generation capacity.
d. Relocate any wind turbine tower by more than 50 feet; or
e. Change the height of any wind turbine tower by more than 10 feet.

~~No amendment would be required if an expansion of power-generating capacity is due to technology upgrades installed within the existing boundaries of the established energy facility. Notification by the permit holder to the Planning Department of changes not requiring an amendment are encouraged, but not required.~~

4. Non-Resource Zone Standards for Related and Supporting Facilities. Draft LUDO § 19.030(B), Att. A at 19-26–19-27:

Draft LUDO § 19.030(B)(3) would allow related and supporting facilities in non-resource zones where large-scale commercial power generating facilities are otherwise prohibited. Draft LUDO § 19.030(B), Att. A at 19-26–19-27. Related and supporting facilities, such as transmission lines, substations, and haul routes, can cause impacts to local communities just as significant as the primary energy generating facility. Given the risk of unacceptable impacts to non-resource lands, Friends is concerned that allowing related and supporting facilities in non-resource zones would lead to unnecessary controversy and ill-conceived energy facility proposals. As such Friends generally opposes Draft LUDO § 19.030(B)(3). However, if the County retains this section Friends recommends including revisions that provide stronger protection to non-resource lands.

The proposed subsection creates five criteria for determining whether it would be "necessary" for related facilities to be located in non-resource zoned lands. This includes a requirement that impacts be consistent with the size, scale, and impact of other existing uses in the non-resource zone. Draft LUDO § 19.030(B), Att. A at 19-26. This factor seems misplaced, as it appears to protect non-resource zoned land from unacceptable development impacts rather than providing a factor for evaluating "necessity." To improve the standard, Friends recommends moving the first factor, (B)(3)(a), to the introductory paragraph for the subsection (B)(3). Friends also recommends that the word "shall" be replaced with the word "may" in the introductory paragraph to be consistent with Conditional Use Review standards.

Friends recommends the following revisions:

Draft LUDO § 19.030(B), Att. A at 19-26:

Related or Supporting Facilities (Reasonable Alternatives Analysis) - Related or supporting facilities to a commercial power generating facility ~~shall~~ may be allowed in non-resource zones subject to Conditional Use Review upon a showing that such related or supporting facilities are necessary for siting the commercial power generating facility. Any related or supporting facilities ~~will~~ must be consistent in size, scale, and impact as other existing or allowed uses in the non-resource zone. Related or Supporting Facilities shall be reviewed as part of the Commercial Power Generating Facility and not subject to a separate Conditional Use Review. To demonstrate the related or supporting facilities are necessary within the meaning of this section, an applicant must show that reasonable alternatives have been considered and that the related or supporting facilities must be sited in a non-resource zone after considering the following factors:

~~a. The related or supporting facilities will be consistent in size scale and impact as other existing or allowed uses in the non-resource zone;~~

5. Visual Resources.
Draft LUDO § 19.030(C)(4), Att. A at 19-27–19-29:

The Planning Commission was presented with three options for providing protection to regionally and nationally significant scenic landscapes. The Planning Commission reached a unanimous decision recommending that the BOCC adopt language implementing EFSC regulations that prohibit energy development that would cause adverse scenic impacts to designated scenic areas, including the Columbia River Gorge National Scenic Area and Wild and Scenic River Areas.

Friends supports the Planning Commission's recommendation. However, the language that has been submitted to the BOCC has been modified from what the Planning Commission recommended. An excerpt of the Planning Commission's exact recommendation is attached for reference. The modified proposal reorganizes this section and includes new language that was not approved by the Planning Commission. In addition, the proposed language creates ambiguities and potential conflicts with other laws.

a. The BOCC must ensure that the ordinance does not conflict with National Scenic Area Act.

The draft Visual Impacts section begins with a list of area where commercial energy facility development is prohibited, but creates an exception for certain uses. The draft ordinance states: "Except as provided in subsections (b) and (c) below, an energy facility shall not be located in the following areas." Draft LUDO § 19.030(c)(4), Att. A at 19-27. The list includes the National

Scenic Area, Wild and Scenic Rivers, State Parks, natural heritage areas, and several other designated areas.

The exception in subsections (b)(3) of the draft ordinance would allow related or supporting facilities in the National Scenic Area. Draft LUDO § 19.030(c)(4)(b)(3), Att. A at 19-28. A "related and supporting facility" is by definition part of a wind energy facility. Draft LUDO § 1.080, Att. A at 19-12. However, the National Scenic Area Act prohibits industrial uses, which include commercial energy development, within the National Scenic Area. Related and supporting facilities, being primarily involved with an "industrial use," are prohibited under the Wasco County National Scenic Area Ordinance. NSA-LUDO § 1.200 (Definition of "industrial use").[1] As proposed, Chapter 19 could be interpreted as allowing related and supporting facilities—industrial uses—within the National Scenic Area. This would directly violate the National Scenic Area Act.

Similarly, the exceptions also state that electrical transmission lines and natural gas pipelines would be allowed in the National Scenic Area. Draft LUDO § 19.030(c)(4)(b)(1), (2), & (b)(3), Att. A at 19-28. These uses may be allowed, but allowing the use would be subject to the County's Scenic Area Ordinance.

To avoid conflicts with the Scenic Area Act and unnecessary controversy, Friends recommends the following revisions.

> Draft LUDO § 19.030(c)(4)(b), Att. A at 19-27:
>
> Except where the following uses are regulated by federal, state, or local laws, including but not limited to Columbia River Gorge National Scenic Area Act and implementing land use ordinances, ~~T~~the following may be approve in a protected area identified in subsection (a) above if other alternative routes or sites have been studied and been determined to have greater impacts.

b. *The BOCC should clarify the "no adverse effect" standard as recommended by the Planning Commission.*

A critical component of the Planning Commission's recommendation is that the BOCC implement EFSC's no-adverse effect standard for protecting important scenic landscapes. The Draft Energy Ordinance presented to the BOCC modifies the Planning Commission's recommended language. Draft LUDO § 19.030(c)(4)(d), Att. A at 19-28–19-29.[2] The modified provision removes a portion of the Planning Commission recommendation that explicitly stated that proposals "located outside" the identified areas shall not adversely affect those areas.

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[1] The Wasco County Scenic Area ordinance defines "industrial use" to include "any use of land *primarily involved in* . . . production of electric power for commercial purposes." NSA-LUDO § 1.200 Defnitions (emphasis added).

[2] An excerpt of the language recommend for approval by the Planning Commission is attached. The excerpt was copied from the version of Draft Chapter 19 that was reviewed by the Planning Commission and made available on the County's website.

Friends recommends the following revisions, which would provide clarity and implement all of the language from the Planning Commission's recommendation:

> Draft LUDO § 19.030(c)(4)(d), Att. A at 19-28–19-29:
>
> To approve an energy facility located outside the areas listed below, Wasco County must find that ~~T~~the design, construction and operation of the energy facility, taking into account mitigation, will ~~are~~ not ~~likely to~~ result in significant adverse impact to scenic resources and values of the areas identified in subsection (a) above. Methods to mitigate adverse visual impacts could include but are not limited to:
>
> (1) Building the energy facility near the edge of contiguous timber areas or using the natural topography to obscure the energy facility;
>
> (2) Using materials and colors that blend with the background unless otherwise required by the Federal Aviation Administration or the Oregon Department of Aviation; and
>
> (3) Retaining or planting vegetation to obscure views of the energy facility.

6. Natural Resource/Wildlife Protection.
Draft LUDO § 19.030(C)(5), Att. A at 19-29–19-30.

The draft ordinance includes provisions to protect natural resources, including water resources, plants, and wildlife. Draft LUDO § 19.030(C)(5), Att. A at 19-29–19-30. Friends recommends revising this section to clarify requirements and include explicit references to agencies that the Wasco County Planning Department will consult with during the permitting process.

The U.S. Fish and Wildlife Service (USFWS) has extensive knowledge about wildlife species that would be affected by wind energy development in Wasco County. As such, USFWS is an invaluable resource for evaluating potential impacts to wildlife resources. Moreover, USFWS has jurisdictional authority to protect migratory birds, golden eagles, bald eagles, and certain species listed under the Endangered Species Act. Given the central role USFWS plays in protecting these species, it is critical that the agency be involved with the permitting process and that resources identified by the agency are protected.

The Oregon Natural Heritage Program has expert knowledge on the location of rare, threatened, and endangered plant species. As such, consultation with the Natural Heritage Program should be required.

The draft ordinance would limit natural resource protections to natural resources that are "identified . . . [in a] resource management plan adopted and in effect on the date the application is submitted." Draft LUDO § 19.030(C)(5), Att. A at 19-29. Not all significant natural resources are identified in agency resource management plans. Some significant natural resources, such as

golden eagle nest sites, are documented on agency lists and maps of rare, threatened, and endangered species and important habitats. Some significant natural resources may not be discovered until the pre-construction surveys are complete. The specific resource may not be identified in a formal resource management plan. To ensure all significant natural resources are protected, the ordinance should be revised to provide protection to any natural resource identified by an expert agency.

The natural resource protection provisions would also be substantially improved by providing more detailed requirements for preconstruction studies and post-construction monitoring. As proposed the draft ordinance includes studies, analysis, and post-construction monitoring as measures that can be employed to reduce significant impacts to wildlife. Draft LUDO § 19.030(C)(5), Att. A at 19-29–19-30. However, the draft ordinance does not create explicit mandate requiring avoidance of significant impact and clear mitigation measures when avoidance is not possible. The preconstruction studies and post construction monitoring are limited to "[p]roviding information pertaining to the energy facilities potential impacts," "conducting biologically appropriate baseline surveys," and "developing a plan for post-construction monitoring." Draft LUDO § 19.030(C)(5)(a), (b), and (m).

Pre-construction surveys and reports and post-construction monitoring provide information on how to reduce impacts, but the studies themselves do not prevent or reduce impacts. These requirements should be revised to include measures that would avoid or fully mitigate impacts identified in the required reports. For post-construction impacts, the County should give itself authority to require that modifications to projects if unanticipated impacts occur during operation.

Friends recommends the following revisions to implement the above-referenced recommendations:

> Draft LUDO § 19.030(C)(5)(a), (b), & (m), Att. A at 19-29–19-30:
>
> Taking into account mitigation, siting, design, construction, and operation, ~~the energy facility has been designed and will be constructed and operated without~~ the facility will not cause significant adverse impact to important or significant natural resources identified in the Wasco County Comprehensive Plan, Wasco County Land Use and Development Ordinance or by any jurisdictional wildlife or natural resource agency ~~resource management plan adopted and in effect on the date the application is submitted~~. The permit holder agrees to implement all permit conditions, including siting, monitoring and mitigation actions that Wasco County determines appropriate after consultation with the Oregon Department of Fish and Wildlife, Oregon Natural Heritage Program, United State Fish and Wildlife Service, or other jurisdictional wildlife or natural resource agency. Measures to reduce significant impacts may include, but are not limited to the following:
>
> a. Providing information pertaining to the energy facility's potential impacts and measures to avoid impacts on:

(1) Wildlife (all potential species of reasonable concern);
(2) Wildlife Habitat;
(3) Endangered Plants; and
(4) Wetlands & Other Water Resources.

b. Conducting biologically appropriate baseline surveys in the areas affected by the proposed energy facility to determine natural resources present, ~~and~~ patterns of habitat use, predict likely impacts, and identify measures to avoid and mitigate identified impacts.

****

m. Developing a plan for post-construction monitoring of the facility site using appropriate survey protocols to measure the impact of the project on identified natural resources in the area. If impacts occur in excess of those identified in pre-construction estimates, the County shall have authority to require modifications to the project permit, including but not limited to requiring that problematic turbines be shut down during key migratory periods and requiring additional mitigation.

7. Radar-triggered aviation safety lighting.
Draft LUDO § 19.030(D)(1)(a)(3), Att. A at 19-34.

The draft ordinance would require the use of radar triggered aviation safety lighting if radar triggered technology is on a list approved by the Federal Aviation Administration ("FAA"). Draft LUDO § 19.030(D)(1)(a)(3), Att. A at 19-34. The ordinance does not define the "list" or process that the FAA uses to approve radar triggered lighting. To ensure that the wind facility developers fully explore this option, Friends recommend requiring that applicants seek approval of radar-triggered lighting. Notably, this requirement has been enforced on at least one wind facility in Wyoming. Attached is an excerpt of the Wyoming Department of Energy permit with the relevant permit condition.

Friends recommends the following language:

Draft LUDO § 19.030(D)(1)(a)(3), Att. A at 19-34:

Lighting - Lighting of towers is only allowed if required by the Oregon Department of Aviation of Federal Aviation Administration. If lighting is required by Oregon Department of Aviation or Federal Aviation Administration the applicant shall seek approval of radar triggered lighting. ~~and radar triggered lighting is on the list of approved lighting, it shall required.~~

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8. Setbacks from dwelling and non-resource zones.
Draft LUDO § 19.030(D)(1)(c), Att. A at 19-35–19-36.

The draft ordinance provides setbacks for wind energy facilities from non-project property lines, dwellings in resource and, and the boundaries of non-resource zones. Draft LUDO § 19.030(D)(1)(c), Att. A at 19-35–19-36.

For Resource Zone dwellings the Planning Commission recommended a setback of 3,520 feet or the distance necessary to comply with DEQ noise standards, whichever is greater. Draft LUDO § 19.030(D)(1)(c)(3). The Planning Commission also recommended a waiver provision to allow a developer to obtain permission to construct turbines within the DEQ noise buffer.

For projects near Non-Resource Zone lands the Planning Commission recommend setbacks of 1 mile from all non-resource zoned property; 3/4 of a mile (3,960 feet) from city limits, urban growth boundaries, and urban reserve boundaries; or the distance required to comply with DEQ noise standards. Draft LUDO § 19.030(D)(1)(c)(4). The Planning Commission did not recommend a waiver for the setback from non-resource zones.

Friends recommends increasing the setback for resource zone dwellings and all non-resource zoned lands to 1.5 miles. The County should allow residents in resource zones to waive the 1.5-mile setback from dwellings. A uniform 1.5-mile setback would substantially protect the community from adverse impacts of wind energy development, including the impacts from noise and impacts to visual resources. Allowing for waivers in resource zones would provide an avenue for energy facility developers to negotiate with landowners to place turbines closer to dwellings.

A 1.5-mile setback would be consistent with EFSC's implementation of the state noise standards found in OAR 340-035-0035. The state noise standards effectively create buffers up to and beyond 1.5 miles. As evidence of this, Friends has attached "noise contour" maps from the Shepherds Flat Wind Project, the Leaning Juniper II Wind Project, and the Summit Ridge Wind Project. The 36-decibel contour line on each map depicts the effective noise buffer created by OAR 340-035-0035.

These maps show that wind facilities can violate DEQ's default 36 decibel ambient noise standard at distances well over a mile—in some cases up to 2 miles from wind turbines. For example, the noise contour map for the Leaning Juniper II, which modeled 3.0-megawatt wind turbines, showed that the 36 decibel noise contour would be predominately 1.5 to 2 miles from wind turbines. Thus, the actual setback would be 1.5 to 2 miles from dwellings in proximity to the facility.

For background, the state "ambient degradation" standard prevents a wind facility from creating noise in excess of 10 decibels above ambient levels. A wind facility developer can obtain a waiver from a resident to intrude into the ambient noise buffer. In no circumstance is a wind facility allowed to violate the more rigorous "maximum allowable test," which caps allowable

noise levels at 50 decibels.[3] To demonstrate compliance with the ambient degradation standard wind facility developers may assume 26-decibel ambient noise levels in rural areas. In practice this creates a default 36-decibel cap on noise that can be heard at rural residences. By allowing developers to assume a 26-decibel ambient noise level, residents in areas with ambient noise levels below 26-decibels are given the burden of proving the actual ambient noise level.

Actual ambient noise levels in parts of rural Wasco County could be as low as 20 decibels, which would theoretically cap noise at levels as low as 30 decibels. However, since developers can assume a 26 decibel ambient noise level, residences with ambient noise levels below 26 decibels have the burden of proving that ambient noise was actually below 26 decibels. The citizens of Wasco County generally do not have access to the professional consultants employed by the wind industry. As such, rural residents are placed at a severe disadvantage if they attempt to challenge the industry's noise analysis. The burden placed on rural residents justifies establishing a default 1.5-mile setback with a waiver process to reduce the buffer.

A 1.5-mile buffer is supported by findings from the Oregon Public Health Division, which recently released a draft *Strategic Health Impact Assessment on Wind Energy Development in Oregon*. That concluded the following:

> Sound from wind energy facilities in Oregon could potentially impact people's health and well-being if it increases background sound levels by more than 10 dBA, or results in long-term outdoor community sound levels above 35-40 dBA. The potential impacts from wind turbine sound could range from moderate disturbance to serious annoyance, sleep disturbance and decreased quality of life.

Strategic Health Impact Assessment on Wind Energy Development in Oregon at 51. As demonstrated by the attached noise contour maps, the distance where potential impacts to public health become significant can extend up to 2 miles from a wind facility.

Since noise impacts analysis is a highly technical science and subject to complex modeling prepared by a project developer, adopting uniform setbacks creates a fair and transparent setback that is readily apparent to all citizens. Deferring to state noise standards obscures a landowners rights behind industry technical reports, which risks leaving affected landowners in a great deal of uncertainty.

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[3] The "ambient degradation" test requires that facilities "not increase the ambient hourly . . . noise levels at any noise sensitive receiver by more than 10 decibels." Shepherds Flat Wind Farm Final Order (SFWF Final Order) at 132. For the ambient degradation test the project developer can either assume a 26 decibel ambient noise or measure the actual noise. Most projects reviewed by EFSC have assumed a 26-decibel ambient noise level. This creates a 36-decibel threshold for the "ambient degradation test." EFSC also applies a "maximum allowable" test, which requires that facility "not exceed an hourly . . . noise level of 50 dBA at any noise sensitive receiver." SFWF Final Order at 133. A developer is not allowed to obtain waivers from this standard.

Instead of requiring citizens to trust the industry's noise analysis or hire expensive expert consultants, the more balanced approach would be to employ larger default setbacks. For dwellings in Resource Zones the County should include a process for obtaining waivers to allow development as close as 1.320 feet. Friends encourages the BOCC to adopt a setback of 1.5 to 2 miles, with a waiver process to allow development as close as 1,320 feet for dwellings in resource zone lands.

C. EFSC preemption of County standards.

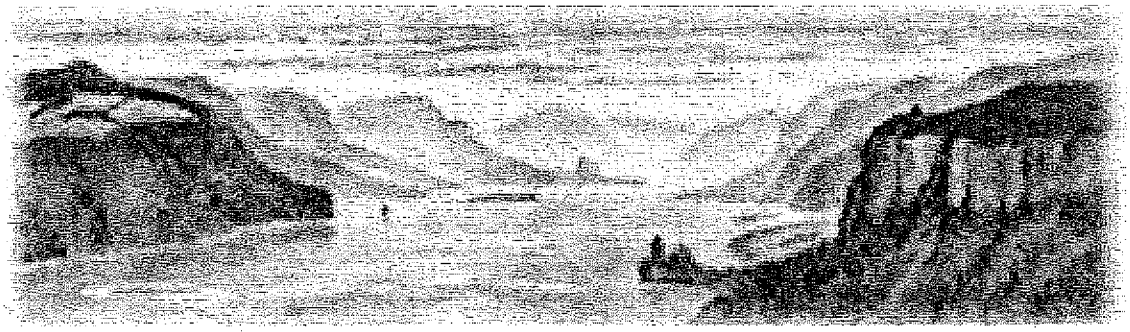
The County should be aware that EFSC has authority to preempt any Wasco County standards that were adopted to implement Statewide Planning Goals. ORS 469.504(b)(1)(B) allows EFSC to preempt local land use laws implementing a Statewide Planning Goal if the proposed development would violate the local rule but comply with purpose of the Statewide Planning Goal.

The County should be aware that there is risk that any project that elects to use EFSC's permitting process may be able to preempt the standards established in Chapter 19. To avoid this risk, the County should clarify where standards are intended to implement Statewide Planning goals and where standards implement the County's broad zoning authority.

D. Conclusion

Thank you for the opportunity to comment.

/s/ *R. F. Till*
Richard Till
Conservation Legal Advocate



FRIENDS OF THE COLUMBIA GORGE

Friends of the Columbia Gorge
Recommended revisions to LUDO Chapter 19
(PLALEG-09-06-0003)

January 17, 2012

Recommendations for new language are **underlined**.

Recommended deletions are identified by ~~**strikethrough**~~.

Citations refer to the specific Draft LUDO section and the page number in Staff Report Attachment A ("Att. A").

Purposes.
Draft LUDO § 19.010, Att. A at 19-7.

Friends recommends the following revisions:

- Encourage renewable energy development that is appropriately sited to avoid and minimize adverse impacts to the community and environment."

BOCC to serve as Special Advisory Group to EFSEC – Public Comment accepted.
Draft LUDO § 19.030(A)(1)(c), Att. A at 19-24–19-25.

Friends recommends retaining the language proposed by the Planning Commission.

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County Decision Options: Tentative Approval and Final Approval.
Draft LUDO § 19.030(A)(2), Att. A at 19-25:

Friends preferred option: Removal tentative approval process and provide a single decision.

In the alternative, Friends recommends the following revisions:

2. County Decision Options - As part of the application materials the applicant shall indicate if they are requesting final or tentative approval. Both tentative and final approval are subject to conditional use review and appeal procedures.

Modifications to Permits.
Draft LUDO § 19.030(A)(2), Att. A at 19-26.

Friends recommends the following revisions:

3. Modifications - ~~Energy facility requirements shall be facility specific, but can be modified as long as the facility does not exceed the boundaries of the Wasco County conditional use permit where the original facility was constructed.~~

   An amendment to the conditional use permit shall be required if the proposed facility changes would:

a. Require an expansion of the established facility boundaries;
b. Increase the number of towers; or
c. Increase generator output by more than 25 percent relative to the generation capacity authorized by the initial permit due to the repowering or upgrading of power generation capacity.
d. Relocate any wind turbine tower by more than 50 feet; or
e. Change the height of any wind turbine tower by more than 10 feet.

   ~~No amendment would be required if an expansion of power-generating capacity is due to technology upgrades installed within the existing boundaries of the established energy facility. Notification by the permit holder to the Planning Department of changes not requiring an amendment are encouraged, but not required.~~

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Non-Resource Zone Standards for Related and Supporting Facilities.
Draft LUDO § 19.030(B), Att. A at 19-26–19-27:

Friends recommends not allowing related and supporting facilities in non-resource zones. In the alternative, Friends recommends the following revisions:

3. Related or Supporting Facilities (Reasonable Alternatives Analysis) - Related or supporting facilities to a commercial power generating facility ~~shall~~ may be allowed in non-resource zones subject to Conditional Use Review upon a showing that such related or supporting facilities are necessary for siting the commercial power generating facility. Any related or supporting facilities ~~will~~ must be consistent in size, scale, and impact as other existing or allowed uses in the non-resource zone. Related or Supporting Facilities shall be reviewed as part of the Commercial Power Generating Facility and not subject to a separate Conditional Use Review. To demonstrate the related or supporting facilities are necessary within the meaning of this section, an applicant must show that reasonable alternatives have been considered and that the related or supporting facilities must be sited in a non-resource zone after considering the following factors:

~~a. The related or supporting facilities will be consistent in size scale and impact as other existing or allowed uses in the non-resource zone;~~

Visual Resources.
Draft LUDO § 19.030(C)(4), Att. A at 19-27–19-29:

Friends recommends the following revisions:

Draft LUDO § 19.030(c)(4)(b), Att. A at 19-27:

b. Except where the following uses are regulated by federal, state, or local laws, including but not limited to Columbia River Gorge National Scenic Area Act and implementing land use ordinances, ~~T~~the following may be approve in a protected area identified in subsection (a) above if other alternative routes or sites have been studied and been determined to have greater impacts.

Draft LUDO § 19.030(c)(4)(d), Att. A at 19-28–19-29:

d. To approve an energy facility located outside the areas listed below, Wasco County must find that ~~T~~the design, construction and operation of the energy facility, taking into account mitigation, will ~~are~~ not ~~likely to~~ result in significant adverse impact to scenic resources and values of the areas identified in subsection (a) above. Methods to mitigate adverse visual impacts could include but are not limited to:

Natural Resource/Wildlife Protection.
Draft LUDO § 19.030(C)(5), Att. A at 19-29–19-30.

Friends recommends the following revisions:

> Taking into account mitigation, siting, design, construction, and operation, ~~the energy facility has been designed and will be constructed and operated without~~ the facility will not cause significant adverse impact to important or significant natural resources identified in the Wasco County Comprehensive Plan, Wasco County Land Use and Development Ordinance or by any jurisdictional wildlife or natural resource agency ~~resource management plan adopted and in effect on the date the application is submitted~~. The permit holder agrees to implement all permit conditions, including siting, monitoring and mitigation actions that Wasco County determines appropriate after consultation with the Oregon Department of Fish and Wildlife, Oregon Natural Heritage Program, United State Fish and Wildlife Service, or other jurisdictional wildlife or natural resource agency. Measures to reduce significant impacts may include, but are not limited to the following:
>
> a. Providing information pertaining to the energy facility's potential impacts and measures to avoid impacts on:
>
> (1) Wildlife (all potential species of reasonable concern);
> (2) Wildlife Habitat;
> (3) Endangered Plants; and
> (4) Wetlands & Other Water Resources.
>
> b. Conducting biologically appropriate baseline surveys in the areas affected by the proposed energy facility to determine natural resources present, ~~and~~ patterns of habitat use, predict likely impacts, and identify measures to avoid and mitigate identified impacts.
>
> *******
>
> m. Developing a plan for post-construction monitoring of the facility site using appropriate survey protocols to measure the impact of the project on identified natural resources in the area. If impacts occur in excess of those identified in pre-construction estimates, the County shall have authority to require modifications to the project permit, including but not limited to requiring that problematic turbines be shut down during key migratory periods and requiring additional mitigation.

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Radar-triggered aviation safety lighting.
Draft LUDO § 19.030(D)(1)(a)(3), Att. A at 19-34.

Friends recommends the following revisions:

> Draft LUDO § 19.030(D)(1)(a)(3), Att. A at 19-34:
>
> Lighting - Lighting of towers is only allowed if required by the Oregon Department of Aviation of Federal Aviation Administration. If lighting is required by Oregon Department of Aviation or Federal Aviation Administration the applicant shall seek approval of radar triggered lighting. ~~and radar triggered lighting is on the list of approved lighting, it shall required.~~

Setbacks from dwelling and non-resource zones.
Draft LUDO § 19.030(D)(1)(c), Att. A at 19-35–19-36.

Friends recommends the following revisions:

Dwellings in resource zones: 1.5 miles with a waiver process.

Non-resource zones: 1.5 miles.

Excerpt of the Visual Impact standard from the June 7, 2011 version of Draft Chapter 19. The Planning Commission adopted this language as its recommendation to the BOCC.

June 7, 2011 Draft Chapter 19 at pages 19-25–19-27, Draft LUDO § 19.030(C)(4):

Option 3 - Use standards more consistent with EFSC for Protected Areas & Scenic Resources - OAR- 345-022-0040:

(1) Except as provided in sections (2) and (3), Wasco County shall not approve an energy facility located in the areas listed below. To approve an energy facility located outside the areas listed below, Wasco County must find that, taking into account mitigation, the design, construction and operation of the facility are not likely to result in significant adverse impact to the areas listed below.

(c) Wilderness areas established pursuant to The Wilderness Act, 16 U.S.C. 1131 et seq. and areas recommended for designation as wilderness areas pursuant to 43 U.S.C. 1782

(e) National recreation and scenic areas, including but not limited to the Oregon Cascades Recreation Area, and Columbia River Gorge National Scenic Area

(f) State parks and waysides as listed by the Oregon Department of Parks and Recreation

(k) Scenic waterways designated pursuant to ORS 390.826, wild or scenic rivers designated pursuant to 16 U.S.C. 1271 et seq., and those waterways and rivers listed as potentials for designation;

(o) Bureau of Land Management areas of critical environmental concern, outstanding natural areas and research natural areas

(p) State wildlife areas and management areas identified in OAR chapter 635, division 8

(2) Notwithstanding section (1), Wasco County may issue an approval for an electrical transmission line or a natural gas pipeline or for an energy facility located outside a protected area that includes an electrical transmission line or natural gas or water pipeline as a related or supporting facility located in a protected area identified in section (1), if other alternative routes or sites have been studied and determined by Wasco County to have greater impacts. Notwithstanding section (1), Wasco County may issue approval for surface facilities related to an underground gas storage reservoir that have pipelines and injection, withdrawal or monitoring wells and individual wellhead equipment and pumps located in a protected area, if other alternative routes or sites have been studied and determined by Wasco County to be unsuitable.

OAR 345-022-0080 - Scenic Resources

(1) Except for facilities described in section (2), to issue an approval, Wasco County must find that the design, construction and operation of the facility, taking into account mitigation, are not likely to result in significant adverse impact to scenic resources and values identified as significant or important.

(2) Wasco County may issue approval for a special criteria facility under OAR 345-015-0310 (Certain Natural Gas Energy Facilities) without making the findings described in section (1). However, Wasco County may apply the requirements of section (1) to impose conditions on a site certificate issued for such a facility.

WASCO COUNTY

John Roberts <johnr@co.wasco.or.us>

Friends Comments (2 of 3)

1 message

Rick Till <Rick@gorgefriends.org> **Tue, Jan 17, 2012 at 1:58 PM**
To: John Roberts <johnr@co.wasco.or.us>, SherryH@co.wasco.or.us, ScottH@co.wasco.or.us, RodR@co.wasco.or.us

Commissioners,

Please find the 3 attachments, which are noise contour maps from three wind projects proposed and/or constructed in the region. The maps depict the distance where Oregon State noise regulations establish setbacks from residences.

Richard Till, Conservation Legal Advocate

Friends of the Columbia Gorge

rick@gorgefriends.org

522 SW 5th Ave., Suite 720

Portland, Oregon 97204-2100

(503) 241-3762 x 107

Fax: (503) 241-3873

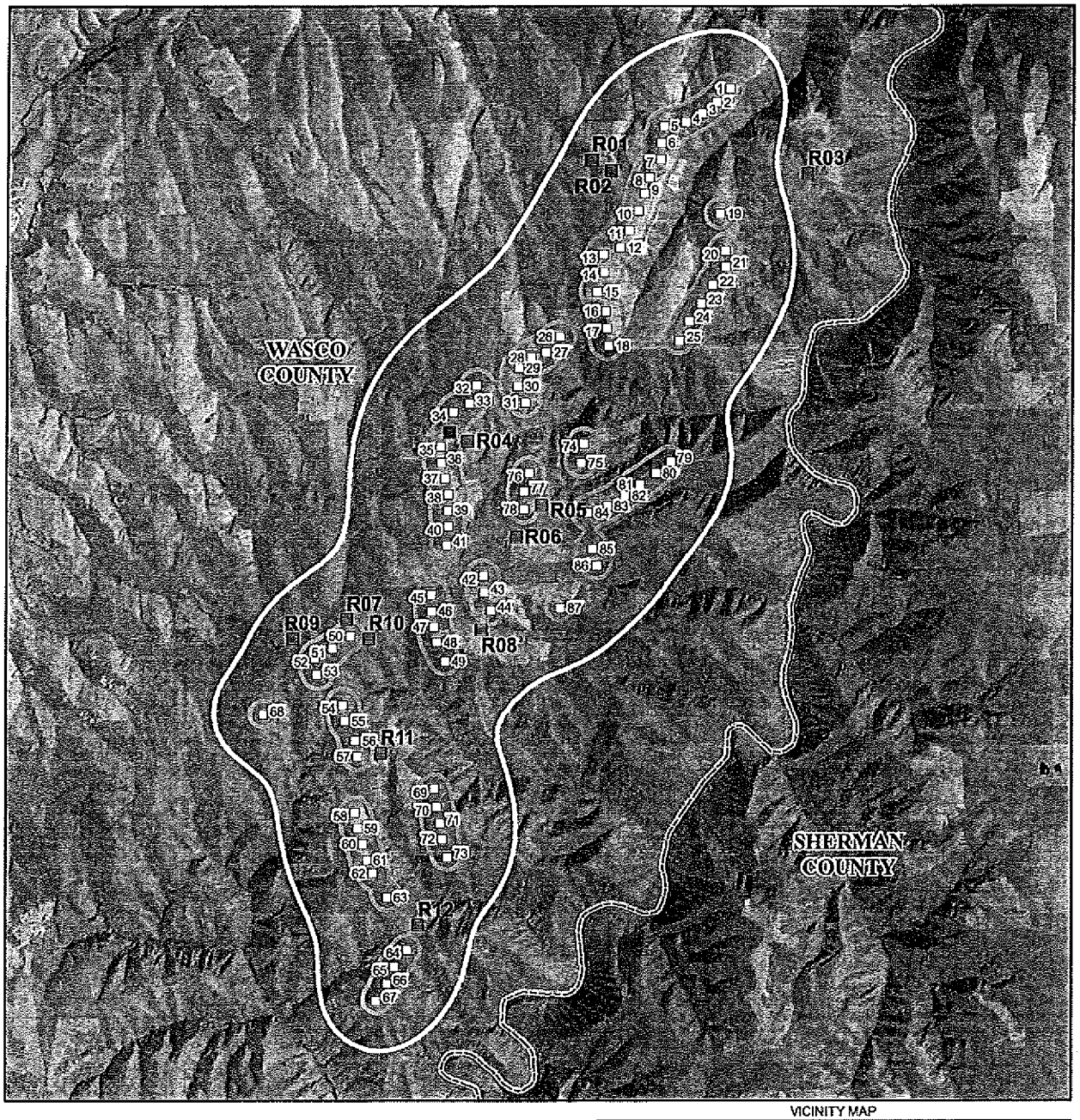
Become a Friend of the Columbia Gorge at www.gorgefriends.org

3 attachments

Noise Contour Map - Summit Ridge Noise.pdf
346K

Noise Contour Map - Leaning Juniper II.pdf
308K

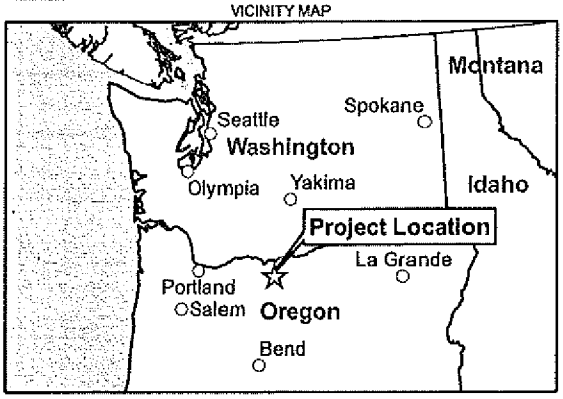
Noise Contour Map - Sheppards Flats.pdf
929K



LEGEND

- Turbine
- Substation
- Receptor
- 36-dBA Noise Contour
- 50-dBA Noise Contour
- County Boundary

VICINITY MAP



N

0 5,000 10,000

Feet

FIGURE X-1
Noise Contours (Siemens 2.3 MW Turbines)
Lotus Works Energy
Wasco County, Oregon

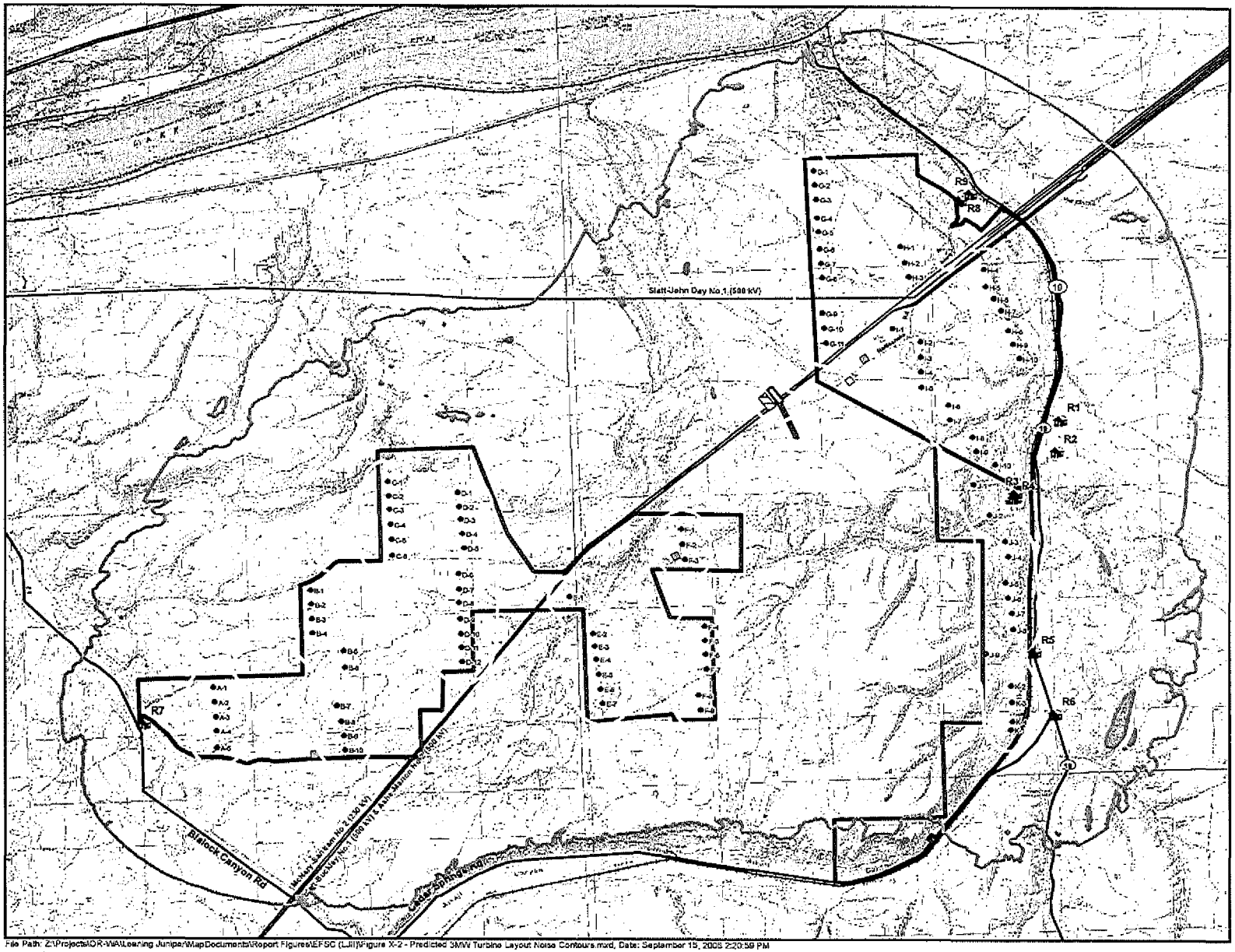


Figure X-2

Predicted 3.0-MW Turbine Layout Noise Contours (dBA)

Leaning Juniper II
Wind Power Facility

PPM Energy

Legend

- House
- 36-dBA Noise Contour
- 50-dBA Noise Contour

Proposed Permanent Facilities

- Proposed Substation
- Proposed O&M Facility and Laydown Area
- Alternate O&M Facility and Laydown Area
- BPA Jones Canyon Switching Station

Existing Facilities

- Existing BPA Transmission Line
- Major Roads
- Railroads
- Streams
- Leaning Juniper II - North
- Leaning Juniper II - South

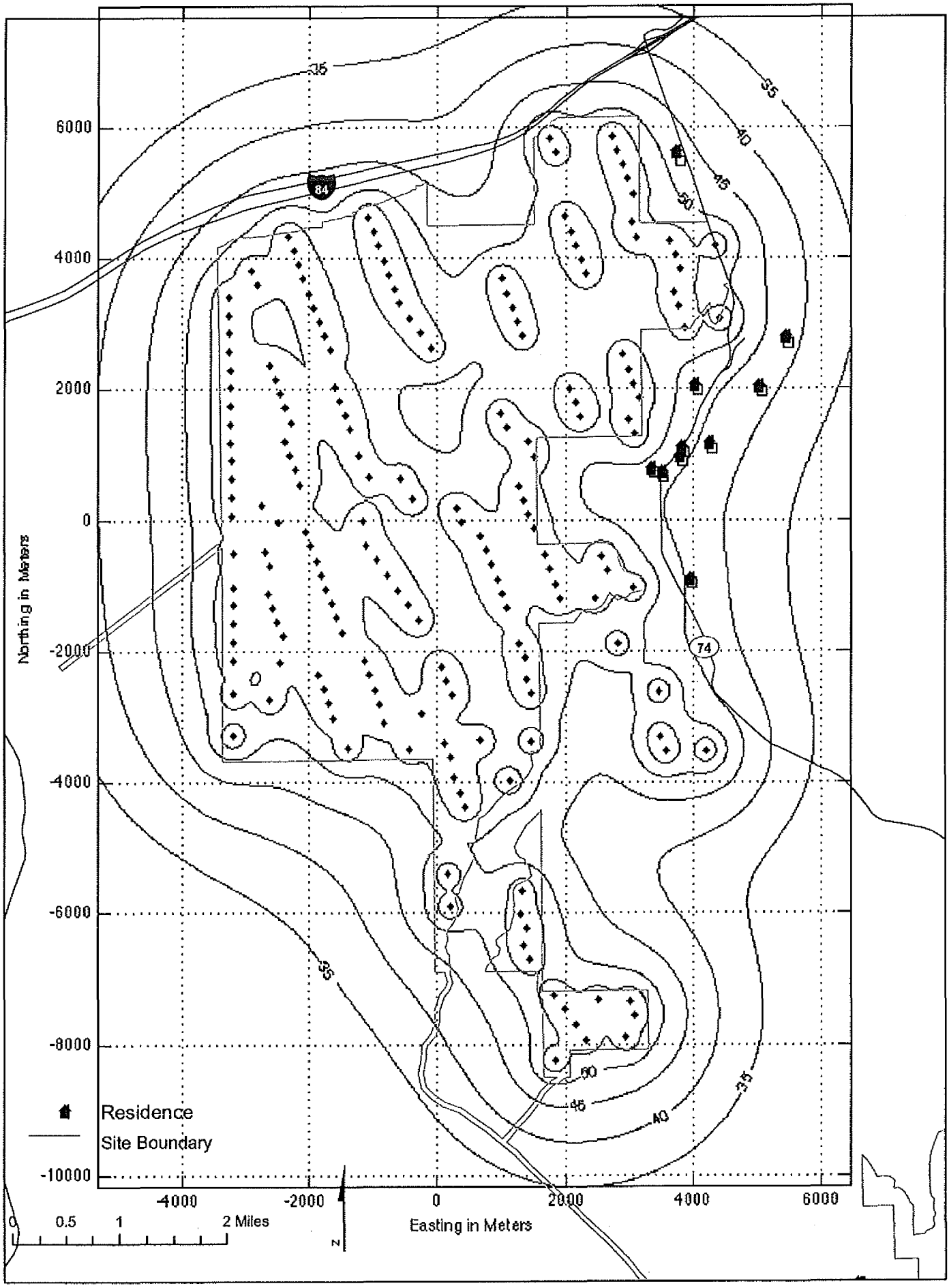
N
W E
S

0 0.5 1 1.5
Miles

File Path: Z:\Projects\OR-WA\Leaning Juniper\MapDocuments\Report Figures\EFSC (LJII)\Figure X-2 - Predicted 3MW Turbine Layout Noise Contours.mxd, Date: September 15, 2008 2:20:59 PM

Figure RAI#2 X1a

Noise Contours - 192 Wind Turbines at 109.2 dB LWA



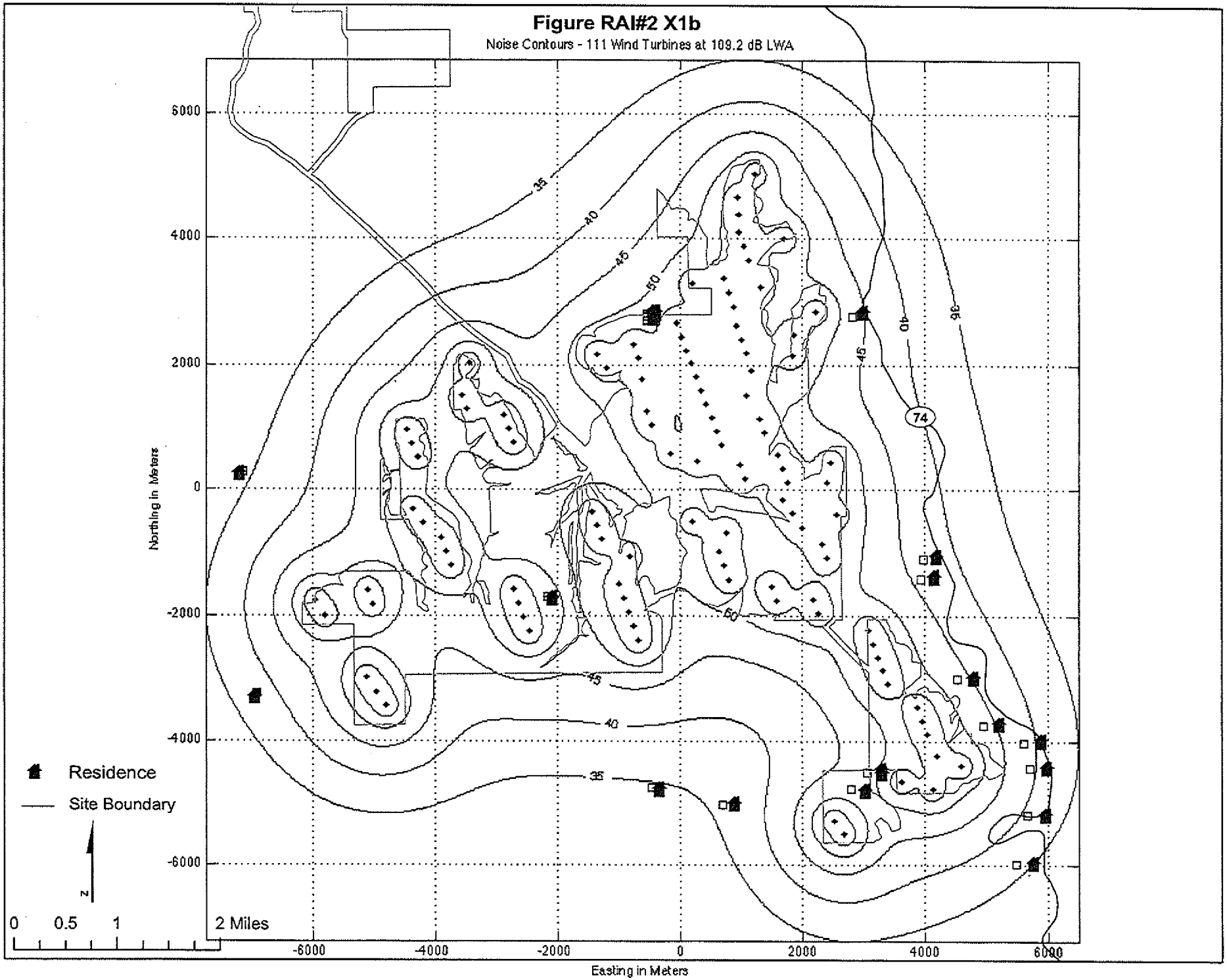


Figure RAI#2 X1b
Noise Contours - 111 Wind Turbines at 109.2 dB LWA
Northing in Meters
Easting in Meters
6000
4000
2000
0
-2000
-4000
-6000
-6000
-4000
-2000
0
2000
4000
6000
35
40
45
50
74
Residence
Site Boundary
N
0
0.5
1
2 Miles

WASCO COUNTY

John Roberts <johnr@co.wasco.or.us>

Friends Comments (3 of 3)

1 message

Rick Till <Rick@gorgefriends.org> **Tue, Jan 17, 2012 at 2:00 PM**
To: John Roberts <johnr@co.wasco.or.us>, SherryH@co.wasco.or.us, ScottH@co.wasco.or.us, RodR@co.wasco.or.us

Commissioners,

Please find the attached documents. These documents show that radar triggered lighting has previously been approved by the Federal Aviation Administration and that requiring developers to seek approval of the technology has been required as a condition of approval for at least one industrial energy facility.

Thanks for you consideration,

Richard Till, Conservation Legal Advocate

Friends of the Columbia Gorge

rick@gorgefriends.org

522 SW 5th Ave., Suite 720

Portland, Oregon 97204-2100

(503) 241-3762 x 107

Fax: (503) 241-3873

Become a Friend of the Columbia Gorge at www.gorgefriends.org

3 attachments

Radar Lighting - FAA, Memo on Changes to Advisory Circular on Obstruction Marking and Lighting.pdf
473K

Radar Lighitng - Wasatch Wind Permit.pdf
1771K

Radar Lighting - FAA, Maine Wind Project, Determination of No Hazard to Air Navigation.pdf
17K

Federal Aviation Administration

Memorandum

Date: JUN 15 2009

To: Obstruction Evaluation Services Personnel

From: Kevin Haggerty
Manager, Obstruction Evaluation Services

Subject: Changes to Federal Aviation Administration (FAA) Advisory Circular (AC) 70/7460-1K, Obstruction Marking and Lighting

We are preparing changes to FAA AC 70/7460-1K, Obstruction Marking and Lighting. The changes will incorporate Audio Visual Warning Systems (AVWS) as an acceptable form of marking and lighting that will meet established technical standards to identify an obstruction to air navigation.

AVWS is an all-weather, day and night, low-voltage, Radar-based obstacle avoidance system that utilizes current obstruction lighting products and does not require additional equipment in an aircraft.

AVWS activates obstruction lighting and audio signals to alert pilots of potential collisions with obstacles such as power lines, wind turbines, bridges, and towers. The obstruction lights and audio warnings are inactive when there is no air traffic in the area of the obstruction.

The FAA has analyzed and reviewed the Obstruction Collision Avoidance System (OCAS™) and has determined that OCAS™ provides an equivalent level of safety and is a suitable alternative to the marking and lighting requirements of obstacles as recommended in FAA AC 70/7460-1K.

OCAS™ is the first AVWS to be installed, tested, and approved in the National Airspace System (NAS).

The OES will accept, analyze, and approve an AVWS as an alternative to conventional lighting systems on a case-by-case basis.

OES personnel shall:

1. Review each FAA Form 7460-1, Notice of Proposed Construction or Alteration, for requests to use an AVWS.

2. If an AVWS is indicated, select "AVWS" as the requested Marking and Lighting.
3. Ensure that Technical Operations and Spectrum Engineering are selected to provide comment on the aeronautical study.
4. Business rules will be incorporated into the Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) System based on AVWS as the Requested Marking/Lighting to override current auto screens and ensure proper coordination. If AVWS is not selected as the Requested Marking/Lighting, ensure that the case is manually unlocked for review from AF and FM.
5. Before the issuance of the Determination, ensure that comments from Technical Operations and Spectrum Engineering are reviewed and specifically acknowledge that the AVWS was reviewed, approved, or conditionally approved (e.g., No Audio).
6. Adjudicate all AVWS concerns and indicate in the Additional Information section that AVWS is approved for the specific study with or without conditions or limitations prior to the issuance of a Determination of No Hazard to Air Navigation.
7. If AVWS is approved with conditions or limitations or if AVWS is not approved: provide your supervisor with the Aeronautical Study Number and wait for approval to issue the Determination of No Hazard to Air Navigation.
8. Ensure that the 7460-2, Notice of Actual Construction or Alteration, indicates that AVWS is installed.

The OES will incorporate an AVWS section to the external OE/AAA Web site to inform the public about AVWS and its benefits in the NAS.

Please direct any questions or comments to the Manager, OES.

IN THE OFFICE OF ADMINISTRATIVE HEARINGS

UPON REFERRAL FROM THE
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
INDUSTRIAL SITING DIVISION

STATE OF WYOMING

IN THE MATTER OF THE INDUSTRIAL SITING PERMIT APPLICATION OF PIONEER WIND PARKS, WASATCH WIND INTERMOUNTAIN, LLC	))))	DOCKET NO. DEQ/ISD 10-02

FINDINGS OF FACT, CONCLUSIONS OF LAW AND ORDER GRANTING PERMIT APPLICATION WITH CONDITIONS AND ALLOCATING IMPACT ASSISTANCE FUNDS

THIS MATTER came before the Industrial Siting Council (Council) on May 16, 17 and 18, 2011 and June 13, 2011, for evidentiary hearing. The record was officially closed on June 13, 2011. Council members present for the proceedings included Shawn Warner, Chairman, Sandy Shuptrine, Darrell Offe, Gregg Bierei, Jim Miller, Peter Brandjord and Mike Daly. Bridget Hill, Senior Assistant Attorney General, was also present on the Council's behalf. Deborah A. Baumer from the Office of Administrative Hearings served as the Hearing Examiner in the proceedings. The Applicant, Pioneer Wind Parks, Wasatch Wind Intermountain (Wasatch Wind) appeared by and through its counsel, Brent R. Kunz and John A. Masterson. The Industrial Siting Division (Division) appeared by and through its counsel, Assistant Attorney General, Luke J. Esch. Seven other parties participated in the evidentiary hearing including Natrona County represented by Bill Knight, Converse County represented by Quentin Richardson, the Town of Rolling Hills represented by F. Scott Peasley, Grant Ranch represented by Lynne Boomgaarden, True Ranches represented by David L. True, Chester and Jennifer Hornung (the

Hornung's) represented by Scott J. Olheiser and the Northern Laramie Range Alliance/Northern Laramie Range Foundation (NLRF) represented by Peter C. Nicolaysen. Wasatch Wind's Application (WWI), Addenda 1 and 2, Replacement Pages, Exhibit B consisting of Exhibits 1 through 26 (Exhibit 10 revised) and Rebuttal Exhibits 1 through 4, the Division's Exhibits 1 through 4, Converse County's Exhibits 1 and 2, Grant Ranches Exhibits 1 through 6 (Exhibit 6 revised), Hornung's Exhibits 1 through 4, and NLRF's 1, 2, 4, 5, 6, 10, 11, 12, 21, 24, 27, 28, 29, 34, 38 through 47, 49, 50, 51, 51PP, 52, 52R and 55 were admitted for purposes of the evidentiary hearing. The Council also received 28 limited appearance statements in this case before the close of the evidentiary hearing and considered those statements in making its final decision. The Council has considered the evidence and argument of the Applicant and the parties, and makes the following findings:

I. JURISDICTION

Wyo. Stat. Ann. § 35-12-106(a) (LEXIS 2010) provides that, "No person shall commence to construct a facility, as defined in this chapter, in this state without first obtaining a permit for that facility from the council."

"Industrial facility" or "facility" means any industrial facility with an estimated construction cost of at least one hundred seventy eight million, three hundred thousand dollars ($178,300,000.00) and any commercial facility generating electricity from wind and associated collector systems that consists of 30 or more wind turbines. Wyo. Stat. Ann. § 35-12-102(a)(vii) (LEXIS 2010).

10. According to Mikell, the turbine site was chosen because the data collected by Grant Ranch, the location of the Projects, was shown to be extremely windy. Additionally, transmission lines were within close proximity to the proposed site and a market to sell the power existed. *Tr. of Proc., pp. 40-42.*

11. Due to concerns expressed by the citizens of the area, Wasatch Wind agreed that, subject to FAA approval, lighting technology would be retrofitted on the turbines to turn off the blinking red lights unless a plane is flying nearby. Mikell testified that Wasatch Wind would not be opposed to a permit condition requiring installation of the technology once it is approved. According to Mikell, only one resident would be affected by shadow flicker which would be noticed nine minutes each year. That resident is a lessor and has no objection to the Projects. Additionally, on April 1, 2011, a revised turbine layout was submitted to the Division. The revision occurred as a result of view shed concerns of Glenrock citizens surrounding a golf course, and the close proximity to the Huxtable Ranch listed on the National Historic Register of Places as a historic property on April 7, 2011. Huxtable Ranch, also known as the White Creek Ranch, is owned by Kenneth Lay. A total of seven turbines were moved, five to a string closer to the Hornung's property. Portions of seven turbines will be visible from the White Creek Ranch driveway. Seven residences are within two miles of the closest turbine. Six of the seven residences have signed leases with Wasatch and none are opposed to the Projects. Twenty-one residences are within five miles of the Projects, and six have publicly opposed the Projects. Thirty eight residences are within 7.6 miles from the nearest turbine and one additional resident opposed the Projects. *Tr. of Proc., pp. 54-58, 104-109, 112; 1060-1061;1066; Wasatch Wind Exhibits 7, 9 and 10R; Rebuttal Exhibit 1.*

Converse County. The Director of Land Acquisition, Sam Lichenstein (Lichenstein), attended the meeting and spoke to the Hornung's. Other than mailing, Wasatch Wind has had no further direct contact with the Hornung's. Stevens and Lichenstein also had direct contacts with Kenneth Lay, who is opposed to the Projects. *Tr. of Proc., pp. 369-379.*

21. Stevens testified that Wasatch knew that visual aesthetics were a concern in the area. As a result, if approved by the FFA, Wasatch Wind will use AVWS radar system which keeps night skies dark and the lights on the turbines off unless an aircraft is approaching. Wasatch also chose seven key observation points and did visual simulations which were presented at the November 9, 2010, open house. Turbines were only visible from four of the observation points. Stevens also met with 20 landowners in Glenrock who expressed concerns about the turbine locations. Turbines were relocated as a result of that meeting. In Stevens' professional opinion, the Pioneer Wind Park I and Pioneer Wind Park II met the notification requirements in the statute. *Tr. of Proc., pp. 379-383.*

22. George Blankenship (Blankenship) conducted the socioeconomic assessments for Wasatch Wind. Blankenship has 32 years of experience in conducting socioeconomic assessments and has worked on 15 industrial siting applications. Blankenship reviewed monitoring reports from nearby wind farm projects to determine the residency distribution during the peak quarters of construction. Within the three nearby projects, over 95 percent of non-local construction work force lived in Converse and Natrona Counties. Of that amount of workers, 95 percent lived in the three communities of Glenrock, Douglas and Casper. Pioneer Wind Park I construction schedule starts with 100 workers in the first month and peaks at 168 workers in the second month. The work force then drops to 80 workers after the first two months and in the final month, drops to 45 workers. Pioneer Wind Park I estimates 17.8 construction worker

decommission and reclaim the facility. If sufficient financial resources are not obtained within two years, the Permit shall expire.

Special Condition #20. Upon opponent landowner agreement, the Applicant will negotiate in good faith, mitigation for visual and potential audio impacts of Pioneer Wind Projects I and II, such as but not limited to vegetative screening.

Special Condition #21. FFA approval for remote control night lighting of wind generating towers will be sought and installed within six months of FFA approval.

ORDER

IT IS THEREFORE ORDERED that the Industrial Siting Permit Application known as Wasatch Wind Intermountain, LLC, doing business as Pioneer Wind Park I, LLC and Pioneer Wind Park II, LLC, as submitted by the Applicant and modified by this Council as set forth above in Permit Conditions #1 through #21 is granted.

DONE this __18__ day of July, 2011.

_____/s/_____
Shawn Warner, Chairman
Industrial Siting Council
Herschler Building, Fourth Floor West
122 West 25th Street
Cheyenne, Wyoming 82002
(307) 777-7170

Federal Aviation Administration
Air Traffic Airspace Branch, ASW-520
2601 Meacham Blvd.
Fort Worth, TX 76137-0520

Aeronautical Study No.
2010-WTE-1248-OE

Issued Date: 04/29/2010

Travis Bullard
Eolian Renewable Energy
155 Fleet Street
Portsmouth, NH 03801

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine Turbine 5
Location:	Bangor, ME
Latitude:	44-39-05.34N NAD 83
Longitude:	68-38-39.27W
Heights:	410 feet above ground level (AGL) 1187 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

As a condition to this Determination, the structure is marked and/or lighted with AVWS and White Paint.

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be completed and returned to this office any time the project is abandoned or:

_____ At least 10 days prior to start of construction (7460-2, Part I)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part II)

See attachment for additional condition(s) or information.
Your request for consideration to utilize an Audio Visual Warning System to operate the is approved. See attached for additional information.

This determination expires on 04/29/2012 unless:

(a) extended, revised or terminated by the issuing office.
(b) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE POSTMARKED OR DELIVERED TO THIS OFFICE AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE.

Additional wind turbines or met towers proposed in the future may cause a cumulative effect on the national airspace system. This determination is based, in part, on the foregoing description which includes specific coordinates and heights . Any changes in coordinates will void this determination. Any future construction or alteration requires separate notice to the FAA.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (404) 305-7081. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2010-WTE-1248-OE.

Signature Control No: 682686-125309177 (DNE -WT)
Michael Blaich
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2010-WTE-1248-OE

Use of an Audio Visual Warning System is approved. Audio Visual Warning Systems use a combination of both audio (through VHF radio based communications to an aircraft) and visual lighting warnings systems.

FRIENDS OF THE COLUMBIA GORGE

SUBMITTED VIA E-MAIL AND HAND DELIVERY

February 13, 2011

Wasco County Board of County Commissioners
c/o Wasco County Department of Planning and Economic Development
2705 East Second Street
The Dalles, Oregon 97058

Re: Wasco County's proposed Energy Ordinance Updates (PLALEG-09-06-0003).

Dear Commissioners:

Friends of the Columbia Gorge (Friends) previously submitted comments on the proposed revisions to Wasco County energy ordinance. Since that time Friends has been notified of a recent Land Use Board of Appeals decision related to Umatilla County's land use standards for wind energy facilities. *Cosner v. Umatilla County*, 63 Or LUBA ___ (Jan. 12, 2012)(LUBA Nos. 2011-070, 2011-071, and 2011-072). Friends submits these comments to address legal findings in that case that should be addressed in Wasco County's proposed ordinance. Friends also provides additional comments in response to comments submitted on behalf of Iberdrola Renewables, Inc.

A. Cosner *establishes that two-mile setbacks are permissible and that if waivers from setbacks are allowed, there must be standards for granting such waivers.*

Cosner establishes several important precedents relevant to the County's proposed energy ordinance. A critical finding of *Cosner* is that Umatilla County had a sufficient factual basis for imposing a two-mile setback for wind energy facilities from urban growth boundaries and residences. Based on this precedent and the facts currently in the record before Wasco County, there is clear authority and factual basis for adopting a two-mile setback from non-resource zoned lands and all residences in resource lands.

Friends previously recommended a 1.5 mile setback. Based on *Cosner*, Friends encourages Wasco County to adopt a two-mile setback.

The *Cosner* decision also addresses the legal requirements for authorizing waivers from setbacks. LUBA determined that Umatilla County improperly delegated legislative authority by authorizing waivers "determined solely at the discretion of . . . the landowner, based on no standards at all." *Cosner* at 5–6. LUBA did not explain what type of standards would be adequate to comply with state law and focused on the fact that there were absolutely *no* standards to be applied by the county.

Based on this ruling Wasco County has two options when considering whether to allow waivers. First, Wasco County could choose to not allow waivers. Second, Wasco County could authorize discretionary waivers only if specified conditions are met. If the County prefers to include a waiver provision for residences in resource zone lands, Friends recommends requiring that any waiver be subject to the variance requirements in LUDO Chapters 6 and 7. Wasco County could include additional standards to tailor variance standards to apply to the unique circumstances of wind facilities. For non-project boundaries variances should not be allowed to reduce setbacks below the general property line setbacks for the applicable zone. For non-resource zone dwellings, setbacks should not be reduced below 1,320 feet, which EFSC has previously found is necessary to protect against turbine failure and blade throw.

Friends recommends the following language to implement this recommendation:

Draft LUDO § 19.030(D)(1)(c)(2), (3), Att. A at 19-36:[1]

(2) Non Project Boundaries - Wind turbines and their above ground parts shall be set back from the property line of any abutting property not part of the project, the right of way of any dedicated road, and any above ground major utility facility line a minimum of 1.5 times the height of the wind turbine tower. Wind turbines and their above ground parts shall be set back from any above ground minor utility facility line a minimum of 1.1 times the height of the wind turbine tower.

Wind turbines and their above ground parts ~~shall~~ may be allowed closer to a property line of any abutting property not part of the project, the right of way of any dedicated road, or any above ground utility facility line than the distances cited above ~~without~~ subject to obtaining a variance pursuant to either Chapter 6 or 7 ~~if~~ and obtaining ~~granted~~ written permission from the abutting property owner, road authority, or utility. ~~Said w~~Written permission shall be made part of permit and the deed records to any private property. Variances shall not reduce the setback to less than the property line setback of the zone in which the turbine is located.

[1] Citations refer to the specific Draft LUDO section and the page number in Staff Report Attachment A ("Att. A"). Recommendations for new language are **underlined.** Recommended deletions are identified by **~~strikethrough~~.**

~~Notwithstanding receiving permission from the abutting property owner, road authority or utility, wind turbines and their above ground parts shall still be required to meet the property line setback of the zone in which they are located unless a variance is granted pursuant to either Chapter 6 or 7.~~

(3) Resource Zone Dwellings - Wind turbines shall be setback from all approved resource zone dwellings a minimum of 2 ~~2/3~~ miles ~~(3,520 feet),~~ measured from the center line of the turbine tower to the edge of the dwelling or the distance required to comply with the DEQ noise standard (OAR 340-035-0035) in Subsection D(3) above, whichever is greater. ~~*(Following this same noise standard EFSC has typically required a setback of approximately ¼ mile (1,320 feet) for turbines. This was put forth on a vote of 5 – 2 by the planning commission. The 2 dissenting planning commissioner votes were in favor of a ¼ mile buffer.)*~~

Wind turbines shall be allowed closer to an approved resource zone dwelling subject to obtaining a variance pursuant to either Chapter 6 or 7 and obtaining ~~granted~~ written permission from the owner of the property where the approved resource zone dwelling is located. Said written permission shall be made part of the permit and deed records to any private property. A variance may exceed 50% of the requirement in Chapter 7 (LUDO § 7.010(A)), but not less than 1,320 feet or the "maximum allowable/Table 8" noise test in OAR 340-035-0035(1)(b)(B), whichever is greater.

If the location of the wind turbine(s) would not comply with the DEQ "ambient degradation" noise standard in OAR 340-035-0035(1)(b)(B) ~~(OAR 340-035-0035)~~ as required in Subsection D(3) above, a waiver would only be allowed pursuant to the same standard.

B. Editorial remarks in the Draft Ordinance misstate EFSC's typical setbacks for noise impacts.

Under the section for setbacks from resource zone dwellings the propose ordinance includes the following editorial remarks regarding EFSC's typical setback for wind turbines:

> Following this same noise standard EFSC has typically required a setback of approximately ¼ mile (1,320 feet) for turbines. This was put forth on a vote of 5 – 2 by the planning commission. The 2 dissenting planning commissioner votes were in favor of a ¼ mile buffer.

Draft LUDO § 19.030(D)(1)(c)(2), Att. A at 19-3. Friends emphasizes that this description of ESFC setbacks is demonstrably false. As such, the assumptions underlying the Planning Commission's recommendation were incorrect. EFSC's prior use of a 1,320-foot-setback was actually based on the risk associated with turbine failure and blade throw. EFSC's Final Order for the Shepards Flats Wind Farm is very clear on this point:

A quarter-mile safety setback (1,320 feet) provides a margin of safety beyond the maximum reported throw distance of 984 feet for a blade fragment.

Shepherds Flat Wind Farm Final Order at 24. An excerpt of the relevant portion of the Shepherds Flat Wind Farm Final Order is attached for the County Commission's reference. The Shepherds Flats Final Order clearly ties a minimum 1,320-foot minimum setback to the risk of turbine failure, blade fragmentations, and blade throw. Notably, the Shepherds Flat Final Order does not allow for a waiver from the 1,320-foot minimum setback. The Shepherds Flat decision also requires an additional buffer from residences to address noise impacts, but deferred identification of the specific setback.

Contrary to the false statement in the draft ordinance, EFSC's implementation of the DEQ noise standards has actually resulted in a range of setbacks based on complex noise modeling performed by project applicants. Identifying the exact setback for the DEQ noise standards is exceedingly complex. To demonstrate the rigors of that process, Friends has will submit the noise impact analysis for the Shepherds Flat Wind Project. The analysis is 63 pages long and packed with an enormous amount of technical analysis. Based on this complex modeling, the project applicant estimated the noise contours for the "ambient degradation" test and the "maximum allowable" test required by the DEQ noise regulations. This modeling was used to determine the actual setbacks from residences.

Friends previously submitted noise contour maps for the Shepherds Flat Wind Project, the Leaning Juniper II Wind Project, and the Summit Ridge Wind Project. As stated before, these maps depict the effective noise setbacks. Rather than a distance of 1,320 feet as the Planning Commission was led to believe, the distance is actually up to two miles from wind facilities.

If the Planning Commission had had complete and accurate information it may have recommended a substantially larger setback from resource zone residences and non-resource zones. The County Commission should base its decision on the correct factual assumptions.

C. Response to Iberdrola Renewables Inc.'s recommended revisions.

Iberdrola Renewables Inc. submitted comments through its attorney. These comments include recommended revisions to the draft ordinance. Friends provides the following response to Iberdrola's comments.

1. Onsite Access Roads and Staging Areas LUDO § 19.030(C)(11).

Iberdrola recommends revising the regulations for access roads and dust control to only address "private" roads within the "Energy Facility Project Area." Iberdrola Comment at 2, addressing LUDO § 19.030(C)(11) and (12). The recommended revision would undermine the County's efforts to ensure accountability for all impacts associated with wind facility development. Wind energy facilities often require the use public roads as haul-routes and access roads. Preventing and fixing impacts from using public roads should be the responsibility of the developer. As such, the County should not adopt the proposed revision.

2. FAA Lighting LUDO § 19.030(D)(1)(a)(3).

Iberdrola recommends that the County not expressly require the use of radar triggered lighting even if the FAA approves the use of the technology for wind energy facilities. Iberdrola Comment at 3. The comment also states that the FAA may approve the technology on a case-by-case basis. *Id.* The red-lined version of the ordinance includes a note stating that radar triggered lighting could still be considered even though it is not explicitly referenced. The comment does not provide any facts or rationale for not requiring that developers apply for approval to use radar triggered lighting.

Nighttime lighting on wind facilities dramatically transforms rural landscapes and is one of the most significant concerns of rural landowners. If the technology is available and approved by the FAA, the County should require that developers apply to the FAA for approval to use radar triggered lighting.

3. Wind Specific Setbacks LUDO § 19.030(D)(1)(c).

Iberdrola recommends adopting 1,320-foot setbacks for residences in resource zone lands and a 3,520-foot setback for non-resource zone lands. Iberdrola Comment at 3. Iberdrola also recommends creating an "adjustment" process for allowing a reduction of both setbacks. Iberdrola's recommended revisions would be a substantial deviation from the Planning Commission's recommendation. Moreover, the recommendations are contrary to the preferences of the overwhelming majority of public comments and the facts in the record.

Iberdrola recommends allowing waivers from the setback for non-resource zoned land. Friends encourages the BOCC to follow the Planning Commission's recommendation to not allow a waiver or adjustment from the setback for non-resource zone lands. Adopting substantial setbacks from non-resource zone lands will protect residentially zoned areas and urban areas from large-scale industrial development. There is no need to invite controversy by allowing waivers.

Iberdrola recommends a 1,320-foot setback from dwellings in resource zones as well as a waiver to reduce that setback even more. Iberdrola states that its "recommended setbacks are based on distances EFSC has found to be sufficiently protective of public health and safety." Iberdrola Comment at 4. As explained above, EFSC's use of a 1,320-foot setback was based solely on the risk of turbine failure and blade throw. In addition, EFSC does not allow waivers below the 1,320-foot safety setback. In practice, EFSC has implemented larger setbacks to protect the public from excessive noise. A larger setback is also justified to reduce the adverse scenic impacts and ensure compatibility with surrounding land uses. In addition, in *Cosner* LUBA held that the 2-mile setback adopted by Umatilla County was permissible.

Based on the facts and the law, Wasco County should adopt substantially larger setbacks than those recommended by Iberdrola. Moreover, based on the risk of flying blade fragments, the County should not allow setbacks to be reduced below 1,320 feet.

C. Conclusion

Thank you for the opportunity to comment.

/s/ *R. F. Till*
Richard Till
Conservation Legal Advocate

Attachments

BEFORE THE
ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

In the Matter of the Application for a Site Certificate for the Shepherds Flat Wind Farm	))))	FINAL ORDER

The Oregon Energy Facility Siting Council

July 25, 2008

An attachment to the CWEC report discusses actual turbine failure reports from Denmark and Germany. The data show that blade fragments are likely to be thrown farther from the turbine tower than whole blades.[56] For turbines larger than 1 MW, the maximum reported throw distance for a blade fragment is 300 meters (984 feet). The maximum throw distance for an entire blade is 150 meters (492 feet), but there is no data for turbines larger than 600 kW. The zone of risk for a turbine collapse is a distance equal to the maximum blade tip height.[57]

A recently-completed report commissioned by the Union of Nova Scotia Municipalities reviewed peer-reviewed journal articles and other sources regarding the impacts of wind energy generation and approaches to regulation.[58] The report noted that "there is no scientific or societal consensus on many aspects of wind development." Nevertheless, with regard to blade failure risk, the report suggested a safety setback distance of 2 to 3 times maximum blade tip height. This recommendation appeared to be based on consideration of the range setback regulations adopted by various Canadian municipalities.

Until more definitive turbine-failure data become available, the Council adopts safety setbacks based on the Council's own precedents, on ordinances from other jurisdictions that have addressed the issue and on the available turbine failure data discussed above. For public roads, the Council adopts a safety setback of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest edge of the public road right-of-way, assuming a minimum right-of-way width of 60 feet. For residences, the Council adopts a safety setback of one-quarter mile (1,320 feet or 402 meters).[59] The distance would be measured from the centerline of the turbine tower to the center of the house and would apply to residences existing at the time of facility construction. In addition, the Council adopts a setback requirement of 110-percent of maximum blade tip height from the centerline of the turbine to the nearest boundary of the certificate holder's lease area.[60] These safety setback distances would apply unless a greater setback distance is required under the County ordinances discussed below or is necessary for compliance with noise control regulations (discussed at page 130).

GCZO Section 7.020(T)(4)(d)(1), discussed below at page 34, requires that "no portion of the facility" be located within 3,520 feet of properties zoned for residential use. The application states that no portion of the proposed facility would be located within 3,520 feet of property zoned for residential use or designated in the Gilliam County Comprehensive Plan as a residential zone.[61] Based on the applicant's representation, the Council includes this restriction in the site certificate.

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[56] The throw distance for ice shedding from a turbine blade is assumed to be similar to the range of a blade fragment (CWEC report, Attachment 1, p. 2).
[57] CWEC report, Attachment 1, p. 19.
[58] Jaques Whitford Consultants, *Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities*, January 2008.
[59] A quarter-mile safety setback (1,320 feet) provides a margin of safety beyond the maximum reported throw distance of 984 feet for a blade fragment, as discussed above. For comparison, the ordinances of Alameda County, Riverside County and Solano County (California) require a setback of 3 times maximum blade tip height, which would result in a setback distance of 1,476 feet, assuming a blade-tip height of 150 meters (the maximum that would be allowed under Condition 26).
[60] The lease-boundary setback requirement is based on the applicant's representation in the application and supporting record, in accordance with OAR 345-027-0020(10).
[61] App Supp, Exhibit K, response to RAI K1, p. 5.

control regulations adopted by the Environmental Quality Commission, the Division of State Lands' regulations for removal or fill of material affecting waters of the state, the Water Resources Department's (WRD) regulations for appropriating ground water and the Council's statutory authority to consider protection of public health and safety.

(a) Noise Control Regulations

The applicable noise control regulations are as follows:

OAR 340-035-0035

Noise Control Regulations for Industry and Commerce

(1) Standards and Regulations:

* * *

(b) New Noise Sources:

* * *

(B) New Sources Located on Previously Unused Site:

(i) No person owning or controlling a new industrial or commercial noise source located on a previously unused industrial or commercial site shall cause or permit the operation of that noise source if the noise levels generated or indirectly caused by that noise source increase the ambient statistical noise levels, L10 or L50, by more than 10 dBA in any one hour, or exceed the levels specified in Table 8, as measured at an appropriate measurement point, as specified in subsection (3)(b) of this rule, except as specified in subparagraph (1)(b)(B)(iii).

(ii) The ambient statistical noise level of a new industrial or commercial noise source on a previously unused industrial or commercial site shall include all noises generated or indirectly caused by or attributable to that source including all of its related activities. Sources exempted from the requirements of section (1) of this rule, which are identified in subsections (5)(b) - (f), (j), and (k) of this rule, shall not be excluded from this ambient measurement.

(iii) For noise levels generated or caused by a wind energy facility:

(I) The increase in ambient statistical noise levels is based on an assumed background L50 ambient noise level of 26 dBA or the actual ambient background level. The person owning the wind energy facility may conduct measurements to determine the actual ambient L10 and L50 background level.

(II) The "actual ambient background level" is the measured noise level at the appropriate measurement point as specified in subsection (3)(b) of this rule using generally accepted noise engineering measurement practices. Background noise measurements shall be obtained at the appropriate measurement point, synchronized with windspeed measurements of hub height conditions at the nearest wind turbine location. "Actual ambient background level" does not include noise generated or caused by the wind energy facility.

(III) The noise levels from a wind energy facility may increase the ambient statistical noise levels L10 and L50 by more than 10 dBA (but not above the limits

specified in Table 8), if the person who owns the noise sensitive property executes a legally effective easement or real covenant that benefits the property on which the wind energy facility is located. The easement or covenant must authorize the wind energy facility to increase the ambient statistical noise levels, L10 or L50 on the sensitive property by more than 10 dBA at the appropriate measurement point.

(IV) For purposes of determining whether a proposed wind energy facility would satisfy the ambient noise standard where a landowner has not waived the standard, noise levels at the appropriate measurement point are predicted assuming that all of the proposed wind facility's turbines are operating between cut-in speed and the wind speed corresponding to the maximum sound power level established by IEC 61400-11 (version 2002-12). These predictions must be compared to the highest of either the assumed ambient noise level of 26 dBA or to the actual ambient background L10 and L50 noise level, if measured. The facility complies with the noise ambient background standard if this comparison shows that the increase in noise is not more than 10 dBA over this entire range of wind speeds.

(V) For purposes of determining whether an operating wind energy facility complies with the ambient noise standard where a landowner has not waived the standard, noise levels at the appropriate measurement point are measured when the facility's nearest wind turbine is operating over the entire range of wind speeds between cut-in speed and the windspeed corresponding to the maximum sound power level and no turbine that could contribute to the noise level is disabled. The facility complies with the noise ambient background standard if the increase in noise over either the assumed ambient noise level of 26 dBA or to the actual ambient background L10 and L50 noise level, if measured, is not more than 10 dBA over this entire range of wind speeds.

(VI) For purposes of determining whether a proposed wind energy facility would satisfy the Table 8 standards, noise levels at the appropriate measurement point are predicted by using the turbine's maximum sound power level following procedures established by IEC 61400-11 (version 2002-12), and assuming that all of the proposed wind facility's turbines are operating at the maximum sound power level.

(VII) For purposes of determining whether an operating wind energy facility satisfies the Table 8 standards, noise generated by the energy facility is measured at the appropriate measurement point when the facility's nearest wind turbine is operating at the windspeed corresponding to the maximum sound power level and no turbine that could contribute to the noise level is disabled.

* * *

Findings of Fact

A. Applicable Regulations

The applicant addressed compliance with the noise regulations adopted by the Oregon Department of Environmental Quality (DEQ) in Exhibit X of the application. The proposed facility would be a "new industrial or commercial noise source" under OAR 340-035-0035

because construction of the facility would begin after January 1, 1975.[338] The noise control regulations impose different limits on new noise sources constructed on a "previously used industrial or commercial site" compared to the limits imposed on new sources constructed on a "previously unused industrial or commercial site." A site is considered a "previously unused industrial or commercial site" if the site has not been in an industrial or commercial use at any time during the 20 years preceding the construction of a new noise source on the site.[339] According to the applicant, all the equipment associated with the proposed SFWF would be located on property that has not been used for industrial or commercial operations during the past 20 years. The SFWF should be considered a "new industrial noise source" located on a "previously unused industrial or commercial site." Therefore, the noise generated by the proposed project must comply with OAR 340-035-0035 (1)(b)(B).

OAR 340-035-0035 (1)(b)(B) requires that the noise generated by a new wind energy facility located on a previously unused site must comply with two tests. Facility-generated noise must not increase the ambient hourly L_{10} or L_{50} noise levels at any noise sensitive receiver by more than 10 decibels (dBA) when turbines are operating "between cut-in speed and the wind speed corresponding to the maximum sound power level."[340] This requirement is known as the "ambient degradation" test. To show that a proposed facility complies with this test, the applicant may use an assumed ambient hourly L_{50} noise level of 26 dBA; otherwise, the applicant must measure the actual ambient hourly noise levels at the receiver in accordance with the procedures specified in the regulation. OAR 340-035-0035 (1)(b)(B)(iii)(III) relieves the applicant from having to show compliance with the ambient degradation test "if the person who owns the noise sensitive property executes a legally effective easement or real covenant that benefits the property on which the wind energy facility is located" (a "noise waiver").

The potential "waiver" of the ambient degradation test does not relieve the wind facility from compliance with the second test imposed under OAR 340-035-0035 (1)(b)(B). A new wind energy facility located on a previously unused site must not radiate sound levels to any noise sensitive receiver exceeding the noise limits specified in Table 8 of the regulation. This is known as the "Table 8" or "maximum allowable" test. Table 8 provides the following limits:

[338] OAR 340-035-0015(33) defines "new industrial or commercial noise source."
[339] OAR 340-035-0015(47) defines "previously unused industrial or commercial site."
[340] In this discussion, "dBA" refers to sound levels in decibels as measured on a sound level meter using the A-weighted filter network, which corresponds closely to the frequency response of the human ear. The regulation applies the test "as measured at an appropriate measurement point." The "appropriate measurement point," as defined by OAR 340-035-0015 (3), is "25 feet (7.6 meters) toward the noise source from that point on the noise sensitive building nearest the noise source" or "that point on the noise sensitive property line nearest the noise source," whichever is farther from the source. OAR 340-035-0015 (38) defines "noise sensitive property" as "real property normally used for sleeping, or normally used as schools, churches, hospitals, or public libraries." Private residences are the only "noise sensitive properties" potentially affected by the proposed SFWF. We refer to these as the "noise sensitive receivers."

Statistical Noise Limits for Industrial and Commercial Sources		
Statistical Descriptor	Maximum Permissible Statistical Noise Levels (dBA)	
	Daytime (7:00 AM - 10:00 PM)	Nighttime (10:00 PM - 7:00 AM)
L_{50}	55	50
L_{10}	60	55
L_1	75	60
The hourly L_{50}, L_{10} and L_1 noise levels are defined as the noise levels equaled or exceeded 50 percent, 10 percent and 1 percent of the hour, respectively.		

Because the proposed energy facility would operate on a 24-hour basis, the noise radiating from the facility must not exceed the maximum allowable nighttime noise limits (10:00 PM to 7:00 AM). To comply with the "maximum allowable" test, the noise radiating from the SFWF must not exceed an hourly L_{50} noise level of 50 dBA at any noise sensitive receiver. For the purpose of assessing whether the proposed wind facility would comply with this test, noise levels must be predicted "assuming that all of the proposed wind facility's turbines are operating at the maximum sound power level."

B. Construction Noise

OAR 340-035-0035(5)(g) specifically exempts noise caused by construction activities. Construction of the proposed SFWF would produce localized, short duration noise levels similar to those produced by any large construction project with heavy construction equipment. Much of the project work would be far removed from any noise sensitive receivers. Nevertheless, to mitigate noise impacts at local residences, the Council adopts Condition 96, which would require the certificate holder to confine the noisiest construction activities to daylight hours.

C. Compliance with the Regulations

The applicant has elected to use the assumed ambient hourly L_{50} noise level of 26 dBA for the background ambient noise level rather than to conduct noise measurements at the noise sensitive receivers in the vicinity of the project. Accordingly, to show compliance with the ambient degradation test, the noise generated by the operation of the proposed SFWF wind turbines between cut-in wind speed and maximum sound power level wind speed must not cause the hourly L_{50} noise level at any noise sensitive receiver to exceed 36 dBA.

The applicant is proposing a wind energy facility that will contain up to 303 wind turbines. The applicant provided sound power level and octave band data for four turbine types that might be selected for use in the proposed SFWF: the GE Energy 1.5-MW, the Siemens SWT-93 2.3-MW, the Clipper Liberty 2.5-MW and the Vestas V90 3.0-MW.[341] The applicant requests flexibility to use any combination of turbine types, subject to the restrictions described in Condition 26. The final selection of turbine types used in the project would be based on the availability and cost of the turbines and on the constraints placed on the project by the site certificate. In addition, the applicant requests the design flexibility to locate the turbines anywhere within the proposed site boundary, subject to the conditions of the site certificate. For the purpose of showing that the proposed facility can comply with the noise regulations, the

[341] App Supp, Amended Exhibit B, pp. 4-5.

Department asked the applicant to submit data that demonstrates that there is at least one layout of wind turbines on the site that would comply with the regulations (a "default layout").

The applicant submitted a default layout of turbines within the site boundary that includes 280 Siemens SWT-93 turbines in the northern project area and 23 Vestas V90 turbines in the southern project area.[342] To support the conclusion that the default layout would be in compliance with the noise regulations, the applicant retained an acoustical consultant, Mr. Bruce Walker, Ph.D. of Channel Island Acoustics, to calculate the predicted sound pressure level at each noise sensitive receiver.[343] The Department consulted with Mr. Kerrie Standlee of Daly Standlee and Associates to review and confirm Walker's findings.

The equations used in Walker's program were classical sound propagation equations that account for distance attenuation, atmospheric attenuation, ground attenuation and terrain attenuation. In predicting the maximum noise levels at the 31 noise sensitive receivers, Walker included distance attenuation and atmospheric attenuation associated with conditions of 50 degrees F (10 degrees C) and 70 percent relative humidity. The final calculations did not include factors for ground attenuation or terrain attenuation. The predicted noise levels would likely have been lower if factors for ground attenuation and terrain attenuation had been included. The predicted noise levels, therefore, are conservative predictions of what the actual noise effects would be.

Octave band sound power level reference data supplied by the turbine manufacturer (data for wind blowing at 8 meters per second, 10 meters off the ground) were used in predicting the maximum noise levels at the 31 noise sensitive receivers. The octave band data were increased so that the resulting overall A-weighted sound power level reference data was 2 dB higher than the overall maximum sound power level warranted by the manufacturer. This adjustment was applied to account for the amount of uncertainty associated with the manufacturer's warranted data. Accordingly, the applicant assumed that the Siemens turbines had a maximum A-weighted sound power level output of 109.0 dBA and the Vestas turbines had a maximum A-weighted sound power level output of 111.3 dBA.

In addition to calculating the noise generated by the wind turbines, the applicant calculated and included the noise that would radiate to each receiver from the power transformers located at the two proposed substations. The applicant used a maximum A-weighted sound power level of 105 dBA for each of four transformers expected at the north substation and 101 dBA for the single transformer expected at the south substation.

In presenting the results of the analysis, the applicant provided three tables showing the noise level contributed by 303 turbines and five transformers. One table presented the predicted turbine-generated sound pressure levels reaching 10 receivers (Receivers 1 through 10) located near the northern project area.[344] Another table presented predicted turbine-generated sound

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[342] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, Figure RAI#3 X1a revision 3 and Figure RAI#3 X1b revision 3.

[343] Walker used an in-house, Matlab-based, computer program to predict the noise levels at 31 noise sensitive receivers located around the project site. He located the turbines and the noise sensitive receivers on a 501 by 501 grid and then used tied the grid to his computer program to calculate the total sound pressure level at each receiver contributed by all turbines (email from Kerrie Standlee, January 9, 2008).

[344] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, table entitled "North turbine noise analysis using A-weighted octave band data."

pressure levels reaching 21 residences (Receivers 11 through 31) near the southern project area.[345] The third table presented the predicted transformer-generated sound pressure levels reaching each of the 31 receivers investigated around the site.[346] Each table included the total sound pressure level expected at the receiver and the sound pressure level contributed by each source included in the calculation. In addition, as a visual aid, the applicant presented Figure RAI#3 X1c to show the 5-dB interval noise contours between 30 dBA and 55 dBA around the northern project area.[347] Based on data from the applicant's tables, the maximum predicted noise levels generated by the SFWF are as shown in Table 15 below. Data shown in boldface exceed the 36-dBA ambient degradation limit.

Table 15: Predicted Noise Levels

Receiver	Predicted Maximum Hourly L_{50} Noise Level (dBA)	Receiver	Predicted Maximum Hourly L_{50} Noise Level (dBA)
R1	32	R17	32
R2	29	R18	34
R3	34	R19	**40**
R4	30	R20	34
R5	33	R21	29
R6	35	R22	29
R7	35	R23	26
R8	36	R24	23
R9	36	R25	22
R10	35	R26	30
R11	**39**	R27	32
R12	**39**	R28	29
R13	35	R29	31
R14	**39**	R30	21
R15	36	R31	19
R16	**39**		

As seen from the data in Table 15, the noise levels at all receivers are predicted to comply with the 50-dBA maximum allowable test. At five receivers (R11, R12, R14, R16 and R19), operation of the proposed facility could increase the ambient statistical noise level by more than 10 dBA above the assumed background L_{50} ambient noise level of 26 dBA. At these properties, the ambient degradation limit would be exceeded. The proposed facility would comply with the applicable noise regulations if it were constructed according to the default layout (using the turbine types analyzed above) and if the certificate holder had acquired noise waivers from the owners of properties R11, R12, R14, R16 and R19. The applicant has discussed the potential noise impacts with the owners of these properties but prefers to negotiate any necessary waivers after the final facility layout has been determined. The Department asked the applicant to

[345] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, table entitled "South turbine noise analysis using A-weighted octave band data."
[346] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, table entitled "Transformer sound levels using 105 dB(A) for each north transformer and 101 dB(A) for the south transformer."
[347] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, Figure RAI#3 X1c. The applicant did not provide a similar contour map for the southern project area.

identify which turbines would be eliminated from the default layout to ensure compliance with the ambient degradation limit. The applicant identified twelve turbines within the southern project area that would need to be eliminated.[348] The Department's consultant, Kerrie Standlee, reviewed the data and confirmed that removal of the twelve identified turbines would bring the facility-generated noise levels into compliance with the ambient noise degradation limit of 36 dBA at Receivers R11, R12, R14, R16 and R19.[349] The Council finds that the proposed SFWF would comply with the applicable noise regulations in OAR 340-035-0035 if the facility were built according to the default layout described herein and if the twelve identified turbines were eliminated from that layout.

To ensure that the facility as built would comply with the noise control regulations, the Council adopts Condition 97. This condition would require the certificate holder to provide information about the turbines selected and about the final design layout to the Department before beginning construction. The condition requires the certificate holder to demonstrate to the satisfaction of the Department that the facility as built according to the final design layout would comply with the applicable noise control regulations.

Under OAR 340-035-0035 (4)(a), DEQ has authority to require the owner of an operating noise source to monitor and record the statistical noise levels upon written notification. In the event of a complaint regarding noise levels during operation of the SFWF, the Council has the authority to act in the place of DEQ to enforce this provision to verify that the certificate holder is operating the facility in compliance with the noise control regulations. Under Condition 3, the certificate holder would be required to operate the facility in accordance with all applicable state laws and administrative rules. The Council adopts Condition 98, which would require the certificate holder to notify the Department of any complaints received about noise from the facility as well as the actions taken to address them.

Conclusions of Law

Based on the findings and site certificate conditions discussed above, the Council finds that the proposed facility would comply with the applicable State noise control regulations.

(b) Removal-Fill Law

The Oregon Removal-Fill Law (ORS 196.800 through 990) and regulations (OAR 141-085-0005 through 141-085-0090) adopted by the Department of State Lands (DSL) require a permit if 50 cubic yards or more of material is removed, filled or altered within any "waters of the state" at the proposed site.[350] The Council must determine whether a permit is needed. The U.S. Army Corps of Engineers administers Section 404 of the Clean Water Act, which regulates the discharge of fill into waters of the United States (including wetlands). A Nationwide or Individual fill permit may be required.

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[348] Email from Patricia Pilz, January 28, 2008. The twelve turbines are numbered 283, 284, 291 through 294, 296 through 299, 301 and 302 in the application (App Supp, Exhibit X, Correspondence, email from Patricia Pilz, November 12, 2007).

[349] Email from Kerrie Standlee, January 31, 2008.

[350] OAR 141-085-0010(225) defines "Waters of this State." The term includes wetlands and certain other water bodies.

38 During construction and operation of the facility, the certificate holder shall implement a plan to control the introduction and spread of noxious weeds. The certificate shall develop the weed control plan consistent with the Gilliam County and Morrow County Weed Control Programs.

39 Before beginning construction of the facility, the certificate holder shall record in the real property records of Gilliam County a Covenant Not to Sue with regard to generally accepted farming practices on adjacent farmland consistent with Gilliam County Zoning Ordinance 7.020(T)(4)(a)(5).

40 The certificate holder shall construct all facility components in compliance with the following setback requirements:

(a) All facility components must be at least 3,520 feet from the property line of properties zoned residential use or designated in the Gilliam County Comprehensive Plan as residential.

(b) Where (a) does not apply, the certificate holder shall maintain a minimum distance of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest edge of any public road right-of-way. The certificate holder shall assume a minimum right-of-way width of 60 feet.

(c) Where (a) does not apply, the certificate holder shall maintain a minimum distance of 1,320 feet, measured from the centerline of the turbine tower to the center of the nearest residence existing at the time of tower construction.

(d) Where (a) does not apply, the certificate holder shall maintain a minimum distance of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest boundary of the certificate holder's lease area.

41 Within 90 days after beginning operation, the certificate holder shall provide to the Department and to the Planning Directors of Gilliam County and Morrow County the actual latitude and longitude location or Stateplane NAD 83(91) coordinates of each turbine tower, connecting lines and transmission lines. In addition, the certificate holder shall provide to the Department and to the Planning Directors of Gilliam County and Morrow County, a summary of as-built changes in the facility compared to the original plan, if any.

42 The certificate holder shall install gates on all private facility access roads in Gilliam County, in accordance with Gilliam County Zoning Ordinance Section 7.020(T)(4)(d)(6).

3. Cultural Resource Conditions

43 Before beginning construction, the certificate holder shall provide to the Department a map showing the final design locations of all components of the facility and areas that would be temporarily disturbed during construction. In addition, the certificate holder shall comply with the following requirements:

(a) The certificate holder shall avoid disturbance within a 30-meter buffer around the two prehistoric archaeological sites and five historic-period archaeological sites identified by AINW as "possibly eligible" for listing in the National Register of Historic Places (NRHP) as described in the Final Order on the Application.

(b) The certificate holder shall avoid disturbance of the 36 stacked rock features identified by AINW as "possibly eligible" for listing in the NRHP as described in the Final Order on the Application and shall, to the extent practicable, maintain a 30-meter no-

9. Visual Effects Conditions

93 To reduce the visual impact of the facility, the certificate holder shall:

(a) Mount nacelles on smooth, steel structures, painted uniformly in a matte-finish, neutral white color.

(b) Paint substation structures in a neutral color to blend with the surrounding landscape.

(c) Not allow any advertising to be used on any part of the facility.

(d) Use only those signs required for facility safety, required by law or otherwise required by this site certificate, except that the certificate holder may erect a sign to identify the facility near each field workshop, may paint turbine numbers on each tower and may allow unobtrusive manufacturers' logos on turbine nacelles.

(e) Not locate any facility signs along Highway 74.

(f) Design signs in accordance with Gilliam County Zoning Ordinance Section 8.030 and Morrow County Zoning Ordinance Section 4.070, as applicable.

(g) Maintain any signs allowed under this condition in good repair.

94 The certificate holder shall design and construct the field workshops to be generally consistent with the character of similar buildings used by commercial farmers or ranchers in the area and shall paint the buildings in a neutral color to blend with the surrounding landscape.

95 The certificate holder shall not use exterior nighttime lighting except:

(a) The minimum turbine tower lighting required or recommended by the Federal Aviation Administration.

(b) Security lighting at the field workshops and substations, provided that such lighting is shielded or downward-directed to reduce glare.

(c) Minimum lighting necessary for repairs or emergencies.

10. Noise Control Conditions

96 To reduce noise impacts at nearby residences, the certificate holder shall:

(a) Confine the noisiest operation of heavy construction equipment to the daylight hours.

(b) Require contractors to install and maintain exhaust mufflers on all combustion engine-powered equipment; and

(c) Establish a complaint response system at the construction manager's office to address noise complaints.

97 Before beginning construction, the certificate holder shall provide to the Department:

(a) Information that identifies the final design locations of all turbines to be built at the facility.

(b) The maximum sound power level for the substation transformers and the maximum sound power level and octave band data for the turbines selected for the facility based on manufacturers' warranties or confirmed by other means acceptable to the Department.

(c) The results of noise analysis of the facility to be built according to the final design performed in a manner consistent with the requirements of OAR 340-035-0035 (1)(b)(B)(iii)(IV) and (VI) demonstrating to the satisfaction of the Department that the total noise generated by the facility (including the noise from turbines and substation transformers) would meet the ambient degradation test and maximum allowable test at the appropriate measurement point for all potentially-affected noise sensitive properties.

(d) For each noise-sensitive property where the certificate holder relies on a noise waiver to demonstrate compliance in accordance with OAR 340-035-0035 (1)(b)(B)(iii)(III), a copy of the a legally effective easement or real covenant pursuant to which the owner of the property authorizes the certificate holder's operation of the facility to increase ambient statistical noise levels L_{10} and L_{50} by more than 10 dBA at the appropriate measurement point. The legally-effective easement or real covenant must: include a legal description of the burdened property (the noise sensitive property); be recorded in the real property records of the county; expressly benefit the certificate holder; expressly run with the land and bind all future owners, lessees or holders of any interest in the burdened property; and not be subject to revocation without the certificate holder's written approval.

98 During operation, the certificate holder shall maintain a complaint response system to address noise complaints. The certificate holder shall promptly notify the Department of any complaints received regarding facility noise and of any actions taken by the certificate holder to address those complaints. In response to a complaint from the owner of a noise sensitive property regarding noise levels during operation of the SFWF, the Council may require the certificate holder to monitor and record the statistical noise levels to verify that the certificate holder is operating the facility in compliance with the noise control regulations.

11. Waste Management Conditions

99 The certificate holder shall provide portable toilets for on-site sewage handling during construction and shall ensure that they are pumped and cleaned regularly by a licensed contractor who is qualified to pump and clean portable toilet facilities.

100 During operation, the certificate holder shall discharge sanitary wastewater generated at the field workshops to licensed on-site septic systems in compliance with county permit requirements. The certificate holder shall design each septic system for a discharge capacity of less than 2,500 gallons per day.

101 The certificate holder shall implement a waste management plan during construction that includes but is not limited to the following measures:

(a) Recycling steel and other metal scrap.

(b) Recycling wood waste.

(c) Recycling packaging wastes such as paper and cardboard.

(d) Collecting non-recyclable waste for transport to a local landfill by a licensed waste hauler or by using facility equipment and personnel to haul the waste.

(e) Segregating all hazardous wastes such as used oil, oily rags and oil-absorbent materials, mercury-containing lights and lead-acid and nickel-cadmium batteries for disposal by a licensed firm specializing in the proper recycling or disposal of hazardous wastes.

(f) Discharging all concrete truck rinse water into foundation holes and completing truck wash-down off-site.

102 The certificate holder shall implement a waste management plan during operation that includes but is not limited to the following measures:

(a) Training employees to minimize and recycle solid waste.

(b) Recycling paper products, metals, glass and plastics.

X1

Respond to OAR 345-021-0010(1)(x). A noise analysis (including modeling data used to show compliance under OAR 340-035-0035(1)(B)(iii)(IV) and (VI)) must be included as part of a "complete" application. You must analyze the potential noise levels at any noise sensitive property that could receive significant noise from the proposed facility, whether or not the noise sensitive properties (typically residences) are owned by "the project's landlords."

NOISE ANALYSIS

Applicant's predicted noise contours for its "worst-case" turbine, the Vestas V-90, are shown in figures RAI#2 X1a and RAI#2 X1b. Applicant located all noise sensitive properties (all were residences) within one mile of the site boundary, and recorded each of these property's GPS address. Thirty-one such properties were identified. Figures RAI#2 X1a and RAI#2 X1b show only those properties within the 35 dBA contour. The turbine array used for the analysis placed turbines as close as practical to the site boundaries and these residences.

Computations

Noise contours were computed from the noise emission level of 109.2 dB LWA for Vestas 3 MW turbines in accordance with the following procedure:

1. A 501 x 501 (=251501) point computation grid was set up for the area encompassing the turbine array with a 2000 meter open space around the perimeter.
2. The Easting (X) and Northing (Y) coordinates of each wind turbine site and each calculation grid were stored in computer files.
3. Distances were computed for each turbine/grid point pair

$$d_{T,G} = \sqrt{\left(X_T - X_G\right)^2 + \left(Y_T - Y_G\right)^2 + HubHeight^2}$$

4. The A-weighted sound pressure level (SLA) from each turbine and grid point was computed from the Effective A-Weighted Sound Power Level (LWA).

$$SLA_{T,IG} = LWA - 10\log\left(2\pi d_{T,G}^2\right) - .00328 d_{T,G}$$

   where $d_{T,G}$ is the distance in meters from turbine T to grid point G. The first loss term results from hemispherical wave spreading and the second from atmospheric absorption.

5. The total sound pressure level at each grid point was determined as the sum of contributions from all turbines

$$SLA_G = 10\log\left[\sum_T 10^{\left(SLA_{T,G}/10\right)}\right]$$

6. The Matlab contour function was used to interpolate the gridded noise levels and compute and plot constant noise level contours on 5 dB intervals. Locations of proposed turbine sites and known off-site residences were overlaid on the contour plots for reference

The noise contours computed in the above manner provide a conservative determination of turbine noise levels at off-site and on-site locations. They are conservative because:

a. They assume all turbines are generating noise at the maximum level demonstrated by manufacturer testing.

b. They assume all grid points are exposed to noise from all turbines, whereas in practice, many turbines will be shielded by terrain features and/or the energy from more distant turbines will be partially dissipated by ground absorption.

c. Elevation offsets between turbine sites and actual off-site locations have been ignored, so that $d_{T,G}$ is slightly understated.

Results

OAR 340-035-0035 allows for a 10 dBA increase over an assumed ambient noise level of 26 dBA. Noise sensitive properties within the 35 dBA contour might, therefore, be impacted by the facility.

When turbines are selected, and the facility layout is determined for each phase of the Shepherds Flat Wind Farm, the noise analysis will be repeated. Should any noise sensitive properties remain within the 35 dBA contour, actual background noise measurements will be taken in order to ascertain whether the facility layout complies with the regulation. In the event that the noise level is increased by more than 10 dBA at a noise sensitive property, a noise easement will be sought from the affected property owner as provided for in the regulation. In the event that an easement cannot be secured, the facility layout will be changed until the regulation's allowable noise levels are met.

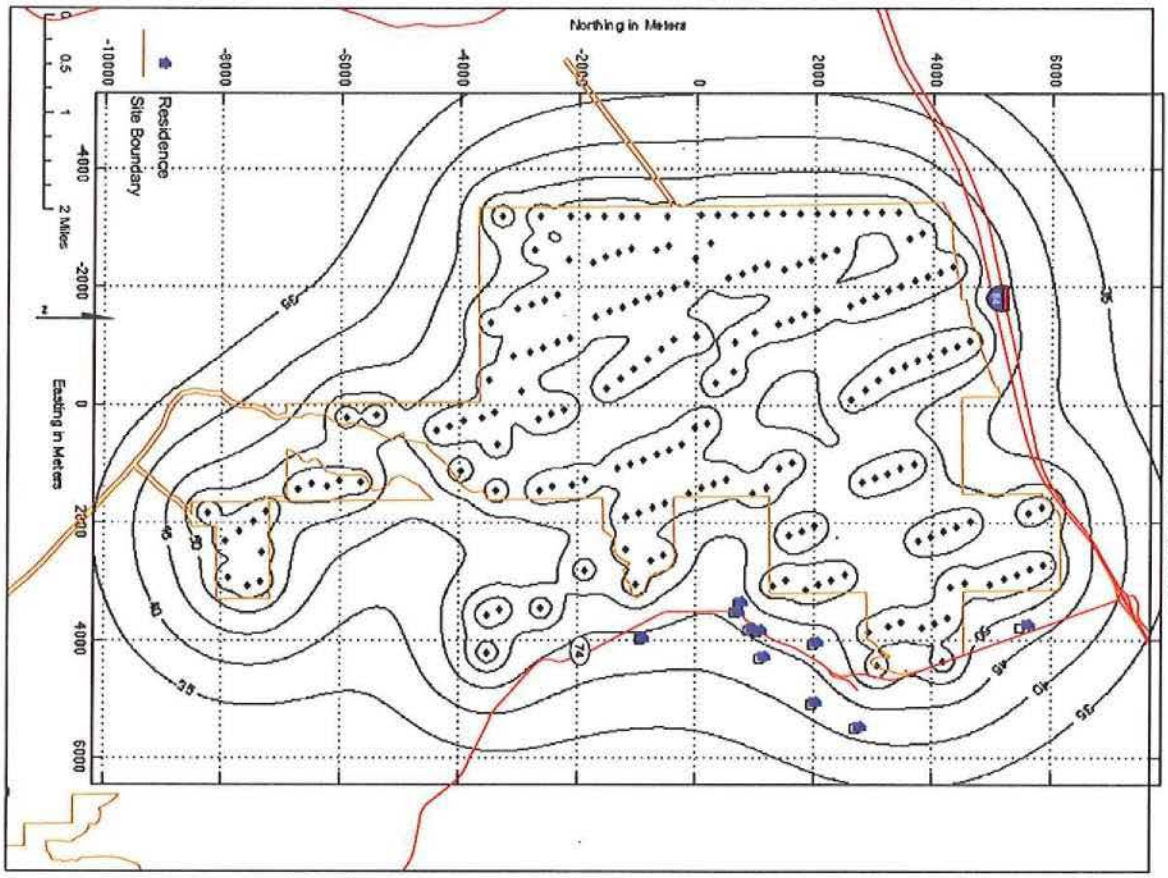
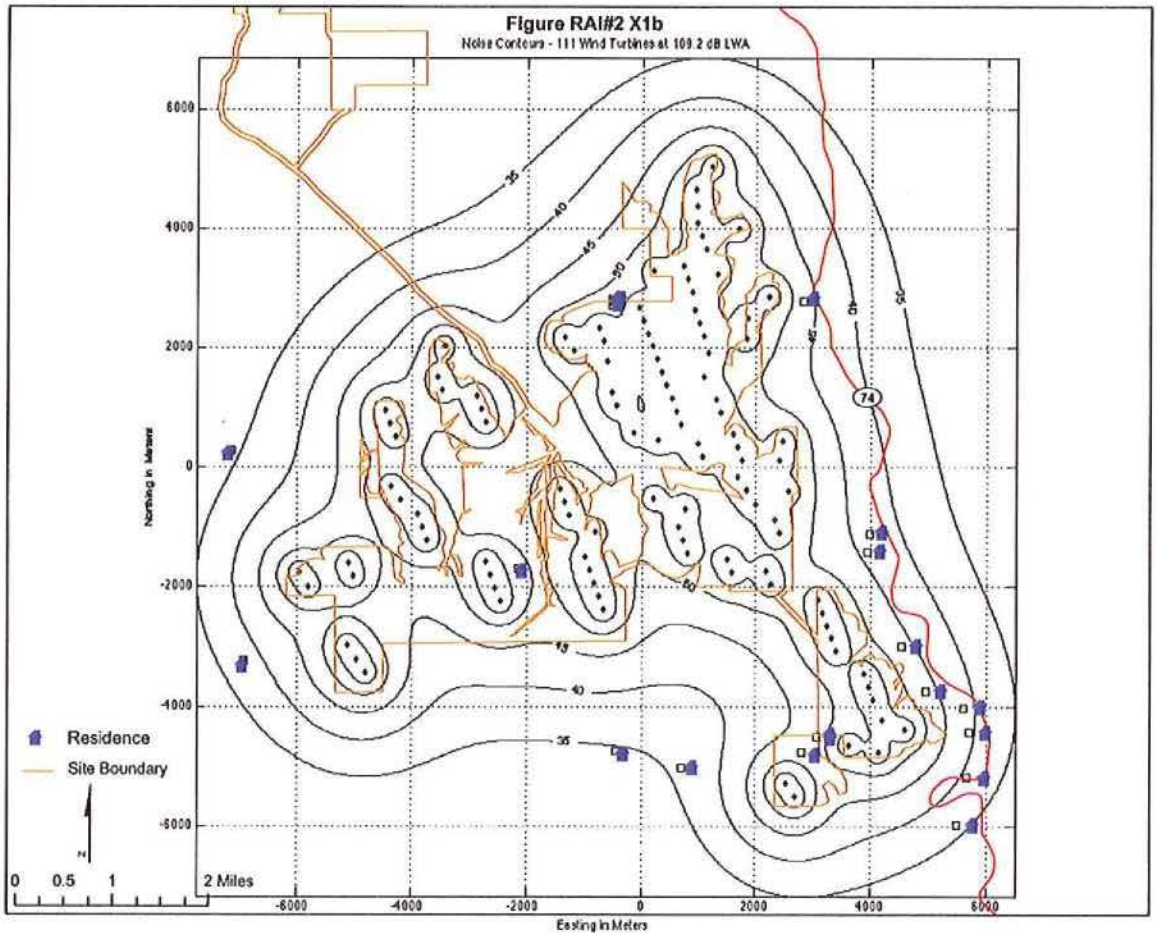


Figure RAI#2 X1a
Noise Contours - 192 Wind Turbines at 109.2 dB LWA



RAI#3, X2: NOISE

In computing noise levels likely to be generated by the SFWF, CFS applied the sound power level guaranteed for the Vestas V-90 wind turbine (as shown on Table B1). The Department expects the applicant to add the manufacturer's uncertainty level to the guaranteed maximum sound power level before making predictions. Please recalculate the noise contours using a reference sound power level of 111.2 dBA, i.e., the manufacturer's guaranteed sound power level plus the manufacturer's uncertainty level.

MANUFACTURER'S UNCERTAINTY LEVEL

Applicant's responses to RAI#3, X9 and X10 provide noise contours calculated using a reference sound power level of 111.2 dBA.

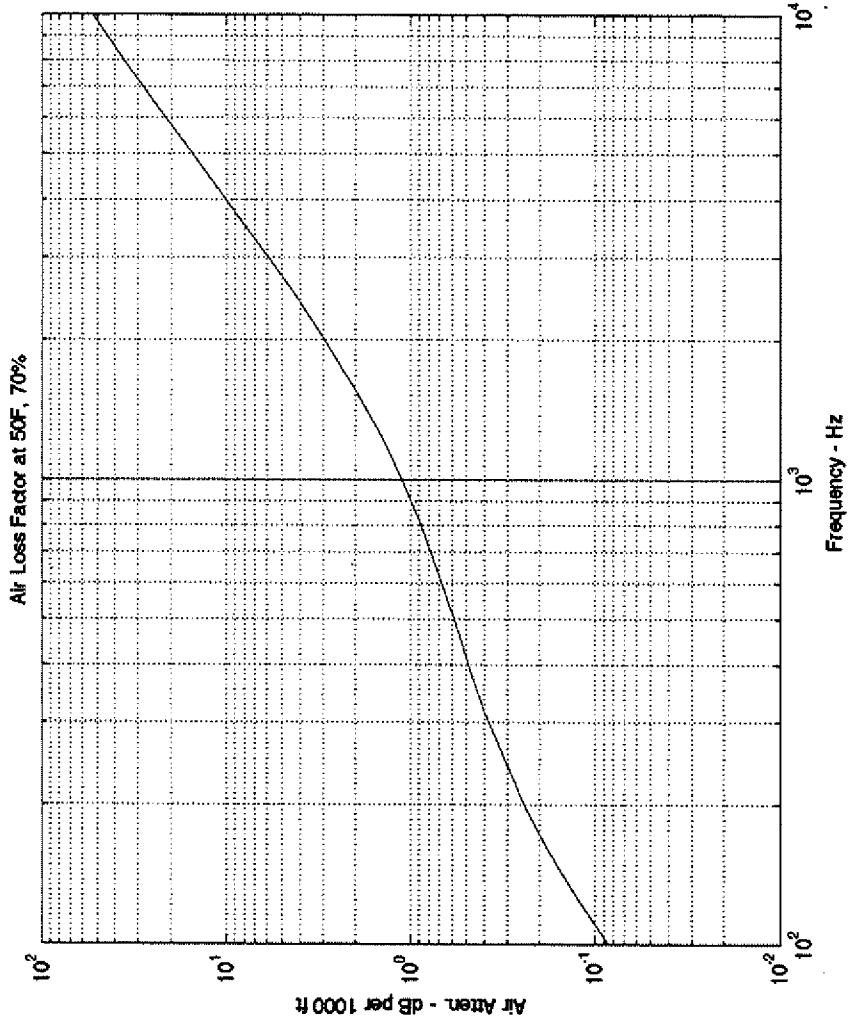
RAI#3, X3: NOISE

CSF stated that the amount of atmospheric absorption expected to be present between each turbine and each receiver was computed using the term, $0.00328d_{T-G}$ where "d" is the distance in meters between the turbine "T" and the grid point "G." While this basic equation is correct, the amount of reduction provided by atmospheric absorption between a source and receiver depends on the frequency spectrum of the sound source. Please confirm that the computations of sound pressure level were made using the frequency spectrum data provided for the turbines and not just the overall A-weighted sound power level data and that atmospheric absorption was calculated using a temperature of 50° F and a relative humidity of 70%.

ATMOSPHERIC ABSORPTION

Contours were computed with A-weighted noise emissions using the 1 dB per 1,000 ft excess attenuation factor. This approach virtually always produces a result within one dB or so of the more rigorous spectral approach and is also virtually always on the conservative side. With sound propagation over thousands of feet, uncertainties associated with ground conditions, vegetation and atmospheric turbulence negate any gain in precision that one might hope to achieve through another approach.

Please see Figure RAI#3 X3.



RAI#3, X4: NOISE

CSF stated that the sound power level of the Vestas V-90 turbine was used in the calculations because the guaranteed overall sound power level of the Vestas turbine was higher than the sound power level guaranteed for all of the other turbine alternatives (i.e. the V-90 is the "worst-case" turbine, as indicated by Table B-1). While the overall sound power level of the Vestas V-90 turbine is higher than that generated by all other turbines, the resulting sound pressure level at receivers may actually be slightly higher for the Siemens SWT-2.3-93 turbine than the Vestas turbine due to the frequency spectrum associated with the turbine and the fact that the amount of atmospheric absorption between the turbine and the receiver depends on the frequency spectrum of the turbine. To ensure the analysis adequately predicts the loudest noise levels that might be generated by the SFWF, please provide a prediction of the sound pressure level that would be found at 1000, 2000 and 3000 feet from a Vestas V-90 turbine and 1000, 2000 and 3000 feet from a Siemens SWT-2.3-93 turbine using a temperature of 500 F and a relative humidity of 70%.

TURBINE COMPARISONS

Applicant has provided a facility configuration, using the Vestas V-90 turbine, that would meet the Council's noise standard (please see applicant's response to RAI#3 X10).

RAI#3, X5: NOISE

CSF provided Figures RAI#2 X1a and RAI#2 X1b to show the noise levels that will radiate from the proposed wind turbines. CSF presented the predicted noise levels using noise contours on the two figures that show the noise levels every 5 dB between 35 dBA and 55 dBA. CSF stated that noise sensitive receivers were located and placed on the figures using GPS addresses. While the location of the noise sensitive receivers may be accurate, it is not possible to determine the predicted sound pressure level at each of the noise sensitive receivers by reference to these figures. In addition, reference to the figures does not enable the reviewer to determine the exact locations of all the facility turbines. Please revise the figures to show the location of all the turbines and noise sensitive receivers included in the noise analysis, and include for each turbine and each noise sensitive receiver an identifying name or number.

IDENTIFICATION OF RECEIVERS AND TURBINES

Please see Table RAI#3 X5.

Shepherds Flat Wind Farm Noise Sensitive Properties Within One Mile of the Facility Boundary

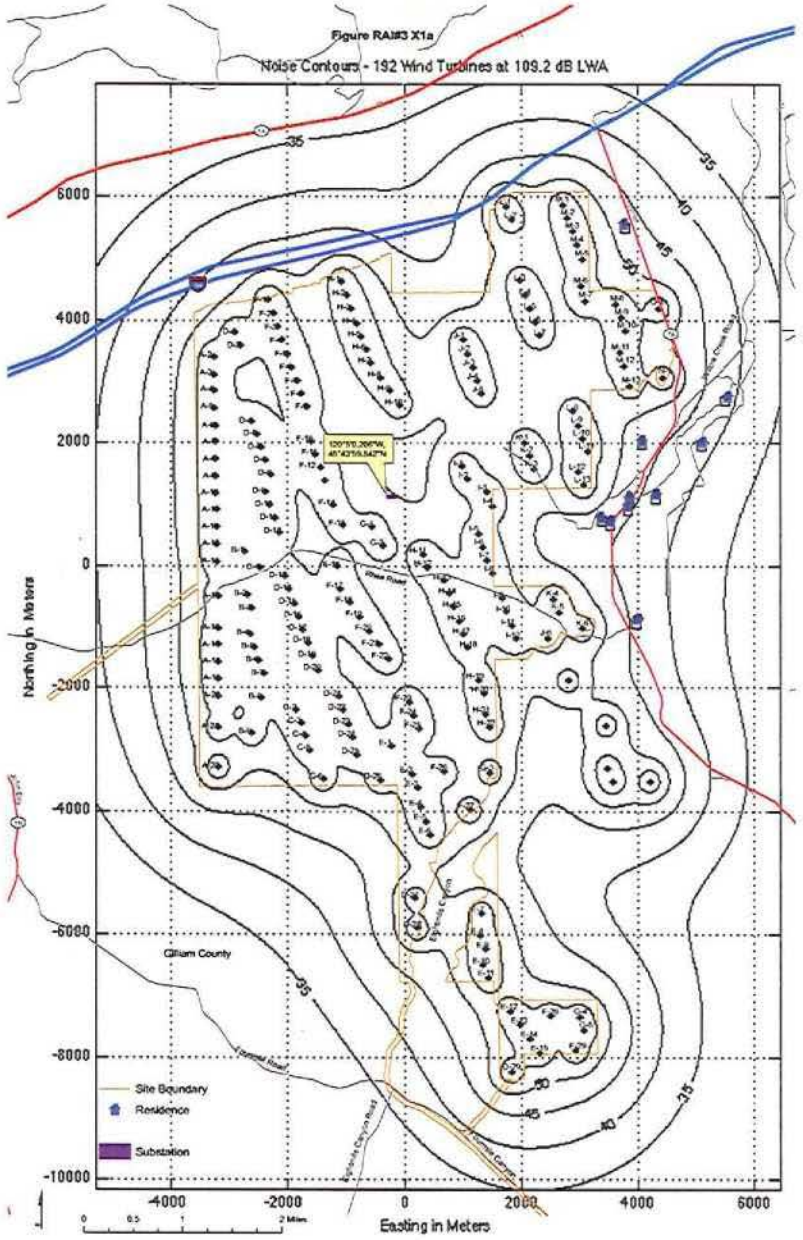
	Residence Location								Nearest Turbine Location						
Residence	degrees	minutes	seconds		degrees	minutes	seconds		degrees	minutes	seconds		degrees	minutes	seconds		Distance (miles)
1	45	46	21	N	120	2	1	W	45	46	22	N	120	2	27	W	0.35514
2	45	44	51	N	120	0	43	W	45	44	59	N	120	1	30	W	0.648946
3	45	44	28	N	120	1	48	W	45	44	27	N	120	2	25	W	0.512957
4	45	44	27	N	120	1	2	W	45	44	27	N	120	2	25	W	1.128472
5	45	43	59	N	120	1	37	W	45	44	2	N	120	2	24	W	0.629795
6	45	43	57	N	120	1	57	W	45	44	2	N	120	2	24	W	0.37035
7	45	43	53	N	120	1	59	W	45	44	2	N	120	2	24	W	0.384823
8	45	43	47	N	120	2	19	W	45	44	2	N	120	2	24	W	0.308397
9	45	43	45	N	120	2	12	W	45	44	2	N	120	2	24	W	0.383242
10	45	42	53	N	120	1	52	W	45	42	49	N	120	2	23	W	0.429502
11	45	37	8	N	119	59	58	W	45	37	6	N	119	59	57	W	0.043403
12	45	37	8	N	119	59	56	W	45	37	6	N	119	59	57	W	0.0279
13	45	37	7	N	119	57	26	W	45	37	7	N	119	57	52	W	0.366951
14	45	37	7	N	119	59	58	W	45	37	6	N	119	59	57	W	0.0279
15	45	35	46	N	120	4	57	W	45	34	40	N	120	4	13	W	1.371928
16	45	37	5	N	119	59	58	W	Residence is within the site boundary								
17	45	35	44	N	120	3	16	W	45	35	44	N	120	3	15	W	1.36522
18	45	35	19	N	120	5	28	W	45	34	40	N	120	4	13	W	1.247149
19	45	35	1	N	119	56	34	W	45	35	1	N	119	57	42	W	0.923304
20	45	34	42	N	120	1	12	W	Residence is within the site boundary								
21	45	34	51	N	119	56	35	W	45	34	30	N	119	57	10	W	0.61505
22	45	33	52	N	120	4	47	W	45	33	51	N	120	3	35	W	0.982481
23	45	34	0	N	119	56	8	W	45	33	50	N	119	56	19	W	0.237596
24	45	33	35	N	119	55	49	W	45	33	25	N	119	55	59	W	0.23549
25	45	33	26	N	119	55	19	W	45	33	11	N	119	55	45	W	0.435049
26	45	33	13	N	119	55	15	W	45	33	11	N	119	55	45	W	0.411887
27	45	33	11	N	119	57	15	W	45	33	13	N	119	57	14	W	0.036378
28	45	33	3	N	119	59	55	W	45	33	1	N	119	57	58	W	1.598011
29	45	33	2	N	119	57	27	W	Residence is within the site boundary								
30	45	32	54	N	119	59	2	W	45	32	54	N	119	57	59	W	0.865744
31	45	32	49	N	119	55	16	W	45	33	11	N	119	55	55	W	0.589022
32	45	32	23	N	119	55	25	W	45	32	42		119	57	2	W	1.348405
									Substation Locations								
									45	43	60	N	120	5	0	W	
									45	35	49	N	119	59	4	W	

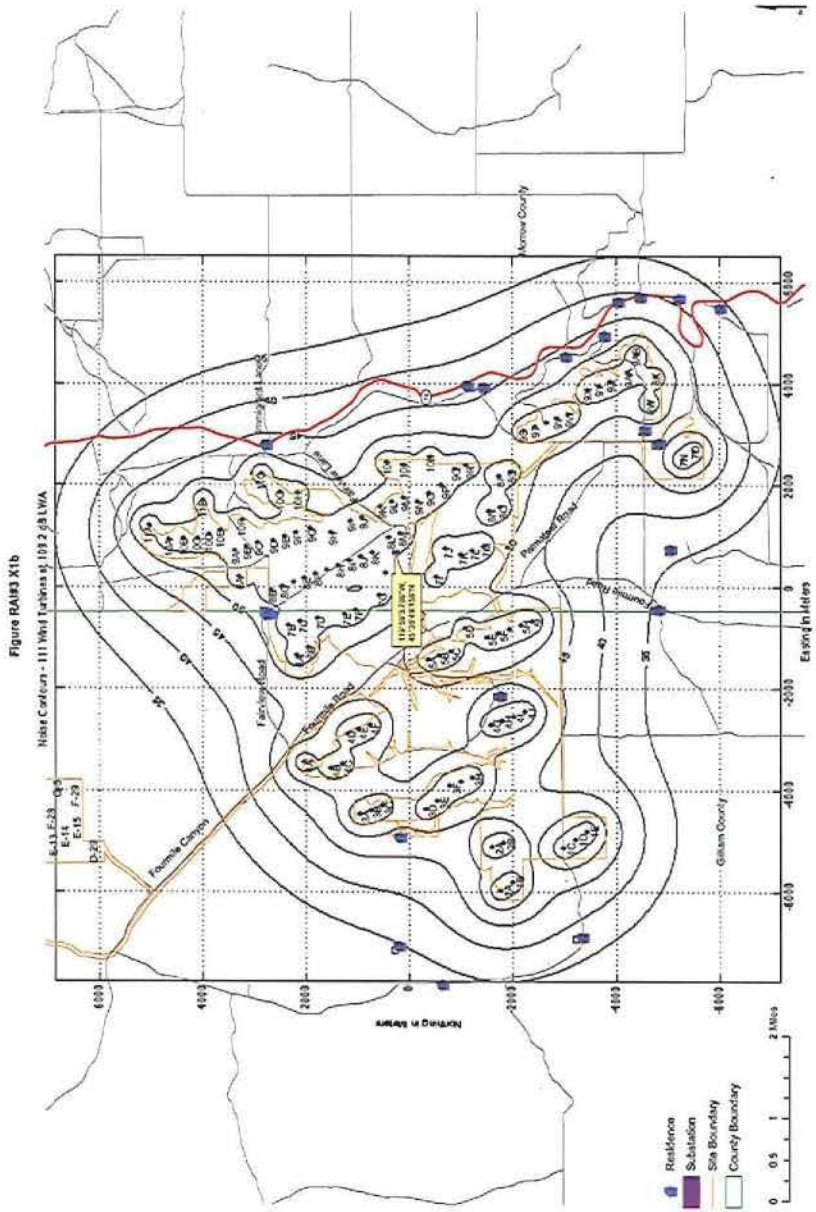
RAI#3, X6: NOISE

Figures X1a and X2b do not depict the proposed substations. Please revise the figures to include the locations of the substations, including coordinates.

SUBSTATION LOCATIONS

Please see Figures RAI# 3 X1a and RAI#3 X1b. Substation coordinates may be found in the table included in Applicant's response to RAI#3 X5.





RAI#3, X7: NOISE

Figures X1a and X1b depict the general locations of noise sensitive receivers and wind turbines by means of X-Y coordinates. These figures would more effectively reflect site and surrounding attributes if they were transferred to USGS quadrangle maps. Please provide noise contour figures that show the precise locations of noise sensitive receivers, turbines and substations relative to surrounding features and the site boundary. Please label the major features (for example, county boundary line, major roads, Eightmile Canyon, Fourmile Canyon).

NOISE CONTOUR FIGURES

USGS quadrangle maps depicting the site and surrounding attributes have been provided by applicant in Exhibit C. Figures X1a and X1b depict precise (GPS based) locations of noise sensitive receivers and wind turbines—precision which would be lost were noise contours to be drawn on USGS quadrangle maps.

Applicant has layered additional major features onto its noise contour analysis. Please see Figures RAI#3 X1a and RAI#3 X1b.

RAI#3, X8: Noise

Please provide sound levels that will be associated with the substations and ensure that the noise from the substations is included in the calculation of overall noise levels at each noise sensitive receiver.

Substation Noise

Project substations have added to Figures RAI#3 X1a and RAI#3 X1b. Applicant notes that the northern substation is located 2.04 miles from the nearest noise sensitive receiver, and the southern substation is located 1.55 miles from the nearest noise sensitive receiver—to far in each case to impact those residences.

RAI#3, X9: Noise

After completion of the corrected noise analysis, please provide a table showing the predicted total sound pressure level at each noise sensitive receiver and the contribution from each turbine and substation included in the calculation to the total sound pressure level predicted at each noise sensitive receiver.

Predicted Total Sound Pressure

North Turbines and Residences:

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASLA									
Turbine	East	North	30.1	25.9	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
D-29	-4623	5073151	-25.1	-15.9	-11.5	-12.5	-8.1	-7.5	-6.9	-5.8	-5.6	0.7
E-15	-4150	5073462	-23.6	-14.1	-9.9	-10.7	-6.4	-5.8	-5.2	-4.2	-4.0	2.5
F-29	-3517	5073490	-23.3	-13.3	-9.4	-9.9	-5.8	-5.3	-4.8	-3.8	-3.6	3.2
E-14	-4314	5073691	-22.8	-13.4	-9.1	-10.0	-5.6	-5.0	-4.4	-3.3	-3.1	3.4
G- 5	-3381	5073833	-21.9	-11.8	-7.9	-8.4	-4.3	-3.8	-3.2	-2.3	-2.1	4.8
E-13	-4478	5073919	-22.0	-12.7	-8.3	-9.3	-4.9	-4.1	-3.6	-2.4	-2.3	4.1
G- 4	-3462	5074051	-21.1	-11.0	-7.0	-7.6	-3.4	-2.9	-2.3	-1.4	-1.2	5.8
F-28	-3960	5074059	-21.2	-11.5	-7.3	-8.1	-3.8	-3.1	-2.6	-1.5	-1.3	5.4
E-12	-4642	5074148	-21.2	-12.1	-7.5	-8.6	-4.1	-3.4	-2.8	-1.6	-1.5	4.9
E-11	-5020	5074681	-19.4	-10.6	-5.8	-7.1	-2.5	-1.6	-1.0	0.3	0.4	6.6
E-10	-5101	5074899	-18.6	-9.9	-5.0	-6.4	-1.7	-0.8	-0.2	1.1	1.2	7.3
E- 9	-5071	5075154	-17.5	-8.9	-3.9	-5.3	-0.6	0.3	0.9	2.3	2.3	8.5
E- 8	-5152	5075372	-16.8	-8.2	-3.1	-4.6	0.1	1.1	1.7	3.1	3.2	9.2
D-28	-6235	5075487	-17.4	-10.0	-4.4	-6.4	-1.5	-0.4	0.2	1.8	1.8	6.9
E- 7	-5143	5075731	-15.3	-6.9	-1.6	-3.2	1.6	2.6	3.2	4.7	4.7	10.8
D-27	-6265	5075984	-15.6	-8.3	-2.6	-4.7	0.3	1.5	2.1	3.8	3.7	8.7
E- 6	-6014	5077019	-11.2	-4.1	1.9	-0.4	4.7	6.1	6.7	8.5	8.4	13.2
E- 5	-6095	5077238	-10.5	-3.5	2.6	0.1	5.3	6.8	7.4	9.2	9.1	13.7
F-27	-5335	5077409	-8.8	-1.0	4.9	2.7	8.0	9.3	10.0	11.8	11.7	17.1
E- 4	-6177	5077456	-9.7	-3.0	3.2	0.7	5.9	7.4	8.0	9.9	9.7	14.1
E- 3	-6235	5077779	-8.6	-2.1	4.3	1.6	6.9	8.4	9.0	11.0	10.8	14.8
D-26	-6880	5077901	-9.2	-3.5	3.0	0.0	5.2	6.9	7.4	9.5	9.2	12.4
C- 6	-7855	5077918	-11.0	-6.5	0.1	-3.1	2.0	3.7	4.2	6.3	5.9	8.2
E- 2	-6317	5077997	-7.9	-1.6	4.9	2.1	7.4	9.0	9.6	11.6	11.4	15.1
G- 3	-4984	5078022	-6.0	2.1	8.2	5.9	11.4	12.8	13.4	15.3	15.3	20.9
F-26	-5780	5078037	-6.9	0.0	6.4	3.8	9.2	10.7	11.4	13.4	13.2	17.6
A-22	-9650	5078100	-14.5	-11.9	-5.3	-8.8	-4.1	-2.3	-1.9	0.2	-0.2	0.9
D-25	-7272	5078304	-8.4	-3.5	3.2	0.0	5.1	6.9	7.4	9.6	9.2	11.6
C- 5	-8069	5078376	-9.8	-5.9	0.8	-2.6	2.4	4.2	4.7	6.9	6.4	8.1
E- 1	-6682	5078433	-6.8	-1.3	5.4	2.3	7.6	9.3	9.9	12.1	11.7	14.5
D-24	-7345	5078588	-7.5	-3.0	3.8	0.5	5.7	7.5	8.0	10.2	9.8	11.8
C- 4	-8151	5078595	-9.2	-5.6	1.2	-2.3	2.7	4.5	5.0	7.1	6.7	8.1

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASLA									
Turbine	East	North	30.1	25.3	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
B- 9	-9073	5078654	-11.3	-8.6	-1.9	-5.5	-0.7	1.1	1.6	3.7	3.2	4.1
F-25	-6215	5078714	-4.9	1.0	7.8	4.7	10.1	11.9	12.5	14.7	14.4	17.4
A-21	-9645	5078739	-12.5	-10.4	-3.7	-7.4	-2.8	-0.9	-0.5	1.6	1.1	1.7
H-22	-4995	5078740	-3.0	4.7	11.3	8.6	14.3	15.9	16.6	18.7	18.6	23.6
D-23	-7428	5078806	-6.9	-2.6	4.2	0.8	5.9	7.8	8.3	10.5	10.1	11.8
C- 3	-8232	5078813	-8.7	-5.4	1.5	-2.1	2.9	4.7	5.2	7.4	6.9	8.0
F-24	-6296	5078935	-4.2	1.4	8.4	5.1	10.6	12.4	13.0	15.3	14.9	17.5
D-22	-7510	5079025	-6.3	-2.3	4.6	1.1	6.2	8.1	8.6	10.8	10.4	11.7
C- 2	-8314	5079032	-8.1	-5.1	1.8	-1.8	3.0	4.9	5.4	7.6	7.1	7.9
F-23	-6378	5079151	-3.5	1.8	8.9	5.5	10.9	12.8	13.4	15.7	15.3	17.4
B- 8	-8905	5079217	-9.0	-6.8	0.1	-3.6	1.1	3.0	3.4	5.6	5.1	5.4
D-21	-7591	5079243	-5.7	-2.0	5.0	1.3	6.4	8.3	8.8	11.1	10.6	11.6
A-20	-9637	5079246	-10.9	-9.4	-2.6	-6.4	-1.8	0.1	0.5	2.6	2.1	2.2
A-19	-9636	5079535	-10.0	-8.8	-2.0	-5.8	-1.3	0.6	1.0	3.1	2.6	2.4
B- 7	-8866	5079614	-7.6	-5.8	1.1	-2.7	2.0	3.9	4.3	6.5	6.0	5.9
D-20	-7943	5079683	-5.0	-2.2	4.8	1.0	5.9	7.9	8.3	10.6	10.1	10.3
A-18	-9642	5079814	-9.2	-8.3	-1.4	-5.4	-0.9	1.0	1.4	3.5	3.0	2.5
B- 6	-8948	5079833	-7.2	-5.6	1.3	-2.6	2.0	4.0	4.3	6.6	6.0	5.6
F-22	-6737	5079868	-1.5	2.6	9.9	6.1	11.4	13.5	14.0	16.5	15.9	16.4
D-19	-8025	5079902	-4.5	-2.0	5.1	1.1	6.0	8.0	8.4	10.7	10.2	10.0
B- 5	-9029	5080051	-6.7	-5.5	1.4	-2.6	2.0	4.0	4.3	6.5	6.0	5.3
A-17	-9647	5080093	-8.4	-7.8	-0.9	-4.9	-0.5	1.4	1.8	3.9	3.3	2.5
F-21	-6902	5080097	-1.0	2.6	10.0	6.0	11.2	13.3	13.8	16.3	15.7	15.7
D-18	-8107	5080120	-3.9	-1.9	5.3	1.2	6.0	8.1	8.5	10.8	10.2	9.7
B- 4	-9112	5080270	-6.3	-5.4	1.5	-2.5	2.0	3.9	4.3	6.5	5.9	5.0
F-20	-7066	5080325	-0.5	2.5	10.0	5.9	11.0	13.1	13.6	16.0	15.4	14.9
D-17	-8188	5080339	-3.4	-1.7	5.4	1.3	6.0	8.1	8.5	10.8	10.2	9.3
A-16	-9653	5080372	-7.6	-7.3	-0.5	-4.5	-0.2	1.7	2.1	4.2	3.6	2.5
F-19	-7230	5080554	-0.1	2.4	9.9	5.7	10.7	12.8	13.2	15.7	15.1	14.1
D-16	-8270	5080557	-3.0	-1.6	5.5	1.4	6.0	8.1	8.4	10.7	10.1	8.9
B- 3	-9072	5080685	-4.9	-4.6	2.4	-1.7	2.6	4.7	5.0	7.2	6.5	5.2
D-15	-8352	5080776	-2.5	-1.6	5.6	1.4	5.9	8.0	8.3	10.6	10.0	8.5
F-18	-7394	5080782	0.2	2.3	9.7	5.4	10.3	12.4	12.8	15.3	14.6	13.2
A-15	-9654	5080878	-6.2	-6.6	0.3	-3.9	0.3	2.3	2.6	4.7	4.1	2.5
B- 2	-9154	5080903	-4.6	-4.5	2.4	-1.8	2.5	4.5	4.8	7.0	6.4	4.7
D-14	-8434	5080994	-2.1	-1.5	5.6	1.4	5.8	7.9	8.2	10.5	9.8	8.0
F-17	-7559	5081011	0.6	2.1	9.5	5.1	9.8	12.0	12.4	14.8	14.1	12.3
D-13	-8516	5081213	-1.6	-1.5	5.6	1.3	5.6	7.7	8.0	10.3	9.6	7.5
C- 1	-8941	5081351	-2.6	-3.0	4.0	-0.3	3.8	5.9	6.2	8.4	7.7	5.5
F-16	-7597	5081373	1.7	2.5	10.0	5.5	10.1	12.2	12.6	14.9	14.2	11.8
A-14	-9662	5081460	-4.7	-5.8	1.0	-3.3	0.7	2.7	3.0	5.1	4.4	2.2
B- 1	-9204	5081623	-2.7	-3.7	3.2	-1.2	2.8	4.9	5.1	7.3	6.6	4.1
G- 2	-6831	5081703	5.1	6.4	14.1	9.4	14.1	16.4	16.7	19.3	18.4	15.2
A-13	-9668	5081738	-4.0	-5.5	1.3	-3.1	0.8	2.8	3.1	5.1	4.4	2.0
D-12	-8600	5081937	0.2	-0.9	6.2	1.7	5.7	7.8	8.1	10.2	9.5	6.5

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASLA									
Turbine	East	North	30.1	25.3	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
A-12	-9673	5082017	-3.3	-5.2	1.5	-2.9	0.9	2.9	3.1	5.2	4.5	1.7
G- 1	-7004	5082020	5.7	6.1	13.8	9.0	13.4	15.7	16.0	18.4	17.6	13.9
F-15	-7508	5082058	4.2	4.0	11.4	6.7	10.9	13.2	13.4	15.7	14.9	11.4
D-11	-8682	5082156	0.5	-1.0	6.0	1.5	5.4	7.5	7.7	9.8	9.1	5.9
A-11	-9679	5082296	-2.7	-5.0	1.7	-2.7	0.9	2.9	3.1	5.1	4.4	1.4
D-10	-8764	5082374	0.8	-1.1	5.8	1.3	5.1	7.1	7.3	9.4	8.7	5.3
F-14	-7688	5082379	4.6	3.6	10.9	6.1	10.1	12.3	12.5	14.7	13.9	10.1
A-10	-9684	5082576	-2.0	-4.8	1.8	-2.6	0.9	2.9	3.1	5.0	4.3	1.0
D- 9	-8846	5082593	1.1	-1.2	5.6	1.1	4.7	6.7	6.9	8.9	8.2	4.6
F-13	-7816	5082776	5.3	3.4	10.6	5.8	9.5	11.6	11.8	13.9	13.1	8.8
A- 9	-9690	5082854	-1.4	-4.7	1.9	-2.5	0.9	2.8	3.0	4.9	4.2	0.6
D- 8	-8747	5082888	2.2	-0.6	6.2	1.6	5.1	7.1	7.3	9.3	8.5	4.6
F-12	-7899	5082995	5.6	3.2	10.2	5.5	9.0	11.1	11.3	13.3	12.5	8.0
D- 7	-8829	5083107	2.4	-0.8	5.9	1.3	4.6	6.6	6.8	8.7	7.9	3.8
A- 8	-9694	5083133	-0.9	-4.5	2.0	-2.5	0.8	2.7	2.8	4.7	4.0	0.2
F-11	-7980	5083213	5.9	3.0	9.9	5.1	8.5	10.6	10.7	12.7	11.9	7.2
D- 6	-8911	5083325	2.6	-1.1	5.5	0.9	4.2	6.1	6.3	8.1	7.4	3.1
A- 7	-9700	5083412	-0.3	-4.4	1.9	-2.5	0.6	2.5	2.6	4.5	3.7	-0.3
F-10	-8062	5083432	6.2	2.7	9.5	4.7	8.0	10.0	10.1	12.0	11.2	6.4
D- 5	-8993	5083544	2.7	-1.4	5.1	0.6	3.7	5.6	5.7	7.5	6.8	2.4
A- 6	-9705	5083691	0.2	-4.4	1.9	-2.6	0.4	2.3	2.4	4.2	3.4	-0.8
D- 4	-9074	5083761	2.9	-1.7	4.7	0.2	3.1	5.1	5.1	6.9	6.1	1.6
A- 5	-9711	5083970	0.6	-4.4	1.8	-2.7	0.2	2.0	2.1	3.8	3.1	-1.3
F- 9	-8136	5083983	7.2	2.5	9.0	4.3	7.1	9.1	9.1	10.9	10.0	4.8
H-10	-6541	5084019	13.8	9.9	17.0	11.8	14.6	16.6	16.6	18.3	17.4	10.8
F- 8	-8218	5084201	7.3	2.1	8.5	3.8	6.5	8.4	8.4	10.1	9.3	4.0
H- 9	-6705	5084248	13.8	9.1	15.9	10.8	13.4	15.3	15.3	16.9	16.0	9.4
A- 4	-9716	5084249	1.1	-4.4	1.6	-2.8	-0.1	1.7	1.8	3.4	2.7	-1.9
F- 7	-8300	5084420	7.3	1.7	7.9	3.3	5.8	7.7	7.7	9.3	8.5	3.1
H- 8	-6870	5084476	13.7	8.3	14.8	9.8	12.2	14.1	14.0	15.5	14.7	8.1
A- 3	-9722	5084527	1.5	-4.5	1.4	-3.0	-0.4	1.4	1.4	3.0	2.3	-2.5
F- 6	-8382	5084638	7.4	1.3	7.4	2.8	5.2	7.0	7.0	8.5	7.7	2.2
H- 7	-7035	5084704	13.5	7.4	13.7	8.8	11.0	12.8	12.7	14.2	13.3	6.8
A- 2	-9727	5084807	1.8	-4.6	1.2	-3.2	-0.8	1.0	1.0	2.5	1.8	-3.1
F- 5	-8463	5084857	7.4	0.9	6.8	2.2	4.5	6.3	6.2	7.7	6.9	1.4
H- 6	-7118	5084920	13.6	6.9	12.9	8.2	10.2	12.0	11.8	13.2	12.4	5.9
D- 2	-9269	5084986	4.0	-2.7	3.0	-1.4	0.9	2.6	2.6	4.1	3.4	-1.8
F- 4	-8546	5085075	7.3	0.4	6.1	1.6	3.8	5.5	5.5	6.9	6.1	0.5
J- 1	-5453	5085077	22.0	14.8	20.8	15.7	16.9	18.5	18.2	19.1	18.3	10.3
H- 5	-7200	5085138	13.6	6.4	12.2	7.5	9.3	11.1	10.9	12.2	11.4	4.9
D- 1	-9352	5085205	3.9	-3.2	2.4	-1.9	0.2	1.9	1.9	3.3	2.6	-2.7
F- 3	-8628	5085294	7.2	-0.1	5.5	1.0	3.0	4.8	4.7	6.1	5.3	-0.4
H- 4	-7282	5085357	13.6	5.8	11.4	6.8	8.5	10.2	10.0	11.3	10.5	3.9
F- 2	-8709	5085512	7.1	-0.6	4.8	0.4	2.3	4.0	3.9	5.2	4.5	-1.2
H- 3	-7365	5085575	13.5	5.2	10.6	6.1	7.6	9.3	9.1	10.3	9.5	2.9

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASEA									
Turbine	East	North	30.1	25.3	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
F- 1	-8791	5085731	6.9	-1.1	4.2	-0.2	1.6	3.2	3.1	4.4	3.7	-2.1
H- 2	-7446	5085793	13.4	4.6	9.8	5.4	6.8	8.4	8.2	9.3	8.6	2.0
H- 1	-7528	5086012	13.2	4.0	9.0	4.7	5.9	7.4	7.3	8.3	7.6	1.0
E-14A	-4232	5073576	-23.2	-13.7	-9.5	-10.3	-6.0	-5.4	-4.8	-3.7	-3.6	3.0
E-13A	-4396	5073805	-22.4	-13.1	-8.7	-9.6	-5.2	-4.6	-4.0	-2.9	-2.7	3.8
G- 4A	-3422	5073942	-21.5	-11.4	-7.5	-8.0	-3.8	-3.3	-2.8	-1.9	-1.6	5.3
E-12A	-4560	5074033	-21.6	-12.4	-7.9	-8.9	-4.5	-3.8	-3.2	-2.0	-1.9	4.5
D-24A	-7309	5078446	-8.0	-3.3	3.5	0.2	5.4	7.2	7.7	9.9	9.5	11.7
C- 4A	-8110	5078486	-9.5	-5.8	1.0	-2.4	2.5	4.3	4.8	7.0	6.6	8.1
D-23A	-7386	5078697	-7.2	-2.8	4.0	0.7	5.8	7.6	8.1	10.4	9.9	11.8
C- 3A	-8192	5078704	-9.0	-5.5	1.3	-2.2	2.8	4.6	5.1	7.3	6.8	8.1
D-22A	-7469	5078915	-6.6	-2.5	4.4	0.9	6.1	7.9	8.4	10.7	10.2	11.7
C- 2A	-8273	5078923	-8.4	-5.2	1.6	-2.0	3.0	4.8	5.3	7.5	7.0	8.0
D-21A	-7550	5079134	-6.0	-2.2	4.8	1.2	6.3	8.2	8.7	11.0	10.5	11.6
A-19A	-9637	5079391	-10.5	-9.1	-2.3	-6.1	-1.5	0.3	0.7	2.9	2.3	2.3
B- 7A	-8885	5079416	-8.3	-6.3	0.6	-3.2	1.5	3.4	3.9	6.1	5.5	5.7
D-20B	-7767	5079463	-5.3	-2.1	4.9	1.2	6.2	8.1	8.6	10.9	10.4	10.9
A-18A	-9639	5079675	-9.6	-8.5	-1.7	-5.6	-1.1	0.8	1.2	3.3	2.8	2.4
B- 6A	-8907	5079723	-7.4	-5.7	1.2	-2.7	2.0	3.9	4.3	6.5	6.0	5.8
A-17A	-9645	5079954	-8.8	-8.0	-1.2	-5.2	-0.7	1.2	1.6	3.7	3.1	2.5
D-18A	-8066	5080011	-4.2	-2.0	5.2	1.2	6.0	8.0	8.5	10.8	10.2	9.8
D-17A	-8148	5080230	-3.7	-1.8	5.3	1.3	6.0	8.1	8.5	10.8	10.2	9.5
A-16B	-9650	5080232	-8.0	-7.6	-0.7	-4.7	-0.4	1.6	1.9	4.1	3.5	2.5
D-16A	-8229	5080448	-3.2	-1.7	5.5	1.4	6.0	8.1	8.5	10.8	10.1	9.1
D-15A	-8311	5080667	-2.7	-1.6	5.6	1.4	6.0	8.0	8.4	10.7	10.0	8.7
D-14A	-8393	5080885	-2.3	-1.5	5.6	1.4	5.9	7.9	8.3	10.6	9.9	8.3
D-13A	-8475	5081104	-1.8	-1.5	5.6	1.3	5.7	7.8	8.1	10.4	9.7	7.8
A-13A	-9665	5081599	-4.3	-5.7	1.1	-3.2	0.8	2.8	3.0	5.1	4.4	2.1
A-12A	-9671	5081877	-3.6	-5.4	1.4	-3.0	0.9	2.9	3.1	5.2	4.5	1.8
D-11A	-8641	5082047	0.4	-0.9	6.1	1.6	5.6	7.7	7.9	10.0	9.3	6.2
A-11A	-9676	5082157	-3.0	-5.1	1.6	-2.8	0.9	2.9	3.1	5.2	4.4	1.5
D-10A	-8723	5082265	0.7	-1.0	5.9	1.4	5.3	7.3	7.5	9.6	8.9	5.6
A-10A	-9682	5082436	-2.3	-4.9	1.8	-2.7	0.9	2.9	3.1	5.1	4.4	1.2
D- 9A	-8805	5082484	1.0	-1.2	5.7	1.2	4.9	6.9	7.1	9.2	8.4	4.9
A- 9A	-9687	5082715	-1.7	-4.7	1.9	-2.6	0.9	2.9	3.0	5.0	4.2	0.8
D- 8A	-8797	5082740	1.6	-0.9	5.9	1.3	4.9	6.9	7.1	9.1	8.3	4.6
A- 8A	-9692	5082994	-1.1	-4.6	1.9	-2.5	0.8	2.8	2.9	4.8	4.1	0.4
D- 7A	-8788	5082997	2.3	-0.7	6.0	1.4	4.9	6.9	7.0	9.0	8.2	4.2
D- 6A	-8870	5083216	2.5	-0.9	5.7	1.1	4.4	6.4	6.5	8.4	7.7	3.5
A- 7A	-9697	5083273	-0.6	-4.5	2.0	-2.5	0.7	2.6	2.7	4.6	3.8	0.0
D- 5A	-8952	5083434	2.7	-1.2	5.3	0.7	3.9	5.9	6.0	7.8	7.1	2.7
A- 6A	-9703	5083552	-0.1	-4.4	1.9	-2.5	0.5	2.4	2.5	4.3	3.6	-0.5
D -4A	-9034	5083652	2.8	-1.5	4.9	0.4	3.4	5.3	5.4	7.2	6.5	2.0
A- 5A	-9708	5083830	0.4	-4.4	1.8	-2.6	0.3	2.2	2.3	4.0	3.3	-1.0
D- 3B	-9115	5083870	2.9	-1.8	4.5	-0.1	2.9	4.8	4.8	6.6	5.8	1.2

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASEA									
Turbine	East	North	30.1	25.3	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
D- 3A	-9156	5083979	2.9	-2.0	4.3	-0.3	2.6	4.5	4.5	6.3	5.5	0.8
A- 4A	-9713	5084110	0.9	-4.4	1.7	-2.7	0.0	1.9	1.9	3.6	2.9	-1.6
H- 9A	-6623	5084133	13.8	9.5	16.4	11.3	14.0	16.0	15.9	17.6	16.7	10.1
H- 8A	-6788	5084362	13.8	8.7	15.3	10.3	12.8	14.7	14.6	16.2	15.3	8.8
A- 3A	-9719	5084388	1.3	-4.4	1.5	-2.9	-0.3	1.6	1.6	3.2	2.5	-2.2
H- 7A	-6952	5084590	13.6	7.9	14.2	9.3	11.6	13.5	13.4	14.8	14.0	7.5
A- 2A	-9724	5084667	1.6	-4.5	1.3	-3.1	-0.6	1.2	1.2	2.8	2.0	-2.8
H- 6A	-7076	5084812	13.6	7.2	13.3	8.5	10.6	12.4	12.3	13.7	12.9	6.3
A- 1A	-9730	5084946	2.0	-4.6	1.1	-3.3	-1.0	0.8	0.8	2.3	1.5	-3.4
J- 1A	-5412	5084968	21.8	15.1	21.3	16.1	17.5	19.1	18.8	19.7	18.9	10.9
H- 5A	-7159	5085029	13.6	6.7	12.6	7.8	9.8	11.5	11.4	12.7	11.9	5.4
H- 4A	-7241	5085248	13.6	6.1	11.8	7.2	8.9	10.6	10.5	11.7	11.0	4.4
H- 3A	-7323	5085466	13.6	5.5	11.0	6.5	8.1	9.7	9.6	10.8	10.0	3.4
H- 2A	-7405	5085684	13.5	4.9	10.3	5.8	7.2	8.8	8.7	9.8	9.0	2.5
H- 1A	-7487	5085903	13.3	4.3	9.4	5.0	6.3	7.9	7.7	8.8	8.1	1.5
F-28B	-3738	5073774	-22.2	-12.4	-8.3	-9.0	-4.8	-4.2	-3.7	-2.7	-2.5	4.3
E-10A	-5060	5074790	-19.0	-10.3	-5.4	-6.7	-2.1	-1.2	-0.6	0.7	0.8	7.0
E- 9A	-5086	5075027	-18.1	-9.4	-4.4	-5.9	-1.1	-0.2	0.3	1.7	1.8	7.9
E- 8A	-5112	5075263	-17.2	-8.6	-3.5	-5.0	-0.2	0.7	1.3	2.7	2.8	8.9
E- 7A	-5148	5075552	-16.0	-7.5	-2.4	-3.9	0.9	1.9	2.5	3.9	3.9	10.0
E- 5A	-6055	5077128	-10.9	-3.8	2.2	-0.1	5.0	6.4	7.0	8.9	8.7	13.4
E- 4A	-6136	5077347	-10.1	-3.3	2.9	0.4	5.6	7.1	7.7	9.6	9.4	13.9
E- 3A	-6206	5077617	-9.2	-2.5	3.8	1.1	6.4	7.9	8.5	10.5	10.3	14.5
F-26B	-5558	5077723	-7.9	-0.5	5.7	3.3	8.7	10.1	10.7	12.6	12.5	17.4
E- 2A	-6276	5077888	-8.2	-1.8	4.6	1.8	7.1	8.7	9.3	11.3	11.1	15.0
D-25B	-7076	5078102	-8.8	-3.5	3.1	0.0	5.2	6.9	7.4	9.6	9.2	12.0
C- 5B	-7962	5078147	-10.4	-6.2	0.5	-2.8	2.2	4.0	4.5	6.6	6.2	8.2
E- 1B	-6499	5078215	-7.3	-1.4	5.2	2.2	7.5	9.2	9.8	11.9	11.6	14.9
F-25B	-5997	5078376	-5.9	0.6	7.2	4.3	9.7	11.4	12.0	14.1	13.9	17.6
A-21B	-9648	5078420	-13.5	-11.2	-4.5	-8.1	-3.4	-1.6	-1.2	0.9	0.5	1.3
F-24A	-6255	5078824	-4.5	1.2	8.1	4.9	10.4	12.2	12.7	15.0	14.7	17.4
B- 8A	-8989	5078936	-10.1	-7.7	-0.9	-4.6	0.2	2.1	2.5	4.6	4.2	4.8
A-20B	-9641	5078993	-11.7	-9.9	-3.1	-6.9	-2.3	-0.4	0.0	2.1	1.6	1.9
F-23A	-6337	5079042	-3.8	1.6	8.6	5.3	10.7	12.6	13.2	15.5	15.1	17.5
C- 1A	-8356	5079142	-7.9	-5.0	1.9	-1.8	3.1	5.0	5.5	7.7	7.2	7.9
F-22B	-6558	5079510	-2.5	2.3	9.5	5.9	11.2	13.2	13.8	16.2	15.7	17.0
D-19A	-7984	5079793	-4.7	-2.1	5.0	1.1	6.0	8.0	8.4	10.7	10.1	10.1
B- 5A	-8989	5079942	-7.0	-5.6	1.4	-2.6	2.0	4.0	4.3	6.6	6.0	5.5
F-21A	-6819	5079983	-1.2	2.6	10.0	6.1	11.3	13.4	13.9	16.4	15.8	16.1
B- 4A	-9070	5080160	-6.5	-5.5	1.5	-2.5	2.0	4.0	4.3	6.5	5.9	5.2
F-20A	-6984	5080211	-0.8	2.6	10.0	6.0	11.1	13.2	13.7	16.2	15.6	15.3
F-19A	-7148	5080440	-0.3	2.5	9.9	5.8	10.8	13.0	13.4	15.9	15.3	14.5
B- 3A	-9092	5080477	-5.6	-5.0	2.0	-2.1	2.3	4.3	4.7	6.9	6.2	5.1
A-15B	-9654	5080625	-6.9	-6.9	-0.1	-4.2	0.1	2.0	2.4	4.5	3.9	2.5
F-18A	-7312	5080668	0.1	2.4	9.8	5.6	10.5	12.6	13.1	15.5	14.8	13.6

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASLA									
Turbine	East	North	30.1	25.3	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
B- 2A	-9113	5080794	-4.7	-4.5	2.4	-1.8	2.6	4.6	4.9	7.1	6.5	5.0
F-17A	-7476	5080897	0.4	2.2	9.6	5.3	10.1	12.2	12.6	15.0	14.3	12.7
F-16A	-7578	5081192	1.1	2.3	9.7	5.3	10.0	12.1	12.5	14.9	14.2	12.0
D-12B	-8558	5081575	-0.7	-1.1	6.0	1.5	5.7	7.8	8.1	10.3	9.6	7.1
G- 1A	-6918	5081861	5.4	6.2	14.0	9.2	13.8	16.1	16.4	18.9	18.0	14.5
F-14A	-7598	5082218	4.4	3.8	11.2	6.4	10.6	12.8	13.0	15.2	14.4	10.7
F-13A	-7752	5082577	5.0	3.5	10.7	6.0	9.8	12.0	12.2	14.3	13.5	9.4
F-12A	-7858	5082885	5.5	3.3	10.4	5.6	9.3	11.4	11.5	13.6	12.8	8.4
F-11A	-7939	5083104	5.8	3.1	10.1	5.3	8.8	10.9	11.0	13.0	12.2	7.6
F-10A	-8021	5083322	6.0	2.8	9.7	4.9	8.3	10.3	10.4	12.4	11.5	6.8
F- 9A	-8099	5083707	6.7	2.6	9.3	4.5	7.6	9.6	9.6	11.5	10.7	5.6
F- 8A	-8177	5084092	7.2	2.3	8.8	4.0	6.8	8.7	8.8	10.5	9.7	4.4
F- 7A	-8259	5084311	7.3	1.9	8.2	3.5	6.2	8.1	8.1	9.7	8.9	3.5
F- 6A	-8341	5084529	7.4	1.5	7.7	3.0	5.5	7.4	7.3	8.9	8.1	2.7
F- 5A	-8423	5084748	7.4	1.1	7.1	2.5	4.8	6.6	6.6	8.1	7.3	1.8
F- 4A	-8504	5084966	7.4	0.6	6.5	1.9	4.1	5.9	5.9	7.3	6.5	0.9
D- 1A	-9311	5085095	4.0	-2.9	2.7	-1.7	0.5	2.3	2.3	3.7	3.0	-2.3
F- 3A	-8587	5085185	7.3	0.2	5.8	1.3	3.4	5.1	5.1	6.5	5.7	0.1
F- 2A	-8668	5085403	7.2	-0.3	5.2	0.7	2.7	4.4	4.3	5.7	4.9	-0.8
F- 1A	-8750	5085622	7.0	-0.9	4.5	0.1	1.9	3.6	3.5	4.8	4.1	-1.7
F-28C	-3628	5073632	-22.8	-12.8	-8.9	-9.5	-5.3	-4.7	-4.2	-3.2	-3.0	3.8
F-28A	-3849	5073917	-21.7	-12.0	-7.8	-8.5	-4.3	-3.7	-3.1	-2.1	-1.9	4.9
D-27C	-6265	5075612	-17.0	-9.6	-4.0	-6.0	-1.1	0.1	0.6	2.3	2.2	7.3
D-27B	-6265	5075736	-16.5	-9.2	-3.5	-5.6	-0.7	0.5	1.1	2.8	2.7	7.8
D-27A	-6265	5075860	-16.0	-8.7	-3.1	-5.2	-0.2	1.0	1.6	3.3	3.2	8.2
F-26C	-5446	5077566	-8.3	-0.7	5.3	3.0	8.3	9.7	10.3	12.2	12.1	17.3
F-26A	-5669	5077880	-7.4	-0.2	6.1	3.6	8.9	10.4	11.0	13.0	12.9	17.5
D-25C	-6978	5078002	-9.0	-3.5	3.0	0.0	5.2	6.9	7.4	9.5	9.2	12.2
C- 5C	-7908	5078032	-10.7	-6.3	0.3	-2.9	2.1	3.8	4.3	6.4	6.1	8.2
E- 1C	-6408	5078106	-7.6	-1.5	5.0	2.1	7.5	9.1	9.7	11.8	11.5	15.0
D-25A	-7174	5078203	-8.6	-3.5	3.1	0.0	5.2	6.9	7.4	9.6	9.2	11.8
F-25C	-5889	5078206	-6.4	0.3	6.8	4.1	9.5	11.1	11.7	13.8	13.6	17.6
A-21C	-9649	5078260	-14.0	-11.5	-4.9	-8.4	-3.7	-1.9	-1.5	0.6	0.1	1.1
C- 5A	-8016	5078262	-10.1	-6.1	0.6	-2.7	2.3	4.1	4.6	6.7	6.3	8.2
E- 1A	-6591	5078324	-7.1	-1.4	5.3	2.3	7.6	9.3	9.8	12.0	11.7	14.7
F-25A	-6106	5078545	-5.4	0.8	7.5	4.5	10.0	11.7	12.3	14.5	14.2	17.5
A-21A	-9646	5078579	-13.0	-10.8	-4.1	-7.7	-3.1	-1.3	-0.8	1.3	0.8	1.5
A-20C	-9643	5078866	-12.1	-10.2	-3.4	-7.1	-2.5	-0.7	-0.2	1.9	1.4	1.8
A-20A	-9639	5079119	-11.3	-9.6	-2.9	-6.6	-2.0	-0.2	0.2	2.4	1.9	2.1
F-22C	-6468	5079331	-3.0	2.1	9.2	5.7	11.1	13.0	13.6	16.0	15.5	17.3
D-20C	-7679	5079353	-5.5	-2.1	5.0	1.3	6.3	8.2	8.7	11.0	10.5	11.3
D-20A	-7855	5079573	-5.2	-2.2	4.9	1.1	6.1	8.0	8.5	10.8	10.3	10.6
F-22A	-6647	5079689	-2.0	2.5	9.7	6.0	11.4	13.4	13.9	16.3	15.8	16.8
A-15C	-9653	5080498	-7.3	-7.1	-0.3	-4.4	-0.1	1.9	2.2	4.4	3.7	2.5
A-15A	-9654	5080752	-6.6	-6.7	0.1	-4.0	0.2	2.2	2.5	4.6	4.0	2.5

Residence Number:			1	2	3	4	5	6	7	8	9	10
			OASLA									
Turbine	East	North	30.1	25.3	31.9	27.4	31.1	33.0	33.3	35.2	34.6	34.8
D-12A	-8579	5081756	-0.2	-1.0	6.1	1.6	5.7	7.8	8.1	10.3	9.5	6.8
F-15A	-7417	5081897	4.0	4.1	11.6	6.9	11.3	13.5	13.8	16.2	15.4	12.1
D- 2H	-9168	5084091	3.1	-2.0	4.2	-0.4	2.4	4.3	4.3	6.0	5.3	0.6
D- 2G	-9181	5084203	3.2	-2.1	4.1	-0.5	2.2	4.1	4.2	5.8	5.1	0.3
D- 2F	-9194	5084315	3.4	-2.2	3.9	-0.6	2.1	3.9	3.9	5.6	4.8	0.0
D- 2E	-9206	5084427	3.5	-2.2	3.8	-0.7	1.9	3.7	3.7	5.4	4.6	-0.3
D- 2D	-9219	5084538	3.6	-2.3	3.7	-0.8	1.7	3.5	3.5	5.1	4.4	-0.6
D- 2C	-9232	5084650	3.7	-2.4	3.5	-1.0	1.5	3.3	3.3	4.9	4.1	-0.9
D- 2B	-9244	5084762	3.8	-2.5	3.4	-1.1	1.3	3.1	3.1	4.6	3.9	-1.2
D- 2A	-9257	5084874	3.9	-2.6	3.2	-1.2	1.1	2.9	2.8	4.4	3.6	-1.5

South Turbines and Residences:

Residence Number:			11	12	14	13	16	15	17	18	20	19
			OASLA									
Turbine	East	North	36.6	36.5	36.6	32.1	36.7	36.5	33.0	35.2	35.3	39.5
2B	-4434	5065162	5.9	5.8	6.0	-5.7	6.2	23.9	23.4	-5.4	-5.2	24.8
8O	2149	5065221	12.7	12.8	12.8	14.3	13.1	-5.1	-7.3	27.2	27.8	19.5
2A	-4516	5065381	6.4	6.2	6.5	-5.6	6.6	25.3	24.4	-5.7	-5.6	24.3
8N	2068	5065439	13.8	13.9	14.0	15.3	14.3	-4.6	-6.9	27.0	27.3	19.9
7M	1380	5065553	15.7	15.7	15.8	14.5	16.1	-1.6	-3.9	22.7	23.0	23.9
7L	1299	5065772	16.9	17.0	17.1	15.3	17.4	-1.0	-3.5	22.3	22.4	24.3
7K	1218	5065990	18.2	18.2	18.3	16.1	18.6	-0.5	-3.1	21.9	21.8	24.5
3E	-3620	5066436	13.0	12.8	13.1	-0.1	13.3	23.6	20.2	-1.9	-1.9	28.2
9O	2411	5066594	18.2	18.3	18.3	21.9	18.6	-5.3	-8.1	28.8	28.1	16.9
3D	-3784	5066664	13.1	12.9	13.2	-0.3	13.4	24.9	21.1	-2.7	-2.7	26.4
3C	-3705	5067502	15.9	15.7	16.0	1.3	16.2	24.7	19.8	-2.9	-3.0	23.4
3B	-3787	5067721	16.1	15.9	16.2	1.2	16.4	25.1	19.8	-3.4	-3.6	22.1
4F	-2139	5067737	23.8	23.6	24.0	8.5	24.2	15.7	11.5	3.6	3.3	27.0
3A	-3868	5067939	16.3	16.1	16.4	1.1	16.5	25.3	19.8	-3.9	-4.2	20.9
4E	-2220	5067957	24.4	24.1	24.5	8.4	24.7	16.0	11.6	3.0	2.7	25.4
4D	-2302	5068175	24.8	24.5	24.9	8.4	25.1	16.2	11.7	2.3	2.0	24.0
4C	-2888	5068272	22.0	21.8	22.1	5.8	22.2	19.2	14.2	-0.3	-0.6	22.3
4B	-2970	5068491	22.1	21.9	22.2	5.7	22.3	19.2	14.2	-0.9	-1.3	20.9
4A	-2863	5069007	23.8	23.5	23.8	6.5	23.9	17.6	12.5	-1.3	-1.7	18.4
10A	1525	5071627	28.0	28.2	27.8	26.1	27.5	-6.2	-10.4	5.6	4.4	3.1
11A	1804	5072010	24.9	25.1	24.7	25.4	24.4	-8.0	-12.2	4.6	3.4	1.0
2A1	-4475	5065271	6.1	6.0	6.2	-5.7	6.4	24.6	23.9	-5.6	-5.4	24.5
8N1	2108	5065330	13.2	13.3	13.4	14.8	13.7	-4.8	-7.1	27.1	27.6	19.7
7L1	1340	5065662	16.3	16.4	16.4	14.9	16.8	-1.3	-3.7	22.6	22.7	24.1
7K1	1259	5065881	17.5	17.6	17.7	15.7	18.0	-0.8	-3.3	22.1	22.2	24.4
7J1	1273	5066139	18.8	18.9	19.0	17.0	19.3	-0.7	-3.3	22.1	22.0	23.9
3D1	-3702	5066550	13.1	12.9	13.2	-0.2	13.4	24.2	20.7	-2.3	-2.3	27.3
3B1	-3746	5067612	16.1	15.9	16.1	1.3	16.3	24.9	19.8	-3.1	-3.3	22.8

Residence Number:			11	12	14	13	16	15	17	18	20	19
			OASLA									
Turbine	East	North	36.6	36.5	36.6	32.1	36.7	36.5	33.0	35.2	35.3	39.3
3A1	-3827	5067830	16.2	16.0	16.3	1.2	16.4	25.2	19.8	-3.7	-3.9	21.5
4E1	-2179	5067847	24.1	23.9	24.2	8.5	24.5	15.9	11.6	3.3	3.0	26.2
4D1	-2261	5068066	24.6	24.3	24.7	8.4	24.9	16.1	11.7	2.7	2.3	24.7
4C1	-2595	5068223	23.4	23.2	23.5	7.1	23.7	17.7	13.0	1.0	0.7	23.2
4B1	-2929	5068381	22.1	21.8	22.1	5.7	22.3	19.2	14.2	-0.6	-0.9	21.6
10B	1523	5071767	27.3	27.4	27.1	25.4	26.8	-6.4	-10.7	5.1	3.8	2.5
3C2	-3784	5066778	13.5	13.3	13.6	-0.1	13.8	25.0	21.0	-2.7	-2.8	26.0
3C1	-3784	5066892	13.8	13.6	13.9	0.1	14.1	25.1	21.0	-2.8	-2.9	25.6

Residence Number:			22	21	23	24	25	26	27	28	29	30	31
			OASLA										
Turbine	East	North	29.4	33.7	25.3	21.7	20.3	29.7	29.7	29.0	29.6	18.2	16.2
2B	-4434	5065162	-8.0	28.0	-10.2	-13.1	-13.8	-3.3	10.8	-2.6	5.4	-14.6	-14.9
8O	2149	5065221	22.5	-3.7	18.4	14.6	13.2	23.1	20.2	22.2	21.5	11.1	9.1
2A	-4516	5065381	-8.5	27.4	-10.7	-13.6	-14.4	-3.9	9.9	-3.3	4.6	-15.1	-15.5
8N	2068	5065439	21.6	-3.5	17.4	13.7	12.3	21.7	19.4	20.9	20.4	10.1	8.1
7M	1380	5065553	17.8	-0.7	14.0	10.5	9.1	19.1	20.5	18.6	20.3	7.2	5.5
7L	1299	5065772	16.9	-0.6	13.1	9.6	8.3	17.8	19.5	17.3	19.0	6.3	4.5
7K	1218	5065990	16.0	-0.5	12.2	8.7	7.4	16.6	18.5	16.1	17.8	5.4	3.5
3E	-3620	5066436	-5.7	19.0	-8.4	-11.3	-12.2	-2.3	9.8	-1.9	5.0	-13.3	-14.1
9O	2411	5066594	19.4	-6.2	14.9	11.5	9.8	16.5	13.2	15.4	13.9	7.3	4.8
3D	-3784	5066664	-6.6	18.7	-9.3	-12.3	-13.2	-3.3	8.4	-3.0	3.7	-14.4	-15.2
3C	-3705	5067502	-7.5	14.9	-10.4	-13.3	-14.3	-5.0	5.6	-4.7	1.3	-15.7	-16.7
3B	-3787	5067721	-8.1	14.2	-11.0	-14.0	-15.0	-5.8	4.6	-5.6	0.3	-16.4	-17.4
4F	-2139	5067737	-1.8	9.0	-5.0	-8.0	-9.2	-0.3	8.2	-0.3	4.6	-10.8	-12.1
3A	-3868	5067939	-8.8	13.5	-11.7	-14.7	-15.7	-6.6	3.5	-6.4	-0.6	-17.1	-18.2
4E	-2220	5067957	-2.6	8.5	-5.8	-8.7	-9.9	-1.2	7.1	-1.2	3.6	-11.6	-13.0
4D	-2302	5068175	-3.3	8.0	-6.5	-9.5	-10.7	-2.1	6.0	-2.1	2.5	-12.4	-13.8
4C	-2888	5068272	-5.7	9.5	-8.8	-11.8	-12.9	-4.2	4.5	-4.2	0.8	-14.5	-15.9
4B	-2970	5068491	-6.5	8.8	-9.6	-12.5	-13.7	-5.1	3.4	-5.1	-0.2	-15.3	-16.7
4A	-2863	5069007	-7.2	6.5	-10.4	-13.3	-14.5	-6.3	1.5	-6.4	-1.9	-16.2	-17.7
10A	1525	5071627	-3.0	-14.2	-6.7	-9.0	-10.7	-7.1	-7.5	-8.0	-8.3	-13.3	-16.0
11A	1804	5072010	-4.0	-16.1	-7.7	-9.9	-11.6	-8.4	-9.3	-9.3	-9.9	-14.3	-17.0
2A1	-4475	5065271	-8.2	27.7	-10.5	-13.4	-14.1	-3.6	10.3	-2.9	5.0	-14.8	-15.2
8N1	2108	5065330	22.1	-3.6	17.9	14.2	12.7	22.4	19.8	21.6	21.0	10.6	8.6
7L1	1340	5065662	17.4	-0.7	13.6	10.0	8.7	18.4	20.0	18.0	19.6	6.8	5.0
7K1	1259	5065881	16.5	-0.6	12.7	9.2	7.8	17.2	19.0	16.7	18.4	5.8	4.0
7J1	1273	5066139	15.9	-1.0	12.0	8.6	7.2	16.1	17.6	15.6	17.0	5.1	3.2
3D1	-3702	5066550	-6.2	18.9	-8.8	-11.8	-12.7	-2.8	9.1	-2.4	4.4	-13.8	-14.6
3B1	-3746	5067612	-7.8	14.6	-10.7	-13.6	-14.7	-5.4	5.1	-5.2	0.8	-16.0	-17.1
3A1	-3827	5067830	-8.5	13.9	-11.4	-14.3	-15.4	-6.2	4.0	-6.0	-0.2	-16.7	-17.8
4E1	-2179	5067847	-2.2	8.7	-5.4	-8.4	-9.5	-0.7	7.7	-0.7	4.1	-11.2	-12.5
4D1	-2261	5068066	-2.9	8.3	-6.2	-9.1	-10.3	-1.6	6.6	-1.7	3.1	-12.0	-13.4
4C1	-2595	5068223	-4.5	8.8	-7.7	-10.6	-11.8	-3.2	5.3	-3.2	1.7	-13.5	-14.8
4B1	-2929	5068381	-6.1	9.2	-9.2	-12.2	-13.3	-4.7	4.0	-4.7	0.3	-14.9	-16.3

Residence Number:			22	21	23	24	25	26	27	28	29	30	31
			OASLA										
Turbine	East	North	29.4	33.7	25.3	21.7	20.3	29.7	29.7	29.0	29.6	18.2	16.2
10B	1523	5071767	-3.5	-14.6	-7.3	-9.5	-11.2	-7.6	-8.1	-8.5	-8.8	-13.9	-16.5
3C2	-3784	5066778	-6.8	18.3	-9.5	-12.4	-13.4	-3.6	8.0	-3.2	3.4	-14.6	-15.4
3C1	-3784	5066892	-6.9	17.8	-9.7	-12.6	-13.6	-3.8	7.6	-3.5	3.0	-14.8	-15.6

RAI#3, X10: Noise

CSF has requested deferral of the final noise analysis pending determination of the facility layout for each phase of construction. In order for the Department to recommend to the Council that the applicant can meet the noise standard, the applicant must prepare a preliminary site configuration showing that the standard can be met, i.e., that the sound pressure level at each noise sensitive receiver does not exceed allowable limits or, where applicable, that the applicant has received from the occupants of the noise sensitive receiver the appropriate waiver. Please provide a noise analysis for a facility configuration that would meet the noise standard, including noise contour maps and a table showing the predicted total sound pressure level at each noise sensitive receiver and the contribution from each turbine and substation to the total sound pressure level predicted at each noise sensitive receiver.

Allowable Limits

Please see Applicant's response to RAI#3, X9 for tables showing the predicted total sound pressure level at each noise sensitive receiver (residence).

In the Southern Project Area, 6 residences in three locations show predicted total sound pressure levels in excess of the allowable limits but well within the limits allowed with a noise waiver. All of these residences are owned by the project landlords, and all of these landlords have agreed to enter into the appropriate waiver agreement should the final facility configuration produce sound pressure levels which exceed allowable limits.

Please see Figure RAI#3, X1a and Figure RAI#3, X1b for noise contour maps.

Patricia Pilz

From: Patricia Pilz [pat@pilzandco.com]
Sent: Monday, October 29, 2007 11:08 AM
To: 'John White'; 'jflarson@PacificEnergySystems.com'
Cc: 'Carol Pilz Weisskopf'; Kathy
Subject: RE: Conference call for noise

Yes, this is a mess. I've put my comments in your text (>>):

-----Original Message-----
From: John White [mailto:John.White@state.or.us]
Sent: Monday, October 29, 2007 10:15 AM
To: Patricia Pilz
Cc: kstandlee@acoustechgroup.com; Noiseybw@aol.com; jflarson@pacificenergysystems.com
Subject: Re: Conference call for noise

Pat,
I have attached some questions from Kerrie Standlee to help frame our discussion during the conference call this afternoon.

In addition, I would like to confirm with you the evolution of your responses to the Exhibit X RAIs to make sure that we all have the same understanding. It appears to me (correct me if this is not accurate) that in the responses to the RAI #2 questions, you were trying to demonstrate compliance based on a "worst-case" analysis approach. For example, the response to RAI X1 states that the "worst-case" turbine was used in the analysis and further states that the turbine layout shown in Figures RAI #2 X1a and X1b "placed turbines as close as practical to the site boundaries and these residences."

>>Yes, although it was pretty much the typical layout.

In RAI X6 (RAI #3), we asked that the substations be added to the figures. You did so in Figures RAI #3 X1a and X1b (you also added some geographical reference information, in response to RAI X7) It appears that these figures are otherwise identical to the figures you submitted in response to RAI X1; that is, the turbine layout is intentionally a worst-case layout, placing turbines as close as possible to residences.

>>Yes. We did not have the new analysis done yet, as we did not yet have
>>buy-in on the sound level from Vestas. We produced those maps to add
>>the geographical information requested to help the process along.

In responding to RAI X10, you followed a different approach. Instead of trying to show compliance based on a worst-case layout, you presented a new turbine layout intending to show a configuration that would comply with the noise regulations, using a sound pressure level (SPL) of 111.2 dBA in the analysis.

This was in response to our RAI X2, in which we noted that the analysis must include the uncertainty band of +/- 2 dBA. For the Vestas V-90, this would make the assumed maximum SPL 111.2 instead of 109.2.

>>Yes. Once Vestas agreed, we did the whole thing over again, and
>>produced the tables and other information that was requested.

Figures RAI #3 X1a and X1b Revised present a new layout. For this layout, 75 turbines were moved from the southern project area to the northern project area.

>>Yes. We moved turbines around to produce a layout that complied with
>>the standard as we understood RAI#3, X10.

As Kerrie's questions point out, these layouts do not identify each turbine used in the analysis with a unique identification number.

>>Actually, they do. We did not add every turbine number to the maps
>>because we thought it would be too hard to read. But the numbers are
>>rationally organized, and we thought one could identify each turbine
>>on the map with reference to the turbine numbers in the table.

He also notes that residences 11, 12, 16 and 32 are not shown on the figures.

>>Residences 11, 12, 14 and 16 are in one compound (they are all stacked
>>on each other on the map). We thought that one could see this by the
>>location coordinates.

>>There is no residence 32. On our original location tables and maps, we
>>ended up with a non-existent residence (original residence number 17).
>>We found this error and therefore corrected it in the final tables and
>>maps. There are only 31 residences.

I would add that the residence identifying numbers shown on the revised figures are inconsistent with the residence identifying numbers shown on the original figures RAI #3 X1a and X1b. See, for example residences 18 and 20 on the Revised X1b compared to the original X1b, where the same two houses are identified as 19 and 21.

>>Yes, because we renumbered them when we eliminated 17.

As a result of the differing layouts and different turbine and residence numbering schemes, it is impossible for us to match the data in the tables that you have submitted in response to RAI X5 and X9 with any set of layout figures.

>>The new maps and the X9 tables are consistent. But we did not think to
>>give you a new residence location table. I will format that now and
>>send it to you.

Although I have not taken the time to compare the various X1a/X1b maps with other maps that you have provided – for example the maps showing habitat avoidance areas – my guess is that the noise maps do not show the "typical" layout that you have used elsewhere in the application.

>>No. It was built for noise, but is consistent with habitat avoidance
>>and cultural resources corridors.

Ultimately, we need to craft a noise compliance condition that cross-references a noise-compliant turbine layout. Ideally, that layout would also be compliant with other site certificate conditions (in particular, conditions that will require avoidance of certain kinds of habitat). The condition, for example, might say that the certificate holder "must" build the facility in conformance with the noise-compliant "default" layout (or demonstrate how a different layout would comply with the noise regulations).

>>The condition we propose is that we must demonstrate how our final
>>layout will comply with the noise regulations. Because that is the
>>time we will take actual background noise level readings at the
>>residences and use them instead of the default.

I want to avoid requiring a default layout in the noise condition that, in fact, is unbuildable because of a conflict with the habitat-related conditions (or other conditions that might restrict turbine locations).

>>I'll call you on this as I do not understand.

I had hoped to avoid asking you to produce another set of maps this late in the completeness phase, but I think that is now unavoidable. We should discuss this further in today's conference call or afterward, but we will very likely need to have another set of maps showing a noise-compliant (and otherwise buildable) layout that identifies each turbine and each residence with identifying numbers that can be matched up with the data tables.

>>OK.

Regards,
John

John G. White
Oregon Department of Energy
625 Marion St., NE
Salem, Oregon 97301-3742
john.white@state.or.us

Comments on Additional Information Sent by Applicant of Shepherds Flat Wind Farm in Response to RAI#3, Section X Questions

1. In RAI#3, X3, the applicant was requested to confirm that the sound level computations had been made using the octave band sound power level data associated with the wind turbines and not just the overall A-weighted sound power level data provided by the manufacturer. In addition, the applicant was asked to confirm that the calculations were made assuming a temperature of 50 degrees F and a relative humidity of 70%.

   The applicant responded in a September 2007 response stating the sound level computations were made using the overall A-weighted sound power level data supplied by the manufacturer instead of the octave band sound power levels. In addition, the applicant stated the analysis was made with the assumption that the atmosphere will provide at least 1 dB of excess attenuation in the overall A-weighted sound level at a receiver for every 1000 feet of distance between the turbines and the receiver. The applicant stated that this approach virtually always produces a result that is within 1 dB or so of that predicted by the more rigorous spectral approach. And the applicant said the result using the overall sound power level is virtually always on the conservative side. While the applicant may very well be correct to conclude that the DEQ noise regulation will be met at all receivers, unless I have the results of the calculations using the spectral data, I will not be able to corroborate that conclusion. I still request that the applicant supply the results of an analysis using octave band frequency sound power level data instead of just the A-weighted overall sound power levels.

2. In RAI#3, X5, the applicant was requested to revise Figures RAI#2 X1a and RAI#2 X1b and show the location of all the turbines and noise sensitive receivers and include for each turbine and noise sensitive receptor, an identifying name or number.

   In September, 2007, in response to RAI#3 X7, the applicant supplied Figure RAI#3 X1a and RAI#3 X1b showing wind turbines with a letter and number identifier (B-1 for instance) and residences with a number identifier. The title to Figure RAI#3 X1a indicated the figure showed the location of 192 wind turbines with 109.2 dB LWA. The title to Figure RAI#3 X1b indicated the figure showed the location of 111 wind turbines with 109.2 LWA. It was noted that Residence 11, 12 and 16 were not included on either of the two figures and it was noted that the positions of some of the turbines within a string were either not shown or listed (for instance turbines A-1, D-3 or 7A were not on identified on either of the figures and there were some turbines shown on Figure RAI#3 X1a where there were no identifying letters or numbers).

   In October, 2007, the applicant submitted Figure RAI#3 X1a (revised) and RAI#3 X1b (revised). While the two figures were similar to the original RAI#3 X1a and RAI#3 X1b, both figures had substantial differences from the original ones. The

title of RAI#3 X1a had been changed from 192 wind turbines with 109.2 dB LWA to 267 wind turbines with 111.2 dB LWA and the title of RAI#3 X1b had been changed from 111 wind turbines with 109.2 LWA to 36 wind turbines with 111.2 LWA. In addition, turbine identifiers were shown in the figures for just a few of the turbines in each string and it appears that many turbines have been removed from some of the strings shown in the original figures and inserted among other strings shown in the new figures without turbine identification numbers. Thus it is difficult to know which turbines are which in the revised figures.

In addition to providing the two revised figures in October 2007, the applicant supplied Table RAI#3 X5 to identify the location of 32 residences located within one mile of the facility boundary in terms of degrees, minutes and seconds North and West and the location of the turbine nearest each residence also in terms of degrees, minutes and seconds North and West. It was noted however that, of the 32 residences, the location of residences 11, 12, 16 and 32 were not shown. It was also noted that in Table RAI#3 X5, the location of the turbine nearest residences 16, 20 and 29 were not given. The information in the table indicated the three residences were within the project site boundary but no explanation was given as to why the turbine locations were not given for those residences. Finally, there was no turbine identifier associated with the data shown in Table RAI#3 X5 which would have been very helpful in connecting the data in Table 5 with the data in Figures RAI#3 X1a (revised) and RAI#3 X1b (revised).

Consequently, I will be asking to have each of the turbines and each of the residences identified in Figures RAI#3 X1a and X1b (revised) and I will ask to have the turbine identifiers listed in Table RAI#3 X5.

3. In RAI#3, X8, the applicant was asked to provide the sound levels associated with the substations that would be included in the project. In response, the applicant basically provided a statement saying the substations were located too far from any residences to contribute to the noise at any residence. While this statement may in fact be true, we would still like to have the sound power levels of the transformers included in the record so it will be easier to conduct the final review in the future and so that the public can see all the data that was included in the analysis. I will be asking the applicant to supply the sound data for the record.

4. In RAI#3, X9, the applicant was asked to provide a table showing the predicted total sound pressure level at each receiver and the contribution of each turbine to the overall sound pressure level at each receiver. In October 2007, the applicant supplied a table as requested. However, the layout of the data in the table is so random that it will take a significant amount of time just to verify that the data for all turbines affecting a residence has been included in the table and to get a feel for how much energy is contributed to the exposure at a residence by different strings in the project. The information in the table is used to allow a quick review of the projected noise levels at receivers in the future when the applicant submits

the final layout of the turbines within the requested corridor. I will be asking the applicant to revise the table and present the data in a more organized manner.

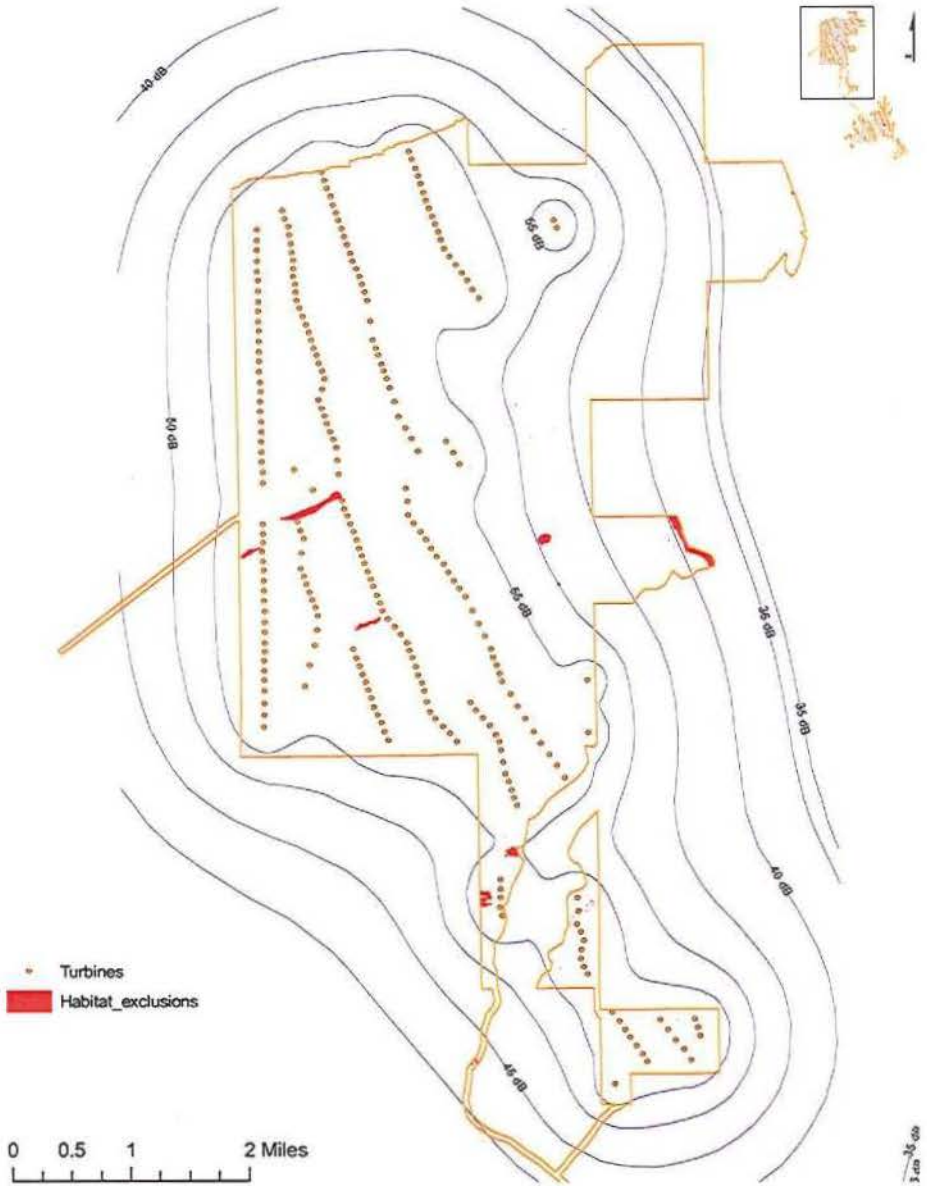
Patricia Pilz

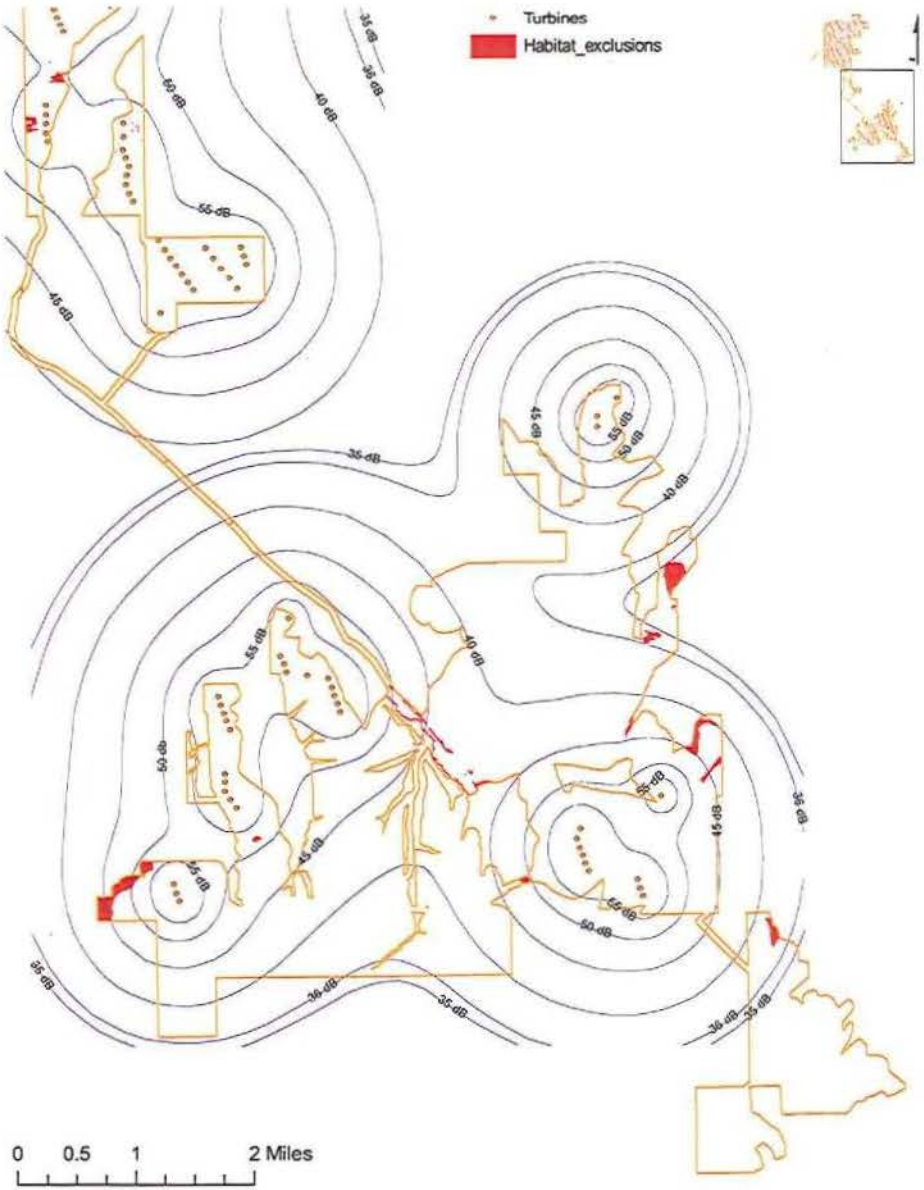
From: Carol Pilz Weisskopf [carol@pilzandco.com]
Sent: Monday, October 29, 2007 5:41 PM
To: John White
Cc: Pat; John Larson
Subject: Noise layout and habitat


Noise S.pdf


Noise N.pdf

I noticed you were concerned that the turbine siting for the noise analysis did not take into consideration our habitat exclusions. I prepared maps showing both, and excluded habitats (including the trees) have all been avoided.


Turbines
Habitat_exclusions
0 0.5 1 2 Miles


Turbines
Habitat_exclusions
0 0.5 1 2 Miles

Patricia Pilz

From: John White [John.White@state.or.us]
Sent: Thursday, November 08, 2007 2:59 PM
To: kstandlee@acoustechgroup.com
Cc: pat@pilzandco.com
Subject: RE: Noise submittals

Kerrie,
At the time you wrote the message below, you were addressing the "November 4 version of the Shepherds Flat Wind Farm site plan" and the related data (Noise110407.xls). You concluded we had sufficient information for completeness.

Subsequently Carol sent a new configuration that uses 280 Siemens 2.3 MW turbines in the north section and 23 Vestas V90 turbines in the south. She sent a data table (Noise110607.xls) and a contour map of the north area (FigureRAI#3X1c.pdf) via e-mail copied to you on 11/6.

The message from Bruce Walker on 11/6 (earlier in the day) included the octave band SPLs for both the Vestas and the Siemens turbines.

The use of the Siemens turbines appears to reduce the sound levels predicted at residences 1-10 in the north area, compared to the November 4 configuration. While it appears to me that Exhibit X is still complete under this revised configuration, would you please confirm for the record that you agree?

Thanks,

John

John G. White
Oregon Department of Energy
625 Marion St., NE
Salem, Oregon 97301-3742
john.white@state.or.us
>>> "Kerrie Standlee" <kstandlee@acoustechgroup.com> 11/06/07 10:35 AM
>>> >>>
John and Pat,

I just got off the phone talking with Bruce Walker and he explained to me that the octave band sound power levels presented in Table B-2 of the application were A-weighted levels and not un-weighted levels. Given that information, the analysis provided by Bruce has sufficiently predicted the maximum noise level at receptors for the layout shown in the November 4 version of the Shepherds Flat Wind Farm site plan. Therefore, I conclude that we have enough information in the record now to find the noise section of the application complete.

Kerrie Standlee
phone 503-646-4420; fax 503-646-3385

-----Original Message-----
From: Noiseybw@aol.com [mailto:Noiseybw@aol.com]
Sent: Tuesday, November 06, 2007 9:14 AM
To: John.White@state.or.us; kstandlee@acoustechgroup.com; Noiseybw@aol.com;
Pat@pilzandco.com
Cc: dgrant@caithnessenergy.com; jflarson@PacificEnergySystems.com;
carol@pilzandco.com
Subject: Re: Noise submittals

In a message dated 11/6/07 4:57:12 AM, John.White@state.or.us writes:

It appears from Bruce's message that he used the appropriate sound power levels in the calculation, but I will wait for Kerrie to review this. I am a bit puzzled by the comment that the Table B-2 values add up to 109.3. Kerrie found the total to be 107.5, but perhaps he can confer with Bruce to figure out the discrepancy. For the record, we would still like to know the octave band sound power levels that were used as input to the calculation.

John,

I have confirmed that the problem was double-Aweighting. Possibly the tabulated octaves were not explicitly stated to be A-weighted.

The values we used are shown in the atteched exerpt from the Matlab script. The LwAOct values are straight from the manufacturers' ratings. 2 dB was added prior to running as shown. (If you aren't familiar with Matlab, give me a call and I'll walk you through it.)

For Vestas, LwA is 109.3 and LwAA is 107.5. LwA recalculated after adding 2 dB is 111.3 as reported. The extra tenth of a dB compared to the 109.2 dB stated LwA probably results from round-off or the distribution of noise in the octave bands. We just left it is as an added conservatism pad.

For Siemens, LwA is 107.0 and LwAA is 103.9. LwA recalculated after adding 2 dB is 109.0 as reported.

For both cases, the octave band sound powers were preserved through the distance attenuation process and then added for each reception point to recover the overall A-weighted sound level.

```
ORantifudge=2 % Evaluate at upper end of turbine uncertainty range OctFreq=[63 125 250 500
1000 2000 4000 8000] % ISO Octave Bands
Awt=Aweight(OctFreq)
%LwAOct=[92.4 97.4 101.6 104.2 104.3 99.4 93.1 82.9] % Vestas V90 Octaves LwAOct=[86.3
95.3 102.0 102.6 99.0 95.0 90.2 85.4] % Siemens SWT-2.3 Octaves
LwA=10*log10(sum(10.^(LwAOct/10)))
LwAA=10*log10(sum(10.^((LwAOct+Awt)/10)))
LwAOct=LwAOct+ORantifudge*ones(size(LwAOct))
LwA=10*log10(sum(10.^(LwAOct/10)));
TurbPower=10.^((LwAOct-120)/10);
```

Respectfully,

Bruce

Bruce Walker, Ph.D., INCE Bd. Cert.
Channel Islands Acoustics
805-484-8000
FAX 805-482-5075
bwalker@channelislandsacoustics.com
noiseybw@aol.com

Patricia Pilz

From: Patricia Pilz [pat@pilzandco.com]
Sent: Monday, November 12, 2007 2:18 PM
To: 'John White'; 'jflarson@pacificenergysystems.com'; 'kstandlee@acoustechgroup.com'
Cc: Derrel A. Grant
Subject: Unified noise correspondence

Here is the unified noise information.

Regards,
Pat

Patricia Pilz
Pilz & Co, LLC
656 San Miguel Way
Sacramento, CA 95819
(T) 916-456-7651
(M) 916-803-0602

Noise analysis description

Turbine layout
The submitted noise layout places 280 Siemens SWT-2.3-93 turbines in the north project area and 23 Vestas V90 turbines in the south project area. This layout requires four transformers in the north substation and one transformer in the south substation. Each turbine and residence has been assigned a unique identifying number. The identifying number assigned to each of the 303 turbines and 31 residences shown in the tabulation of sound levels in the attached Excel file (Noise final.xls) is identical to that shown for the corresponding turbine or residence shown in the attached figures (RAI#3X1aRevision3.PDF, RAI#3X1bRevision3.PDF and RAI#3 X1c.PDF). Although all turbine identification numbers have been shown in these figures, please note that residence numbers 11, 12, 14 and 16 in the south project area are all located in the same compound and are therefore not individually discernable at the scale of the map.

The facility as shown in the noise layout is physically buildable. The turbine locations for the noise analysis comply with proposed siting restrictions (habitat avoidance areas and turbine setbacks from the Columbia River bluffs and the Willow Creek Valley). Turbine placement is consistent with string locations shown in the typical layout, and therefore the noise layout does not conflict with the cultural resource survey corridors. The locations of both substations in the noise layout are identical to their locations in the typical layout.

Location data
Noise final.xls shows each location for 303 turbines, five transformers and 31 residences, with latitude and longitude presented in degrees, minutes and seconds using the NAD83 reference datum. Residence locations are to the nearest whole second, and facility component locations shown to the nearest tenth of a second.

Sound level computations
Sound level computations tabulated in Noise final.xls for all turbines were based on the octave band sound power level data associated with each turbine model, as supplied by the corresponding manufacturer and shown in Table B-2 of revised Exhibit B. Although not stated in the table, the Vestas and Siemens data are A-weighted sound levels.

The octave band sound power levels were adjusted to result in overall A-weighted sound power levels 2.0 dB(A) higher than the unadjusted sum, resulting in overall sound levels of 111.3 and 109.0 dB(A) for the Vestas and Siemens turbines, respectively. These are 2.1 and 2.0 dB(A) higher than the manufacturer's guaranteed maximum sound power levels shown in Table B-1 for the Vestas and Siemens turbines, respectively. For both turbine models, the octave band sound powers were preserved through the distance attenuation process and then added for each residence to recover the overall A-weighted sound level.

Sound levels tabulated in Noise final.xls for transformers were computed using overall A-weighted sound power level data, using 105 dB(A) for each transformer in the north substation and 101 dB(A) for the single transformer in the south substation. Sound contours shown for the north turbines in RAI#3 X1c.PDF were based on an overall A-weighted sound power level of

109.0 dB(A). This represents the manufacturer's maximum guaranteed sound power level for the Siemens turbines (Exhibit B Table B-1) plus an uncertainty level of 2.0 dB(A).

Calculation of the data compiled in Noise final.xls assumed a temperature of 50°F and a relative humidity of 70%. Ground attenuation was set at 0 dB per km. Topographical data were not included in the model so terrain effects were ignored. All turbine locations for calculations tabulated in Noise final.xls are as shown in the attached figures.

RAI#3X1c.PDF shows noise contours produced by 280 SWT-2.3-93 turbines in the north project area. Turbine and residence locations in this figure are identical to those shown in RAI#3X1aRevision3.PDF and tabulated in Noise final.xls. The attenuation rate used in developing these contours was adjusted to give the best match between contours and the sound levels generated from the octave data.

Consistency with previous submissions

Noise final.xls has been formatted to allow it to be conveniently printed, with some editing to clarify headings, tab names and column labels. It contains the exact turbine and transformer sound levels, turbine and transformer locations and turbine and residence identifying numbers as Noise110607.xls, submitted on November 6, 2007. In Noise final.xls, the turbine and transformer locations, turbine and residence identifying numbers and south project area turbine sound levels are identical to those in Noise110407.xls, submitted on November 4, 2007. The residence identifying numbers and location data in Noise final.xls are identical to those in CorrectedResidencesTable.PDF submitted on October 29, 2007 and in ResidenceLocationTable.xls, submitted on November 2, 2007.

The attached figures have been formatted to display the identification number of the turbines, and an error in identification of one turbine in RAI#3X1bRevision3.PDF as submitted on November 4, 2007 was corrected. Other than the number of the misidentified turbine, residences and turbine locations and identification numbers in the attached figures are identical to those shown in correspondingly named figures submitted November 4 and November 6, 2007.

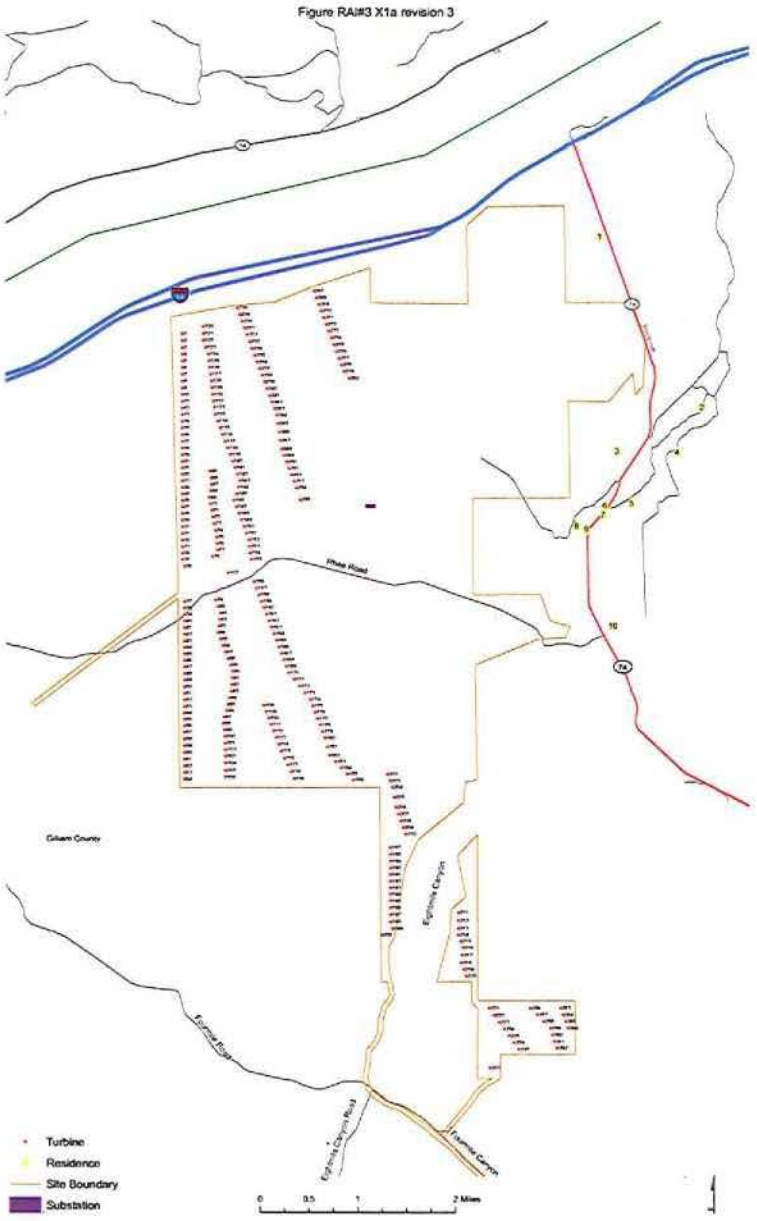
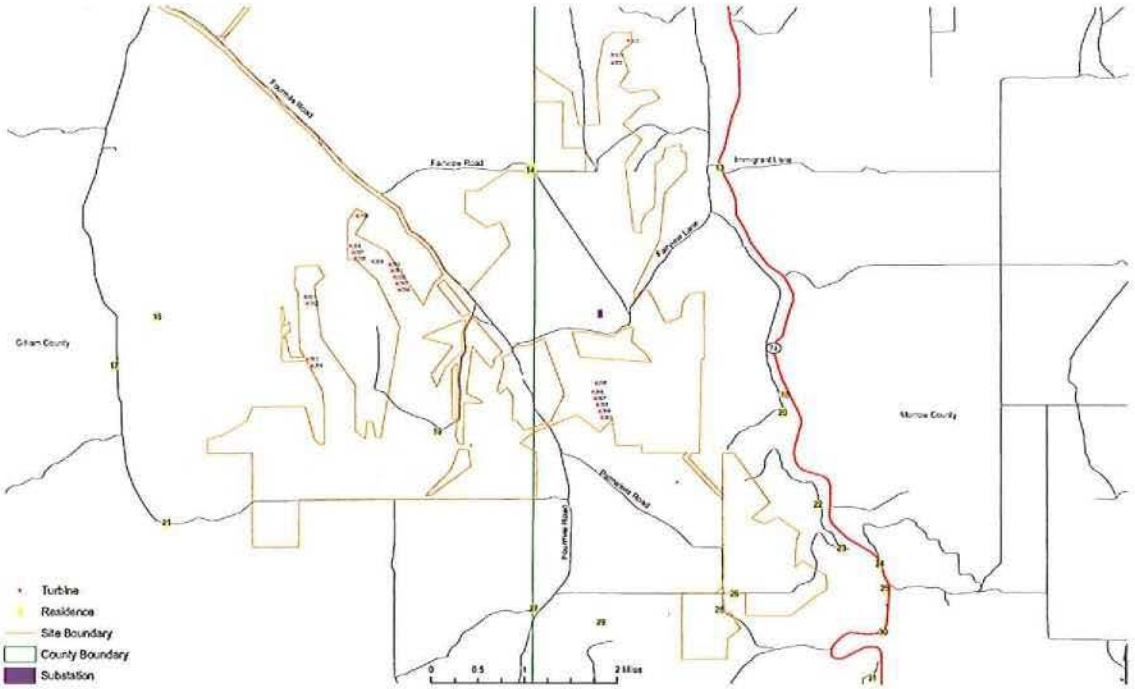


Figure RA#3 X1b revision 3



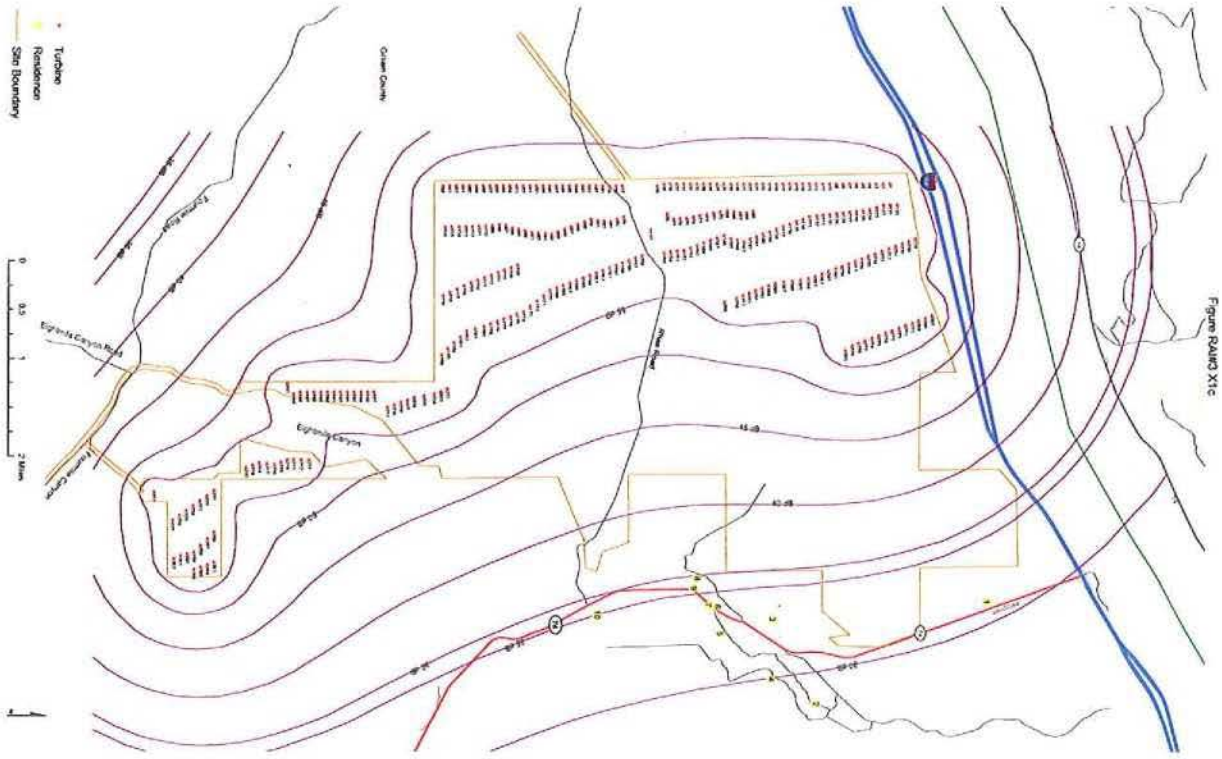


Figure RA#3 X1c

Residence locations

Residence ID	Longitude Degrees	Longitude Minutes	Longitude Seconds	Latitude Degrees	Latitude Minutes	Latitude Seconds
1	-120	2	1	45	46	21
2	-120	0	43	45	44	51
3	-120	1	48	45	44	28
4	-120	1	2	45	44	27
5	-120	1	37	45	43	59
6	-120	1	57	45	43	57
7	-120	1	59	45	43	53
8	-120	2	19	45	43	47
9	-120	2	12	45	43	45
10	-120	1	52	45	42	53
11*	-119	59	58	45	37	8
12*	-119	59	56	45	37	8
13	-119	57	26	45	37	7
14*	-119	59	58	45	37	7
15	-120	4	57	45	35	46
16*	-119	59	58	45	37	5
17	-120	5	28	45	35	19
18	-119	56	34	45	35	1
19	-120	1	12	45	34	42
20	-119	56	35	45	34	51
21	-120	4	47	45	33	52
22	-119	56	8	45	34	0
23	-119	55	49	45	33	35
24	-119	55	19	45	33	26
25	-119	55	15	45	33	13
26	-119	57	15	45	33	11
27	-119	59	55	45	33	3
28	-119	57	27	45	33	2
29	-119	59	2	45	32	54
30	-119	55	16	45	32	49
31	-119	55	25	45	32	23

* These 4 residences are in the same compound.

North turbine locations: Turbines are Siemens SWT-2.3-93

Turbine ID	Longitude Degrees	Longitude Minutes	Longitude Seconds	Latitude Degrees	Latitude Minutes	Latitude Seconds
1	-120	7	19.3	45	45	30.8
2	-120	7	19.3	45	45	27.2
3	-120	7	19.3	45	45	23.7
4	-120	7	19.3	45	45	20.1
5	-120	7	19.4	45	45	16.5
6	-120	7	19.4	45	45	13.0
7	-120	7	19.4	45	45	9.4
8	-120	7	19.4	45	45	5.8
9	-120	7	19.4	45	45	2.3
10	-120	7	19.5	45	44	58.7
11	-120	7	19.5	45	44	55.1
12	-120	7	19.5	45	44	51.6
13	-120	7	19.5	45	44	48.0
14	-120	7	19.6	45	44	44.5
15	-120	7	19.6	45	44	40.9
16	-120	7	19.6	45	44	37.3
17	-120	7	19.6	45	44	33.8
18	-120	7	19.7	45	44	30.2
19	-120	7	19.7	45	44	26.6
20	-120	7	19.7	45	44	23.1
21	-120	7	19.7	45	44	19.5
22	-120	7	19.8	45	44	16.0
23	-120	7	19.8	45	44	12.4
24	-120	7	19.8	45	44	8.8
25	-120	7	19.8	45	44	5.3
26	-120	7	19.9	45	44	1.7
27	-120	7	19.9	45	43	58.1
28	-120	7	19.9	45	43	54.6
29	-120	7	19.9	45	43	51.0
30	-120	7	19.9	45	43	47.5
31	-120	7	20.0	45	43	43.9
32	-120	7	20.0	45	43	40.3
33	-120	7	20.0	45	43	36.8
34	-120	7	20.0	45	43	33.2
35	-120	7	20.1	45	43	29.6
36	-120	7	18.5	45	43	26.1
37	-120	7	18.7	45	43	7.2
38	-120	7	18.7	45	43	3.7
39	-120	7	18.7	45	43	0.1
40	-120	7	18.7	45	42	56.6
41	-120	7	18.8	45	42	53.0
42	-120	7	18.8	45	42	49.4
43	-120	7	18.8	45	42	45.9
44	-120	7	18.8	45	42	42.3
45	-120	7	18.9	45	42	38.7
46	-120	7	18.9	45	42	35.2
47	-120	7	18.9	45	42	31.6

North turbine locations: Turbines are Siemens SWT-2.3-93

Turbine ID	Longitude Degrees	Minutes	Seconds	Latitude Degrees	Minutes	Seconds
48	-120	7	18.9	45	42	28.0
49	-120	7	19.0	45	42	24.5
50	-120	7	19.0	45	42	20.9
51	-120	7	19.0	45	42	17.4
52	-120	7	19.0	45	42	13.8
53	-120	7	19.0	45	42	10.2
54	-120	7	19.1	45	42	6.7
55	-120	7	19.1	45	42	3.1
56	-120	7	19.1	45	41	59.5
57	-120	7	19.1	45	41	56.0
58	-120	7	19.2	45	41	52.4
59	-120	7	19.2	45	41	48.9
60	-120	7	19.2	45	41	45.3
61	-120	7	19.2	45	41	41.7
62	-120	7	19.3	45	41	38.2
63	-120	7	19.3	45	41	34.6
64	-120	7	19.3	45	41	31.0
65	-120	6	58.8	45	44	17.6
66	-120	6	57.8	45	44	14.1
67	-120	6	57.6	45	44	10.5
68	-120	6	58.2	45	44	6.9
69	-120	6	59.4	45	44	3.4
70	-120	6	58.5	45	43	59.8
71	-120	6	57.5	45	43	56.3
72	-120	6	56.6	45	43	52.7
73	-120	6	55.7	45	43	49.1
74	-120	6	54.8	45	43	45.6
75	-120	6	53.9	45	43	42.0
76	-120	6	53.6	45	43	38.4
77	-120	6	53.4	45	43	34.9
78	-120	6	57.3	45	43	31.3
79	-120	6	55.2	45	43	8.0
80	-120	6	53.3	45	43	4.4
81	-120	6	51.4	45	43	0.9
82	-120	6	51.9	45	42	57.4
83	-120	6	52.4	45	42	53.8
84	-120	6	53.3	45	42	50.3
85	-120	6	51.4	45	42	46.8
86	-120	6	49.6	45	42	43.2
87	-120	6	47.7	45	42	39.7
88	-120	6	45.8	45	42	36.1
89	-120	6	44.0	45	42	32.6
90	-120	6	42.1	45	42	29.1
91	-120	6	42.6	45	42	25.5
92	-120	6	43.0	45	42	22.0
93	-120	6	43.5	45	42	18.5
94	-120	6	44.7	45	42	15.0

North turbine locations: Turbines are Siemens SWT-2.3-93

Turbine ID	Longitude Degrees	Minutes	Seconds	Latitude Degrees	Minutes	Seconds
95	-120	6	45.8	45	42	11.4
96	-120	6	46.9	45	42	7.9
97	-120	6	48.9	45	42	4.4
98	-120	6	49.4	45	42	0.8
99	-120	6	48.7	45	41	57.3
100	-120	6	48.4	45	41	53.8
101	-120	6	48.4	45	41	50.3
102	-120	6	48.1	45	41	46.7
103	-120	6	48.1	45	41	43.2
104	-120	6	48.1	45	41	39.7
105	-120	6	48.1	45	41	35.7
106	-120	6	48.2	45	41	32.1
107	-120	6	45.2	45	43	22.4
108	-120	6	18.6	45	42	10.8
109	-120	6	16.7	45	42	7.2
110	-120	6	14.9	45	42	3.7
111	-120	6	13.0	45	42	0.1
112	-120	6	11.2	45	41	56.6
113	-120	6	9.3	45	41	53.1
114	-120	6	7.4	45	41	49.5
115	-120	6	5.6	45	41	46.0
116	-120	6	3.1	45	41	42.2
117	-120	6	0.7	45	41	38.5
118	-120	5	58.2	45	41	34.8
119	-120	5	55.8	45	41	31.1
120	-120	7	3.3	45	45	34.5
121	-120	7	3.3	45	45	30.9
122	-120	7	3.3	45	45	27.3
123	-120	7	1.5	45	45	23.8
124	-120	6	59.6	45	45	20.2
125	-120	6	59.0	45	45	16.6
126	-120	6	58.5	45	45	13.1
127	-120	6	57.9	45	45	9.5
128	-120	6	57.4	45	45	5.9
129	-120	6	56.8	45	45	2.4
130	-120	6	56.2	45	44	58.8
131	-120	6	55.7	45	44	55.3
132	-120	6	55.1	45	44	51.7
133	-120	6	54.5	45	44	48.1
134	-120	6	52.7	45	44	44.6
135	-120	6	50.8	45	44	41.0
136	-120	6	49.0	45	44	37.4
137	-120	6	47.1	45	44	33.8
138	-120	6	45.2	45	44	30.3
139	-120	6	43.4	45	44	26.7
140	-120	6	41.5	45	44	23.1
141	-120	6	39.6	45	44	19.6

North turbine locations: Turbines are Siemens SWT-2.3-93

Turbine ID	Longitude Degrees	Minutes	Seconds	Latitude Degrees	Minutes	Seconds
142	-120	6	37.8	45	44	16.0
143	-120	6	35.9	45	44	12.4
144	-120	6	37.1	45	44	8.9
145	-120	6	38.2	45	44	5.3
146	-120	6	40.5	45	44	1.8
147	-120	6	38.7	45	43	58.2
148	-120	6	36.8	45	43	54.6
149	-120	6	34.9	45	43	51.1
150	-120	6	33.1	45	43	47.5
151	-120	6	31.2	45	43	43.9
152	-120	6	29.3	45	43	40.3
153	-120	6	28.8	45	43	36.8
154	-120	6	28.4	45	43	33.2
155	-120	6	27.4	45	43	29.6
156	-120	6	25.6	45	43	17.9
157	-120	6	23.7	45	43	14.4
158	-120	6	21.8	45	43	10.8
159	-120	6	20.0	45	43	7.3
160	-120	6	18.1	45	43	3.7
161	-120	6	16.2	45	43	0.2
162	-120	6	14.4	45	42	56.6
163	-120	6	12.5	45	42	53.1
164	-120	6	10.6	45	42	49.6
165	-120	6	8.7	45	42	46.0
166	-120	6	6.9	45	42	42.4
167	-120	6	5.0	45	42	38.9
168	-120	6	3.2	45	42	35.4
169	-120	6	1.3	45	42	31.8
170	-120	5	59.4	45	42	28.3
171	-120	5	55.4	45	42	24.7
172	-120	5	51.3	45	42	21.1
173	-120	5	47.3	45	42	17.5
174	-120	5	43.2	45	42	13.9
175	-120	5	41.4	45	42	10.4
176	-120	5	39.5	45	42	6.9
177	-120	5	37.7	45	42	3.3
178	-120	5	35.8	45	41	59.8
179	-120	5	33.9	45	41	56.2
180	-120	5	32.1	45	41	52.7
181	-120	5	30.4	45	41	48.1
182	-120	5	28.7	45	41	43.5
183	-120	5	24.2	45	41	40.2
184	-120	5	19.7	45	41	36.9
185	-120	5	15.2	45	41	33.6
186	-120	5	10.7	45	41	30.4
187	-120	4	42.6	45	40	54.5
188	-120	4	42.6	45	40	50.9

North turbine locations: Turbines are Siemens SWT-2.3-93

Turbine ID	Longitude Degrees	Minutes	Seconds	Latitude Degrees	Minutes	Seconds
189	-120	4	42.6	45	40	47.4
190	-120	4	42.6	45	40	43.8
191	-120	4	42.7	45	40	40.3
192	-120	4	42.7	45	40	36.7
193	-120	4	42.7	45	40	33.1
194	-120	4	42.7	45	40	29.6
195	-120	4	42.8	45	40	26.0
196	-120	4	42.8	45	40	22.4
197	-120	4	42.8	45	40	18.9
198	-120	4	42.8	45	40	15.3
199	-120	4	41.5	45	40	11.7
200	-120	4	49.5	45	40	8.2
201	-120	3	27.6	45	38	56.1
202	-120	4	44.6	45	41	33.4
203	-120	4	42.8	45	41	29.8
204	-120	4	40.9	45	41	26.3
205	-120	4	39.6	45	41	21.1
206	-120	4	38.3	45	41	15.8
207	-120	4	36.4	45	41	12.3
208	-120	4	34.6	45	41	8.7
209	-120	4	32.7	45	41	5.2
210	-120	4	30.9	45	41	1.6
211	-120	3	51.0	45	40	19.8
212	-120	3	51.2	45	40	15.7
213	-120	3	51.3	45	40	11.7
214	-120	3	51.5	45	40	8.2
215	-120	3	49.6	45	40	4.6
216	-120	3	47.8	45	40	1.1
217	-120	3	48.5	45	39	57.0
218	-120	3	49.2	45	39	52.8
219	-120	3	47.4	45	39	49.3
220	-120	3	45.5	45	39	45.8
221	-120	3	28.2	45	39	28.4
222	-120	3	24.5	45	39	24.7
223	-120	3	20.7	45	39	20.9
224	-120	3	16.9	45	39	17.2
225	-120	3	13.2	45	39	13.5
226	-120	3	9.4	45	39	9.8
227	-120	3	5.7	45	39	6.1
228	-120	6	37.3	45	45	44.3
229	-120	6	35.4	45	45	40.7
230	-120	6	33.5	45	45	37.2
231	-120	6	31.7	45	45	33.7
232	-120	6	29.8	45	45	30.1
233	-120	6	27.9	45	45	26.6
234	-120	6	26.1	45	45	23.0
235	-120	6	24.2	45	45	19.5

North turbine locations: Turbines are Siemens SWT-2.3-93

Turbine ID	Longitude Degrees	Minutes	Seconds	Latitude Degrees	Minutes	Seconds
236	-120	6	22.3	45	45	15.9
237	-120	6	20.5	45	45	12.4
238	-120	6	18.6	45	45	8.8
239	-120	6	16.7	45	45	5.3
240	-120	6	14.8	45	45	1.8
241	-120	6	13.0	45	44	58.2
242	-120	6	11.1	45	44	54.7
243	-120	6	9.2	45	44	51.1
244	-120	6	7.4	45	44	47.6
245	-120	6	6.6	45	44	43.1
246	-120	6	5.7	45	44	38.6
247	-120	6	4.9	45	44	34.2
248	-120	6	4.1	45	44	29.7
249	-120	6	2.2	45	44	26.1
250	-120	6	0.3	45	44	22.6
251	-120	5	58.5	45	44	19.1
252	-120	5	56.6	45	44	15.5
253	-120	5	54.7	45	44	12.0
254	-120	5	52.9	45	44	8.4
255	-120	5	49.9	45	44	2.0
256	-120	2	56.7	45	39	28.3
257	-120	2	51.6	45	39	24.7
258	-120	2	46.5	45	39	21.1
259	-120	2	41.4	45	39	17.5
260	-120	2	40.2	45	39	14.0
261	-120	2	38.9	45	39	10.4
262	-120	2	36.4	45	39	6.8
263	-120	2	33.7	45	39	28.2
264	-120	2	31.9	45	39	24.6
265	-120	2	30.0	45	39	21.0
266	-120	2	28.1	45	39	17.5
267	-120	5	38.8	45	45	53.2
268	-120	5	36.9	45	45	49.7
269	-120	5	35.0	45	45	46.1
270	-120	5	33.2	45	45	42.6
271	-120	5	31.3	45	45	39.0
272	-120	5	29.4	45	45	35.5
273	-120	5	27.6	45	45	32.0
274	-120	5	25.7	45	45	28.4
275	-120	5	23.8	45	45	24.8
276	-120	5	21.9	45	45	21.3
277	-120	5	20.1	45	45	17.8
278	-120	5	18.1	45	45	14.3
279	-120	5	16.2	45	45	10.8
280	-120	5	12.5	45	45	7.0

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine ID	1 31.58	2 28.497	3 33.34	4 30.149	5 32.898	6 34.304	7 34.49	8 35.963	9 35.494	10 35.139
1	7.7677	2.3908	6.5175	3.2698	4.8514	6.1336	6.1112	7.2021	6.6434	2.7786
2	7.6841	2.4369	6.6091	3.3485	4.9753	6.2692	6.2526	7.3615	6.8011	2.9727
3	7.5952	2.4788	6.6958	3.423	5.0951	6.4004	6.3897	7.5168	6.9546	3.1642
4	7.5012	2.5164	6.7775	3.4932	5.2107	6.5273	6.5225	7.6676	7.1039	3.3529
5	7.4019	2.5497	6.854	3.559	5.3219	6.6496	6.6508	7.8141	7.2489	3.5389
6	7.2977	2.5787	6.9255	3.6204	5.4287	6.7674	6.7746	7.9559	7.3895	3.7219
7	7.1885	2.6034	6.9917	3.6774	5.5311	6.8804	6.8938	8.0931	7.5255	3.9019
8	7.0745	2.6237	7.0526	3.73	5.6289	6.9887	7.0083	8.2254	7.6569	4.0789
9	6.9556	2.6396	7.1083	3.778	5.7221	7.092	7.118	8.3529	7.7835	4.2527
10	6.8321	2.6512	7.1585	3.8215	5.8106	7.1905	7.2228	8.4753	7.9052	4.4233
11	6.7041	2.6584	7.2034	3.8605	5.8943	7.2839	7.3227	8.5925	8.022	4.5905
12	6.5715	2.6611	7.2428	3.8948	5.9732	7.3721	7.4174	8.7046	8.1337	4.7543
13	6.4346	2.6595	7.2767	3.9246	6.0473	7.4552	7.507	8.8112	8.2402	4.9145
14	6.2934	2.6535	7.3051	3.9497	6.1164	7.533	7.5914	8.9125	8.3415	5.0712
15	6.148	2.6431	7.3279	3.9701	6.1805	7.6054	7.6705	9.0081	8.4374	5.2241
16	5.9986	2.6284	7.3452	3.9859	6.2395	7.6725	7.7443	9.0981	8.5278	5.3732
17	5.8451	2.6093	7.3569	3.997	6.2935	7.7341	7.8125	9.1824	8.6127	5.5184
18	5.6878	2.5858	7.363	4.0034	6.3423	7.7902	7.8753	9.2609	8.692	5.6597
19	5.5267	2.5579	7.3635	4.0052	6.3859	7.8406	7.9325	9.3334	8.7656	5.7968
20	5.3619	2.5258	7.3584	4.0022	6.4243	7.8855	7.9842	9.4	8.8334	5.9298
21	5.1936	2.4893	7.3477	3.9945	6.4575	7.9247	8.0301	9.4605	8.8953	6.0585
22	5.0217	2.4486	7.3314	3.9822	6.4854	7.9582	8.0703	9.5149	8.9514	6.1828
23	4.8465	2.4036	7.3095	3.9652	6.508	7.9859	8.1048	9.5631	9.0014	6.3027
24	4.668	2.3543	7.2821	3.9435	6.5252	8.0079	8.1335	9.6051	9.0455	6.418
25	4.4863	2.3009	7.2492	3.9172	6.5372	8.0241	8.1564	9.6408	9.0835	6.5287
26	4.3015	2.2433	7.2108	3.8863	6.5437	8.0345	8.1735	9.6701	9.1154	6.6347
27	4.1137	2.1816	7.1669	3.8507	6.5449	8.0391	8.1847	9.6931	9.1411	6.7359
28	3.923	2.1157	7.1176	3.8106	6.5408	8.0379	8.19	9.7098	9.1607	6.8322
29	3.7294	2.0458	7.0629	3.7659	6.5313	8.0308	8.1895	9.72	9.1741	6.9235
30	3.5332	1.9719	7.0029	3.7167	6.5165	8.018	8.1831	9.7238	9.1813	7.0098
31	3.3343	1.894	6.9376	3.6629	6.4963	7.9993	8.1709	9.7212	9.1823	7.091
32	3.1328	1.8122	6.8671	3.6048	6.4708	7.9749	8.1528	9.7122	9.177	7.167

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
33	2.9288	1.7265	6.7914	3.5422	6.4401	7.9447	8.1288	9.6968	9.1656	7.2378
34	2.7225	1.637	6.7106	3.4752	6.404	7.9088	8.0991	9.675	9.1479	7.3033
35	2.5138	1.5437	6.6248	3.4039	6.3628	7.8672	8.0636	9.6468	9.1241	7.3634
36	2.388	1.5485	6.6441	3.4345	6.4286	7.9349	8.1378	9.7311	9.212	7.5322
37	1.2332	0.97219	6.0813	2.9629	6.096	7.5907	7.8238	9.4431	8.9508	7.7309
38	1.009	0.85228	5.9605	2.861	6.0174	7.5086	7.7471	9.3694	8.8827	7.7507
39	0.78316	0.72903	5.8353	2.7552	5.934	7.4213	7.665	9.2899	8.8087	7.7647
40	0.55561	0.60248	5.7058	2.6456	5.8457	7.3288	7.5776	9.2044	8.7291	7.7731
41	0.32646	0.4727	5.5721	2.5322	5.7528	7.2312	7.485	9.1132	8.6437	7.7757
42	0.095775	0.33974	5.4343	2.415	5.6552	7.1286	7.3872	9.0163	8.5528	7.7726
43	-0.13639	0.20367	5.2924	2.2942	5.553	7.0211	7.2844	8.9139	8.4564	7.7638
44	-0.36997	0.064537	5.1466	2.1698	5.4463	6.9087	7.1767	8.8059	8.3546	7.7492
45	-0.60493	-0.077594	4.997	2.0419	5.3352	6.7916	7.064	8.6927	8.2475	7.729
46	-0.8412	-0.22266	4.8437	1.9105	5.2197	6.6699	6.9466	8.5741	8.1352	7.703
47	-1.0787	-0.37061	4.6866	1.7757	5.0999	6.5436	6.8245	8.4504	8.0178	7.6714
48	-1.3175	-0.52138	4.5261	1.6376	4.976	6.4128	6.6978	8.3216	7.8954	7.6342
49	-1.5574	-0.67491	4.362	1.4962	4.8479	6.2777	6.5666	8.188	7.7682	7.5913
50	-1.7984	-0.83114	4.1946	1.3516	4.7158	6.1383	6.431	8.0495	7.6361	7.543
51	-2.0405	-0.99002	4.0238	1.2039	4.5798	5.9948	6.2911	7.9063	7.4994	7.4891
52	-2.2837	-1.1515	3.8499	1.0532	4.4399	5.8471	6.1471	7.7585	7.3581	7.4297
53	-2.5278	-1.3155	3.6728	0.89939	4.2963	5.6955	5.9989	7.6063	7.2123	7.3649
54	-2.7729	-1.4819	3.4927	0.74269	4.1489	5.5401	5.8467	7.4497	7.0622	7.2948
55	-3.0189	-1.6508	3.3097	0.58312	3.998	5.3808	5.6906	7.2889	6.9078	7.2194
56	-3.2658	-1.822	3.1238	0.42076	3.8435	5.2179	5.5307	7.124	6.7494	7.1388
57	-3.5134	-1.9956	2.9352	0.25567	3.6856	5.0514	5.3671	6.9551	6.5869	7.053
58	-3.7619	-2.1714	2.7438	0.087903	3.5244	4.8814	5.1999	6.7824	6.4205	6.9621
59	-4.0112	-2.3494	2.5499	-0.082465	3.3599	4.708	5.0292	6.6058	6.2504	6.8663
60	-4.2612	-2.5295	2.3534	-0.25537	3.1922	4.5313	4.8551	6.4257	6.0765	6.7655
61	-4.5118	-2.7117	2.1545	-0.43076	3.0214	4.3515	4.6777	6.2419	5.8991	6.6599
62	-4.7632	-2.8959	1.9532	-0.60857	2.8476	4.1685	4.4971	6.0548	5.7182	6.5495
63	-5.0151	-3.0822	1.7495	-0.78873	2.6708	3.9825	4.3134	5.8643	5.5339	6.4345
64	-5.2677	-3.2703	1.5437	-0.97118	2.4912	3.7936	4.1266	5.6707	5.3464	6.3148

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
65	6.4136	3.9085	8.8923	5.4674	8.0011	9.5051	9.6138	11.083	10.501	7.5512
66	6.2848	3.9263	8.9405	5.5172	8.0967	9.6084	9.7245	11.21	10.63	7.747
67	6.109	3.8914	8.9306	5.5126	8.1355	9.6531	9.7766	11.278	10.7	7.8908
68	5.8793	3.7947	8.8526	5.4439	8.1069	9.6285	9.7593	11.274	10.699	7.9716
69	5.6167	3.659	8.731	5.3343	8.0348	9.5589	9.6969	11.224	10.652	8.0111
70	5.4731	3.6582	8.7546	5.3638	8.1073	9.637	9.7825	11.325	10.755	8.1887
71	5.3281	3.6558	8.7754	5.3914	8.1775	9.7125	9.8654	11.422	10.855	8.3653
72	5.1763	3.6454	8.7866	5.4105	8.2385	9.7781	9.9384	11.51	10.944	8.5342
73	5.0232	3.6335	8.7948	5.4277	8.2969	9.8408	10.009	11.593	11.031	8.7018
74	4.8637	3.6136	8.7934	5.4364	8.3461	9.8934	10.069	11.667	11.108	8.8613
75	4.703	3.5921	8.7891	5.4432	8.3926	9.9431	10.126	11.736	11.181	9.0194
76	4.4976	3.5164	8.7246	5.393	8.3783	9.9299	10.12	11.741	11.189	9.1181
77	4.2896	3.4364	8.6543	5.338	8.3582	9.9102	10.107	11.738	11.19	9.2111
78	3.8582	3.0828	8.2852	4.9965	8.0328	9.5772	9.7791	11.409	10.869	8.9968
79	2.4793	2.4912	7.7184	4.5497	7.7824	9.3152	9.5595	11.231	10.727	9.4738
80	2.3392	2.4849	7.719	4.5681	7.834	9.3657	9.6168	11.296	10.797	9.6404
81	2.1952	2.4738	7.7131	4.5812	7.8793	9.4092	9.6672	11.353	10.859	9.8015
82	1.933	2.3098	7.5411	4.4329	7.7507	9.2745	9.5377	11.223	10.737	9.7772
83	1.6699	2.1429	7.3652	4.281	7.6174	9.1348	9.403	11.088	10.609	9.7466
84	1.384	1.9444	7.1548	4.0954	7.447	8.957	9.2298	10.913	10.441	9.6747
85	1.2323	1.9197	7.1304	4.0926	7.4724	8.9786	9.2578	10.945	10.479	9.8142
86	1.075	1.8875	7.0968	4.0815	7.4882	8.9901	9.2755	10.966	10.507	9.944
87	0.91214	1.8478	7.0541	4.0622	7.4946	8.9914	9.2829	10.976	10.523	10.064
88	0.74813	1.8063	7.0084	4.0406	7.4978	8.9891	9.2866	10.981	10.536	10.181
89	0.58088	1.7601	6.9566	4.0137	7.4947	8.98	9.2833	10.978	10.541	10.291
90	0.41046	1.7093	6.8988	3.9817	7.4853	8.9639	9.2729	10.968	10.538	10.395
91	0.13519	1.5151	6.6876	3.7975	7.311	8.78	9.0928	10.783	10.36	10.312
92	-0.13854	1.3212	6.4763	3.6133	7.1359	8.5952	8.9116	10.596	10.181	10.227
93	-0.41467	1.1224	6.2593	3.4235	6.9541	8.4034	8.7232	10.401	9.9938	10.132
94	-0.72216	0.8788	5.9947	3.1859	6.7202	8.1588	8.4813	10.151	9.7514	9.9752
95	-1.0236	0.6417	5.7369	2.9549	6.4928	7.9206	8.2458	9.9079	9.5155	9.8238
96	-1.3268	0.40047	5.4745	2.7191	6.2597	7.6768	8.0044	9.6584	9.2733	9.6637

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
97	-1.6637	0.11111	5.1616	2.4322	5.9711	7.3769	7.7062	9.3506	8.9725	9.4373
98	-1.9399	-0.096444	4.9344	2.2313	5.7745	7.1699	7.502	9.1389	8.7679	9.3152
99	-2.1684	-0.23946	4.7745	2.0982	5.6502	7.0358	7.3712	9.002	8.6386	9.2755
100	-2.4146	-0.40819	4.5872	1.9377	5.4957	6.8711	7.2095	8.8333	8.4772	9.1993
101	-2.6743	-0.59696	4.3787	1.7557	5.3177	6.6826	7.0236	8.6397	8.2908	9.0941
102	-2.9203	-0.76792	4.1884	1.5921	5.159	6.5133	6.8571	8.4657	8.124	9.01
103	-3.1812	-0.96102	3.9748	1.4049	4.9743	6.318	6.6641	8.2645	7.9299	8.894
104	-3.4426	-1.1561	3.759	1.2152	4.7866	6.1196	6.4679	8.0599	7.7323	8.7728
105	-3.7405	-1.3804	3.5108	0.99665	4.5695	5.8902	6.2409	7.8231	7.5034	8.6287
106	-4.0052	-1.5814	3.2883	0.80031	4.3739	5.6836	6.0363	7.6096	7.2968	8.4955
107	3.9429	3.6193	8.9028	5.6267	8.7951	10.359	10.583	12.26	11.726	10.055
108	0.036464	2.1602	7.3339	4.5667	8.2373	9.6834	10.031	11.739	11.354	11.873
109	-0.161	2.0755	7.2316	4.4967	8.1824	9.6174	9.9702	11.672	11.297	11.932
110	-0.36036	1.9855	7.1229	4.4205	8.1196	9.5432	9.9007	11.596	11.23	11.98
111	-0.56473	1.8892	7.0066	4.3374	8.0488	9.4604	9.8224	11.51	11.154	12.019
112	-0.77071	1.788	6.8844	4.2484	7.9706	9.3699	9.7361	11.416	11.069	12.047
113	-0.97729	1.6851	6.7595	4.1572	7.8892	9.2757	9.646	11.317	10.98	12.07
114	-1.1861	1.578	6.6294	4.0612	7.8017	9.1751	9.5493	11.212	10.884	12.085
115	-1.3997	1.4648	6.492	3.9584	7.7063	9.0661	9.444	11.096	10.778	12.091
116	-1.6066	1.3685	6.3703	3.8737	7.6301	8.9755	9.3575	10.999	10.692	12.123
117	-1.8174	1.2676	6.2426	3.7839	7.5476	8.8779	9.2638	10.894	10.598	12.148
118	-2.0309	1.1618	6.1088	3.6884	7.4579	8.7728	9.1623	10.781	10.495	12.163
119	-2.2462	1.0508	5.969	3.5867	7.3607	8.6599	9.0528	10.659	10.383	12.166
120	9.0073	3.4196	7.5287	4.255	5.7659	7.0419	7.005	8.069	7.5048	3.4684
121	8.9239	3.4728	7.6315	4.3427	5.9013	7.1901	7.1592	8.2426	7.6761	3.674
122	8.8349	3.5217	7.7292	4.426	6.0326	7.334	7.3091	8.412	7.8433	3.8771
123	8.8774	3.6968	7.9574	4.635	6.2877	7.6027	7.583	8.7048	8.133	4.1873
124	8.9164	3.8714	8.1852	4.8439	6.5433	7.8722	7.8577	8.9987	8.4239	4.4997
125	8.8489	3.9458	8.3086	4.9531	6.7011	8.0427	8.0344	9.1952	8.6182	4.7296
126	8.7789	4.0188	8.4301	5.0612	6.8579	8.2123	8.2101	9.3909	8.8118	4.9601
127	8.6997	4.0842	8.5431	5.1615	7.0073	8.3742	8.3784	9.5791	8.9981	5.1855
128	8.6181	4.1482	8.6541	5.2606	7.1555	8.5348	8.5456	9.7663	9.1834	5.4113

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
129	8.5308	4.2076	8.7597	5.3551	7.2993	8.6909	8.7082	9.949	9.3644	5.6347
130	8.4347	4.2592	8.8563	5.4416	7.4353	8.8388	8.8629	10.124	9.5376	5.8525
131	8.3363	4.3093	8.9507	5.5267	7.5699	8.9852	9.0161	10.297	9.7094	6.0706
132	8.2324	4.3546	9.0394	5.607	7.6997	9.1265	9.1643	10.465	9.8765	6.2858
133	8.1202	4.392	9.1188	5.6792	7.8213	9.2593	9.3042	10.625	10.035	6.4952
134	8.0928	4.5188	9.293	5.8421	8.035	9.4857	9.5374	10.879	10.287	6.7879
135	8.0588	4.6409	9.4619	6.0006	8.2446	9.7079	9.7665	11.129	10.536	7.0791
136	8.0152	4.7549	9.6217	6.151	8.4466	9.9222	9.988	11.372	10.777	7.3656
137	7.9681	4.8673	9.7792	6.3001	8.6475	10.135	10.208	11.613	11.017	7.6533
138	7.9146	4.9748	9.9309	6.4443	8.8438	10.344	10.424	11.85	11.253	7.9391
139	7.8547	5.0772	10.076	6.5835	9.0354	10.547	10.635	12.083	11.484	8.223
140	7.7885	5.1745	10.216	6.7175	9.2221	10.745	10.841	12.31	11.711	8.5047
141	7.716	5.2665	10.349	6.8464	9.4037	10.938	11.042	12.532	11.932	8.7841
142	7.6374	5.3533	10.475	6.97	9.58	11.125	11.237	12.748	12.148	9.0611
143	7.5526	5.4348	10.595	7.0881	9.7508	11.306	11.426	12.959	12.359	9.3355
144	7.2765	5.2967	10.473	6.9789	9.6842	11.243	11.372	12.919	12.322	9.3909
145	6.9988	5.1543	10.346	6.8646	9.611	11.173	11.31	12.87	12.278	9.4398
146	6.6537	4.9308	10.128	6.6654	9.4476	11.01	11.154	12.725	12.137	9.4026
147	6.553	4.9917	10.22	6.7609	9.5928	11.163	11.315	12.905	12.319	9.6583
148	6.4468	5.0471	10.305	6.8507	9.7321	11.31	11.471	13.079	12.494	9.9106
149	6.3351	5.0971	10.382	6.9348	9.8651	11.45	11.619	13.245	12.663	10.159
150	6.2181	5.1415	10.453	7.0129	9.9917	11.583	11.76	13.404	12.824	10.404
151	6.0959	5.1803	10.516	7.0852	10.112	11.709	11.895	13.556	12.978	10.645
152	5.9686	5.2136	10.572	7.1514	10.225	11.827	12.022	13.7	13.125	10.882
153	5.7585	5.1438	10.513	7.1093	10.223	11.826	12.029	13.718	13.148	11.005
154	5.5481	5.0724	10.451	7.065	10.217	11.821	12.031	13.731	13.167	11.126
155	5.3593	5.0274	10.416	7.0479	10.24	11.844	12.063	13.774	13.215	11.276
156	4.6519	4.7615	10.164	6.8646	10.172	11.771	12.015	13.754	13.214	11.63
157	4.4989	4.7576	10.169	6.8889	10.235	11.835	12.087	13.836	13.302	11.825
158	4.3395	4.7469	10.165	6.906	10.291	11.889	12.149	13.908	13.38	12.014
159	4.1783	4.7321	10.155	6.918	10.34	11.936	12.205	13.971	13.45	12.197
160	4.0131	4.7118	10.138	6.9239	10.381	11.975	12.252	14.026	13.511	12.374

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
161	3.8441	4.6861	10.113	6.9237	10.415	12.006	12.29	14.071	13.564	12.544
162	3.6689	4.6535	10.079	6.9161	10.441	12.028	12.32	14.105	13.606	12.708
163	3.4924	4.617	10.04	6.9035	10.46	12.042	12.341	14.131	13.64	12.864
164	3.3124	4.5751	9.9934	6.8849	10.472	12.048	12.355	14.148	13.665	13.014
165	3.1269	4.525	9.9365	6.8571	10.473	12.042	12.356	14.152	13.677	13.152
166	2.9376	4.471	9.874	6.8249	10.469	12.03	12.351	14.148	13.682	13.286
167	2.7475	4.4133	9.8061	6.7881	10.458	12.011	12.339	14.135	13.68	13.412
168	2.5543	4.3504	9.7313	6.7452	10.439	11.984	12.319	14.114	13.668	13.53
169	2.358	4.2824	9.6496	6.6965	10.414	11.949	12.29	14.083	13.646	13.64
170	2.1562	4.2076	9.5593	6.6401	10.379	11.904	12.251	14.04	13.614	13.74
171	2.0374	4.2551	9.5976	6.714	10.485	12.001	12.357	14.147	13.732	14.009
172	1.9123	4.2949	9.6255	6.7793	10.582	12.088	12.451	14.24	13.836	14.268
173	1.7811	4.327	9.6429	6.8358	10.667	12.162	12.534	14.32	13.928	14.518
174	1.6438	4.3513	9.6499	6.8836	10.742	12.225	12.604	14.386	14.007	14.757
175	1.425	4.248	9.5217	6.7942	10.666	12.133	12.518	14.29	13.922	14.811
176	1.2023	4.1375	9.3846	6.6964	10.579	12.031	12.42	14.182	13.826	14.85
177	0.97627	4.0228	9.2421	6.5939	10.486	11.923	12.316	14.067	13.722	14.883
178	0.75068	3.9055	9.096	6.4879	10.388	11.808	12.206	13.945	13.612	14.906
179	0.52449	3.7862	8.9468	6.3792	10.286	11.69	12.092	13.817	13.496	14.923
180	0.29466	3.6599	8.7896	6.2626	10.174	11.561	11.967	13.679	13.369	14.926
181	-0.033504	3.4472	8.5345	6.0583	9.9702	11.335	11.745	13.437	13.142	14.853
182	-0.36222	3.2311	8.2749	5.8497	9.7603	11.103	11.516	13.188	12.907	14.767
183	-0.49556	3.2406	8.2538	5.875	9.798	11.122	11.54	13.199	12.932	14.949
184	-0.6343	3.2428	8.223	5.8919	9.8252	11.13	11.553	13.197	12.944	15.117
185	-0.77557	3.2399	8.1853	5.9026	9.8442	11.129	11.557	13.185	12.946	15.274
186	-0.92476	3.2273	8.1355	5.9026	9.8504	11.115	11.547	13.158	12.933	15.416
187	-3.2939	1.7938	6.2644	4.4934	8.3473	9.3927	9.8395	11.238	11.134	14.742
188	-3.6015	1.5144	5.949	4.2069	8.0411	9.071	9.5164	10.898	10.8	14.446
189	-3.9085	1.2346	5.6336	3.9198	7.7344	8.7493	9.1932	10.558	10.466	14.147
190	-4.215	0.95422	5.3184	3.6321	7.4273	8.4275	8.87	10.219	10.132	13.846
191	-4.5209	0.67347	5.0034	3.344	7.1199	8.1057	8.5467	9.88	9.7984	13.543
192	-4.8263	0.39234	4.6885	3.0554	6.8121	7.7839	8.2234	9.5414	9.465	13.238

North turbine noise analysis using A-weighted octave band data

	North residences: residence number and sound level [dB (A)]									
Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
193	-5.1311	0.11086	4.3739	2.7664	6.504	7.4622	7.9002	9.2033	9.1319	12.931
194	-5.4353	-0.17095	4.0595	2.4771	6.1958	7.1407	7.5771	8.8657	8.7991	12.623
195	-5.739	-0.45303	3.7454	2.1874	5.8874	6.8193	7.2542	8.5286	8.4666	12.313
196	-6.0421	-0.73538	3.4316	1.8975	5.5789	6.4981	6.9315	8.1921	8.1345	12.002
197	-6.3447	-1.018	3.118	1.6073	5.2702	6.1771	6.609	7.8561	7.8029	11.69
198	-6.6467	-1.3007	2.8048	1.3168	4.9616	5.8564	6.2868	7.5207	7.4717	11.377
199	-6.9223	-1.5361	2.5337	1.0755	4.7023	5.5822	6.0115	7.2297	7.1867	11.128
200	-7.3731	-2.0931	1.9801	0.5014	4.1093	4.996	5.421	6.643	6.5924	10.439
201	-12.309	-5.7816	-2.6341	-3.3313	-0.17061	0.33519	0.73772	1.5687	1.672	6.3794
202	0.037966	4.6848	9.5932	7.4452	11.504	12.749	13.206	14.821	14.628	17.554
203	-0.22504	4.5049	9.3674	7.2662	11.313	12.535	12.994	14.584	14.405	17.449
204	-0.48924	4.3213	9.1376	7.0827	11.117	12.316	12.775	14.343	14.175	17.333
205	-0.91854	3.9769	8.7283	6.7333	10.742	11.91	12.369	13.904	13.751	17.037
206	-1.3452	3.6305	8.3182	6.381	10.363	11.502	11.96	13.462	13.324	16.727
207	-1.6121	3.4354	8.0773	6.184	10.15	11.266	11.724	13.204	13.077	16.575
208	-1.8799	3.2372	7.8331	5.9831	9.9327	11.027	11.485	12.942	12.825	16.412
209	-2.1525	3.0313	7.5813	5.774	9.7058	10.778	11.236	12.67	12.564	16.235
210	-2.422	2.827	7.3312	5.5661	9.4796	10.531	10.988	12.4	12.303	16.055
211	-5.3982	0.77259	4.6522	3.4538	7.1039	7.8696	8.3182	9.4338	9.4649	14.143
212	-5.7562	0.41922	4.2646	3.088	6.7127	7.4663	7.9121	9.0139	9.0478	13.719
213	-6.1113	0.070459	3.8816	2.7271	6.3268	7.0682	7.5114	8.5994	8.6361	13.302
214	-6.4202	-0.23364	3.5484	2.4126	5.9909	6.7221	7.163	8.2395	8.2785	12.939
215	-6.7034	-0.48234	3.2592	2.1544	5.7089	6.4241	6.8631	7.9223	7.9669	12.648
216	-6.9862	-0.73122	2.9701	1.896	5.4267	6.1261	6.5632	7.6054	7.6554	12.356
217	-7.3513	-1.1018	2.5715	1.5133	5.0213	5.7118	6.1463	7.1782	7.2295	11.913
218	-7.718	-1.4741	2.1717	1.129	4.6146	5.2965	5.7284	6.7502	6.8028	11.469
219	-7.9995	-1.7244	1.8832	0.86917	4.332	4.9992	5.4292	6.4353	6.4928	11.175
220	-8.2816	-1.9773	1.593	0.60679	4.047	4.7	5.1281	6.119	6.1811	10.876
221	-9.5813	-3.0369	0.30371	-0.50214	2.81	3.3729	3.7918	4.6876	4.782	9.6056
222	-9.8657	-3.2746	0.017566	-0.75128	2.5329	3.0773	3.4941	4.3703	4.4711	9.3152
223	-10.149	-3.5127	-0.26826	-1.0009	2.2554	2.7818	3.1964	4.0535	4.1604	9.0229
224	-10.433	-3.7539	-0.55664	-1.2539	1.9745	2.4833	2.8957	3.7341	3.8469	8.7256

North turbine noise analysis using A-weighted octave band data

North residences: residence number and sound level [dB (A)]

Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
225	-10.719	-3.998	-0.84748	-1.51	1.6905	2.182	2.5922	3.4123	3.5308	8.4237
226	-11.008	-4.2478	-1.1436	-1.772	1.4005	1.8751	2.283	3.0851	3.209	8.1141
227	-11.296	-4.4976	-1.439	-2.034	1.1107	1.5687	1.9744	2.7589	2.8881	7.8036
228	11.164	5.0262	9.0275	5.7379	7.0569	8.2998	8.2298	9.2157	8.6476	4.2886
229	11.058	5.0682	9.1261	5.8175	7.1888	8.4464	8.3827	9.3902	8.819	4.4917
230	11.12	5.2673	9.3856	6.0524	7.4714	8.7444	8.6854	9.7126	9.1374	4.8212
231	11.175	5.4623	9.6409	6.2833	7.7506	9.039	8.985	10.032	9.453	5.1486
232	11.219	5.6502	9.8894	6.5079	8.0246	9.3287	9.2797	10.348	9.7643	5.4735
233	11.259	5.8375	10.138	6.7325	8.2996	9.6194	9.5757	10.665	10.077	5.8008
234	11.29	6.0213	10.383	6.9545	8.5735	9.9095	9.8713	10.982	10.391	6.1301
235	11.317	6.2039	10.628	7.1755	8.8468	10.199	10.166	11.299	10.704	6.4599
236	11.333	6.379	10.864	7.3895	9.1143	10.483	10.456	11.611	11.012	6.7868
237	11.338	6.5464	11.093	7.5965	9.3757	10.761	10.74	11.919	11.315	7.1108
238	11.336	6.7128	11.322	7.8034	9.6385	11.04	11.026	12.228	11.621	7.4391
239	11.329	6.8744	11.545	8.0056	9.8971	11.316	11.308	12.534	11.923	7.765
240	11.313	7.0313	11.763	8.2036	10.152	11.588	11.587	12.838	12.222	8.0905
241	11.289	7.1833	11.976	8.3971	10.404	11.856	11.863	13.139	12.519	8.4154
242	11.256	7.3304	12.184	8.5865	10.653	12.123	12.136	13.438	12.815	8.7416
243	11.217	7.4723	12.386	8.7708	10.897	12.384	12.405	13.732	13.106	9.0652
244	11.169	7.609	12.582	8.9501	11.138	12.641	12.67	14.024	13.393	9.388
245	10.992	7.659	12.696	9.0523	11.316	12.838	12.877	14.264	13.631	9.6932
246	10.808	7.7034	12.802	9.1487	11.488	13.028	13.079	14.498	13.863	9.9966
247	10.615	7.7356	12.892	9.232	11.647	13.204	13.266	14.717	14.081	10.29
248	10.414	7.7619	12.974	9.3094	11.799	13.373	13.447	14.93	14.292	10.583
249	10.325	7.8639	13.127	9.4544	12.007	13.596	13.679	15.19	14.55	10.895
250	10.231	7.9603	13.273	9.5936	12.209	13.813	13.905	15.443	14.801	11.204
251	10.13	8.0507	13.411	9.7267	12.405	14.023	14.125	15.69	15.047	11.511
252	10.02	8.1317	13.537	9.8501	12.591	14.223	14.335	15.927	15.283	11.812
253	9.9033	8.2092	13.659	9.9705	12.775	14.42	14.542	16.162	15.517	12.116
254	9.7854	8.2844	13.776	10.088	12.956	14.614	14.746	16.392	15.747	12.419
255	9.5196	8.3627	13.921	10.241	13.22	14.899	15.05	16.743	16.1	12.921
256	-9.3386	-2.386	0.73186	0.13312	3.3548	3.8171	4.2337	5.0268	5.1663	10.275

North turbine noise analysis using A-weighted octave band data

North residences: residence number and sound level [dB (A)]

Turbine	1	2	3	4	5	6	7	8	9	10
ID	31.58	28.497	33.34	30.149	32.898	34.304	34.49	35.963	35.494	35.139
257	-9.6163	-2.6077	0.45112	-0.10308	3.0837	3.5237	3.9375	4.707	4.8539	9.9813
258	-9.8964	-2.8343	0.16603	-0.34451	2.8071	3.2254	3.6364	4.3827	4.5367	9.6802
259	-10.179	-3.0664	-0.12362	-0.5917	2.5249	2.9221	3.3301	4.0539	4.2147	9.371
260	-10.479	-3.3623	-0.44735	-0.89901	2.1967	2.5855	2.9914	3.706	3.8683	9.0099
261	-10.779	-3.6582	-0.77049	-1.2061	1.869	2.2497	2.6536	3.3592	3.5229	8.6497
262	-11.074	-3.9352	-1.0836	-1.4956	1.5548	1.9237	2.3252	3.018	3.1847	8.3046
263	-9.2251	-1.9856	0.95132	0.51217	3.6499	4.0334	4.4459	5.1571	5.3295	10.616
264	-9.527	-2.2774	0.62611	0.20762	3.3209	3.694	4.104	4.8038	4.9783	10.25
265	-9.8284	-2.5689	0.30153	-0.096522	2.9926	3.3554	3.763	4.4515	4.6282	9.8862
266	-10.13	-2.8607	-0.022755	-0.4009	2.6645	3.0173	3.4225	4.1	4.2787	9.5226
267	15.853	8.7544	12.613	9.2593	10.227	11.409	11.273	12.101	11.527	6.5385
268	15.934	8.994	12.93	9.5394	10.559	11.76	11.628	12.477	11.896	6.9003
269	16.004	9.2309	13.247	9.8184	10.892	12.112	11.984	12.856	12.269	7.2655
270	16.063	9.4631	13.559	10.093	11.222	12.462	12.339	13.232	12.64	7.6293
271	16.109	9.6879	13.865	10.362	11.548	12.808	12.69	13.607	13.008	7.9919
272	16.151	9.9155	14.176	10.635	11.879	13.16	13.046	13.988	13.382	8.3602
273	16.178	10.135	14.48	10.901	12.206	13.508	13.399	14.366	13.754	8.7272
274	16.194	10.351	14.78	11.163	12.531	13.855	13.752	14.745	14.126	9.0952
275	16.198	10.562	15.079	11.423	12.856	14.203	14.106	15.126	14.5	9.4667
276	16.192	10.768	15.371	11.678	13.177	14.548	14.456	15.505	14.872	9.8368
277	16.175	10.968	15.66	11.929	13.497	14.891	14.806	15.884	15.243	10.208
278	16.152	11.166	15.946	12.179	13.816	15.234	15.155	16.264	15.616	10.58
279	16.115	11.356	16.224	12.42	14.129	15.572	15.5	16.64	15.984	10.951
280	16.204	11.694	16.667	12.814	14.597	16.068	16.002	17.173	16.508	11.449

South turbine locations: Turbines are Vestas V90

Turbine ID	Longitude Degrees	Minutes	Seconds	Latitude Degrees	Minutes	Seconds
281	-120	2	56.4	45	35	57.0
282	-120	2	54.5	45	35	53.4
283	-120	2	54.6	45	35	22.6
284	-120	2	50.9	45	35	18.9
285	-120	2	15.3	45	36	42.0
286	-120	2	20.3	45	36	25.3
287	-120	2	18.5	45	36	21.7
288	-120	2	16.6	45	36	18.2
289	-120	2	3.1	45	36	16.6
290	-120	1	49.6	45	36	14.9
291	-120	1	47.7	45	36	11.4
292	-120	1	45.9	45	36	7.9
293	-120	1	44.0	45	36	4.3
294	-120	1	42.2	45	36	0.7
295	-119	59	5.2	45	35	8.3
296	-119	59	7.8	45	35	3.5
297	-119	59	6.0	45	34	59.9
298	-119	59	4.1	45	34	56.4
299	-119	59	2.3	45	34	52.8
300	-119	59	0.4	45	34	49.3
301	-119	58	52.0	45	38	10.5
302	-119	58	52.0	45	38	6.0
303	-119	58	39.0	45	38	18.4

South turbine noise analysis using A-weighted octave band data

	South residences: residence number and sound level [dB(A)]										
Turbine ID	11 39.187	12 39.135	14 39.207	13 34.597	16 39.253	15 35.516	17 31.88	18 33.539	20 33.572	19 40.333	22 28.99
281	20.348	20.185	20.413	8.7793	20.542	27.678	23.413	5.4577	5.3062	25.871	1.9949
282	20.259	20.099	20.328	8.8018	20.462	27.521	23.388	5.6577	5.5173	26.421	2.2382
283	17.943	17.809	18.024	7.6675	18.185	27.096	24.115	6.0933	6.0644	29.705	3.206
284	17.884	17.753	17.968	7.7555	18.134	26.531	23.738	6.387	6.3709	30.465	3.55
285	26.701	26.481	26.742	12.806	26.819	21.617	17.463	6.8448	6.501	22.264	2.4503
286	25.326	25.127	25.386	12.134	25.503	22.938	18.828	7.1268	6.8437	24.315	2.9798
287	25.287	25.09	25.351	12.197	25.478	22.916	18.867	7.3722	7.0991	24.88	3.2569
288	25.229	25.036	25.298	12.253	25.434	22.876	18.893	7.614	7.3511	25.452	3.5316
289	26.396	26.202	26.477	13.238	26.634	21.657	17.866	8.5954	8.3221	26.215	4.4161
290	27.553	27.359	27.646	14.233	27.83	20.463	16.843	9.5901	9.3051	26.88	5.3065
291	27.391	27.203	27.489	14.267	27.683	20.384	16.829	9.8404	9.5669	27.49	5.5923
292	27.207	27.026	27.31	14.292	27.512	20.291	16.806	10.088	9.8261	28.115	5.8771
293	26.999	26.825	27.106	14.308	27.317	20.187	16.773	10.333	10.084	28.759	6.1624
294	26.768	26.601	26.878	14.312	27.096	20.075	16.733	10.571	10.335	29.42	6.4435
295	22.624	22.687	22.757	21.092	23.025	7.3	5.3233	25.34	25.254	26.837	20.222
296	22.062	22.119	22.194	20.418	22.459	7.405	5.4793	25.113	25.098	27.323	20.316
297	21.547	21.604	21.677	20.101	21.938	7.2112	5.3275	25.325	25.359	27.241	20.682
298	21.04	21.096	21.168	19.776	21.425	7.017	5.1751	25.516	25.601	27.14	21.041
299	20.535	20.59	20.661	19.445	20.915	6.8155	5.0153	25.694	25.832	27.012	21.403
300	20.041	20.097	20.166	19.112	20.416	6.6144	4.8552	25.848	26.041	26.866	21.754
301	29.686	29.839	29.542	28.116	29.255	3.0037	-0.073565	11.67	10.734	9.6994	5.1424
302	30.332	30.498	30.188	28.68	29.9	3.208	0.13728	12.116	11.177	10.129	5.5523
303	27.651	27.798	27.521	28.058	27.261	1.8803	-1.1616	11.325	10.367	8.5382	4.7907

South turbine noise analysis using A-weighted octave band data

	South residences: residence number and sound level [dB(A)]									
Turbine	21	23	24	25	26	27	28	29	30	31
ID	29.321	25.97	23.261	22.205	29.695	31.632	29.315	30.886	20.702	19.344
281	19.177	-0.10627	-2.2181	-2.9567	3.7924	11.677	3.9512	8.4133	-3.9139	-4.6463
282	19.458	0.14446	-1.9744	-2.7083	4.0953	12.079	4.2635	8.7814	-3.6555	-4.3764
283	22.673	1.2469	-0.89949	-1.5641	5.7012	14.808	5.9861	11.123	-2.3732	-2.9385
284	22.786	1.5986	-0.55623	-1.2162	6.1113	15.336	6.4064	11.608	-2.0154	-2.5698
285	12.82	0.097917	-1.9798	-2.8506	3.1024	8.9776	3.0456	6.3885	-4.0714	-5.1048
286	14.609	0.67822	-1.4315	-2.2707	3.9772	10.426	3.9784	7.6469	-3.4248	-4.3809
287	14.854	0.95791	-1.1613	-1.9975	4.3061	10.833	4.3143	8.028	-3.1443	-4.092
288	15.091	1.2354	-0.89312	-1.7263	4.6333	11.239	4.6487	8.4082	-2.8657	-3.8049
289	14.55	2.0778	-0.069853	-0.92071	5.4323	11.838	5.4242	9.0795	-2.092	-3.067
290	13.97	2.9237	0.75685	-0.11259	6.2281	12.408	6.1943	9.7318	-1.3174	-2.3302
291	14.163	3.2119	1.0346	0.16827	6.5698	12.827	6.5432	10.127	-1.0291	-2.0333
292	14.35	3.4996	1.3118	0.4487	6.9121	13.249	6.893	10.524	-0.74082	-1.7361
293	14.534	3.7882	1.5898	0.73027	7.2574	13.679	7.2461	10.927	-0.451	-1.4369
294	14.713	4.0733	1.8645	1.0087	7.6007	14.11	7.5977	11.331	-0.1638	-1.1398
295	7.0853	17.104	14.408	13.306	20.404	21.619	19.956	21.143	11.714	10.259
296	7.4028	17.248	14.531	13.453	20.806	22.325	20.398	21.796	11.908	10.502
297	7.373	17.617	14.874	13.801	21.296	22.743	20.892	22.284	12.269	10.874
298	7.3408	17.982	15.213	14.146	21.789	23.161	21.389	22.777	12.626	11.244
299	7.3005	18.351	15.555	14.495	22.295	23.581	21.9	23.28	12.99	11.62
300	7.2571	18.713	15.89	14.838	22.801	23.996	22.411	23.784	13.348	11.992
301	-2.9217	2.3913	0.73269	-0.4548	2.13	1.7814	1.4646	1.2424	-2.3768	-4.2479
302	-2.6377	2.7852	1.1093	-0.081711	2.5519	2.2052	1.8856	1.6685	-2.0066	-3.8787
303	-3.9835	2.0608	0.4618	-0.73224	1.5784	0.91589	0.88641	0.47544	-2.6804	-4.5886

Transformer locations

Transformer	Longitude			Latitude		
ID	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
Transformer 1 (North substation)	-120	5	0.2	45	43	59.5
Transformer 2 (North substation)	-120	5	0.2	45	43	59.5
Transformer 3 (North substation)	-120	5	0.2	45	43	59.5
Transformer 4 (North substation)	-120	5	0.2	45	43	59.5
Transformer 5 (South substation)	-119	59	3.8	45	35	49.2

Transformer sound levels using 105 dB (A) for each north transformer and 101 dB(A) for the south transformer

North residences: residence number and sound level [dB(A)]

Transformer	1	2	3	4	5	6	7	8	9	10
ID	13.926	13.834	20.104	16.02	19.437	21.348	21.523	23.473	22.724	18.812
Transformer 1	7.9013	7.7779	14.04	9.9577	13.364	15.271	15.446	17.39	16.641	12.726
Transformer 2	7.9526	7.8508	14.125	10.035	13.449	15.36	15.535	17.483	16.733	12.801
Transformer 3	7.8968	7.8307	14.108	10.023	13.449	15.362	15.539	17.493	16.744	12.838
Transformer 4	7.8687	7.7906	14.061	9.9804	13.403	15.313	15.49	17.442	16.693	12.796
Transformer 5	-34.888	-26.445	-25.193	-24.542	-22.544	-22.671	-22.36	-22.19	-21.894	-17.038

South residences: residence number and sound level [dB(A)]

Transformer	11	12	14	13	16	15	17	18	20	19
ID	22.152	22.264	22.303	19.714	22.608	1.061	-1.4217	17.620	17.044	17.677
Transformer 1	-19.443	-19.503	-19.522	-24.815	-19.681	-21.94	-24.354	-35.479	-36.149	-29.639
Transformer 2	-19.415	-19.476	-19.495	-24.78	-19.654	-21.939	-24.356	-35.448	-36.119	-29.623
Transformer 3	-19.364	-19.424	-19.443	-24.735	-19.603	-21.882	-24.299	-35.403	-36.073	-29.569
Transformer 4	-19.379	-19.439	-19.458	-24.755	-19.618	-21.882	-24.298	-35.42	-36.09	-29.578
Transformer 5	22.151	22.262	22.302	19.713	22.607	0.97245	-1.5116	17.62	17.044	17.677

South residences: residence number and sound level [dB(A)]

Transformer	22	21	23	24	25	26	27	28	29	30	31
ID	10.987	-1.0664	7.7497	5.2707	4.0524	9.6736	10.250	9.0954	9.6852	2.2205	0.509
Transformer 1	-40.628	-31.89	-42.993	-44.584	-45.613	-42.185	-39.078	-42.533	-40.863	-47.251	-48.802
Transformer 2	-40.599	-31.889	-42.964	-44.554	-45.584	-42.161	-39.061	-42.509	-40.844	-47.223	-48.775
Transformer 3	-40.553	-31.834	-42.918	-44.51	-45.539	-42.113	-39.009	-42.46	-40.793	-47.178	-48.73
Transformer 4	-40.569	-31.834	-42.934	-44.526	-45.555	-42.126	-39.019	-42.474	-40.804	-47.193	-48.744
Transformer 5	10.987	-1.0809	7.7496	5.2705	4.0522	9.6735	10.249	9.0953	9.685	2.2203	0.50881

WASCO COUNTY

John Roberts <johnr@co.wasco.or.us>

Fwd: wind

1 message

Rod Runyon <rodr@co.wasco.or.us> **Wed, Feb 15, 2012 at 12:10 PM**
To: johnr@co.wasco.or.us

John, I did not see your address on the following and am forwarding a citizen letter.

---------- Forwarded message ----------
From: **Sage Canyon River Co.** <kreinconsulting@yahoo.com>
Date: Wed, Feb 15, 2012 at 10:58 AM
Subject: wind
To: "scotth@co.wasco.or.us" <scotth@co.wasco.or.us>
Cc: "Sherry Holliday (E-mail)" <sherryh@co.wasco.or.us>, "rodr@co.wasco.or.us" <rodr@co.wasco.or.us>

Wasco County Commissioners,

Please do what you can to allow wind development in Wasco County. The two mile set back is too far for the wind farms in South County. The state of Oregon has protection for home owners and there guidelines are what the county should be looking at.

Please allow for people to waive the minimun set backs if they choose....

If the North end of the county does not want wind farms. That is fine. But please don't do something to make them happy and the expense of South County. Im sure you guys can figure a way that keeps wind farms from 7-mile hill, but allows for them in the bakeoven-shaniko area.

Thanks Bob Krein

Partner in AK Ranches 8,000 acres Maupin, OR
Owner of a House in Maupin
Owner of 3 commercial building in Maupin
Part owner of a house in Dufer

The success of wind farm in the county depends on decision made today.....

--
Rod Runyon, Chairman
Wasco County Commission
511 Washington Street, Rm B10
The Dalles, Or. 97058
Office 541-506-2523, Mobile 541-993-6413
e-mail: rodr@co.wasco.or.us www.co.wasco.or.us

WASCO COUNTY

John Roberts <johnr@co.wasco.or.us>

setbacks and property rights associated with wind energy development in wasco county

1 message

Fred Justesen <fredjustesen@hotmail.com> **Tue, Feb 14, 2012 at 10:26 PM**
To: scotth@co.wasco.or.us, sherryh@co.wasco.or.us, rodr@co.wasco.or.us, John Roberts <johnr@co.wasco.or.us>
Cc: michael.greczyn@eon.com, Brian Walsh <brian.walsh@iberdrolaren.com>

I would like to address the Wasco Co. Commissioners, Wasco Co. Planners, and other concerned citizens of Wasco Co.

I'm Fred Justesen. My family have been citizens of Wasco and Sherman Co. for five generations. Family members have been involved in agriculture and various other occupations throughout the years. Through the years we have witnessed many changes in demographics, economics, culture, and technology. Wasco Co. is now faced with an industry that will involve all of those.

If we do this right, it's quite possible the wind energy industry can have a very positive effect on our economy. We don't have to look very far to see a good example of this. Sherman Co. has embraced the wind industry and it has been financially rewarding for the the county government, the schools, individuals, the towns, and the community as a whole. Sherman Co. has transitioned from (how are we going to pay for this) to (how are we going to spend this money). Call the Sherman Co. Court for confirmation.

There are three energy companies interested in locating projects in Wasco Co. They are proposing large projects that could potentially create hundreds of jobs short term. Once they are in operation they can support a significant amount of full time jobs. The communities in Wasco Co. could benefit from these employment opportunities, also allowing some of our youth to be educated and employed in wind energy technology right here in Wasco Co.
New technology in agriculture has contributed to the decline in population of many of the agricultural communities, but the new technology in the wind energy generation has a chance to reverse this trend.

In general,there is overwhelming support for wind energy development in south and central Wasco Co. It's my understanding that the attitude of certain areas of north Wasco Co. is somewhat different. I have been told that the Commissioners are receiving petitions to increase the distance for setbacks. A large number of land owners and residents in the rest of the county have a conflicting opinion. Many would like to see a less restrictive setback rule.
Restrictive setback regulations could seriously effect the wind development and may eliminate the commercial wind energy development in Wasco Co. I personally attended a Shaniko City Council meeting last night, and every member attending signed a petition favoring a more relaxed setback standard. I find it quite offensive, in terms of property rights, that I would not be allowed to place a wind tower in closer proximity to my residence than is now being considered. I live in a very rural area, and if I could elect to site a wind tower in my back yard it would effect no one but myself, and would satisfy the current setback in relation to all others. Perhaps the residents of Shaniko would like to site a tower in their urban development area to generate income for the town. I wonder which would be more noticeable, the trucks passing through town all night or the wind turbines?

I'll be the first to acknowledge that wind turbines will alter the landscape. Dams, bridges, highways, cities, towns, vehicles, trains, power lines, clear cuts, farm fields, airplanes, strip mining, hilltop removal, oil fields (off shore or on), industry smoke stacks, etc.,etc. All of these things alter the land scape, but we have adapted to, or accepted them to accommodate our lifestyle. It seems everything in life has trade offs. In consideration of our environment, we need to ask ourselves what is the least damaging way we can create the energy we need. I think you will be hard pressed to find an energy resource more environmentally friendly than wind turbines.

There are those who are apposed to wind energy because it is tax subsidized. Let's not forget that all the hydro electricity we enjoy now was completely financed with Government money. All the dams, power lines, the locks systems, etc., that compose the BPA system, all payed for with tax payer dollars. The oil, coal,and

natural gas industry which have billions of dollars in profits every year, have received tax subsidies for several decades. The subsidies for wind are insignificant by comparison.

Health effects due to wind turbines are unsubstantiated, and studies have not indicated any connection.

Perhaps a compromise would offer a solution to the apparent conflict of opinions. I would agree that there are areas that are more sensitive to wind turbines. It is my opinion that different areas of the county could adopt different standards in regards to wind turbines.

Thank you for the opportunity to comment on this important issue.

Fred Justesen

WASCO COUNTY

John Roberts <johnr@co.wasco.or.us>

WASCO COUNTY CHAPTER 19 MEMORANDUM AND SETBACK PETITION

1 message

Ken Clark <clarkkwc01@msn.com> **Wed, Feb 15, 2012 at 1:00 PM**
To: johnr@co.wasco.or.us

John,

Attached, you will find the following, for presentation/representation at tonight's meeting:

1. Memorandum and comments regarding Chapter 19 energy updates
2. Wasco County Petition for Setbacks, with three signatures

Thank you,

Kenneth W. Clark
206-236-2756 (office)
206-683-5358 (cell)

Property Address:
91301 Bakeoven Road
Maupin, OR

Mailing Address:
9655 SE 36th St., Suite 100
Mercer Island, WA 98040

2 attachments

John Roberts Memo 02-15-12.pdf
20K

Wasco County Setback Petition.pdf
20K

February 15, 2012

John Roberts
Planning Director
Wasco County Planning Department
2705 East 2nd Street
The Dalles, OR 97058

Subject: Energy Updates to Chapter 19 of Wasco County Land Use Development Ordinance

Mr. Roberts:

I am writing to you today regarding proposed revisions to Chapter 19 (Energy Updates) to the Wasco County Land Use Development Ordinance.

My wife and I recently purchased approximately 1,200 acres in South Wasco County, located at 91301 Bakeoven Road, Maupin, Oregon.

After our purchase, we learned that Iberdrola was planning to propose a wind farm for this area, which includes our property.

Our property was purchased as a family retreat, and for our eventual retirement. Therefore, when we first learned of the proposed wind farm, we were very apprehensive.

However, after working with key personnel at Iberdrola and visiting one of their existing wind farms we are now in favor of wind generated energy, and the proposed Bakeoven project. We strongly believe that this nation needs to work to free ourselves from fossil fuels and nuclear generation for future energy requirements. Additionally, since an increase in hydroelectric power in the Northwest is no longer a viable option, we have become proponents of wind generated energy.

While it may seem reasonable for areas of relatively high density in the Wasco county, such as The Dalles, to have restrictive setbacks such as 1.50 miles from residences, in less dense areas such setbacks make no sense; one size does NOT fit all!

Owners should be allowed to negotiate directly with wind power generating companies, with setbacks the choice of the individual.

Dictating setback restrictions is a direct affront to property rights, in our opinion.

The economics of farming and raising cattle in the less dense areas of Wasco county can be tenuous at best; therefore, the opportunity for economic improvement increases the odds of being able to "hold" the land and pass land along from one generation to the next can be greatly increased by allowing landowners to individually determine setbacks versus the county trying to decide what is best for every owner.

Sincerely,

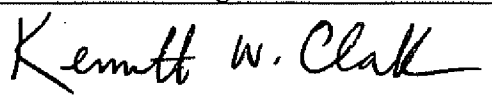
Kenneth W. Clark

Ken and Julie Clark
9655 SE 36th Street, Suite 100
Mercer Island, WA 98040

Attachment: Petition

Petition for Setbacks in Wasco County

I am a resident of Wasco County and request that the Wasco County Board of Commissioners adopt reasonable wind turbine setback distances. I support 1,320-foot wind turbine setbacks from rural residences and a 3,520-foot setback non-resource boundaries. I also support authorizing the County to approve adjustments for lesser setbacks on a project-by-project basis. I think this is fair and safe.

#	Date	Name	Signature	Address/Email
	2/14/12	Kenneth W. Clark		**Property Address:** 91301 Bakeoven Road Maupin, Or **Mailing Address:** 9655 SE 36th St., Suite 100 Mercer Island, WA 98040 Email: clarkkwc01@msn.com
	2/14/12	Julie A. Clark		**Property Address:** 91301 Bakeoven Road Maupin, OR **Mailing Address:** 9655 SE 36th St., Suite 100 Mercer Island, WA 98040 Email: clarkja01@gmail.com
	2/14/12	Austin C. Clark		**Property Address:** 91301 Bakeoven Road Maupin, OR **Mailing Address:** 9655 SE 36th St., Suite 100 Mercer Island, WA 98040 Email: clarkau@live.com

FEB. 15, 2012

WASCO CO. Bd. of COMMISSIONERS:

RE: ISSUES RELATED TO WIND POWER SET BACKS.

DEAR COMMISSIONERS:

WE WISH TO NOTE FIRST THAT HOLDING THIS PUBLIC HEARING AT 4:30 ONLY SERVES TO LIMIT PUBLIC PARTICIPATION. PUBLIC COMMISSIONS SHOULD ALWAYS ENCOURAGE - NOT LIMIT - PUBLIC PARTICIPATION. A 7 O'CLOCK HEARING WOULD HAVE ALLOWED THE WORKING PUBLIC MORE OF AN OPPORTUNITY TO PARTICIPATE.

BEFORE TACKLING SET BACKS YOU SHOULD CONSIDER SOME FUNDAMENTAL BACKGROUND ISSUES THAT SET THE STAGE FOR SET BACKS.

A MAJOR GOAL OF ZONING IS TO PROTECT EXISTING LAND USES & TO PREVENT INCONSISTANT USES. MAKE NO MISTAKE ABOUT THIS: THE INDUSTRIALIZATION OF RURAL AREA'S - ESPECIALLY THOSE AREAS NEAR RESIDENTS - IS AN INCONSISTANT USE IN THOSE RURAL AREAS. THE QUALITY OF LIFE OF RESIDENTS ARE DEGRADED, LAND VALUES $DROP - SOMETIMES TO THE POINT WHERE IT IS IMPOSSIBLE TO SELL ONES LAND AT ALL - & THERE CAN BE PHYSICAL, EMOTIONAL & MENTAL IMPACTS. ALWAY REMEMBER THAT EXISTING USES TAKE PRIORITY OVER NEW PROPOSED USES. CHAOS IS THE RESULT OF THINKING OTHERWISE.

VARIANCES & THE VARIANCE PROCESS IS

A.Gary Nychyk
923 E 12th Street
The Dalles, OR 97058

February 15, 2012

Wasco County Board of Commissioners
511 Washington St, Ste 302
The Dalles, Or 97058

RE: Updates to the Wasco County Energy Ordinance

Good afternoon and thank you for this opportunity;

Before I begin comments on the LUDO, I would like to ask whether the Board voted to include the "Template Test" dwelling provision that was first discussed by Mr. Roberts during the third public hearing of this process. If not, is the Board considering updating the Comp Plan to include those provisions?

I would like to comment on the timeline of this process. The Energy Updates were initiated by the Board in July of 2009. Between February and September of 2010, 20 Advisory Group meetings were held to develop the proposed Ordinance. From September 2010 through January of 2011 the Planning Department completely digitized the 1983 Comp Plan and reorganized the document so it was usable to citizens and staff. Two hearings were held before the Planning Commission, and the BOCC Hearing was scheduled for July of 2011, but was postponed for six months until January 2012. I would like for the County to tell us why the updates were so delayed and quantify the work that has been done on this project since July.

Providing fast or at least reasonable project turnaround times is a form of customer service, and quite frankly, delaying the decision for seven months is **poor** customer service, regardless of which side of the Wind Energy Aisle you reside.

Next, I would like to speak briefly to LUDO Section 19.030.A.1.c. "At their discretion, the BOCC may solicit public input for any response provided to EFSC ..."

The most likely part of the EFSC process where public input would be solicited by the Board is when EFSC requests all applicable regulations and interpretations that may affect a development.

Although collecting public input at every opportunity is appealing, the costs often outweigh any benefits. Especially since this two and a half year process was explicitly designed to develop a clear and understandable ordinance allowing the Planning Department to quickly advise land owners, applicants, and agencies of the applicable rules and the County's interpretation of those rules.

Notifying applicable landowners, compiling comments received, preparing and presenting findings, and publishing those findings takes time and resources. And once the information is compiled, a hearing must be scheduled around your summer vacations, winter weather, and Holidays.

And in the end, it shouldn't matter because through this project, you and your director should know the regulations and any necessary interpretation, and be able to quickly provide complete **and consistent** information to EFSC.

This solicitation should be used sparingly because the result in soliciting public input where there is little or no tangible benefit only provides the "**Appearance**" of Customer Service at the expense of "Actual" customer service.

I would also like to clarify that wind towers <u>are currently</u> allowed in the A-1, F-1, F-2, and FF zones. Citations from LUDO Chapter 3 indicate that "Energy Facilities" or "Utility Facilities for the Purpose of Generating Power" are allowed subject to Conditional Use Review. I've heard it said that folks moved out into the resource zone for an expected quality of life, and that wind turbines would impact that quality of life. However, that expectation may not have been based on the uses allowed when the property was purchased.

Energy Facilities are allowable through the Conditional Use process in every resource zone and many non-resource zones. The same Conditional Use process <u>**must**</u> be used for <u>**any**</u> new dwelling in the F-1, F-2, and FF zones along with any new non-farm dwelling in the A-1 zone. This indicates that like energy production facilities, dwellings are not necessarily compatible with resource zones. Perhaps this incompatibility is because homes are often built where there is no infrastructure to support them, or limited access for school busses, or unacceptable response times for police, fire, and ambulance services. Or, maybe it brings houses into an area where their owners protest a large land owner's rights to conduct certain practices on their land. Regardless of the reason, it is important to remember that energy production facilities are allowable; and dwellings, just like energy facilities, are not necessarily compatible with the Resource Zones.

Next, I would like to comment on the proposal to establish linear setbacks for wind towers to individual houses. Please bring up those images. Although I complement the Planning Department on the production of these great maps, I have to say that do not like the idea. <u>**Math Question...**</u>

> *If a rural citizen who owns a house on ten acres in the A-1 Zone does not like wind energy, how many acres of land does that citizen have veto power over?*

A simple table shows that at ½ mile, the owner can veto 502 acres. At two 2/3 mile, he can veto 893 acres. At one mile - over 2,009 acres. And at 1.5 miles, he has veto power over 4,500 acres. That's a lot of authority over land that you don't own.

What if the Large Land Holders of Wasco County demanded this same level of protection against new dwellings? Perhaps no one could place a dwelling within a mile of a wheat field? Remember; dwellings and energy facilities are both Conditional Uses, and therefore not necessarily compatible.

Now if we could get back to the maps: Theoretically we have the location of every legal dwelling in the County (that's a false assumption). The first thing that comes to my mind is "Spot Zoning". Now I will quickly admit that I am no Planner but I have attended a Focus Group or two, and I've heard that "Spot Zoning" is typically frowned upon. This is the first zoning map I've seen where the uses allowed are dictated at a house by house level. Not even parcel by parcel, but actually house by house. This brings up a bunch of questions:

How accurate is this map?
When was it updated?
Does the County know the location of ***ALL*** legal dwellings?
Are the points taken at the front door?
Is the setback measured to this point or to the corners of the house?
Does the setback include porches?
Does the County have coordinates for the corners?
Is the applicant responsible for surveying the dwellings?
What if the owner doesn't allow the applicant access?

And what about potential dwellings? Especially those Template Testers that you seem to like so much. What effect would those have on the marketability of Wasco County for future energy development?

These questions **will** come up when you set a threshold because sooner or later an applicant will propose a turbine at the threshold "plus one foot".

You may respond that the owner could allow the turbine within the setback making the above questions mute. But that brings up other issues.

Now, I will call these little circles... "Extortion Rings". Surely I am not the only one who sees this.

"I would like to locate a tower here..."
"OOOH the Noise!!!"
"I will give you $500."
"OOOH the vibrations!!!"
"How about $1000?"
"Flicker?"
"I'll give you $5,000?"
"You can make that check out to John Q. Doe at ...."

As belittling as this is, the possibility is certainly there. What affect does a rule like this have on the marketability of wind in Wasco County? How is one to determine what a home owner is "entitled" to? And if he is "entitled" to a view, ambiance, quietude, etc., provided by his neighbor, maybe he should pay that owner for the use.

Requiring a home owner to pay a fee for looking over privately owned land is ludicrous. However, it is no less so than allowing those same over-lookers to deny a property owner the lawful use of hundreds or thousands of acres of his property.

Finally, I would like to chat about communication. In the early part of 2011, I learned that Commissioner Hege had been appointed to the Wind Energy Health Impact Assessment Steering Committee. I was taken by surprise because I had been working closely with Mr. Hege on this ordinance for 8 months, and I had never heard of the Wind Energy HIA. I wish that Commissioner Hege had told the Planning Department and **more importantly** his fellow Advisory Group members that he represented Wasco County as a Steering Committee Member before the Wind Energy HIA. Perhaps an email to his fellow Advisory Group members, or a meeting to discuss the HIA and its potential impacts to the ordinance, or perhaps the Commissioner could have attended one of the Planning Commission Hearings and discussed the HIA there. I feel that the other Advisory Group volunteers deserved more consideration than that given.

With that, I am finished with my presentation. If I need to restate any questions let me know. I would be happy to entertain any questions you may have of me.

from Jill Barker

National Wind Watch

February 10, 2012
Denmark, Press releases

Renowned acoustician denounces double standards in noise regulations

February 9-10, 2012, North American Platform Against Windpower (NA-PAW), European Platform Against Windfarms (EPAW), and the Waubra Foundation

Tricks are used to allow wind farms too close to habitations

In an email replying to the European Platform against Windfarms (EPAW), world-leading specialist in low-frequency sound Professor Henrik Moller of Aalborg University denounces the improper acoustic measurements carried out by Danish authorities. As a result, he says, the new regulations for wind farm noise are not in line with industrial noise standards. According to EPAW, this effectively constitutes discrimination against wind farm neighbors, which now have less protection than other citizens – in Denmark, but also in those countries that may take their cues from the small kingdom.

Henrik Moller and his team of acousticians have been consulted by DEPA, the Danish Environmental Protection Agency. But their recommendations have been ignored: "We had many objections to the proposal, but none of these were accommodated in the final version" (1). Answering a question from EPAW, the Professor explains how the new regulations will not effectively enforce the 20 dB(A) limit of low-frequency noise levels regarding wind farms, but that this limit is indeed being applied to other industries (2). Notes Mark Duchamp, of EPAW: "In reality, this is a case of double standards."

In his email to EPAW dated Feb. 5, 2012, Professor Moller wrote: "All these errors sum up to probably not far from 10 dB, which means that the limit is suddenly not 20 but rather 30 dB(A). But the rules are claimed to give the same protection as for industrial sources, which is simply not true." His letter is reproduced below (2).

"At low frequencies," continues the Professor, "the perceived intensity, the loudness, increases more steeply above threshold than at higher frequencies. This means that when the level is a few decibels above the 20 dB limit, the consequences are more severe, than if a limit for higher frequencies is exceeded by the same amount. Few people would probably accept 25 dB(A) in their home at night and hardly anyone would accept 30 dB(A)."

Adds Duchamp: "It would appear that the Danish authorities have been cooking the figures to accommodate the wind industry. Years ago, governments were protecting tobacco companies; today, they absolve wind farms of all sins and help them commit more."

The North-American Platform against Windpower (NA-PAW) joins EPAW in denouncing these manipulations which threaten wind farm neighbors within and beyond Denmark's frontiers. EPAW and NA-PAW in turn are joined by the Waubra Foundation, Australia's best known organization investigating the serious health issues affecting wind farm neighbors.

Contacts:

Mark Duchamp +34 693 643 736 (Spain); Skype: mark.duchamp; Executive Director, EPAW www.epaw.org; save.the.eagles@gmail.com

Sherri Lange +1 416 567 5115 (Canada); CEO, NA-PAW www.na-paw.org; kodaisl@rogers.com

Dr Sarah Laurie +61 439 865 914 (Australia); Medical Director, Waubra Foundation; sarah@waubrafoundation.com.au

References:

(1) – Quote from the Aalborg University web page on the new wind turbine noise regulations:

http://www.es.aau.dk/sections/acoustics/press/new-danish-regulations-for-wind-turbine-noise/

(2) – Email of February 5, 2012 from Professor Henrik Moller to EPAW:

from Henrik Møller <hm@acoustics.aau.dk>

to

Mark Duchamp <save.the.eagles@gmail.com>

date 5 February 2012 19:56
subject Re: Noise regulations in Denmark

Dear Mark Duchamp

The Danish 20 dB(A) limit for low-frequency noise cannot be compared to normal noise limits because

- it is an indoor limit and not an outdoor limit like usual limits for wind turbine noise
- the limit applies to the limited frequency range of 10-160 Hz – only frequencies in that range are included – the level of the full frequency range may be higher

Without an acoustical background, it may be difficult to understand how much 20 dB(A) 10-160 Hz noise is, but the limit is the same as for industrial noise in Denmark, and it is in the same order of magnitude as the limits in most other countries that have low-frequency limits (the limit may be defined in completely different ways). Most people will easily hear a noise at that level, and some will find it annoying, in particular if it goes on round the clock.

At low frequencies, the perceived intensity, the loudness, increases more steeply above threshold than at higher frequencies. This means that when the level is a few decibels above the 20 dB limit, the consequences are more severe, than if a limit for higher frequencies is exceeded by the same amount. Few people would probably accept 25 dB(A) in their home at night and hardly anyone would accept 30 dB(A). Therefore, measurements must be accurate.

In the new Danish statutory order for wind turbines, the noise is not measured but calculated. This need not be a problem, if the calculations are correct. But they are not.

The main problem is the sound insulation used to obtain indoor levels. The statutory order gives values to be used in the calculation, and these values are based on measurements in 26 Danish houses. Unfortunately, wrong measurements.

Sound at low frequencies varies a lot in a room, and according to the Danish rules for industrial noise, the level should – briefly explained – be measured, where the annoyed person finds it loudest. The sound insulation must be measured the same way in order to be applicable for calculations of indoor levels from the outdoor level. But it was not. The indoor measurement positions were simply chosen randomly and not selected for the high level. Thus the obtained values of sound insulation are too high – by several decibels.

Furthermore, statistical sound insulation values were chosen (from the wrong data) so that 33% of the houses have poorer sound insulation, meaning that the limit may be exceeded in 33% of the cases.

And finally, the calculated values may exceed the limit by a 2 dB uncertainty value. Measured levels from industrial sources are not allowed to exceed the limit.

All these errors sum up to probably not far from 10 dB, which means that the limit is suddenly not 20 but rather 30 dB(A). But the rules are claimed to give the same protection as for industrial sources, which is simply not true.

I hope this helps your understanding.

Sincerely,

~~~

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from Jill Barker

National Wind Watch

February 9, 2012
Maine, Opinions

Big wind's inconvenient truth

by ALAN FARAGO, February 09, 2012, counterpunch.org

The installation of wind turbines too close to houses and personal property is a major headache for the wind power industry, but headache scarcely begins to describe their impact to nearby property owners and neighbors. My property and home are scarcely three quarters of a mile from a three 1.5 megawatt turbine wind farm that went online in November 2009 with blades stretching nearly 400 feet into the air.

Large scale wind turbines represent a tiny and lucrative—thanks to federal tax incentives—corner of the electric power industry. By siting large turbine facilities close to population centers, the industry hopes to minimize the cost of expensive new transmission lines, but it faces a whirlwind of resistance from citizens objecting to the destruction of mountains, seascapes, wilderness areas, and natural quiet.

Opponents argue that wind power is a bad deal for everyone but shareholders who use subsidies to prop up an industry that is otherwise not economically viable. But on Vinalhaven, a small island in Penobscot Bay—where only three turbines are in operation—neighbors have opened up the industry's Achilles heel: excessive noise.

New permit applications in towns across New England are raising hackles of anyone who pays attention to the way citizen dissent has been throttled in Maine where wind warriors mobilized to breach protective legislative barriers erected by the wind industry.

Vinalhaven is a small port town of only a few thousand residents whose primary business is lobstering. During the project's planning phase in the early 2000's I understood that my viewscape would change. My neighbors and I wanted to believe the promise of the promoters that our lives would otherwise be unaffected.

As an environmentalist who has often been on the receiving end of the NIMBY argument—opposing ill-advised developments that threaten the Everglades and water quality in Florida—I didn't want to be part of a movement against wind. Environmentalists can't wait to jettison hydrocarbons driving our economy, but the lessons of the past three years have tempered my perspective. Wind power is the easiest to seize the popular imagination. It is also the breeziest. There are massive obstacles to bring wind power technology to useful grid scale. Wind is intermittent. Storage of electricity when winds fall is highly problematic. Homeowners and businesses skeptical about noise impacts of wind turbines should revisit sitting on the proverbial fence: if the Maine experience is any guide, NIMBY means that the "next idiot might be you."

The wind power industry and its local advocates on Vinalhaven insist that turbine noise is an inevitable cost supported by the public. On Vinalhaven, they trumpet that the vote to approve wind turbines was 380 in favor and only 5 against.

Neighbors have spent three years trying to get the State of Maine to enforce its own inadequate noise standards. As a veteran of wars against water pollution, I never expected that a place of solace and respite would prove the point that government can be its own worst scofflaw. It would be one thing if the small size of our community, fad or preference for local control over state or federal mandates, brought closer to resolution a problem that needs to be fixed. Instead of equity and fairness, neighbors are buried in procedural curliques tied to proving violations of state noise standards. We might as well be hog-tied to those spinning wind turbine blades.

Proving noise pollution is no trivial matter. On Vinalhaven, George Baker, a former Harvard Business School professor and executive of the local wind power facility, claims that the noise of the wind turbines is masked by the wind in the trees.

On a summer morning, there is scarcely a whisper of wind in the trees. The sky is blue and the early morning light casts long shadows in anticipation of day. Twenty five years ago I bought my property for its peace and quiet. In the background, the turbines churn like a rotating drum powered by Blakean bellows. What is so distracting is that the quality of sound varies from moment to moment. This is not the noise of a highway, a factory, an airport, or even the noise scape of a city. Turbine noise is as variable as the shifting wind, cementing one's attention to intermittency like the rotating lights on a police cruiser. That is on the good days.

Neighbors can be woken in the middle of the night with an unidentifiable pounding; it is either in one's head or chest or the walls of one's house. From aural flickering to a constant disturbance: either way; having to spend significant time, energy and money to prove the point compounds the despair.

The worst are the hours shrouded in fog that I treasured. They now pulse with turbine noise. The Maine fog associates with a weather pattern—wind shear– that the wind turbine promoters knew about but ignored. They knew because in 2008 their experts told them so. It can be dead still on the ground and hundreds of feet in the air, the wind is howling. Not only did the project supporters omit informing neighbors of wind shear during the permitting phase of the Vinalhaven project, they obstructed discovery of the consultant report and, now, are spending ratepayer resources to contest a legal challenge in state superior court. Their objection: that neighbors do not have a judicial line of appeal. It is incorporated, they say, in a 2008 state energy law that few legislators read much less questioned before passing.

If wind power isn't economically viable because wind is intermittent by nature, the costs to my life and property are continuous. There is not a single regulation against excessive noise– at the state, local or federal level– to enforce and protect. Given the level of controversy and impact, one would think that industrial wind turbine noise is a public threat where the nation's environmental agency, the US EPA, ought to engage. But the sole staffer of the EPA's Office of Noise Abatement retired years ago.

A 2010 petition to the EPA by Maine residents —triggered by the Vinalhaven controversy— implored the agency to involve itself in regulating wind turbine noise. It was rejected by EPA and an administrator who referred petitioners back to the same state regulator in Maine who subsequently resigned after the regulatory effort to tame turbine noise was thwarted by political meddling.

Dead still. So quiet that a conversation can carry a mile. Hundreds of feet above the island, wind shear picks up the turbine blades and hurls them around (The sardonic anthem of turbine advocates on Vinalhaven is "Spin, baby, spin".) casting sound pulses through moisture heavy air. At other times, sound from the turbines skips like a rock on the surface of a cove.

Think of the sounds from a wind turbine as of a thunderstorm. The noise metric, called the dbA scale, captures the peal of thunderbolts. It fails to capture the low rumble of the storm; the vibration and hum of the turbines. Most wind noise controversies are framed around the dbA level because that is how the industry established the metric for sound in the 1990's. At nighttime in Maine, for instance, the upper limit is set at 45dbA. For ordinary homeowners, though, to prove 45dbA is more complicated than pointing an acoustic measurement instrument and registering its results. Our neighbor group has chased in the middle of the night, in the middle of the freezing cold, pointing microphones and instrumentation at the pitch black sky in an effort to provide statistics and samples that state-hired consultants will accept. You can't pick up the phone and complain. You have to pay for tests to prove your complaint. On that playing field, ie. what constitutes a verifiable and legitimate complaint, the goal posts keep moving. So far as low frequency noise is concerned, the goal posts that citizens are trying to reach might as well be on the other side of the world.

Various terms have been used to describe the low frequency sound output of wind turbines: a droning noise or the dreaded thump that alternates or morphs into and out of a woosh. Sometimes, it is like the low sonic end of a spinning dryer. Depending on the wind and direction, the thrum quickens or slows. It can change from the whine of a jet engine to a pulse in the space of seconds. For unfortunate homeowners who live even closer to wind turbines, the effects are mind-blowing. Those who live closest—within half a mile– report their entire dwelling can throb and pulse in time with the swoosh of the turbine blades.

For neighbors in Vinalhaven, learning how to provide data deemed valid by state regulators, including its own consultant, to prove violations by the wind turbine operator (whose shareholders are soundly sleeping, tucked away in their quiet quarters) required learning, spending and acquiring a level of acoustic expertise no homeowner should be required to produce under any circumstances simply to protect themselves. But that is not how it works with industrial pollution.

All neighbors wanted was peace and quiet, and all neighbors have are data files of acoustics measuring turbine noise in the gigabytes. All neighbors wanted was quiet, and all neighbors have is the enmity, indifference, or silence of those who know an injustice was done on Vinalhaven but feel powerless to solve it. The fact that local electric rates on Vinalhaven have significantly increased in recent years while the cost of merchant power in the region has remained stable is an embarrassment of someone else's riches.

The industry understands that chasing citizens around the dbA scale is a fool's errand. The Vinalhaven neighbors pursued Maine state regulators up the regulatory ladder from the bottom only to find at the top, that lobbyists pressured the governor's office to intervene against neighbors on their behalf. There ought to be a law, and indeed there should. It is not exactly an insight to point out that polluters are expert at erecting high legal hurdles to keep citizens at bay. It is a good regulation, in other words, so long as it is one they wrote. The wind industry spends in states where those "should's" are likely to change the playing field.

Every large law firm in the state is under restrictive agreements with the wind industry. Well-placed lobbyists and shareholders rotate in and out of government office and appointments. The state environmental agency's top regulator, Patty Aho, is a former lobbyist for the law firm representing the wind turbine utility on Vinalhaven. Aho "did what she was told" by throttling provisions that might have offered hope to Vinalhaven neighbors in future compliance measurement and enforcement. At a July 2011 public hearing at the state capitol on revisions to the state noise regulation—ostensibly to stiffen them to protect people—Aho affirmed that the purpose of regulatory review was to assist industry.

A former governor, Angus King, is a large shareholder of a wind turbine company, First Wind. He wrote in a Maine business publication that he spent last July 4th on Vinalhaven and didn't meet a single opponent of the wind turbines. He also didn't seek the neighbors out. A recent single-question poll by First Wind claimed to measure public support for wind power. A similar poll question, limited to a single question, might solicit the opinion of neighbors who live within three miles of industrial scale wind turbines.

The public is ill-informed about wind turbine noise for a variety of reasons. Usually, a gag order accompanies payment when homeowners are bought out—often after a exhausting, protracted struggle. The industry counters with arguments; wind noise disturbs different people in different ways. The inference is that if you object to noise, you are a complainer in the great scheme of freeing energy tied to oil. In small communities like Vinalhaven, these formulas can be used to great effect, dividing the local population.

In the early phase of permitting the Vinalhaven project, a sound consultant to the project developers wrote tellingly that the site chosen for the wind turbines was likely to generate noise complaints from nearby homeowners and residents. Instead of dealing with property owners up front as the consultant recommended, the wind turbine operator buried the report and hired another consultant. In doing so, Mr. Baker, the former Harvard Business School professor and chief executive of the Vinalhaven turbine operation, made an implicit decision that pit islanders against each other. The result imposed a significant cost on the turbine neighbors; let them fight the state.

Divide and conquer is not the last refuge of polluters but it certainly is a popular one. At a public hearing last July when citizens battled industry on the outline of regulatory reform, a neighbor of a wind turbine installation in another part of the state despaired to me privately– she would not be quoted– that her livestock fences had been cut and garbage dumped in her rural driveway when she spoke out against the turbines in the permitting phase. Now that the turbines roar, her children can't play in their backyard. The noise is so relentless in her home, another mother testified, that when her children go to bed she asks every night: "Did you brush your teeth, say your prayers, and take your sleeping pills?"

On Vinalhaven, supporters of the wind farm project—goaded by the local utility board and executives—posted a drawing of goat heads in a bucket of blood on a Facebook page, wishing the worst for neighbors who subsequently moved—for health and safety reasons. There are nights when the lobsterman Arthur Farnham, whose home is only seven hundred feet from the nearest turbine, turns his television volume to high, the fans on, and still can't drown out the noise. It is worst in the winter. But the Harvard Business School professor and turbine operator insisted and the state acquiesced so that wind noise for compliance would only be measured in summer months on Vinalhaven.

Unless you have had something of deep value stripped from you, you don't understand what the noise does to a fine summer morning on Long Cove or a deep winter night when the noise is roaring in your head or in your house.

The solutions are expensive to polluters. 1) Require fair market price buy-outs or property value guarantees for property owners within two and a half miles of turbines, 2) apply 35 dbA limits to nighttime operations immediately, 3) require the wind turbine industry to pay for the costs of noise monitoring and make all data available through web sites in real time, and 4) develop metrics that capture and regulations that protect against low frequency noise.

As stories pile up of citizens driven from their homes by turbine noise—sometimes health and property values ruined —the absence of effective wind turbine noise standards reflects the quest of polluters and their shareholders to demonize regulations. Shifting the costs of noise pollution has created a new caste of politically connected entrepreneurs who in turn have hired consultants, attorneys and lobbyists to obscure the wind power industry's most inconvenient truth.

In its brutal outline, regulating noise from wind turbines illustrates the struggle of our times: whether government regulation can protect public health, or, whether private industry should be left alone to do a better job, whether or not it can demonstrate the results. Industry responds by hiding in the deep weeds of "complexity" and "disagreement with interpreting facts". They buy time for an industry desperate to keep federal subsidies flowing; subsidies set to expire at the end of 2012. The wind power industry hopes Congress and the White House will ignore the fact that people, property values, and natural quiet are collateral damage to popular enthusiasms whose economics have failed to pan out.

We used to say with pride, "this couldn't happen in the United States". But wherever the costs of pollution are unallocated, it happens every day the wind blows.

Alan Farago is a writer living in Coral Gables, Florida and president of Friends of the Everglades. His website is alanfarago.wordpress.com [1]. He can be reached by email at: afarago/earthlink.net.

URLs in this post:
[1] alanfarago.wordpress.com: **http://alanfarago.wordpress.com/**

Board of County Commissioners, Wasco County

February 15, 2012

Re: Revisions to Chapter 19 of the Land Use Development Ordinance
Petition for Setback Standards

Connolly Land and Livestock, Inc, is a 42,000 acre ranch located in Southern Wasco County, extending from the Deschutes River south to the Criterion area, and includes property on both sides of Bakeoven Road, and Highway 197. The ranch has been in the Connolly family since Tom Connolly came to Wasco County in 1899 from Galway, Ireland. He homesteaded, with sheep, and as he acquired any money, he would send it back to Ireland so another brother could come. Five brothers and two sisters came at different times. Now the ranch produces commercial cattle.

In the recent past, we have been approached by Iberdrola Renewables, about participation in a proposed Wind Energy project in the region.

The Wasco County Planning commission did a good job working on the Amendments to the Comprehensive Plan, and the Amendments to the Wasco County Land Use and Development Ordinance, both of which were recommended for adoption to the Board of County Commissioners on June 7, 2011. However, we believe the setbacks need to be adjusted to allow for greater flexibility in South County and rural areas that are less populated. We believe the Wasco County setbacks do not need to exceed those established by the State of Oregon Energy Facility siting Council,

There is a movement by residents of North Wasco County, to influence the BOCC to change the wind turbine set-backs for the entire county, without regard to population density, topography, and private property owner rights .These setbacks exceed the Oregon State DEQ Noise setback ruling and do not allow for a variance by the individual property owner.. This overly restrictive set back restriction may very well threaten the ability of Wind Energy projects to be viable in South Wasco County.

In much of the testimony, there has been little mention of the economic benefit derived from Wind Energy installations. In Sherman County, for the 2011-2012 tax year, six different Wind Energy companies paid a total property tax of $2,730,543.19. (Dick Stradly, assessor, Sherman County) Each city in Sherman County receives $100,000 per year to share in the bounty, and in addition, each household in Sherman County receives $590 per year. Think what the communities in Wasco County could do with similar income!!

We are concerned that if the excessively restrictive wind turbine restrictions are put in place in Wasco County, and therefore makes Wind Energy installation non-viable, our ability to use our property will be compromised. Furthermore, the citizens of Wasco County will be denied the benefits of increased tax revenues.

We urge the BOCC to adopt the current State recommendations for wind turbine setbacks, specifically the OR DEQ Noise setbacks and distances to urban growth boundaries of incorporated cities.

Frances Connolly, President, Connolly Land and Livestock, Inc.

Kathleen C. Tovey, Shareholder, Connolly Land and Livestock, Inc.

Maureen C. Mack M.D. Shareholder, Connolly Land and Livestock, Inc.

I am a property owner of land in Wasco county that could be and will be subject to a lease with Iberdrola Renewables Inc. Wasco County is proposing to change it's current land use rezoning ordinance in a way that will restrict and limit Wind Energy development on my lands. I encourage the Planning Commission to reconsider the setbacks proposed as a part of the domain amendment. I believe 3520 feet set back to be appropriate, or even 1350 feet in some areas.

Wasco County could benefit greatly by the presence of the Wind Energy Industry. And residents of the county could benefit also. DON"T LOSE THIS OPPORTUNITY TO HELP OUR COUNTY AND RESIDENTS BY EXCESSIVE RESTRICTIONS AND ORDINANCES.

Frances Connolly

To: BOCC Board of County Commissioners

From: Dan Carver

Date: February 12, 2012

I am Dan Carver. My family ranches on 32,000 acres in south Wasco County. We have been honored many times for our environmental ethic including a feature in this recent Oregon Business Magazine (handout). We are very proud of helping to restore steelhead to Buckhollow Creek. In 1990, two fish returned. Through proper land management we have seen as many as 800 return to spawn in recent years.

In other words, we and our neighbors don't take land management lightly. As to energy generated by the wind, as recent as 6 years ago, my stance was "not in my back yard." Then as time went on and I started seeing some of the positive things about wind energy, my mind became more open. It was two of my close friends that came to the ranch and tipped me over to be a strong wind proponent. Ken Williamson, Dean of Engineering at OSU, said, "You got used to seeing utility lines and fences didn't you?" He strongly encouraged us to get involved. The second was Yvon Chouinard, founder and owner of Patagonia apparel company, and the founder of "1% For the Planet." When we asked for his opinion as to what to do, he emphatically said, "Times have changed, you must get involved."

So with the momentum shifting and all of the outside encouragement, we signed a wind lease 3 years ago. We now have peace knowing the ranch can pass to the next generation intact; we can continue improving the landscape; and our over 60 plus employees can have confidence in their job stability and opportunities.

We already harvest the sun's energy and market it in our meats, grains and woolen products. We have trademarked "The American Wool Tradition." We are bringing it home to America. Our Wasco County wool is sold in yarn shops across America and into Europe. Consumers love the story of sustainability, so why not harvest the wind. Sun and wind are all part of the same story.

As to how and where to site a wind facility, I believe the state has done a very good job in enacting their minimum siting standards. They had the Department of Energy, Department of Environmental Quality, Fish and Game, Department of Agriculture, and many other state, environmental and private concerns give input. Their standards are very conservative and I highly recommend you, the BOCC, adopt them as stated. Any dilution could possibly jeopardize this whole opportunity that would benefit every person in Wasco county.

Respectively Submitted,

Dan Carver

To: BOCC
From: Jeanne Carver, Imperial Stock Ranch
Re: WC Petition for Setback Standards
Date: February 12, 2011

We (my husband and I) ranch in the southern part of Wasco County. We own and steward a 50 square mile operation. Our first and most important consideration, is the health of the land itself. Second, is the viability of the operation, which harvests sunlight in the form of food and fiber, critical to preserving the future for all. Third, we preserve the history of the people and families who have been a part of this 141 year old operation. And fourth, we preserve the buildings and facilities which are Oregon's only ongoing ranching property designated a National Historic District. Agriculture is a critical segment of Wasco County's fabric and its economic health and vitality. Our family businesses are responsible for the employment of approximately 60 people in south Wasco County.

To survey a small segment of residents residing in a town in the far north end of the county, and then project what the "majority" of county residents think, is inaccurate. Additionally, what should not be dismissed, is that less than 20% of the county population manages a vast majority of the natural resource base in this county, which enhances the livability and quality of life for all residents.

We object to any proposed change in County ordinances that changes the current State approved setbacks of wind turbines. The State of Oregon has rules and regulations in effect that adequately address the setback issues. Under those rules, variance can only be approved by the home/land owner.

We feel honored and convicted to preserve our natural resources in every way possible. We don't take any decision on the ground lightly. When wind development companies first started contacting us, we flat out said no. We reacted from our hearts. We were driven by the aesthetics of open space, and a historical ethic of maintaining things close to the way they'd always been. We were resistant to change.

I want to stress, that any decision we've made with regard to renewable wind energy, was not arrived at quickly. Several years went by. Continuing contacts from development companies, changes in political and environmental factors, other people in our area moving forward with renewable energy projects, all kept the pressure on us. We are located in an area targeted with high potential for wind energy development. We had to continue to ask questions of ourselves and to seek out and ask questions of others, in order to come to a decision about what is the right and best thing to do. It required us to step back and recognize that maybe it isn't about us.

It's about all of us collectively.

It's about a much larger community that is continuing to put increasing pressure on our limited natural resources. Do we continue to take from the earth to support our energy needs, and in so doing, continue exporting our dollars at an alarming rate? Or do we utilize what the earth gives us, moving us more toward energy independence, and keeping more of those dollars at home?

What will our future be?

We've watched businesses come and go in the small communities throughout this county. They try to make it...but don't. There's no money for infrastructure improvements to entice tourists or provide services to tourists if they come. We were recently featured in Oregon Business Magazine: The New Ranch Economy. It tells the story of how things change over time and how we've adapted to remain viable. It gets harder and harder to do that. Family farms and ranches are decreasing in number every year in this state and across the country. It's no different in Wasco County. It's important that we continue to find a way forward.

Evolution is necessary. What we need to pursue in this case, is the best possible path forward based on the considered expertise as set forth by the state; not on how many signatures we get, or how many letters we write, or who shouts the loudest. Who is the authority? Who knows what's best for the safety and health of our citizens, communities and the greater community? Lay people??? Or those we've charged with planning and determining exactly that. Those who have the professional expertise, and what's more...the burden of liability and responsibility for exactly those issues and concerns, and therefore take a professionally conservative position. We should all be proud of Oregon's leading position in this country, with regard to policies and practices relative to the environment and the common good.

Let's not make the mistake of saying what "can't be done" here. Instead say "what can be done" and find a way to do it well. In this case....abide by the carefully considered regulations set forth by the state agencies and committees who worked so hard to put forth a plan for the future benefit of every citizen and resource of this state.

I think it's important to note, that PGE has made recommendations that Wasco County comply with a consistent set of standards in order to facilitate development and delivery of energies across this state and beyond. They state that it is very challenging to implement services when local standards are inconsistent with mandatory state standards and regulations. **We are risking the smart investment and development of our own future. Moving forward with renewable wind development in Wasco County will provide economic benefit to every citizen of the county.**

I would like to respectfully submit the following specific comments:

1. For those who would argue increased setbacks for noise, **Wasco County's Comprehensive Land Use Plan** says:

Noise levels should be maintained in compliance with state and federal standards. (Goal 6 AIR, WATER AND LAND RESOURCES QUALITY – Policy 3)

This is consistent with Oregon law which states that it is legislative policy **...to centralize in the Environmental Quality Commission the authority to adopt reasonable statewide standards for noise emissions permitted within this state and to implement and enforce compliance with such standards. (Oregon Revised Statutes 467.010)**

Based on that law, the Oregon Department of Energy says the following regarding noise regulation for wind energy facilities, **..local jurisdictions may adopt the DEQ noise control regulations in their local land use ordinances and apply the state noise standards at the local level.. (http://www.oregon.gov/ENERGY/RENEW/Wind/noise.shtml) .**

How can we honor state law and adopt setbacks as de factor noise standards. It makes more sense to rely on the Environmental Quality Commission in which the State of Oregon has vested the authority and responsibility to set statewide standards. **For those who would argue other standards, the EQC would be the forum to make those arguments. Let's keep the setbacks we have in place.**

2. The approach of working with the appropriate state agency to develop renewable energy resources also fits with Wasco County's comprehensive land use plan Goal 13 policy:

The County will work with appropriate State and Federal agencies to identify and protect, and if feasible, develop potential energy resources, especially renewable energy resources. (Goal 13 Energy Conservation Policy 1)

Oregon law sets forth the goal of developing permanently sustainable energy resources and that it is the policy of Oregon to encourage the development and use of sustainable energy resources that future generations not be left a legacy of vanished or depleted resources (ORS 469.010).

The Wasco County comprehensive land use plan Goal 13 policy states that use of renewable energy shall be encouraged. The proposed changes in setbacks would severely threaten the viability of continuing forward with wind development projects in this county. The land use plan recognizes that wind is a renewable resource. The proposed amendments acknowledge that there are promising wind resources in ...the southeastern half of the county generally surrounding the cities of Shaniko and Antelope.

This is the area where the Imperial Stock Ranch is located. At the 32,000 acre Imperial Stock Ranch – near Shaniko – we are harvesting sunlight in sun-grown grasses by grazing livestock which convert that sunlight energy to the food and fiber that sustains us. That sunlight is a sustainable resource, like the wind that blows across the ranch. The legacy we must leave future generations is one of working in harmony with our natural resources, using energy given to us rather than energy torn from the earth. We do not create solar energy. We use it to sustain us. We do not create wind energy, but we can use it to sustain us as well.

We believe that the sun, the wind and the land are a legacy worth leaving. Let's adopt standards that will make it possible to build that legacy – not standards that will foreclose it.

Jeanne Carver
Imperial Stock Ranch
Bakeoven Area near Shaniko

THE RANCH ECONOMY
Imperial Stock's diversity

BY THE BOOK
Becker Capital's strategy

SUSTAINABLE SOLDIER
John Miller's bottom line

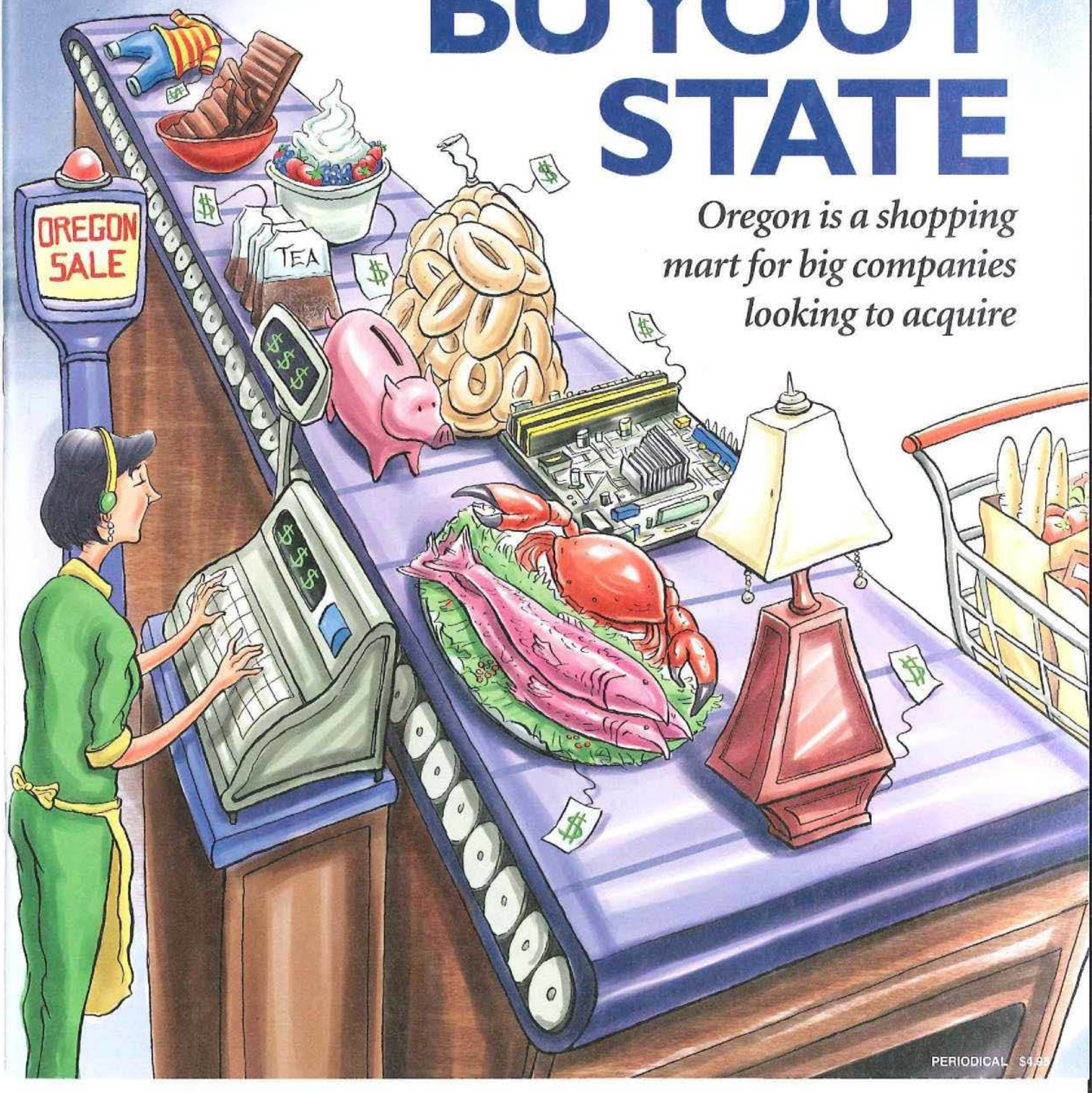
OregonBusiness

OregonBusiness.com

JANUARY/FEBRUARY 2012

BUYOUT STATE

Oregon is a shopping mart for big companies looking to acquire



PERIODICAL $4.9

THE NEW

By **ROBIN DOUSSARD**

The Imperial Stock Ranch sits 20 miles east of Maupin, which is to say in the middle of the most beautiful nowhere in eastern Oregon. The ranch sprawls across 32,000 acres of high desert, so high — 3,600 feet at its peak — that on crystalline days you can see all the way to Mount Baker and the necklace of volcanoes that leads to it.

Only four men have owned this ranch since Richard Hinton founded it 140 years ago. It passed from Hinton to his son, James, who grew the ranch to 70,000 deeded acres in Wasco County, along with more than 25,000 sheep and over 500 cattle, one of the biggest ranches in the county at the time, which made the Hintons important figures in the county and state economy. The 1945 census listed the Imperial Stock Ranch as the largest individually owned ranch in Oregon when James, without heirs, sold it to George Ward, who had worked on the ranch for years. It was from Ward that the fourth man, Dan Carver, bought the ranch in 1988.

Carver had a successful business in Stayton, and had bought a ranch in Dufur in 1978, a hay and grain operation he still owns. At the same time he heard that the Imperial ranch might be for sale, his first wife learned she had cancer. Dan says that each of their small children — Susie, Blaine and Ben — got a vote on whether to move forward and buy the ranch. The ayes had it, and the Carvers began the journey of running their new family business.

On a drive through his property, what the 69-year-old Carver sees today would be a lot like what the first man saw: many of the structures that Richard Hinton built still stand, his breed of Columbia sheep still roam and cattle still graze. The magnificent, ancient beauty of the land

The Imperial Stock Ranch rambles across a high plateau where Mount Adams (the largest mountain) and Mount Rainier (to its right) are visible.

AT LEFT, FROM TOP: Imperial Yarn includes yarn products and fashion patterns, with the Imperial Knits Collection (a pattern-only collection) headlining Portland Fashion Week last year; the historic graveyard on the ranch, where the Hinton women have been buried; Hinton House serves as headquarters for Imperial Yarn; Dan Carver walking his land; a Columbia sheep; Carver and his wife, Jeanne.

OSI PHOTOGRAPHY

RANCH ECONOMY

Photos by **RANDY JOHNSON**

is untouched. But there are other things that Carver and his family see today that Hinton could never have imagined. That wool from his Columbia sheep would be gracing a fashion runway; that giant mechanical turbines could one day dot the landscape; or that people from around the globe would visit the ranch and his home would be an historic treasure. The Carvers have built on the ranch's long-time operations of livestock, grain and hay with agritourism, direct marketing of meat, and a yarn business. And like a growing number of Oregon landowners, they have added to their balance sheet income from a wind exploration lease.

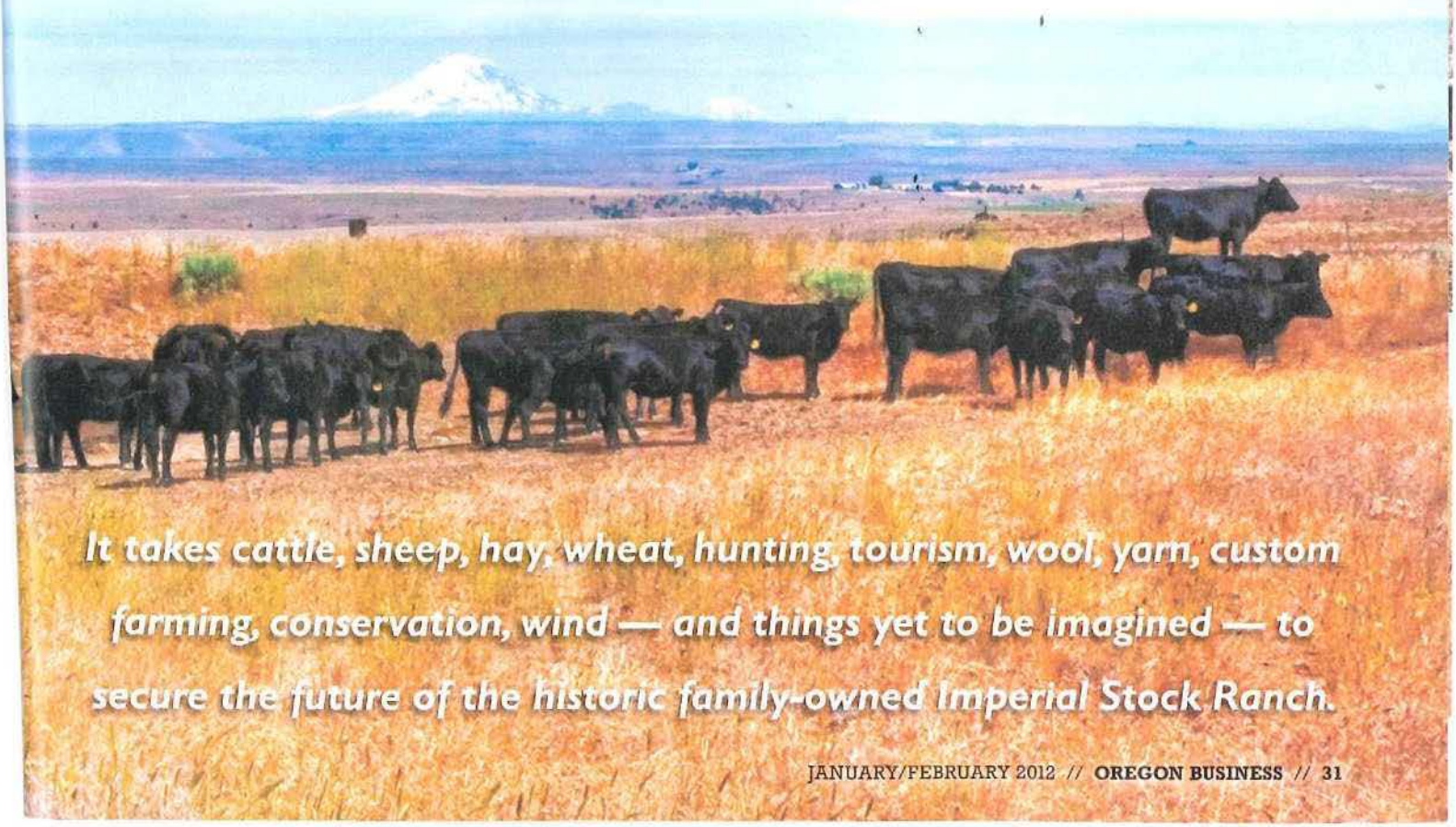
The mighty Hintons, scions of a ranching empire in their day, would be surprised to hear Carver call himself a small fry in the world of Big Ag. But it's a profitable ranch, with success won by its owners' old-school thriftiness and around-the-clock work, a diversity of income streams, and an understanding that evolution is necessary to keep the ranch economically viable. The Hintons, who diversified their livestock operation with grain and hay, would certainly recognize that, as would Ward, who saw the wool market collapse after World War II with the advent of synthetic fibers and made the decision to switch the ranch to cattle.

These forebears are all kindred spirits with Dan and Jeanne Carver, whose love and passion for this land defines them. Introduced by Jeanne's sister after Dan's first wife died in 1990, the Carvers have been married 20 years. In their operation of the ranch, the Carvers fight the same battles against globalization and industrialization that thousands of small family ranches and farms have fought. Indeed, it sometimes seems like a losing battle, with small farms and ranches decreasing each year in Oregon and nationally. The Carvers do not plan to be among them.

> *"Times have changed, the economy has changed. Farmers are looking for other income other than running cows or raising wheat."*
>
> — **DAN CARVER** —

Over the decades, the Carvers have continued to build and diversify their ranch operation: Grains and livestock (Imperial has 700 head of cattle and 3,000 acres of soft white wheat and barley, all exported, plus several hundred sheep) account for 55% of their revenue; wool and yarn are 15%; and hay, subsidies and a wind-energy lease each account for 10%. Along with that, custom farming, hunting fees, tourism, and conservation programs generate small amounts of income.

Doing business in a way that makes the ranch sustainable both economically and environmentally is a bedrock philosophy of the Carvers. Dan has



It takes cattle, sheep, hay, wheat, hunting, tourism, wool, yarn, custom farming, conservation, wind — and things yet to be imagined — to secure the future of the historic family-owned Imperial Stock Ranch.

NEW RANCH ECONOMY

"How to transition and getting along with our family.... It's the hardest thing we do. Raising cows is easy."

— BLAINE CARVER —

developed a conservation plan with the Natural Resource Conservation Service; the ranch helped restore the Buck Hollow watershed and 15 years ago changed to a low-impact no-till crop system, in addition to other ongoing conservation projects. Surging global demand and the rare confluence of record-high prices for both wheat and cattle in the past two years have meant good economic years for the Carvers.

"Right now, I wish I had a 1,000 more cows," says Dan. "But you gear up for the bad years." This is vintage cowboy philosophy and Carver is a believer. "Since the economy went south," says Jeanne, "Dan has continually stayed focused on his basic principles of business: plan to weather the worst of times."

"An old cowboy told me years ago, have a plan and stick to it," says Dan.

The Carvers employ six full-time men on the ranch and six women in the yarn and wool operations. Employing a dozen people is no small thing in this remote rural area. They liken themselves to being a small town, not only doing the many tasks involved in ranch work, but being their own fire, road, utility, medical and landscaping departments.

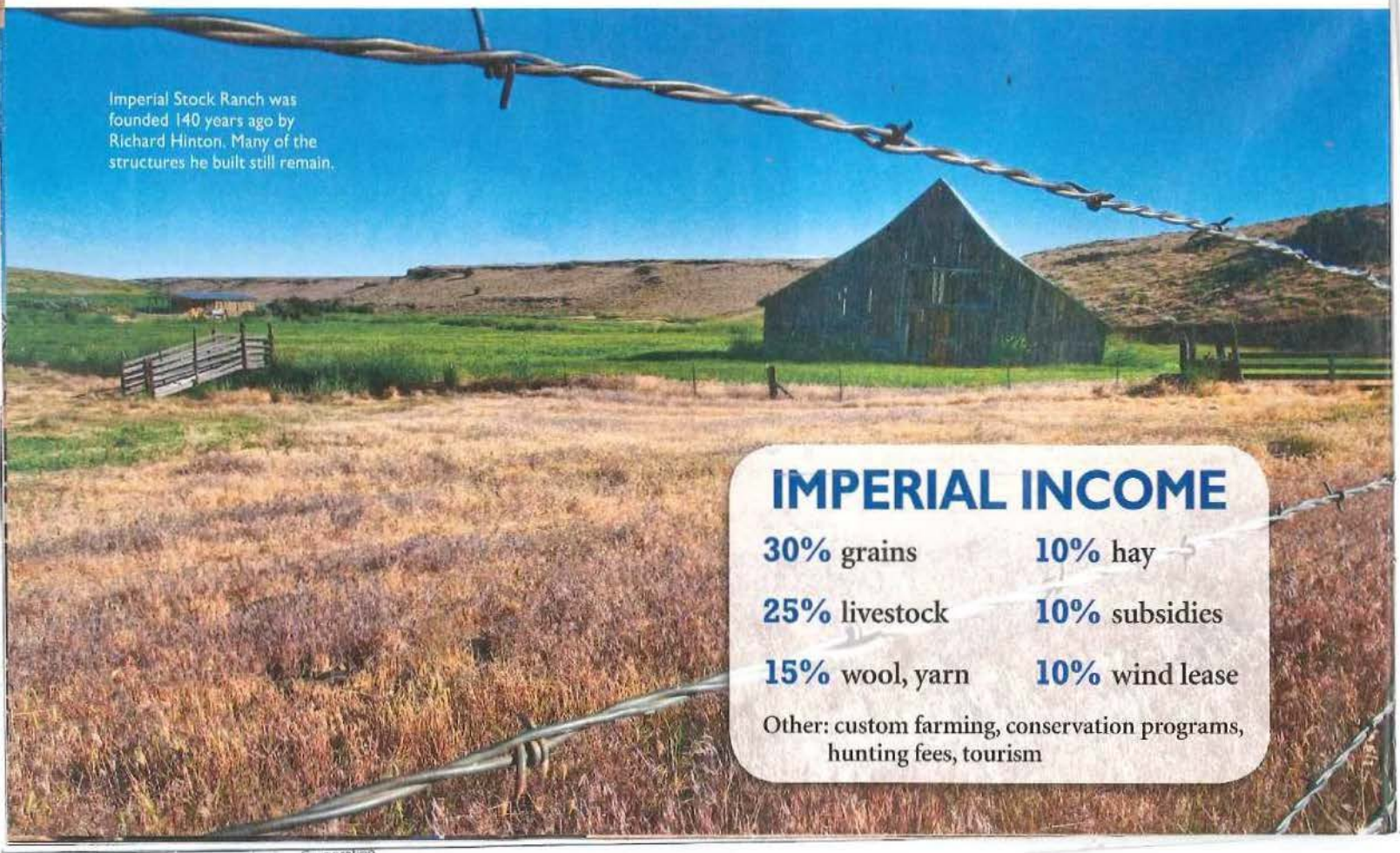
The several hundred all-white Columbia sheep (no black stockings on these babies) are Jeanne's purview, and over the past decade she has created direct-market businesses for their wool, yarn and meat. A natural storyteller and writer, her energetic evangelizing for sustainable practices such as using local fiber has made her semi-famous in the state, in rural and urban circles. Last fall, designs made from Imperial Yarn and patterns headlined Portland Fashion Week.

JEANNE CARVER

Blaine Carver is the ranch's heir apparent. He is in charge of day-to-day operations while his dad, Dan Carver, is in charge of the books.

Jeanne is as bubbly and energetic as Dan is low-key and cowboy cool, and there's a good-natured range war that goes on between the cattleman and the sheep lady. He simmers a bit that his cattle ranch is now known as "the sheep ranch." He considers sheep supremely dumb.

"I enjoy the historic significance of the sheep," says Dan. "I just get worn out hearing about it constantly."



Imperial Stock Ranch was founded 140 years ago by Richard Hinton. Many of the structures he built still remain.

IMPERIAL INCOME

30% grains

25% livestock

15% wool, yarn

10% hay

10% subsidies

10% wind lease

Other: custom farming, conservation programs, hunting fees, tourism

If anyone could rebrand a cattle ranch a "sheep ranch" through sheer force of will, it would be Jeanne Carver.

The Carvers in 1999 started creating retail products from their raw commodities to survive. A small, lean whirlwind, the 58-year-old Jeanne has been working for a dozen years creating retail products from her sheep — artisan wool and meat (some of their beef is also direct market). She calls it her "sunlight story," tying together the ranch animals that eat the sun-grown grasses, and that are being converted into food and fiber for people. The value-add is important because long ago the American sheep industry collapsed, and keeping alive the historic Columbia breed is as important to Jeanne as the revenue.

"It comes from our efforts to remain viable as a family ranch," she said in a recent newsletter that she writes about ranch life, "to preserve the presence and relationship of sheep on the landscape and ... to reach a hand across the rural/urban divide to work together for a richer future."

Over the years, Jeanne's fiber business has taken many turns: in 2004 clothing retailer Norm Thompson agreed to sell the garments that Jeanne produced in collaboration with local weavers and knitters. Portland designer Anna Cohen joined forces with Jeanne in 2008, and in 2009 they debuted the Imperial Collection by Anna Cohen at Portland Fashion Week, an apparel line designed by Cohen. They were back at fashion week last fall with a pattern-only collection designed by Cohen, with a final collaborative effort that included Earthtec, which makes fabric from recycled plastic.

The yarn operation is booming, and Jeanne says they can't keep production ahead of sales. "I'm a work in progress and I'm not a businessperson," she says. "I don't necessarily want to go after as much market share as is possible." Jeanne points with pride to the fact that since January 2011, Imperial Yarn has received no financial support from the ranch (part of the range war). It has grown to stand on its own, with Imperial Yarn more than doubling its sales in 2011 from the previous year. "A growing portion is e-commerce, but our bread and butter is local yarn shops all over the country," says Jeanne. She has also sold to yarn shops in Berlin and London. Area ranches recently expressed interest in selling raw wool to her operation.

Employing women on the ranch is also a point of pride to Jeanne.

AT TOP: Dan and Jeanne Carver have spent more than 20 years diversifying the economy of the Imperial Stock Ranch. Middle: in 1996, the ranch went to a low-impact no-till crop system. Bottom: the ranch has about 700 head of cattle.

FASHION WIRE PRESS

Jeanne Carver has built a yarn business to capitalize on the wool from the ranch's historic Columbia breed of sheep. At far left, the Imperial Collection by Anna Cohen at Portland Fashion Week in 2009. Above, the business is housed in the historic Hinton House. At left, Imperial Yarn products are sold nationally and internationally.

Son Blaine's wife, Keelia, is the full-time warehouse manager at Imperial Yarn, along with five other local women, in addition to Cohen being creative director. They call themselves the Imperial Yarn Girls (buttons available with orders) and have set up headquarters in the historic Hinton House, which the Carvers have restored (they live in the 1970s brick home built for George Ward). Jeanne spent 15 months researching and writing the application for a National Historic District designation, which the 22-acre ranch headquarters received in 1993.

Authors, environmentalists, yarn aficionados, *Vogue Knitting* and schoolchildren who have been known to serenade the sheep all have made pilgrimages to the ranch. Jeanne has embraced education and sharing the history of the ranch to anyone who wants to listen.

"The efforts … are simply our way of honoring the past as we constantly adapt and find the way forward to a solid future," she says.

> *"I'm a work in progress and I'm not a businessperson. I don't necessarily want to go after as much market share as is possible."*
>
> — JEANNE CARVER —

Finding a way to that solid future was part of the Carvers' decision to sign a wind development agreement with Portland-based Iberdrola Renewables, a subsidiary of a Spanish energy company. Though the Carvers won't say how much the deal brings them, it was enough to see that it could help secure the future of the ranch. Iberdrola also sponsored Imperial Yarn at Portland Fashion Week.

"Three years ago they descended like locusts," remembers Dan. "Twelve companies approached us. The neighbors had signed contracts. I knew I was going to look at, turbines no mater what. And wind income would help us keep the ranch in the family .... Times have changed, the economy has changed. Farmers are looking for other income other than running cows or raising wheat."

The size of the ranch and its high elevation made it ideal for wind exploration. The Carvers are one of eight landowners in the area who have signed with Iberdrola. If wind development goes forward, there could be up to 202 wind towers on Imperial land, generating as much as 303 megawatts. Income to the ranch would be considerable. The project is still under evaluation, but Iberdrola says it plans to submit a site certificate application to the state early this year.

"Here's how I see the evolution [of the ranch's economy]. The homesteader couldn't make it. The little guys are still disappearing," Dan says. "I look at sustainability in its true form. There are three parts: social, economic and environmental. If you're going broke, you're not sustainable."

"It might happen, and it's just as likely not to," Jeanne says. "The future of this ranch is secure regardless of wind power. "

The Imperial River Company on the Deschutes River in Maupin is owned by Susie and Rob Miles, the Carvers' daughter and son-in-law. The business markets tours to the ranch, along with serving its lamb and beef.

Numbers and business deals are only part of the story about how a small family ranch survives. Critical to having a future is whether there is a next generation to take over. The agriculture industry is aging and younger people are not flooding in to replace them. Imperial Ranch has both a son and a daughter involved.

"I grew up working for Dad. I fell in love with it at a pretty early age," says Blaine Carver. "Susie and I both want the ranch to go on forever." (Brother Ben is a watershed coordinator in Colorado.)

Blaine, 34, is Dan's heir apparent. He runs the day-to-day operations at Imperial in partnership with his father and also owns an adjacent ranch of 1,000 acres.

Like his dad, and George Ward and the Hintons before him, Blaine sees the economy of the ranch continuing to evolve and he has his own ideas that don't exactly match up with the elder Carvers'.

Blaine doesn't want the ranch to consume him the way it does his parents. "I call them the Intel generation," Dan says. "Jeanne and I work seven days a week. Blaine and his wife try to give workers the weekend off."

The younger Carver does not apologize for not wanting to work the ranch 24-7 and will look for a successful business plan that supports that. "I'm newly married and I want to spend time with my wife," Blaine says. "So part of how you get there is doing better financially ... I want this ranch to run well enough that we all have time to have a garden, have successful marriages and families, go hunting ... This stuff is also important work, it just isn't classified as 'ranch work.'"

His sister, Susie Miles, and her husband, Rob, are the owners and operators of the Imperial River Company in Maupin, which offers lodging, dining, event services, rafting, hunting and fishing on the Deschutes River. With financial backing from the Carvers, they bought the property 10 years ago, and six years ago added a wing. It's decorated with locally made quilts and art, and serves Imperial Ranch meat, along with tours of the ranch. "I'll someday take over the tours at the ranch," says Susie, who is 36. She adds that she and the Carvers are in the planning phases of other things, but like the rest of her clan, doesn't give too much away. "Transitions take time," she says. "That can be the hardest thing."

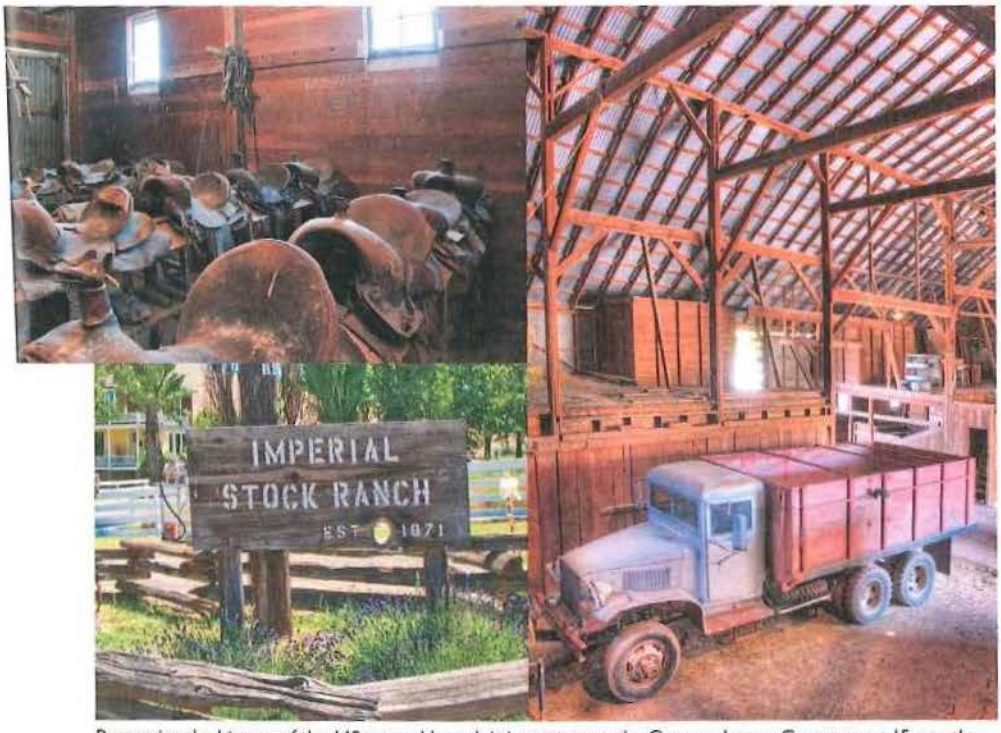
"How to transition and getting along with our family.... It's the hardest thing we do," agrees Blaine. "Raising cows is easy."

He admits he's not tied to Jeanne's beloved wool and yarn operation. "But I think it's cool," he says. "The same with direct marketing of the meat. I believe in it. However, [it's] a 24-hour-a-day job and it doesn't pay that well. I would love to see those programs keep going, but I may not be the person doing them. I would only see wool continuing if someone like Keelia wants to do it. I would support it 100 percent."

Blaine sees a continuing decline in the cattle market and the need to prepare for that, and believes fee hunting on private land will get bigger. "I really see hunting as one of the key future points of this ranch," he says. His own operation is mainly hay and hunting rights, and he also signed a wind lease with Iberdrola.

"[Wind income] perhaps would allow us to do what we do even better; however, it will not change our business that much," he says. "The added income would ensure that you always made decisions with the best interest of the land and animals in mind, rather than the bottom line. One of the biggest income streams for ranchers is the government. If you had wind income or something like that you could get out of those programs and make smarter farming decisions."

All reigns are temporary so it is inevitable that the fourth man eventually will hand over the ranch to the fifth man and the sheep lady will bequeath her animals to her successor. That next generation will find its own way forward. Imperial Stock Ranch has one beginning, and it will have many middles. What the Carvers work for is a ranch with no end. OB



Preserving the history of the 140-year-old ranch is important to the Carvers. Jeanne Carver spent 15 months researching and writing its history for the application for a National Historic District designation, which the 22-acre ranch headquarters received in 1993.

ROBIN DOUSSARD is the editor of *Oregon Business*. She can be reached at robind@oregonbusiness.com.

For more pictures and history of Imperial Stock Ranch go to OregonBusiness.com/ranch

February 12, 2012

Wasco Board of County Commissions

I suggest that the Energy Regulations for Wasco County be re-written. I feel that "one size fits all" is incorrect. The A-1 zone for Agriculture should not be the same as the more highly populated Farm/Forrest and smaller lots.

I recommend that on A-1 zones land, that the set back should be ~~more than~~ 1320 feet, and non resource land 3,520 feet. I believe that this is more than sufficient, due to sparse population of South County.

Wasco County is in need of additional revenue, and the one way is to make wind energy a viable source.

Please consider the input from all of Wasco County citizens.

Ashley Wheat & Cattle Ranch
Larry Ashley, owner

Larry Ashley

SUBMITTED BY PHIL SWAM
2-15-12

An attachment to the CWEC report discusses actual turbine failure reports from Denmark and Germany. The data show that blade fragments are likely to be thrown farther from the turbine tower than whole blades.[56] For turbines larger than 1 MW, the maximum reported throw distance for a blade fragment is 300 meters (984 feet). The maximum throw distance for an entire blade is 150 meters (492 feet), but there is no data for turbines larger than 600 kW. The zone of risk for a turbine collapse is a distance equal to the maximum blade tip height.[57]

A recently-completed report commissioned by the Union of Nova Scotia Municipalities reviewed peer-reviewed journal articles and other sources regarding the impacts of wind energy generation and approaches to regulation.[58] The report noted that "there is no scientific or societal consensus on many aspects of wind development." Nevertheless, with regard to blade failure risk, the report suggested a safety setback distance of 2 to 3 times maximum blade tip height. This recommendation appeared to be based on consideration of the range setback regulations adopted by various Canadian municipalities.

Until more definitive turbine-failure data become available, the Council adopts safety setbacks based on the Council's own precedents, on ordinances from other jurisdictions that have addressed the issue and on the available turbine failure data discussed above. For public roads, the Council adopts a safety setback of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest edge of the public road right-of-way, assuming a minimum right-of-way width of 60 feet. For residences, the Council adopts a safety setback of one-quarter mile (1,320 feet or 402 meters).[59] The distance would be measured from the centerline of the turbine tower to the center of the house and would apply to residences existing at the time of facility construction. In addition, the Council adopts a setback requirement of 110-percent of maximum blade tip height from the centerline of the turbine to the nearest boundary of the certificate holder's lease area.[60] These safety setback distances would apply unless a greater setback distance is required under the County ordinances discussed below or is necessary for compliance with noise control regulations (discussed at page 130).

GCZO Section 7.020(T)(4)(d)(1), discussed below at page 34, requires that "no portion of the facility" be located within 3,520 feet of properties zoned for residential use. The application states that no portion of the proposed facility would be located within 3,520 feet of property zoned for residential use or designated in the Gilliam County Comprehensive Plan as a residential zone.[61] Based on the applicant's representation, the Council includes this restriction in the site certificate.

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[56] The throw distance for ice shedding from a turbine blade is assumed to be similar to the range of a blade fragment (CWEC report, Attachment 1, p. 2).

[57] CWEC report, Attachment 1, p. 19.

[58] Jaques Whitford Consultants, *Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities*, January 2008.

[59] A quarter-mile safety setback (1,320 feet) provides a margin of safety beyond the maximum reported throw distance of 984 feet for a blade fragment, as discussed above. For comparison, the ordinances of Alameda County, Riverside County and Solano County (California) require a setback of 3 times maximum blade tip height, which would result in a setback distance of 1,476 feet, assuming a blade-tip height of 150 meters (the maximum that would be allowed under Condition 26).

[60] The lease-boundary setback requirement is based on the applicant's representation in the application and supporting record, in accordance with OAR 345-027-0020(10).

[61] App Supp, Exhibit K, response to RAI K1, p. 5.

E-Coustic Solutions

Noise Control • Sound Measurement • Consultation
Community • Industrial • Residential • Office • Classroom • HIPPA Oral Privacy
P.O Box 1129, Okemos, MI, 48805
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Richard R. James
Principal
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To: The People of Calumet County and the County and Town Boards of Calumet County

Please let me introduce myself:

My name is Richard R. James.

I am a Noise Control Engineer and the Principal Consultant for E-Coustic Solutions, of Okemos, Michigan. I have over 35 years of experience assisting my client's in addressing their noise related problems. In this capacity, I have worked with companies including: General Motors, Ford, The Goodyear Tire and Rubber Company, Anheuser Busch, Deere and Company, as well as many smaller firms, to address Community noise issues for existing facilities where neighbor's complaints have led to community actions against the firms; or in the early stages of Site Planning for new facilities to determine the compatibility of the proposed facility and the existing neighborhood. I have conducted studies throughout the U.S. and Europe for my clients.

In addition to my business interests in applying the principles of noise control and measurement to my Client's needs, I am an Adjunct Instructor to Michigan State University's Department of Communicative Sciences and Disorders and, until recently, a voting member of the American National Standards Institute's S12 Committee which oversees Acoustical Test procedures used to standardize the work of acousticians and Noise Control Engineers. This function provides oversight of the Standards used in the USA when measuring or otherwise defining sound metrics and for assessing Land-Use-Compatibility of new noise sources with existing communities. I am a Full Member of the Institute of Noise Control Engineers (INCE) which functions as a peer review group for Noise Control in a manner similar to the Professional Engineering Associations do for other types of engineering.

I would like to add that I grew up in Green Bay, Wisconsin and during my youth spent many wonderful summers in Wisconsin's North between Antigo and Rhinelander where my grandparents lived. This made me particularly appreciative of the value of a natural land and soundscape, and the expectations of the people who live in those settings. In the mid-1960's, I left Wisconsin to attend college at General Motor's Institute (GMI) in Flint Michigan. It was at GMI where I earned my bachelor's degree in engineering and decided that I would focus on the emerging field of Noise Control.

And, just so you know, I am still a Packer fan!

Now to some points I would like to share with you.

MYTH NUMBER 1: WIND TURBINE POWER GENERATING CAPACITY

Wind turbines do not produce full power until the wind speeds at hub height reach a certain speed. Once you find out the make and model number of the units scheduled for your community you should be able to locate a graph that shows how power generated varies with wind speed. You will see that power output does not reach full potential until the winds are quite strong. If the wind speeds at hub height are not at or above design speed then the power generated is less than rated capacity. Since there is no way to store the power produced by the turbines, the winds also need to be present during the season(s) when the power grid can use the extra power. This is often the summer time on the hottest days when people are running air conditioning leading to brown-outs if the extra power is not available The Chilton area appears to be a Class 2 (marginal) wind area. A Wind Speed map of annual average wind at 40 meters above ground shows wind speeds range from 5.0 to 6.5 m/s and 6-7.5m/s at 100 meters above ground. Most industrial scale wind turbine generators (WTGs) need at least 4-5 m/s of wind to start. A review of the power curves for a

selection of WTGs shows that at 6 m/s they produce only a fifth to a quarter of rated power. It takes wind speeds of 12-15 m/s to reach full power output. Further, Wisconsin appears to have less wind available in the summer than the rest of the year. The illustration below is from a study conducted at a number of places in Wisconsin[1]. Site 409 is on Honeymoon Hill, near New Holstein and site 410 is near Glenmore. Note how wind speeds are the lowest (4 m/s) in the summer months when energy demand is highest.

When the turbine promoters talk, they will usually talk as though the turbines will produce full power (E.G. 10 units rated at 1.5 MW will be talked about as though they always produce 15 MW. Yet, power produced during seasons when the grid does not need it is wasted unless provisions are made to store it. I am not aware of any utility with the current ability to store winter power until the summer when it is needed.

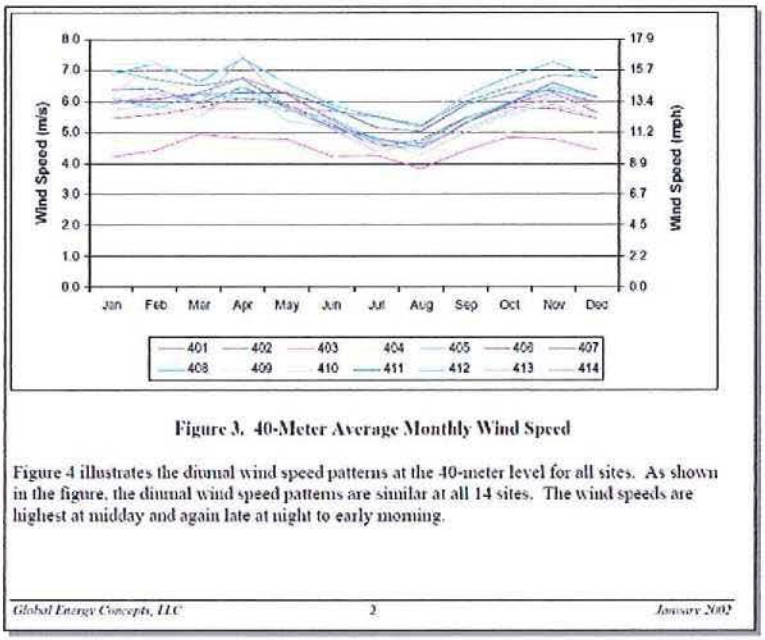


Figure 3. 40-Meter Average Monthly Wind Speed

Figure 4 illustrates the diurnal wind speed patterns at the 40-meter level for all sites. As shown in the figure, the diurnal wind speed patterns are similar at all 14 sites. The wind speeds are highest at midday and again late at night to early morning.

Global Energy Concepts, LLC 2 *January 2002*

One of the questions the community should demand an answer to from the wind farm developer before issuing permits is: "Will your turbines provide power during the times it is needed to meet the summer season and time-of-day grid demand, and if so, how much?" What are the REAL benefits, not the rosy scenario numbers? If the turbines do not have sufficient wind power to produce electricity during the "peak need" periods, the developer's push to install them may be driven only by a desire to get the tax incentives. In this case, the community should say 'No' to the developers. There are only so many dollars to invest in renewable sources of electric power. These dollars and the tax incentives used to motivate them should be spent to install turbines only in areas with high wind class ratings during the seasons and the times of the day that the power is needed and can be used on the grid.

If the investors are just looking for the tax breaks and not truly interested in helping to solve the energy problems, why should communities tolerate the visual and noise pollution the wind turbine generators create? Why should the citizens and taxpayers be expected to offset the losses resulting from locating the WTG's in poor wind areas? Developers should be required to demonstrate the fiscal soundness of their plans before permits are granted.

MYTH NUMBER 2: NOISE FROM WIND WILL COVER THE TURBINE NOISE

A second way wind speed relates to your situation is that wind speeds at ground level are very often considerably lower than at the hub height for industrial grade wind turbines. This is due to the friction created by the earth's surface slowing the air movement close to the ground. The wind turbine promoters will try to minimize the effects of noise concerns by saying that the turbines only work when the winds are present and that the wind will create noise that will mask (cover up) the

[1] Wisconsin Wind Resource Assessment Program, by **Global Energy Concepts, LLC**

sounds produced by the turbines. This may be true when the wind speed at ground level is high, say 15 mph or higher, but it is often the case that wind speeds are sufficient for turbine operation at the hub height and yet are barely noticeable at ground level. Under those circumstances, there are no masking effects due to the wind and the turbines will be clearly audible. The Wind Energy promoters seem to try to obfuscate this effect by use of 'averages' and other diversions. See MYTH #1.

Wind, temperature and other factors can greatly modify the sounds one hears when outdoors. They may sound much quieter and can sound much louder. These factors are generally not considered when establishing permitting regulations.

The promoters will stress sound levels in dBA as being the proper method for evaluating community response. When sound is described or measured in dBA the lower frequency sound energy (especially below 100 Hz) is greatly de-emphasized. The dBA measurement is used to mimic the way the human ear does not hear low frequency sounds as well as it does mid-range and high frequency sounds. It is often used in community noise studies and standards because it is easy to understand and it does relate in many circumstances to community response. But, it works because many common noise sources, vehicles, aircraft, railroads, fans, blowers, and others usually have much of the acoustic energy in the mid-range frequencies and are not dominated by very low frequency sound energy. Thus, the assumptions about the ear's response to the noise are reasonably valid. But, they are not applicable to WTGs. Detailed frequency data is needed for WTGs.

When there is a strong, very low frequency component to the noise source's emissions, dBA is not a good descriptor. Wind Turbines have a very low frequency component. Ignoring this component in permitting regulations will lead to a higher incidence of negative community response than would be anticipated from the dBA levels. It also leads to vibration effects when the contents of near-by homes resonate with the lower frequency energy resulting in rattling dishes and wiggling mirrors.

MYTH NUMBER 3: THERE ARE NO ADVERSE HEALTH EFFECTS FROM WIND TURBINE SOUNDS

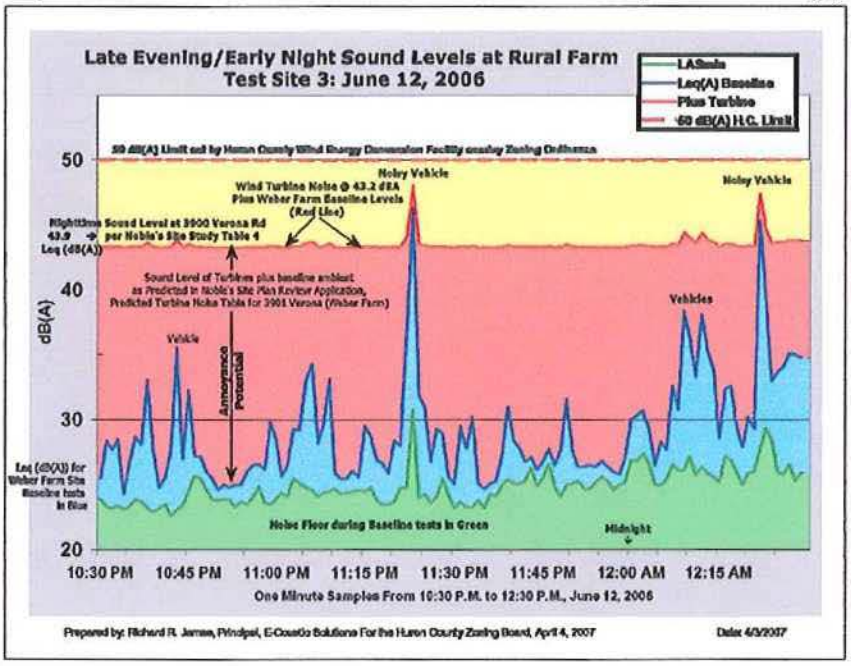
While it may be true that wind turbines do not produce sufficient sound to cause hearing loss they are loud enough to have an affect on quality of life elements like sleep and stress. These are health issues that the promoters tend to discount or just avoid addressing. Since wind turbine generators are a relatively new source of community noise it would be better to require full review of sound emissions across the entire frequency range down to at least 6 Hz, and preferably lower.

This is especially true in light of the health related questions raised by the studies in Europe on Vibroacoustic Disease (VAD). Early studies show that low frequency sound energy can have a negative effect on cardio-vascular health. These studies are preliminary and still subject to verification. But, once wind turbines are installed, they are permanent. Allowing them to be installed if they produce significant low frequency air-borne and structure borne energy may be allowing a serious health risk to be introduced into the community. Caution seems to be the wise plan.

MYTH NUMBER 4: TURBINES WILL BLEND INTO THE COMMUNITY'S SOUNDSCAPE

There are standards for assessing noise sources developed by the American National Standards Institute (ANSI) that are followed and often adopted by Federal and State Agencies and courts in the USA. The ANSI Standard used to evaluate the impact of environmental noise on communities (ANSI S12.9) provides for a rural community's greater expectation of quiet by adding 15 dBA to the 'apparent' sound level of a new noise source. This includes 10 dBA for the expectation of quiet associated with rural communities and 5 dBA for noise sources not previously experienced by the community. Different times of the day make a difference, too. Late evenings may be the most noise sensitive times as the temperature gradient from ground to hub heights may be considerable and wind speeds may also differ. Late evening is also the time when expectations of 'quiet' are the great-

est. This is when people are going to bed or sitting on their porches and patios relaxing after a busy day. These are all factors that should be considered prior to issuing permits.



I did a study for a community in Michigan's Thumb and presented my findings to the County Zoning Board. I have included a graph from my handout for that meeting so you can share the findings. My findings show the sound levels in the late evening to be in the mid 25 dBA range (blue). The predicted sound level of the turbine is shown added to the original soundscape (red). The red area is the added sound of the turbines. The Huron County Wind Turbine siting regulations (and Michigan Guidelines) permit the turbines to emit up to 50 dBA (yellow) and even 55 dBA for some circumstances. The noise study done by or for the Wind Farm Company's Environment Impact Statement claimed that the community sound levels were in the high 30 to 45 dBA range even during evening and nighttime periods. This was contradicted by my study. The graph shows how the wind turbines proposed for property adjacent to one of the residents who will live just a little over 1000 feet from a turbine will affect the late evening sound levels. It is a bit complex but if you study it you will see that after the turbine is operational the soundscape will never be the same again. Or, to borrow from a song from my youth sung by Joni Mitchell: *"You don't know what you've got 'til it's gone."*

You need to pick everything apart and use your own judgment. Trust nothing, and verify everything. Watch for attempts at Social Marketing. If you do not know what this is look it up on the Internet. Wind Turbine power is being marketed as "Green" energy and it is not. It may be 'renewable" but it is not "Green." Wind Turbine Generators are noise and visual polluters. Siting them in rural areas merely moves industrial pollution from urban areas to the countryside. Are the benefits worth it? These decisions should be driven by science, not emotion and marketing prowess.

Thank you for your patience in listening to this rather long letter.

Sincerely,

Richard R. James, INCE

Richard R. James

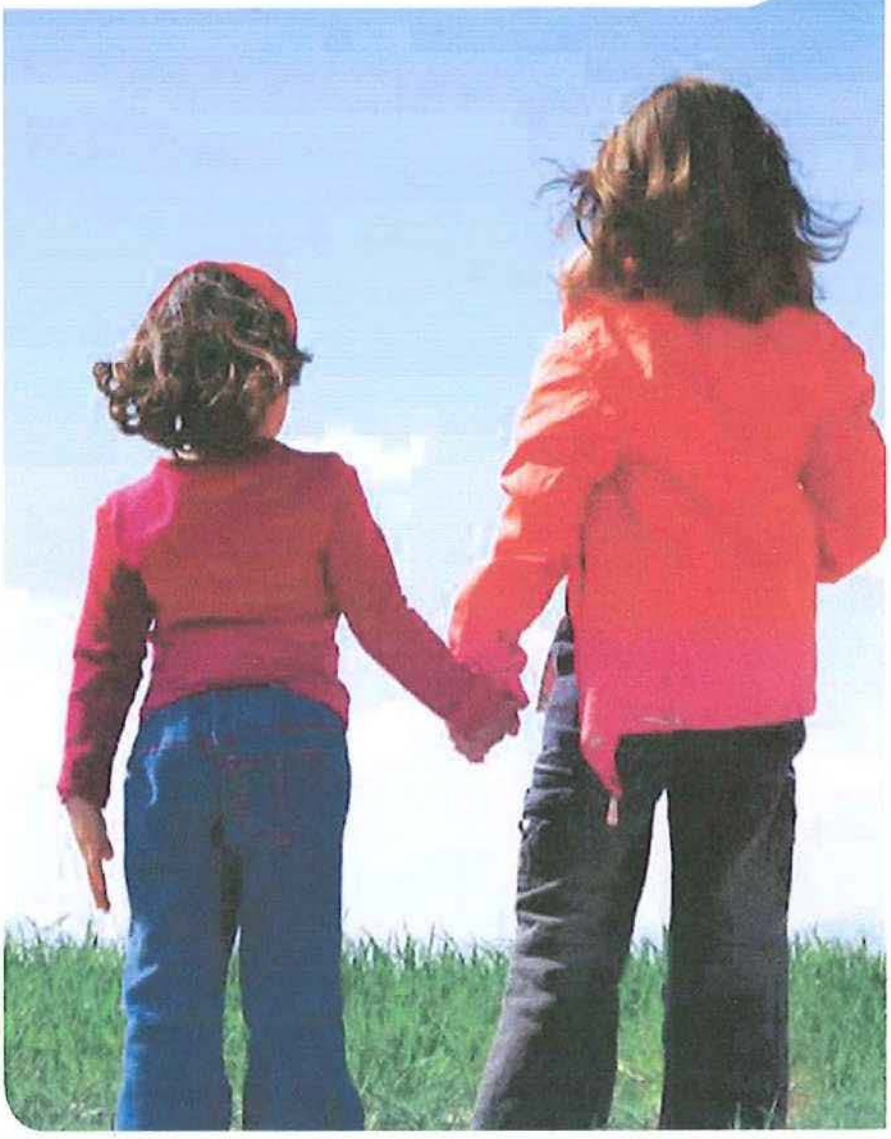
E-Coustic Solutions, Okemos, MI 48805
Tel: (517) 507-5067 Fax: (866) 461-4103
Email: rickjames@e-coustic.com

Wind-Turbine NOISE

What Audiologists Should Know

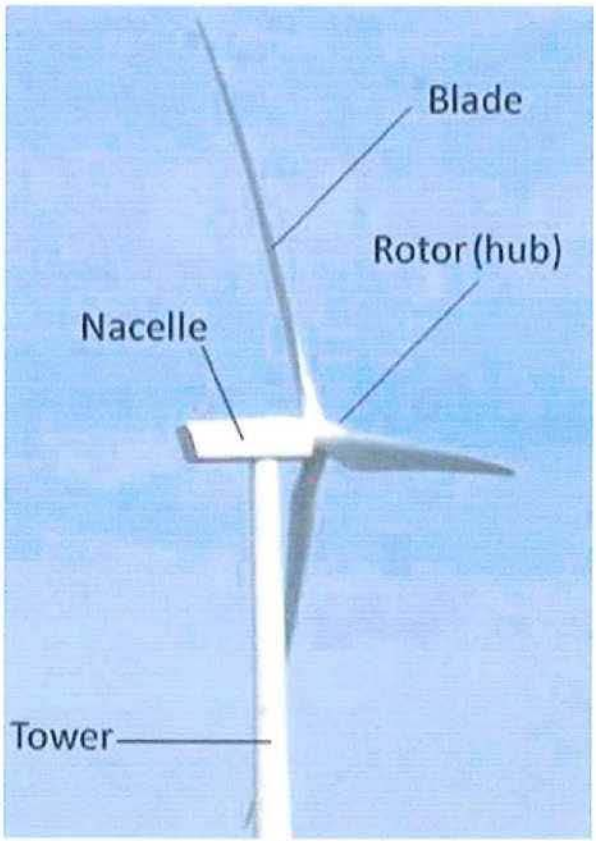
BY JERRY PUNCH, RICHARD JAMES, AND DAN PABST

Noise from modern wind turbines is not known to cause hearing loss, but the low-frequency noise and vibration emitted by wind turbines may have adverse health effects on humans and may become an important community noise concern.



Most of us would agree that the modern wind turbine is a desirable alternative for producing electrical energy. One of the most highly touted ways to meet a federal mandate that 20 percent of all energy must come from renewable sources by 2020 is to install large numbers of utility-scale wind turbines. Evidence has been mounting over the past decade, however, that these utility-scale wind turbines produce significant levels of low-frequency noise and vibration that can be highly disturbing to nearby residents.

None of these unwanted emissions, whether audible or inaudible, are believed to cause hearing loss, but they are widely known to cause sleep disturbances. Inaudible components can induce resonant vibration in solids, liquids, and gases—including the ground, houses, and other building structures, spaces within those structures, and bodily tissues and cavities—that is potentially harmful to humans. The most extreme of these low-frequency (infrasonic) emissions, at frequencies under about 16 Hz, can easily penetrate homes. Some residents perceive the energy as sound, others experience it as vibration, and others are not aware of it at all. Research is beginning to show that, in addition to sleep disturbances, these emissions may have other deleterious consequences on health. It is for these reasons that wind turbines are becoming an important community health issue, especially when hosted in quiet rural communities that have no prior experience with industrial noise or urban hum.



Major components of a modern wind turbine.

The people most susceptible to disturbances caused by wind turbines may be a small percentage of the total exposed population, but for them the introduction of wind turbines in their communities is not something to which they can easily become acclimated. Instead, they become annoyed, uncomfortable, distressed, or ill. This problem is increasing as newer utility-scale wind turbines capable of generating 1.5-5 MWatts of electricity or more replace the older turbines used over the past 30 years, which produced less than 1 MWatt of power. These large wind turbines can have hub heights that span the length of a football field and blade lengths that span half that distance. The increased size of these multi-MWatt turbines, especially the blades, has been associated with complaints of adverse health effects (AHEs) that cannot be explained by auditory responses alone.

For this article, we reviewed the English-language, peer-reviewed literature from around the world on the topic of wind-turbine noise and vibration and their effects on humans. In addition, we used popular search engines to locate relevant online trade journals, books, reference sources, government regulations, and acoustic and vibration standards. We also consulted professional engineers and psychoacousticians regarding their unpublished ideas and research.

Sources of Wind-Turbine Noise and Vibration

Physically, a modern wind turbine consists of a tower; a rotor (or hub); a set of rotating blades—usually three, located upwind to the tower; and a nacelle, which is an enclosure containing a gearbox, a generator, and

computerized controls that monitor and regulate operations (FIGURE 1). Wind speed can be much greater at hub level than at ground level, so taller wind towers are used to take advantage of these higher wind speeds. Calculators are available for predicting wind speed at hub height, based on wind speeds at 10 meter weather towers, which can easily be measured directly.

Mechanical equipment inside the nacelle generates some noise, but at quieter levels than older turbines. This mechanical sound is usually considered of secondary importance in discussions of annoyance from today's turbines. The main cause of annoyance is an aerodynamic source created by interaction of the turning blades with the wind. With optimal wind conditions, this aerodynamic noise is steady and commonly described as an airplane overhead that never leaves.

When wind conditions are not optimal, such as during turbulence caused by a storm, the steady sounds are augmented by fluctuating aerodynamic sounds. Under steady wind conditions, this interaction generates a broadband whooshing sound that repeats itself about once a second and is clearly audible. Many people who live near the wind turbine find this condition to be very disturbing.

The whooshing sound comes from variations of air turbulence from hub to blade tip and the inability of the turbine to keep the blades adjusted at an optimal angle as wind direction varies. The audible portion of the whoosh is around 300 Hz, which can easily penetrate walls of homes and other buildings. In addition, the rotating blades create energy at frequencies as low as 1–2 Hz (the blade-passage frequency), with overtones of up to about 20 Hz. Although some of this low-frequency energy is audible to some people with sensitive hearing, the energy is mostly vibratory to people who react negatively to it.

Adverse Health Effects of Wind-Turbine Noise

Hubbard and Shepherd (1990), in a technical paper written for the National Aeronautics and Space Administration (NASA), were the first to report in depth on the noise and vibration from wind turbines. Most of the relevant research since that time has been conducted by European investigators, as commercial-grade (utility-scale) wind turbines have existed in Europe for many decades. Unfortunately, the research and development done by wind-turbine manufacturers is proprietary and typically has not been shared with the public, but reports of the distressing effects on people living near utility-scale wind turbines in various parts of the world are becoming more common.

Studies carried out in Denmark, The Netherlands, and Germany (Wolsink and Sprengers, 1993; Wolsink et al, 1993), a Danish study (Pedersen and Nielsen, 1994), and two Swedish studies (Pedersen and Persson Waye, 2004, 2007) collectively indicate that wind turbines differ from other sources of community noise in several respects. These investigators confirm the findings of earlier research that amplitude-modulated sound is more easily perceived and more annoying than constant-level sounds (Bradley, 1994; Bengtsson et al, 2004) and that sounds that are unpredictable and uncontrollable are more annoying than other sounds (Geen and McCown, 1984; Hatfield et al, 2002).

Annoyance from wind-turbine noise has been difficult to characterize by the use of such psychoacoustic parameters as sharpness, loudness, roughness, or modulation (Persson Waye and Öhrström, 2002). The extremely low-frequency nature of wind-turbine noise, in combination with the fluctuating blade sounds, also means that the noise is not easily masked by other environmental sounds.

Pedersen et al (2009), in a survey conducted in The Netherlands on 725 respondents, found that noise from

wind turbines is more annoying than transportation or industrial noises at comparable levels, measured in dBA. They noted that annoyance from turbine sounds at 35 dBA corresponds to the annoyance reported for other common community-noise sources at 45 dBA. Higher visibility of the turbines was associated with higher levels of annoyance, and annoyance was greater when attitudes toward the visual impact of the turbines on the landscape were negative. However, the height of wind turbines means that they are also most clearly visible to the people closest to them and those who also receive the highest sound levels. Thus, proximity of the receiver to wind turbines makes it difficult to determine whether annoyance to the noise is independent of annoyance to the visual impact. Pedersen et al (2009) also found that annoyance was substantially lower in people who benefitted economically from having wind turbines located on their property.

Among audiologists and acousticians, it has been understood for many decades that sufficiently intense and prolonged exposure to environmental noise can cause hearing impairment, annoyance, or both. In essence, the view has been *what* you can hear can hurt you. In the case of wind turbines, it seems that *what* you can't hear can also hurt you. Again, there is no evidence that noise generated by wind turbines, even the largest utility-scale turbines, causes hearing loss. But there is increasingly clear evidence that audible and low-frequency acoustic energy from these turbines is sufficiently intense to cause extreme annoyance and inability to sleep, or disturbed sleep, in individuals living near them.

Table 1. Core Symptoms of Wind-Turbine Syndrome

1	Sleep disturbance
2	Headache
3	Visceral Vibratory Vestibular Disturbance (VVVD)
4	Dizziness, vertigo, unsteadiness
5	Tinnitus
6	Ear pressure or pain
7	External auditory canal sensation
8	Memory and concentration deficits
9	Irritability, anger
10	Fatigue, loss of motivation

Source: Pierpont, 2009

Jung and colleagues (2008), in a Korean study, concluded that low-frequency noise in the frequency range above 30 Hz can lead to psychological complaints and that infrasound in the frequency range of 5–8 Hz can cause complaints due to rattling doors and windows in homes.

The energy generated by large wind turbines can be especially disturbing to the vestibular systems of some people, as well as cause other troubling sensations of the head, chest, or other parts of the body. Dr. Nina Pierpont (2009), in her definitive natural experiment on the subject, refers to these effects as Wind-Turbine Syndrome (WTS). TABLE 1 lists the symptoms that, in various combinations, characterize WTS. Although hearing impairment is not one of the symptoms of WTS, audiologists whose patients report these symptoms should ask them if they live near a wind turbine.

It is well known that sleep deprivation has serious consequences, and we know that noncontinuous sounds and nighttime sounds are less tolerable than continuous and daytime sounds. Somewhat related effects, such as cardiac arrhythmias, stress, hypertension, and headaches have also been attributed to noise or vibration from wind turbines, and some researchers are referring to these effects as Vibroacoustic Disease, or VAD (Castelo Branco, 1999; Castelo Branco and Alves-Pereira, 2004). VAD is described as occurring in persons who are exposed to high-level (>90 dB SPL) infra- and low-frequency noise (ILFN), under 500 Hz, for periods of 10 years or more. It is believed to be a systemic pathology characterized by direct tissue damage to a variety of bodily organs and may involve abnormal proliferation of extracellular matrices.

Alves-Pereira and Castelo Branco (2007) reported on a family who lived near wind turbines and showed signs of VAD. The sound levels in the home were less than 60 dB SPL in each 1/3-octave band below 100 Hz. We have measured unweighted sound levels ranging from 60 to 70 dB Leq (averaged over 1 minute) in these low-frequency bands in Ontario homes of people reporting AHEs from wind turbines. A spectral analysis of sounds emitted at a Michigan site revealed that unweighted peak levels at frequencies under 5 Hz exceeded 90 dB SPL (Wade Bray, pers. comm., 2009).

Similar observations have been made in studies of people who live near busy highways and airports, which also expose people to low-frequency sounds, both outdoors and in their homes. Evidence is insufficient to substantiate that typical exposures to wind-turbine noise, even in residents who live nearby, can lead to VAD, but early indications are that there are some more-vulnerable people who may be susceptible. Because ILFN is not yet recognized as a disease agent, it is not covered by legislation, permissible exposure levels have not yet been established, and dose-response relationships are unknown (Alves-Pereira, 2007).

As distinguished from VAD, Pierpont's (2009) use of the term Wind-Turbine Syndrome appears to emphasize a constellation of symptoms due to stimulation, or overstimulation, of the vestibular organs of balance due to ILFN from wind turbines (see TABLE 1). One of the most distinctive symptoms she lists in the constellation of symptoms comprising WTS is Visceral Vibratory Vestibular Disturbance (VVVD), which she defines as "a sensation of internal quivering, vibration, or pulsation accompanied by agitation, anxiety, alarm, irritability, rapid heartbeat, nausea, and sleep disturbance" (p. 270).

Drawing on the recent work of Balaban and colleagues (i.e., Balaban and Yates, 2004), Pierpont describes the close association between the vestibular system and its neural connections to brain nuclei involved with balance processing, autonomic and somatic sensory inflow and outflow, the fear and anxiety associated with vertigo or a sudden feeling of postural instability, and aversive learning. These neurological relationships give credence to Pierpont's linkage of the symptoms of VVVD to the vestibular system.

Todd et al (2008) demonstrated that the resonant frequency of the human vestibular system is 100 Hz, concluding that the mechano-receptive hair cells of the vestibular structures of the inner ear are remarkably sensitive to low-frequency vibration and that this sensitivity to vibration exceeds that of the cochlea. Not only is 100 Hz the frequency of the peak response of the vestibular system to vibration, but it is also a frequency at which a substantial amount of acoustic energy is produced by wind turbines. Symptoms of both VAD and VVVD can presumably occur in the presence of ILFN as a result of disruptions of normal paths or structures that mediate the fine coordination between living tissue deformation and activation of signal transducers; these disruptions can lead to aberrant mechano-electrical coupling that can, in turn, lead to conditions such as heart arrhythmias (Ingber, 2008). Ultimately, further research will be needed to sort out the commonalities and differences among the symptoms variously described in the literature as VAD, VVVD, and WTS.

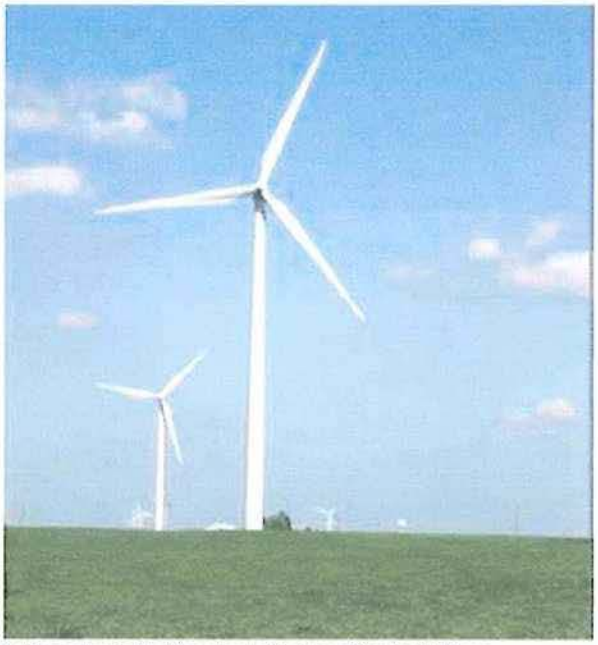
Dr. Geoff Leventhall, a British scientist, and his colleagues (Waye et al, 1997; Leventhall, 2003, 2004) have documented the detrimental effects of low-frequency noise exposure. They consider it to be a special environmental noise, particularly to sensitive people in their homes. Waye et al (1997) found that exposure to dynamically modulated low-frequency ventilation noise (20–200 Hz)—as opposed to midfrequency noise exposure—was more bothersome, less pleasant, impacted work performance more negatively, and led to lower social orientation.

Leventhall (2003), in reviewing the literature on the effects of exposure to low-frequency noise, found no evidence of hearing loss but substantial evidence of vibration of bodily structures (chest vibration), annoyance (especially in homes), perceptions of unpleasantness (pressure on the eardrum, unpleasant perception within the chest area, and a general feeling of vibration), sleep disturbance (reduced wakefulness), stress, reduced performance on demanding

verbal tasks, and negative biological effects that included quantitative measurements of EEG activity, blood pressure, respiration, hormone production, and heart rate.

Regarding work performance, reviewed studies indicated that dynamically modulated low-frequency noise, even when inaudible to most individuals, is more difficult to ignore than mid- or high-frequency noise and that its imperviousness to habituation leads to reduced available information-processing resources. Leventhall hypothesized that low-frequency noise, therefore, may impair work performance. More recently, as a consultant on behalf of the British Wind Energy Association (BWEA), the American Wind Energy Association (AWEA), and the Canadian Wind Energy Association (CANWEA), Leventhall (2006) changed his position, stating that although wind turbines do produce significant levels of low-frequency sound, they do not pose a threat to humans—in effect reverting to the notion that *what* you can't hear can't hurt you.

According to the World Health Organization guidelines (WHO, 2007), observable effects of nighttime, outdoor wind-turbine noise do not occur at levels of 30 dBA or lower. Many rural communities have ambient, nighttime sound levels that do not exceed 25 dBA. As outdoor sound levels increase, the risk of AHEs also increases, with the most vulnerable being the first to show its effects. Vulnerable populations include elderly persons; children, especially those younger than age six; and people with pre-existing medical conditions, especially if sleep is affected. For outdoor sound levels of 40 dBA or higher, the WHO states that there is sufficient evidence to link prolonged exposure to AHEs. While the WHO identifies long-term, nighttime audible sounds over 40 dBA outside one's home as a cause of AHEs, the wind industry commonly promotes 50 dBA as a safe limit for nearby homes and properties. Recently, a limit of 45 dBA has been proposed for new wind projects in Canada (Keith et al, 2008).



Utility-scale wind turbines located in Huron County, Michigan.

Much of the answer as to why the wind industry denies that noise is a serious problem with its wind turbines is because holding the noise to 30 dBA at night has serious economic consequences. The following quotation by Upton Sinclair seems relevant here: "It is difficult to get a man to understand something when his salary depends upon his not understanding it" (Sinclair, 1935, reprinted 1994, p. 109).

In recent years, the wind industry has denied the validity of any noise complaints by people who live near its utility-scale wind turbines. Residents who are leasing their properties for the siting of turbines are generally so pleased to receive the lease payments that they seldom complain. In fact, they normally are required to sign a leasing agreement, or gag clause, stating they will not speak or write anything unfavorable about the turbines. Consequently, complaints, and sometimes lawsuits, tend to be initiated by individuals who live near property on which wind turbines are sited, and not by those who are leasing their own property. This situation pits neighbor against neighbor, which leads to antagonistic divisions within communities.

Measurement of Wind-Turbine Noise

It is important to point out that the continued use of the A-weighting scale in sound-level meters is the basis for misunderstandings that have led to acrimony between advocates and opponents of locating wind turbines in residential areas. The dBA scale grew out of the desire to incorporate a function into the measurement of sound pressure levels of environmental and industrial noise that is the inverse of the minimum audibility curve (Fletcher and Munson, 1933) at the 40-phon level. It is typically used, though, to specify the levels of noises that are more intense, where the audibility curve becomes considerably flattened, obviating the need for A-weighting. It is mandated in various national and international standards for measurements that are compared to damage-risk criteria for hearing loss and other health effects. The A-weighted scale in sound-level meters drastically reduces

sound-level readings in the lower frequencies, beginning at 1000 Hz, and reduces sounds at 20 Hz by 50 dB.

For wind-turbine noise, the A-weighting scale is especially ill-suited because of its devaluation of the effects of low-frequency noise. This is why it is important to make C-weighted measurements, as well as A-weighted measurements, when considering the impact of sound from wind turbines. Theoretically, linear-scale measurements would seem superior to C-scale measurements in wind-turbine applications, but linear-scale measurements lack standardization due to failure on the part of manufacturers of sound-level meters to agree on such factors as low-frequency cutoff and response tolerance limits. The Z-scale, or zero-frequency weighting, was introduced in 2003 by the International Electro-technical Commission (IEC) in its Standard 61672 to replace the flat, or linear, weighting used by manufacturers in the past.

State of Michigan Siting Guidelines

Michigan's siting guidelines (State of Michigan, 2008) will be used as an example of guidelines that deal only in a limited way with sound. These guidelines refer to earlier, now outdated, WHO and Environmental Protection Agency (EPA) guidelines to support a noise criterion that SPLs cannot exceed 55 dBA at the adjacent property line. This level is allowed to be exceeded during severe weather or power outages, and when the ambient sound level is greater than 55 dBA, the turbine noise can exceed that higher background sound level by 5 dB. These levels are about 30 dB above the nighttime levels of most rural communities. When utility-scale turbines were installed in Huron County, Michigan, in May 2008, the WHO's 2007 guidelines that call for nighttime, outside levels not to exceed 30 dBA were already in place. Based on measurements made by the authors, these turbines produce 40–45 dBA sound levels at the perimeter of a 1,000 ft radius under typical weather conditions, and the additive effects of multiple turbines produce higher levels. Many of the turbines have been located close enough to homes to produce very noticeable noise and vibration.

Kamperman and James (2009) have offered recommendations for change in the State of Michigan guidelines (2008) for wind turbines. Some of the more pertinent details of the Michigan siting guidelines are shown in the left-hand column of TABLE 2. The state of Michigan permits sound levels that do not exceed 55 dBA or L90 + 5 dBA, whichever is greater, measured at the property line closest to the wind-energy system. These guidelines make no provisions to limit low-frequency sounds from wind-turbine operations.

In consideration of the current WHO guidelines (2007), measurements made by the authors in Huron County, Michigan, indicate that the current Michigan guidelines do not appear adequate to protect the public from the nuisances and known health risks of wind-turbine noise. In fact, these guidelines appear to be especially lenient

Table 2. Current and Proposed Wind-Turbine Siting Guidelines

Current Michigan Guidelines*	Alternative Proposed Guidelines**
Sound level cannot exceed 55 dBA or L90 + 5 dBA, whichever is greater.	Operating LAeq is not to exceed the background LA90 +5 dBA, where LA90 is measured during a preconstruction noise study at the quietest time of night. Similar dBC limits should also be applied.
Limits apply to sound levels measured at homes (as stated in Huron County Ordinance).	Limits apply to sound levels measured at property lines, except that turbine sounds cannot exceed 35 dBA at any home.
No provisions are made for limiting low-frequency sounds from wind-turbine operations.	LCeq-LA90 cannot exceed 20 dB at receiving property, e.g., LCeq (from turbines) minus (LA90 [background] + 5) < 20 dB, and is not to exceed 55 LCeq from wind turbines (60 LCeq for properties within one mile of major heavily trafficked roads).

*Source: State of Michigan, 2008

**Source: Kamperman and James, 2009

in terms of tolerable sound levels. Sound levels that approach 20 dBA higher than natural ambient levels are considered unacceptable in most countries; Michigan permits 30 dBA increases.

In considering the health and well-being of people living near wind-turbine projects, the changes recommended by Kamperman and James (2009) would abandon the 55 dBA limit in favor of the commonly accepted criteria of L90 + 5 dBA, for both A- and C-scale readings, where L90 is the preconstruction ambient level. These recommendations also include a prohibition against any wind-turbine-related sound levels exceeding 35 dBA on receiving properties that include homes or other structures in which people sleep. Additional protections against low-frequency sound are given in the right-hand column of TABLE 2. These recommended provisions would protect residents by limiting the difference between C-weighted Leq during turbine operation and the quietest A-weighted pre-operation background sound levels, plus 5 dB, to no more than 20 dB at the property line. This level should not exceed 55 dB Leq on the C scale, or 60 dB Leq for properties within one mile of major heavily trafficked roads, which sets a higher tolerance for communities that tend to experience slightly noisier conditions.

People living near wind turbines may experience sleep disturbance.

Implementation of the recommendations of Kamperman and James would result in siting wind turbines differently than what is currently planned for future wind-turbine projects in Michigan. This change would result in sound levels at nearby properties that are much less noticeable, and much less likely to cause sleep deprivation, annoyance, and related health risks. These sound-level measurements should be made by independent acoustical engineers or knowledgeable audiologists who follow ANSI guidelines (1993, 1994) to ensure fair and accurate readings, and not by representatives of the wind industry.

People living within a mile of one or more wind turbines, and especially those living within a half mile, have frequent sleep disturbance leading to sleep deprivation, and sleep disturbances are common in people who live up to about 1.25 miles away. This is the setback distance at which a group of turbines would need to be in order not to be a nighttime noise disturbance (Kamperman and James, 2009). It is also the setback distance used in several other countries that have substantial experience with wind turbines, and is the distance at which Pierpont (2009) found very few people reporting AHEs.

A study conducted by van den Berg (2003) in The Netherlands demonstrated that daytime levels cannot be used to predict nighttime levels and that residents within 1900 mile (1.18 mile) of a wind-turbine project expressed annoyance from the noise. Pierpont (2009) recommends baseline minimum setbacks of 2 kilometers (1.24 mile) from residences and other buildings such as hospitals, schools, and nursing homes, and longer setbacks in mountainous terrain and when necessary to meet the noise criteria developed by Kamperman and James (2009).

In a panel review report, the American Wind Energy Association (AWEA) and Canadian Wind Energy Association (CANWEA) have objected to setbacks that exceed 1 mile (Colby et al, 2009). A coalition of independent medical and acoustical experts, the Society for Wind Vigilance (2010), has provided a recent rebuttal to that report. The society has described the panel review as a typical product of industry-funded white papers, being neither authoritative nor convincing. The society accepts as a medical fact that sleep disturbance, physiological stress, and psychological distress can result from exposure to wind-turbine noise.

Wind turbines have different effects on different people. Some of these effects are somewhat predictable based on financial compensation, legal restrictions on free speech included in the lease contracts with hosting landowners, and distance of the residence from wind projects, but they are sometimes totally unpredictable. Planning for wind projects needs to be directed not only toward benefitting society at large but also toward protecting the individuals living near them. We believe that the state of Michigan, and other states that have adopted similar siting guidelines for wind turbines, are not acting in the best interest of all their citizens and need to revise their siting guidelines to protect the public from possible health risks and loss of property values, as well as reduce complaints about noise annoyance.

Wind-utility developers proposing new projects to a potential host community are often asked if their projects will cause the same negative community responses that are heard from people living in the footprint of operating projects. They often respond that they will use a different

type of wind turbine or that reports of complaints refer to older-style turbines that they do not use. In our opinion, these statements should usually be viewed as diversionary.

Finally, it is important to note that there is little difference in noise generated across makes and models of modern utility-scale, upwind wind turbines once their power outputs are normalized. Kamperman (pers. comm., 2009), after analyzing data from a project funded by the Danish Energy Authority (Søndergaard and Madsen, 2008), has indicated that when the A-weighted sound levels are converted to unweighted levels, the low-frequency energy from industrial wind turbines increases inversely with frequency at a rate of approximately 3 dB per octave to below 10 Hz (the lowest reported frequency). Kamperman has concluded that the amount of noise generated at low frequencies increases by 3–5 dB for every MW of electrical power generated. Because turbines are getting larger, this means that future noise problems are likely to get worse if siting guidelines are not changed.

Conclusion

Our purpose in this article has been to provide audiologists with a better understanding of the types of noise generated by wind turbines, some basic considerations underlying sound-level measurements of wind-turbine noise, and the adverse health effects on people who live near these turbines. In future years, we expect that audiologists will be called upon to make noise measurements in communities that have acquired wind turbines, or are considering them. Some of us, along with members of the medical profession, will be asked to provide legal testimony regarding our opinions on the effects of such noise on people. Many of us will likely see clinical patients who are experiencing some of the adverse health effects described in this article.

As a professional community, audiologists should become involved not only in making these measurements to corroborate the complaints of residents living near wind-turbine projects but also in developing and shaping siting guidelines that minimize the potentially adverse health effects of the noise and vibration they generate. In these ways, we can promote public health interests without opposing the use of wind turbines as a desirable and viable alternative energy source.

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Portions of this work were presented at the Annual Convention of the American Speech-Language-Hearing Association (ASHA), November 2009, New Orleans, LA.

Acknowledgments. We wish to thank the many families and residents of Huron County, Michigan, with whom we spent many hours discussing a variety of issues related to their concerns about the noise and vibration from nearby wind turbines. Their involvement, and especially their compelling stories, provided information and encouragement that led us to the belief that this work should be shared with members of the audiology profession.

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Wind Energy Industry Acknowledgement of Adverse Health Effects

Part 1 Conclusion and Executive Summary

An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009"

Prepared by
The Society for Wind Vigilance

January 2010*

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** Appended January 18, 2009 to include document production details. Note: the contents of this analysis have not been altered.*

FORWARD

Wind Turbine Sound and Health Effects, An Expert Panel Review (A/CanWEA Panel Review) was prepared for and sponsored by the American Wind Energy Association (AWEA) and the Canadian Wind Energy Association (CanWEA).

In response, an analysis was conducted by The Society for Wind Vigilance of the A/CanWEA Panel Review. Details of the analysis are included in Table 1 of this document.

The summary and related points cover a broad spectrum of claims. For convenience the remainder of the analysis and critique is done in a tabulated format of point - counter point. The volume of material necessitated this approach and hopefully will enhance the clarity of the critique being put forward.

The method utilized was to excerpt each of the claims and place it in the context of authoritative and contrary information. In addition an effort has been made to identify the errors of omission as well as those of commission.

CONCLUSION

It is apparent from this analysis that the A/CanWEA Panel Review is neither authoritative nor convincing. The work is characterized by commission of unsupportable statements and the confirmation bias in the use of references. Many important references have been omitted and not considered in the discussion. Furthermore the authors have taken the position that the World Health Organization standards regarding community noise are irrelevant to their deliberation - a remarkable presumption.

There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This is settled medical science.

There are many peer-reviewed studies showing that infra and low frequency sound can cause adverse health effects, especially when dynamically modulated. Modern upwind industrial scale turbines of the types now being located in rural areas of North America require study. The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects upon the human body remains an open question - there is no settled medical science on this issue as of yet.

Perhaps the most egregious conclusion is that no more research is required. That statement implies that the science is settled which quite simply is false. It also demonstrates a disdain for the scientific method itself.

There is but one conclusion: independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind

turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur.

In contrast to the statement of the A/CanWEA Panel Review, our view is that a great deal of research is required for the protection of people's health.

EXECUTIVE SUMMARY

The conclusions of the A/CanWEA Panel Review are not supported by its own contents nor does it have convergent validity with relevant literature.

The A/CanWEA Panel Review acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms. It then ignores the serious consequences.

World Health Organization identifies annoyance and sleep disturbance as adverse health effects.[1]

In 2009 the World Health Organization released a peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effects documented include fatigue, memory difficulties, concentration problems, mood disorders, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, impaired immune system function and a reported increased risk of mortality to name a few.[2]

Health Canada acknowledges the health consequences of stress and considers it a to be a risk factor in a great many diseases, such as heart disease, some types of bowel disease, herpes, mental illness and difficulty for diabetics to control blood sugar. It states severe stress can cause biochemical changes in the body, affecting the immune system, which leaves the body vulnerable to disease.[3]

Despite the acknowledgement that wind turbine noise may cause annoyance, stress and sleep disturbance the A/CanWEA Panel Review fails to offer any science based guidelines that would mitigate these health risks.

On the contrary the A/CanWEA Panel Review concludes by suggesting that the authoritative health based noise guidelines of the World Health Organization should be ignored and that wind turbine noise limits be based on public policy.[4]

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[1] World Health Organization, Guidelines for Community Noise, 1999
http://www.euro.who.int/mediacentre/PR/2009/20091008_1
[2] Night Noise Guidelines for Europe, World Health Organization (2009)
www.euro.who.int/document/e92845.pdf
[3] Health Canada http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/stress-eng.php

The A/CanWEA Panel Review concludes by stating that it does not "advocate for funding further studies."[5]

Others do not agree.

In November 2009 the Japanese Ministry of Environment announced a four year study into the effects of wind farms on health.[6]

In September 2009 members of the Maine Medical Association passed a resolution which among other things calls for independent study and authoritative guidelines.[7]

Preliminary findings of a controlled study (Mars Hill, Maine) being conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomatology, compared to a control group living 5000-6000 meters away. This controlled study is a work in progress.[8]

The A/CanWEA Panel Review can only be viewed for what it is. It is an industry association convened and sponsored attempt to deny the adverse health effects being reported.

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[4] W. David Colby, M.D. et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[5] W. David Colby, M.D. et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[6] http://www.yomiuri.co.jp/dy/national/20091129TDY02309.htm

[7] Maine Medical Association Resolution re Wind Energy and Public Health September 2009

[8] http://windvigilance.com/mars_hill.aspx

SUMMARY OF FINDINGS

The A/CanWEA Panel Review:

- appears to value quantity over quality – it consists largely of filler material including 22 of 85 pages (26%) blank or title pages.
- is not a study: it is an incomplete literature review.
- was prepared for and sponsored by AWEA and CanWEA which raises questions about its objectivity.
- displays selective bias favouring the positions of AWEA and CanWEA in the presentation of the referenced material.
- displays selective bias favouring the positions of AWEA and CanWEA by omission of relevant references.
- displays a negative bias regarding references that do not favour the interest of the AWEA and CanWEA.
- misquotes references.
- contains incomplete risk assessments related to health.
- contains misleading statements.
- contains statements without appropriate supporting references.
- contains conclusions which are not supported by cited references.
- ignores the authoritative research and noise guidelines of the World Health Organization.
- contains pre-emptive stereotyping of those who have concerns about health risks associated with wind turbine facilities. Terms such as "detractors" and "opponents" are used. This pre-emptive stereotyping extends to concerned medical professionals who are calling for authoritative guidelines designed to protect human health. This pre-emptive stereotyping dismisses the claim that the panel is independent and unbiased.

Wind Energy Industry Acknowledgement of Adverse Health Effects

Part 2 Detailed Analysis

An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009"

Prepared by
The Society for Wind Vigilance

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January 2010*

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A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
Notice to Reader **The analysis contained in this table is not intended be exhaustive and does not address all the inadequacies contained in the A/CanWEA Panel Review.**	
Title Page	"Prepared for: American Wind Energy Association and Canadian Wind Energy Association" ***Industry trade associations convening and sponsoring a literature review cannot be considered independent or unbiased.*** ***This approach is reminiscent of the now discredited "Tobacco Industry Research Committee" created in the 1950's and sponsored by the tobacco industry.*** ***http://www.sourcewatch.org/index.php?title=Tobacco_Industry_Research_Committee***
ES1	"Wind energy enjoys considerable public support, but it also has its detractors, who have publicized their concerns that the sounds emitted from wind turbines cause adverse health consequences." ***The A/CanWEA Panel Review uses biased pre-emptive stereotyping by labelling individuals or groups who have concerns about the adverse effects from exposure to industrial wind turbines as "detractors". The pre-emptive stereotyping attempts to invalidate legitimate concerns at the onset.*** ***Detractor is defined as "somebody who disparages or devalues somebody or something".*** ***Encarta® World English Dictionary [North American Edition] © & (P)2009*** ***This pre-emptive stereotyping extends to concerned medical professionals such as members of the Maine Medical Association who have passed a resolution calling for independent research and the development of authoritative wind turbine guidelines designed to protect human health.***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	This pre-emptive stereotyping dismisses the claim that the panel is independent and unbiased.
ES1	"Following review, analysis, and discussion of current knowledge, the panel reached consensus on the following conclusions: • There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects. • The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans. • The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences." ***The contents of the A/CanWEA Panel Review do not support these statements. See discussion on pages 5-1 and 5-2.***
2-1	Methodology 2.1 Formation of Expert Panel "The American and Canadian wind energy associations, AWEA and CanWEA, assembled a distinguished panel of independent experts to address concerns that the sounds emitted from wind turbines cause adverse health consequences." ***Industry trade associations convening and sponsoring a literature review cannot be considered independent or unbiased.*** ***This approach is reminiscent of the now discredited "Tobacco Industry Research Committee" created in the 1950's and sponsored by the tobacco industry.*** ***http://www.sourcewatch.org/index.php?title=Tobacco_Industry_Research_Committee***
2-1	2.2 Review of Literature Directly Related to Wind Turbines "The panel conducted a search of Pub Med under the heading "Wind Turbines and Health Effects" to research and address peer-reviewed literature. In addition, the panel conducted a search on "vibroacoustic disease." The reference section identifies the peer and non-peer reviewed sources that were consulted by the panel."

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The search criteria used in the report is very limited and limiting. ***For example, additional searches should have included relevant headings such "wind turbines and adverse health effects", "noise", "annoyance", "low frequency noise", "stress", "sleep disturbance" and "flicker" to name a few obvious omissions.*** ***The A/CanWEA Panel Review is not comprehensive as it did not consider other environmental exposures associated with wind turbine operations such as safety, visual acceptability, electromagnetic pollution and visual interference or flicker.*** ***The A/CanWEA Panel Review is an incomplete literature review.***
2-2	"The reference section identifies the peer and non-peer reviewed sources that were consulted by the panel." ***The A/CanWEA Panel Review presents peer and non peer reviewed sources but displays selective bias regarding sources which do not support the conclusions of the report.*** ***Many relevant and authoritative sources have not been cited or discussed in the A/CanWEA Panel Review.*** ***See discussion regarding page 6-1.***
2-1	2.3 Review of Potential Environmental Exposures "The panel conducted a review of potential environmental exposures associated with wind turbine operations, with a focus on low frequency sound, infrasound, and vibration." ***The A/CanWEA Panel Review was not comprehensive as it ignored other environmental exposures associated with wind turbine operations such safety, visual acceptability, electromagnetic pollution and visual interference or flicker.*** ***In summary the A/CanWEA Panel Review is an incomplete literature review.***
3-12 to 3-14	3.3 Potential Adverse Effects of Exposure to Sound ***The A/CanWEA Panel Review displays selective bias in citing noise limits from various references regarding potential adverse effects of exposure to sound (sections 3.3.1-3.3.5)***.

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The A/CanWEA Panel Review cites selective noise limits which are consistently higher than the authoritative health based noise guidelines of the World Health Organization. 3.3.1 Speech Interference "Levels below 45 dBA can be considered irrelevant with respect to speech interference." ***The A/CanWEA Panel Review displays selective bias by citing a level of 45dBA.*** ***World Health Organization guidelines indicates a level of 35 LAeq[dB] to protect speech intelligibility and moderate annoyance, daytime and evening (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note: an increase of 10 dBA is a 10-fold increase in acoustic energy.*** 3.3.2 Noise-Induced Hearing Loss "Regulatory (OSHA, 1983) and advisory (NIOSH, 1998) authorities in the U.S. concur that risk of NIHL begins at about 85 dBA" ***The A/CanWEA Panel Review displays selective bias by citing a level of 85dBA.*** ***World Health Organization guidelines recommend a level of 70 LAeq [dB] to protect against hearing impairment in industrial, commercial, shopping and traffic areas, indoors and outdoors (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note an increase of 10 dBA is a 10-fold increase in acoustic energy.*** 3.3.3 Task Interference "Levels below 70 dBA do not result in task interference."

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The A/CanWEA Panel Review displays selective bias by citing a level of 70dBA. ***World Health Organization guidelines recommend a level of 35 LAeq [dB] to protect disturbance of information extraction (e.g. comprehension and reading acquisition). (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note an increase of 10 dBA is a 10-fold increase in acoustic energy.*** 3.3.4 Annoyance "It is important to note that although annoyance may be a frustrating experience for people, it is not considered an adverse health effect or disease of any kind." ***The A/CanWEA Panel Review displays selective bias by ignoring the adverse health effect of noise induced annoyance.*** ***Health Canada states in their publication "It's Your Health":*** ***"The most common effect of community noise is annoyance, which is considered an adverse health effect by the World Health Organization."*** ***http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/community-urbain-eng.php#he*** ***World Health Organization states:*** ***"The range of health effects of noise is wide. They include pain and hearing fatigue, hearing impairment including tinnitus, annoyance…"*** ***http://www.euro.who.int/Noise/activities/20021203_2*** ***"Sleep disturbance and annoyance are the first effects of night noise and can lead to mental disorders.***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	The effects of noise can even trigger premature illness and death." ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***W. David Colby, M.D., one of the authors or the A/CanWEA Panel Review, described the consequence of wind turbines induced annoyance when he publicly stated:*** ***"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick."*** ***W. David Colby, M.D, Sounding Board, 97.9 FM The Beach December 17, 2009*** ***The A/CanWEA Panel Review ignores the serious risk to human health that annoyance and stress may cause.*** ***According to Health Canada:*** ***"…stress is considered to be a risk factor in a great many diseases, including:*** ***• heart disease*** ***• some types of bowel disease*** ***• herpes*** ***• mental illness*** ***Stress also makes it hard for people with diabetes to control their blood sugar.*** ***Stress is also a risk factor in alcohol and substance abuse, as well as weight loss and gain. Stress has even been identified as a possible risk factor in Alzheimer's Disease. Severe stress can cause biochemical changes in the body, affecting the immune system, leaving your body vulnerable to disease."*** ***http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/stress-eng.php*** "Noise from airports, road traffic, and other sources (including wind turbines) may annoy some people, and, as described in Section 4.1, the louder the noise, the more people may become annoyed." ***The A/CanWEA Panel Review ignores the risk to human health from***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"Noise from airports, road traffic, and other sources (including wind turbines)". ***World Health Organization states:*** ***"The effects of noise can even trigger premature illness and death. Night noise from aircraft can increase blood pressure, even if it does not wake people. Noise is likely to be more harmful when people are trying to fall asleep and awaken. Recent studies show that aircraft noise in the early morning is the most harmful in increasing the heart rate."*** ***"Nuisance at night can lead to an increase in medical visits and spending on sleeping pills, which affects families' budgets and countries' health expenditure."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** 3.3.5 Sleep Disturbance "DNL is a 24-hour average that gives 10 dB extra weight to sounds occurring between 10p.m. and 7 a.m., on the assumption that during these sleep hours, levels above 35 dBA indoors may be disruptive." ***While the A/CanWEA Panel Review acknowledges "… levels above 35 dBA indoors may be disruptive" it cites a 1974 document without citing WHO (1999).*** ***World Health Organization guidelines recommend a level of 30 LAeq [dB] indoors to protect against sleep disturbance and when the noise is composed of a large proportion of low-frequency sounds a still lower guideline value is recommended, because low frequency noise (e.g. from ventilation systems) can disturb rest and sleep even at low sound pressure levels. (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note an increase of 10 dBA is a 10-fold increase in acoustic energy.*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states:***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"For the primary prevention of subclinical adverse health effects related to night noise in the population, it is recommended that the population should not be exposed to night noise levels greater than 40 dB of Lnight, outside during the part of the night when most people are in bed. The LOAEL of night noise, 40 dB Lnight, outside, can be considered a health-based limit value of the night noise guidelines (NNG) necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise." ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***The A/CanWEA Panel Review ignores the serious adverse health consequences from noise induced sleep disturbance.*** ***World Health Organization states:*** ***"Recent research clearly links exposure to night noise with harm to health. Noise can aggravate serious health problems, beyond damage to hearing, particularly through its effects on sleep and the relations between sleep and health."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states:*** ***"There is plenty of evidence that sleep is a biological necessity, and disturbed sleep is associated with a number of health problems. Studies of sleep disturbance in children and in shift workers clearly show the adverse effects."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***According to World Health Organization some of the documented health related consequences of sleep debt include poor***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality. ***World Health Organization "Night Noise Guidelines for Europe" 2009*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** 3.3.6 Other Adverse Health Effects of Sound ***The A/CanWEA Panel Review displays selective bias by attempting to understate the risk of noise induced chronic health problems such as hypertension and heart disease. The A/CanWEA Panel Review selectively quotes references, many of which are decades old to understate this risk.*** ***World Health Organization states:*** ***"Recent research clearly links exposure to night noise with harm to health. Noise can aggravate serious health problems, beyond damage to hearing, particularly through its effects on sleep and the relations between sleep and health. When people are asleep, their ears, brains and bodies continue to react to sounds. Sleep disturbance and annoyance are the first effects of night noise and can lead to mental disorders.*** ***The effects of noise can even trigger premature illness and death. Night noise from aircraft can increase blood pressure, even if it does not wake people."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states*** ***"Above 55 dB The situation is considered increasingly dangerous for public health. Adverse health effects occur***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases." ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***The A/CanWEA Panel Review assumes people are inside their homes 24 hours a day with doors and windows shut. This is inaccurate.*** ***Families are entitled to work, play and enjoy all areas of their property. Infants, children, adults and seniors risk being exposed to wind turbine outdoor noise levels much higher than the guidelines allow for noise receptors (homes).*** ***Modern wind turbines emit 100 to 110 dBA Sound Power Level. Unweighted Sound Power Levels which are seldom reported are 120 dB or higher. Additional turbines result in higher combined sound pressure levels. Typically noise guidelines for wind turbines provide no protection for humans outside of their home. In Ontario it is allowable for multiple wind turbines to be sited within 50 meters (blade length plus 10 meters) of a non participant's property line. As an example on a one hundred acre parcel of land it is possible for individuals to be exposed on their property to wind turbine sound pressure levels which may cause speech interference, task interference, annoyance and other adverse health effects of sound. (previously referenced above section 3.3)*** ***The A/CanWEA Panel Review ignores this environmental exposure and the associated risks to human health.*** ***In summary:*** ***Wind turbines emit industrial noise pollution. Wind turbine "noise is a primary siting constraint".*** ***Rogers, A. and J. Manwell . Wright, S. 2002. Wind turbine acoustic noise. Amended January 2006*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The A/CanWEA Panel Review displays selective bias by understating the risk of adverse health effects from environmental noise. ***The A/CanWEA Panel Review displays selective bias by consistently ignoring the recommendations and guidance of the World Health Organization on the issue of noise and health. (see discussion regarding World Health Organization page 4-13)***
3-14	"On the other hand, many people become accustomed to regular exposure to noise or other potential stressors, and are no longer annoyed." ***This A/CanWEA Panel Review statement is false.*** ***World Health Organization states*** ***"During sleep the auditory system remains fully functional. Incoming sounds are processed and evaluated and although physiological changes continue to take place, sleep itself is protected because awakening is a relatively rare occurrence. Adaptation to a new noise or to a new sleeping environment (for instance in a sleep laboratory) is rapid, demonstrating this active protection. The physiological reactions do not adapt, as is shown by the heart rate reaction and the increase of average motility with sound level."*** ***World Health Organization "Night Noise Guidelines for Europe" 2009*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)***
3-17	3.4.3 Low-Frequency Sound and Infrasound "No scientific studies have specifically evaluated health effects from exposure to low frequency sound from wind turbines." ***The absence of scientific studies does not imply that health effects from exposure to low frequency sound from wind turbines do not occur - it implies scientific uncertainty and the requirement for third party independent health studies.***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This <u>is</u> settled medical science. ***Sound energy in the infra and low frequency range may also be a factor for other adverse health effects. Although these sounds may be sub-audible to all but the most sensitive people, others may perceive it as internal body sensations. This is compounded indoors, because the sound pressure levels inside homes may be augmented by building resonance and harmonics. This can result in a larger percentage of the general population that may perceive the sound or vibration in their body or home, and stronger effects on those who responded without such augmentation. It can also result in perceptible audible noise to people who may not have perceived the sounds outdoors or in another building with different resonance characteristics.*** ***The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects upon the human body remains an open question - there is <u>no</u> settled medical science on this issue as yet.*** "Natural sources of low frequency sound include wind, rivers, and waterfalls in both audible and non-audible frequencies. Other sources include road traffic, aircraft, and industrial machinery. The most common source of infrasound is vehicular (National Toxicology Program, 2001)." ***This statement is misleading. There are references that wind turbine low frequency noise is unique.*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise."*** ***(Note: this reference is listed in Additional References but the citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Soysai, H., and O. Soysai. Wind farm noise and regulations in the***

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	eastern United States. 2007 states: ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic."*** ***(Note: this applies to the lower frequency fluctuation of sound of modern upwind industrial scale wind turbines. This reference is listed in Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** "The U.S. Food and Drug Administration (FDA) has approved the use of infrasound for therapeutic massage at 70 dB in the 8 to 14 Hz range (National Toxicology Program, 2001). In light of the FDA approval for this type of therapeutic use of infrasound, it is reasonable to conclude that exposure to infrasound in the 70 dB range is safe." ***This A/CanWEA Panel Review conclusion has no reference to support it.*** ***A therapeutic device would likely have operating instructions and guidance.*** ***The product website states:*** ***"…it should not be used within six inches of a pacemaker, and should not be used on the calves where blood clots are suspected."*** ***"Therapy on the developing fetus has not been studied, we do not recommend applying it directly over the developing fetus."*** ***http://www.chinahealthways.com***
3-15 3-16	3.4.1 Evaluation of Annoyance and Dose-Response Relationship of Wind Turbine Sound

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"To date, three studies in Europe have specifically evaluated potential health effects of people living in proximity to wind turbines (Pedersen and Persson Waye, 2004; Pedersen and Persson Waye, 2007; Pedersen et al., 2009)." ***This A/CanWEA Panel Review statement is misleading as none of the three studies cited were specifically designed to "specifically" evaluate potential adverse health effects. The studies were very specific in scope as noted below:*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008 states:*** ***"The purpose of this study is to gain insight into the perception of a modern wind farm by residents living nearby such a farm. The objective of the WINDFARMperception project is:*** ***- to provide knowledge on the perception of wind turbines by people living close to windfarms;*** ***- to evaluate human responses to audio and visual exposures from wind turbines and to give insight in possibilities to mitigate the local impact of wind farms."*** ***Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and wellbeing in different living environments states:*** ***"The objectives of this study were to evaluate the prevalence of perception and annoyance due to wind turbine noise among people living in the vicinity of one or more turbines, and to study relationships between noise and perception/annoyance with focus on differences between different living environments."*** ***Perception and annoyance due to wind turbine noise—a dose–response relationship Eja Pedersen and Kerstin Persson Waye 2004 states*** ***"The aims of this study were to evaluate the prevalence of annoyance due to wind turbine noise and to study dose–response relationships. The intention was also to look at interrelationships between noise annoyance and sound characteristics, as well as the influence of subjective***

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	variables such as attitude and noise sensitivity." ***The three studies cited documented high annoyance and sleep disturbance associated with wind turbines.*** ***The A/CanWEA Panel Review fails to note that:*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008 concludes:*** ***"With respect to other health effects associated with wind turbines:*** • ***The risk for sleep interruption by noise was higher at levels of wind turbine sound above 45 dBA than at levels below 30 dBA.*** • ***Annoyance with wind turbine noise was associated with psychological distress, stress difficulties to fall asleep and sleep interruption."*** ***The A/CanWEA Panel Review fails to note that:*** ***Perception and annoyance due to wind turbine noise—a dose–response relationship Eja Pedersen and Kerstin Persson Waye 2004 states:*** ***"At lower sound categories, no respondents were disturbed in their sleep by wind turbine noise, but 16% (n520, 95%CI: 11%–20%! of the 128 respondents living at sound exposure above 35.0 dBA stated that they were disturbed in their sleep by wind turbine noise."*** ***"Some of the respondents also stated that they were disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL. The number of respondents disturbed in their sleep, however, was too small for meaningful statistical analysis, but the probability of sleep disturbances due to wind turbine noise can not be neglected at this stage."*** ***The A/CanWEA Panel Review ignores that:*** ***Regarding:*** ***Pedersen, E. and K. Persson Waye. 2007. Wind turbine***

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	noise, annoyance and self-reported health and wellbeing in different living environments: ***Table 1, contained in the report, indicates the mean SPL for respondents was 33.4 dBA which is far lower than the wind turbine SPL that many families are being subjected to.*** ***In an interview with A/CanWEA Panel Review author Dr. Robert McCunney states:*** ***"... the existing peer-reviewed literature generally examined exposure to sounds from homes or residential areas that are about one kilometre away or further from wind turbines."*** ***Canwest News Service December 16, 2009*** ***In North America many turbines have been sited less than 400 metres from homes. New set back guidelines in Ontario allow for multiple turbines within 550 meters of a home.*** ***The A/CanWEA Panel Review displays selective bias by omitting to discuss the significance of the typical setback distances and sound power levels in the references cited.*** ***The report found that:*** ***"Annoyance was further associated with lowered sleep quality and negative emotions. This, together with reduced restoration possibilities may adversely affect health."*** ***The A/CanWEA Panel Review displays selective bias by omitting sleep disturbance, annoyance, stress, and negative emotions (adverse psychological effects) reported by the references used by the Panel.*** "Although some people may be affected by annoyance, there is no scientific evidence that noise at levels created by wind turbines could cause health problems" ***The A/CanWEA Panel Review displays selective bias by concluding with a citation from a 2003 reference when subsequent references by the same author, Eja Pedersen, state in 2004, 2007 and 2008:*** ***"Some of the respondents also stated that they were***

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	disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL. The number of respondents disturbed in their sleep, however, was too small for meaningful statistical analysis, but the probability of sleep disturbances due to wind turbine noise can not be neglected at this stage." ***Perception and annoyance due to wind turbine noise—a dose–response relationship Eja Pedersen and Kerstin Persson Waye 2004*** ***"Annoyance was further associated with lowered sleep quality and negative emotions. This, together with reduced restoration possibilities may adversely affect health."*** ***Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and wellbeing in different living environments*** ***"With respect to other health effects associated with wind turbines:*** ***• The risk for sleep interruption by noise was higher at levels of wind turbine sound above 45 dBA than at levels below 30 dBA.*** ***• Annoyance with wind turbine noise was associated with psychological distress, stress difficulties to fall asleep and sleep interruption."*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008 concludes:*** ***"Perhaps the main finding is that wind turbine sound is relatively annoying, more so than equally loud sound from aircraft or road traffic. A swishing character is perceived by most respondents, indicating that this is an important characteristic of wind turbine sound. Sound should therefore receive more attention in the planning of wind farms, and (more) sound mitigation measures must be considered."*** ***The A/CanWEA Panel Review displays selective bias by omitting***

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	this citation which recommends "additional sound mitigation measures be considered." The A/CanWEA Panel Review ignores this recommendation in section 4.6.3 Wind Turbine Siting Guidelines (see discussion regarding pages 4-13 to 4-15) ***There are other relevant findings in these three studies cited which the A/CanWEA Panel Review neglected to discuss or reference.***
3-17	"According to a report of the National Research Council (NRC), low frequency sound is a concern for older wind turbines but not the modern type (National Research Council, 2007)." ***This statement contained in the A/CanWEA Panel Review is misquoted.*** ***According to "Public Health Impacts of Wind Turbines" Prepared by: Minnesota Department of Health Environmental Health Division, 2009*** ***"The National Research Council of the National Academies (NRC, 2007) has reviewed impacts of wind energy projects on human health and well-being. The NRC begins by observing that wind projects, just as other projects, create benefits and burdens, and that concern about impacts is natural when the source is near one's home. Further, the NRC notes that different people have different values and levels of sensitivity. Impacts noted by the NRC that may have the most effect on health include noise and low frequency vibration, and shadow flicker."*** ***Based on the draft copy of "National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects NRC, Washington, DC."*** ***This citation states:*** ***"Broadband, tonal, and low-frequency noise have all been addressed to some degree in modern upwind horizontal wind turbines, and turbine technologies continue to improve in this regard."*** ***The qualification that "Broadband, tonal, and low-frequency noise have all been addressed to some degree" suggests than there are still low-frequency noise issues with modern turbines. This***

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	qualification contradicts the A/CanWEA Panel Review statement. "According to a report of the National Research Council (NRC), low frequency sound is a concern for older wind turbines but not the modern type (National Research Council, 2007)." ***This is confirmed on page 4-1 of the A/CanWEA Panel Review where it is acknowledged that:*** "The low frequency sound emitted by spinning wind turbines could possibly be annoying to some…" ***The A/CanWEA Panel Review displays selective bias by omitting the following passages from the National Research Council draft cited:*** ***"Low-frequency vibration and its effects on humans are not well understood. Sensitivity to such vibration resulting from wind-turbine noise is highly variable among humans. Although there are opposing views on the subject, it has recently been stated (Pierpont 2006) that "some people feel disturbing amounts of vibration or pulsation from wind turbines, and can count in their bodies, especially their chests, the beats of the blades passing the towers, even when they can't hear or see them." More needs to be understood regarding the effects of low-frequency noise on humans."*** ***"Guidelines for measuring noise produced by wind turbines are provided in the standard, IEC 61400-11: Acoustic Noise Measurement Techniques for Wind Turbines (IEC 2002), which specifies the instrumentation, methods, and locations for noise measurements. Wind-energy developers are required to meet local standards for acceptable sound levels; for example, in Germany, this level is 35 dB(A) for rural nighttime environments."*** ***"Noise-emission measurements potentially are subject to problems, however. A 1999 study involving noise-measurement laboratories from seven European countries found, in measuring noise emission from the same 500 kW wind turbine on a flat terrain, that while apparent sound power levels and wind speed dependence could be measured reasonably reliably, tonality measurements were***

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	much more variable (Kragh et al. 1999.) In addition, methods for assessing noise levels produced by wind turbines located in various terrains, such as mountainous regions, need further development." ***"Shadow flicker caused by wind turbines can be an annoyance, and its effects need to be considered during the design of a wind-energy project. In the United States, shadow flicker has not been identified as even a mild annoyance. In Northern Europe, because of the higher latitude and the lower angle of the sun, especially in winter, shadow flicker has, in some cases, been noted as a cause for concern."*** ***"Recent research studies regarding noise from wind-energy projects suggest that the industry standards (such as the IEC 61400-11 guidelines) for assessing and documenting noise levels emitted may not be adequate for nighttime conditions and projects in mountainous terrain. This work on understanding the effect of atmospheric stability conditions and on site-specific terrain conditions and their effects on noise needs to be accounted for in noise standards. In addition, studies on human sensitivity to very low frequencies are recommended.*** ***Computational tools have become available that not only compute shadow flicker in real time during turbine operation, but also convey information to the turbine-control system to allow shutdown if the shadow flicker at a particular location becomes particularly problematic. Hence, the development and implementation of a real-time system at a wind-energy project to take such actions when shadow flicker is indicated might be useful."***
4-1	4.1 Infrasound, Low-Frequency Sound, and Annoyance "The infrasound emitted from wind turbines is at a level of 50 to 70 dB, sometimes higher, but well below the audible threshold. There is a consensus among acoustic experts that the infrasound from wind turbines is of no consequence to health." ***The NASA Technical paper "Wind Turbine Acoustics" states:*** ***"People who are exposed to wind turbine noise inside buildings experience a much different acoustic environment***

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	than do those outside….They may actually be more disturbed by the noise inside their homes than the would be outside." ***The paper also states:*** ***"One of the common ways that a person might sense the noise-induced excitation of a house is though structural vibrations. This mode of observation is particularly significant at low frequencies, below the threshold of normal hearing."*** "The low frequency sound emitted by spinning wind turbines could possibly be annoying to some when winds are unusually turbulent, but there is no evidence that this level of sound could be harmful to health." ***Public Health Impacts of Wind Turbines*** ***Prepared by: Minnesota Department of Health*** ***Environmental Health Division states:*** ***"Wind turbines generate a broad spectrum of low-intensity noise. At typical setback distances higher frequencies are attenuated. In addition, walls and windows of homes attenuate high frequencies, but their effect on low frequencies is limited."*** ***"The most common complaint in various studies of wind turbine effects on people is annoyance or an impact on quality of life. Sleeplessness and headache are the most common health complaints and are highly correlated (but not perfectly correlated) with annoyance complaints. Complaints are more likely when turbines are visible or when shadow flicker occurs."*** ***"Most available evidence suggests that reported health effects are related to audible low frequency noise. Complaints appear to rise with increasing outside noise levels above 35 dB(A)."*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"For broadband noise, such as wind turbines produce, the low frequency components may travel further than the higher frequency components. Since low-frequency noise is***

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	particularly annoying to most people, it is important to specify limits for low frequency noise." ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise. Light weight building home structures will not attenuate these frequencies components as well as higher frequency components."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Incorporating Low Frequency Noise Legislation for the Energy Industry in Alberta, Canada*** ***Authors: DeGagne, David C.; Lapka, Stephanie D states:*** ***"Complaints related to LFN are often described by the affected party as a deep, heavy sound, like "humming," sometimes with an accompanying vibration. In some cases, the direction of the source of the LFN will be unknown to the receptor. However, it is the complainant that is most able to detect the presence of the LFN, signifying a particular sensitivity of the individual to the sound while others in the same family may not be able to detect the sound at all. To make a proper determination for the presence of LFN, the data must be collected during a time when environmental conditions are representative of when the sound is annoying. Residents who are impacted by LFN may suffer from sleep disturbances, headaches, and in some cases chronic fatigue."*** ***"Unlike higher frequency noise issues, LFN is very difficult to suppress. Closing doors and windows in an attempt to diminish the effects sometimes makes it worse because of the propagation characteristics and the low-pass filtering effect of structures. Individuals often become irrational and anxious as attempts to control LFN fail, serving only to increase the individual's awareness of the noise, accelerating the above symptoms."*** ***World Health Organization, Guidelines for Community Noise, 1999 states***

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	"Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general" ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** "If so, city dwelling would be impossible due to the similar levels of ambient sound levels normally present in urban environments. Nevertheless, a small number of people find city sound levels stressful." ***This A/CanWEA Panel Review conclusion does not appear to be based on scientific evidence. The conclusion there are no adverse health effects from noise on the basis that people are able live in cities ignores the ample evidence that environmental noise is a risk to human health.*** ***World Health Organization states:*** ***"Just like air pollution and toxic chemicals, noise is an environmental hazard to health. While almost everyone is exposed to too much noise, it has traditionally been dismissed as an inevitable fact of urban life and has not been targeted and controlled as much as other risks," concludes Dr Rokho Kim of the WHO Regional Office for Europe, who managed the project to draw up the guidelines. "We hope that the new guidelines will create a culture of noise awareness, and prompt governments and local authorities to invest effort and money in protecting health from this growing hazard, particularly in cities."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***"Noise seriously harms human health and interferes with people's daily activities at school, at work, at home and during leisure time. Traffic noise alone is harming the health of almost every third European. One in five Europeans is regularly exposed to sound levels at night that could significantly damage health."*** ***http://www.euro.who.int/Noise***
4-3	"The main health effect of noise stress is disturbed sleep, which may

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	lead to other consequences." "There is no evidence that sound at the levels from wind turbines as heard in residences will cause direct physiological effects. A small number of sensitive people, however, may be stressed by the sound and suffer sleep disturbances." ***These A/CanWEA Panel Review statements are paradoxical. The statements acknowledge sleep disturbance(s) and stress may occur from wind turbine exposure. The second statement concludes there is no evidence direct physiological effects occur.*** ***World Health Organization, Guidelines For Community Noise 1999 states:*** ***Uninterrupted sleep is a prerequisite for good physiological and mental functioning, and the primary effects of sleep disturbance are: difficulty in falling asleep; awakenings and alterations of sleep stages or depth; increased blood pressure, heart rate and finger pulse amplitude; vasoconstriction; changes in respiration; cardiac arrhythmia; and increased body movements.*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states:*** ***"There is plenty of evidence that sleep is a biological necessity, and disturbed sleep is associated with a number of health problems."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***According to World Health Organization "Night Noise Guidelines for Europe" 2009:*** ***Sleep documented health related consequences of sleep debt include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders***

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	(depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality among others. ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***The A/CanWEA Panel Review is silent on what scientific basis it came to the conclusion that only "***A small number of sensitive people" ***may be*** "stressed by the sound and suffer sleep disturbances." ***The A/CanWEA Panel Review qualification that only a small number and only sensitive people will be adversely affected is not supported by any credible reference.***
4-3 to 4-5	4.1.3 Other Aspects of Annoyance 4.1.4 Nocebo Effect 4.1.5 Somatoform Disorders ***These sections of the A/CanWEA Panel Review are disturbing.*** ***The A/CanWEA Panel Review acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms.*** ***One of the authors of the report W. David Colby, M.D. has stated:*** ***"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick."*** ***Sounding Board, 97.9 FM The Beach December 17, 2009*** ***Despite these acknowledgements and without having studied victims the authors of the A/CanWEA Panel Review offer the Nocebo Effect and Somatoform Disorders as causal explanations for physiological and psychological symptoms being reported by clinicians such as Dr. Pierpont.*** ***Without having studied victims, the A/CanWEA Panel Review***

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	speculates further that: "Associated stress from annoyance, exacerbated by the rhetoric, fears, and negative publicity generated by the wind turbine controversy, may contribute to the reported symptoms described by some people living near rural wind turbines." ***There are people reporting adverse health effects from exposure to wind turbines. Families including children have abandoned their homes to protect their health. This cannot be denied.*** ***There are European peer review studies that have documented high annoyance and sleep disturbance in populations exposed to industrial wind turbines.*** ***A 2009 court decision requires a France industrial wind turbine facility to shut down at night to protect the local population from sleep disturbance.*** ***http://www.ouest-france.fr/actu/actuLocale_-La-justice-demande-l-arret-nocturne-des-huit-eoliennes-de-Cast_-1183050------29103-abd_actu.Htm*** ***Clinicians and other researchers have documented victim symptoms and sleep disturbance which tends to be reported as the number one health complaint.*** ***The A/CanWEA Panel Review ignores the literature on the effects of annoyance, stress and sleep disturbance and the associated symptoms.***
4-8 4-11	4.3 Wind Turbine Syndrome ***The A/CanWEA Panel Review does not deny there are victims experiencing symptoms from exposure to industrial wind turbines.*** "The symptoms are common in cases of extreme and persistent annoyance, leading to stress responses in the affected individual and may also result from severe tinnitus, when there is no external sound." ***The A/CanWEA Panel Review concludes*** "The symptoms are exhibited by a small proportion of sensitive

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	persons…" ***A/CanWEA Panel Review does not provide a credible reference for this statement.***
4-13	4.6 Standards for Siting Wind Turbines 4.6.1 Introduction "Opponents of wind energy development argue that the height and setback regulations established in some jurisdictions are too lenient and that the noise limits which are applied to other sources of noise (either industrial or transportation) are not sufficient for wind turbines for a variety of reasons." ***The A/CanWEA Panel Review uses biased pre-emptive stereotyping by labelling individuals or groups who have legitimate concerns about the adverse effects from exposure to industrial wind turbines as "opponents". These pre-emptive stereotyping attempts to invalidate legitimate concerns at the onset.*** ***This pre-emptive stereotyping extends to concerned medical professionals such as members of the Maine Medical Association who have passed a resolution calling for independent research and the development of authoritative wind turbine guidelines designed to protect human health.*** ***This pre-emptive stereotyping dismisses the claim that the panel is independent and unbiased.*** ***Preliminary findings of a controlled study (Mars Hill, Maine) being conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomatology, compared to a control group living 5000-6000 meters away.*** ***Significantly, they require increased prescription medications to deal with these symptoms compared to the control group. Most symptomatology appears attributable to the quality and persistence of the noise generated by the turbine installations. Additional investigation of the children living in close proximity to industrial wind turbines is urgently needed. Improvements in pre-***

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	construction sound modeling and siting ordinances are required to prevent the negative health effects observed in our study population. This is a work in progress. http://windvigilance.com/mars_hill.aspx ***The A/CanWEA Panel Review displays selective bias by failing to acknowledge that wind turbine noise is unique in character.*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Soysai, H., and O. Soysai. Wind farm noise and regulations in the eastern United States. 2007 states*** ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Aero acoustics of large wind Turbines Harvey Hubbard Lockheed Engineering and Sciences Company, Kevin P Shepherd NASA*** ***"There is a concern for the possible adverse environmental impact of noise from large horizontal axis wind turbines operated for electric power generation. Widespread deployment of such machines is anticipated in wind power***

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	stations, some of which may be located in proximity to residential areas. Routine operations of such wind power stations may result in some unique community noise exposure situations." "Opponents of wind energy development argue that the height and setback regulations established in some jurisdictions are too lenient and that the noise limits which are applied to other sources of noise (either industrial or transportation) are not sufficient for wind turbines for a variety of reasons." ***The A/CanWEA Panel Review displays selective bias with this statement.*** ***A European study concludes:*** ***"Perhaps the main finding is that wind turbine sound is relatively annoying, more so than equally loud sound from aircraft or road traffic. A swishing character is perceived by most respondents, indicating that this is an important characteristic of wind turbine sound. Sound should therefore receive more attention in the planning of wind farms, and (more) sound mitigation measures must be considered."*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008*** "Consequently, there are those who advocate for a revision of the existing regulations for noise and setback pertaining to the siting of wind installations (Kamperman and James, 2009). Some have indicated their belief that setbacks of more than 1 mile may be necessary. While the primary purpose of this study was to evaluate the potential for adverse health effects rather than develop public policy, the panel does not find that setbacks of 1 mile are warranted." ***Note: the reference cited by the A/CanWEA Panel Review*** (Kamperman and James, 2009) ***should be dated*** (Kamperman and James, 2008). ***This A/CanWEA Panel Review statement is ambiguous. The impression is the A/CanWEA Panel Review favours set backs based on public policy over those designed to protect humans from adverse health effects.***

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4-13 to 4-15	4.6.3 Wind Turbine Siting Guidelines ***The A/CanWEA Panel Review does not deny there are victims experiencing adverse health effects from industrial wind turbines.*** ***One of the authors of the A/CanWEA Panel Review W. David Colby, M.D. reinforced this position regarding wind turbines by stating*** ***"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick."*** ***Sounding Board, 97.9 FM The Beach December 17, 2009*** ***The A/CanWEA Panel Review acknowledges that wind turbine noise can cause annoyance, stress and sleep disturbance.*** ***The A/CanWEA Panel Review acknowledges that these effects*** "may lead to other consequences". ***The A/CanWEA Panel Review acknowledges wind turbine low frequency noise can cause annoyance.*** ***Geoff Leventhall, one of the authors of the A/CanWEA Panel Review acknowledges the serious nature of low frequency noise induced annoyance by asserting:*** ***"The claim that their "lives have been ruined" by the noise is not an exaggeration…"*** ***Leventhall HG. Low frequency noise and annoyance. Noise Health 2004*** ***A European study concludes:*** ***"Perhaps the main finding is that wind turbine sound is relatively annoying, more so than equally loud sound from aircraft or road traffic. A swishing character is perceived by most respondents, indicating that this is an important characteristic of wind turbine sound. Sound should therefore receive more attention in the planning of wind farms, and (more) sound mitigation measures must be considered."***

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	Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008
	Despite these acknowledgements, the A/CanWEA Panel Review neglects to advocate for authoritative regulations to mitigate the risk of adverse health effects.
	The A/CanWEA Panel Review discusses random noise limits based on policy, not health protection.
	The A/CanWEA Panel Review uses a draft report titled "Environmental Noise and Health in the UK." to support that World Health Organization noise guidelines do not need to be followed:
	"Surveys have shown that about half of the UK population lives in areas where daytime sound levels exceed those recommended in the WHO Community Noise Guidelines. About two-thirds of the population live in areas where the night-time guidelines recommended by WHO are exceeded."
	This statement does not stand up to scrutiny under a preventative health care model.
	The A/CanWEA Panel Review ignores the serious nature of noise induced annoyance, stress and sleep disruption.
	The inclusion of this section displays selective bias: it favours noise intensive industries such as industrial wind energy. The A/CanWEA Panel Review does not state reasons for including this section. It is an attempt to encourage authorities to circumvent the World Health Organizations noise guidelines which are designed to protect human health.
	World Health Organization states
	"Just like air pollution and toxic chemicals, noise is an environmental hazard to health. While almost everyone is exposed to too much noise, it has traditionally been dismissed as an inevitable fact of urban life and has not been targeted and controlled as much as other risks," concludes Dr Rokho Kim of the WHO Regional Office for Europe, who managed the project to draw up the guidelines. "We hope that the new guidelines will create a culture of noise awareness, and prompt governments and local

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	authorities to invest effort and money in protecting health from this growing hazard, particularly in cities." ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***"…one in five Europeans is regularly exposed to sound levels at night that could significantly damage their health."*** ***http://www.euro.who.int/Noise/activities/20040721_1***
5-1 to 5-2	SECTION 5 Conclusions "There is nothing unique about the sounds and vibrations emitted by wind turbines." ***This conclusion contradicts the content of the A/CanWEA Panel Review which acknowledges that wind turbine noise is complex due to infrasound, low frequency noise, broadband noise, and amplitude modulation.*** ***The US Department of Energy states:*** ***"Types of Wind Turbine Sound Wind turbines make different types of sound, including broadband, infrasonic, impulsive, and tonal sound."*** ***Health Council of the Netherlands (HCN). 2004 The Influence of Night-time Noise on Sleep and Health. The Hague: Health Council of the Netherlands, 2004; publication no. 2004/14E."*** ***The HCN (2004) states:*** ***"The Committee has identified a number of forms of noise that may have a particularly pronounced effect on people exposed to them:*** ***• Noise characterised by low-pitch components (buzzing)*** ***• Noise consisting entirely of one or more low buzzing sounds (low-frequency noise)*** ***• Tonal noise*** ***• Noise events characterised by a rapid increase in intensity at the beginning (impulse noise)*** ***• Industrial noise***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	• Noise characterised by sporadic high LAmax or SEL values." ***Wind turbine noise is known to contain most if not all of these forms of noise.*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Soysai, H., and O. Soysai. Wind farm noise and regulations in the eastern United States. 2007 states:*** ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Aero acoustics of large wind Turbines Harvey Hubbard Lockheed Engineering and Sciences Company, Kevin P Shepherd NASA*** ***"There is a concern for the possible adverse environmental impact of noise from large horizontal axis wind turbines operated for electric power generation. Widespread deployment of such machines is anticipated in wind power stations, some of which may be located in proximity to residential areas. Routine operations of such wind power stations may result in some unique community noise***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	exposure situations."
5-2	"In conclusion: 1. Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans. ***Conclusion 1 contradicts the A/CanWEA Panel Review which acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms.*** 2. Subaudible, low frequency sound and infrasound from wind turbines do not present a risk to human health. ***Conclusion 2 contradicts the NASA Technical paper "Wind Turbine Acoustics" which states:*** ***"People who are exposed to wind turbine noise inside buildings experience a much different acoustic environment than do those outside….They may actually be more disturbed by the noise inside their homes than the would be outside."*** ***The NASA Technical paper also states:*** ***"One of the common ways that a person might sense the noise-induced excitation of a house is though structural vibrations. This mode of observation is particularly significant at low frequencies, below the threshold of normal hearing."*** ***Conclusion 2 contradicts the A/CanWEA Panel Review statement from page 4-1 which states:*** "The low frequency sound emitted by spinning wind turbines could possibly be annoying to some…" ***The World Health Organization acknowledges annoyance as an adverse health effect.*** ***World Health Organization Guidelines For Community Noise 1999***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	Conclusion 2 contradicts the A/CanWEA Panel Review statement from page 4-10 which states that physiological and psychological symptoms caused by annoyance include: "…distraction, dizziness, eye strain, fatigue, feeling vibration, headache, insomnia, muscle spasm, nausea, nose bleeds, palpitations, pressure in the ears or head, skin burns, stress, and tension…" ***There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This is settled medical science.*** ***Sound energy in the infra and low frequency range may also be a factor for other adverse health effects. Although these sounds may be sub-audible to all but the most sensitive people, others may perceive it as internal body sensations. This is compounded indoors, because the sound pressure levels inside homes may be augmented by building resonance and harmonics. This can result in a larger percentage of the general population that may perceive the sound or vibration in their body or home, and stronger effects on those who responded without such augmentation. It can also result in perceptible audible noise to people who may not have perceived the sounds outdoors or in another building with different resonance characteristics.*** ***The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects upon the human body remains an open question - there is <u>no</u> settled medical science on this issue as yet.*** 3. Some people may be annoyed at the presence of sound from wind turbines. Annoyance is not a pathological entity. ***Conclusion 3 contradicts World Health Organization which acknowledges annoyance is an adverse health effect.*** ***World Health Organization Guidelines For Community Noise 1999*** ***Conclusion 3 contradicts the A/CanWEA Panel Review***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	statement from page 4-10 which states that physiological and psychological symptoms caused by annoyance include: "…distraction, dizziness, eye strain, fatigue, feeling vibration, headache, insomnia, muscle spasm, nausea, nose bleeds, palpitations, pressure in the ears or head, skin burns, stress, and tension…" 4. A major cause of concern about wind turbine sound is its fluctuating nature. Some may find this sound annoying, a reaction that depends primarily on personal characteristics as opposed to the intensity of the sound level." ***Conclusion 4 contradicts World Health Organization which acknowledges annoyance is an adverse health effect and states:*** ***"The annoyance response to noise is affected by several factors, including the equivalent sound pressure level and the highest sound pressure level of the noise, the number of such events, and the time of day."*** ***World Health Organization Guidelines For Community Noise 1999*** ***Conclusion 4 contradicts The A/CanWEA Panel Review statement from page 3-13 which states that noise levels directly impact annoyance*** "Noise from airports, road traffic, and other sources (including wind turbines) may annoy some people, and, as described in Section 4.1, the louder the noise, the more people may become annoyed." ***Throughout the A/CanWEA Panel Review it is acknowledged that the wind turbine noise may cause annoyance, stress and sleep disturbance.*** ***The A/CanWEA Panel Review does not deny there are victims experiencing adverse health effects from exposure to industrial wind turbines.*** ***One of the authors of the report W. David Colby, M.D. has stated:***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick." ***Sounding Board, 97.9 FM The Beach December 17, 2009*** ***World Health Organization states:*** ***"Sleep disturbance and annoyance are the first effects of night noise and can lead to mental disorders.*** ***The effects of noise can even trigger premature illness and death."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1***
	The Society for Wind Vigilance Conclusion: ***It is apparent from this analysis that the A/CanWEA Panel Review is neither authoritative nor convincing. The work is characterized by commission of unsupportable statements and the confirmation bias in the use of references. Many important references have been omitted and not considered in the discussion. Furthermore the authors have taken the position that the World Health Organization standards regarding community noise are irrelevant to their deliberation - a remarkable presumption.*** ***There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This is settled medical science.*** ***There are many peer-reviewed studies showing that infra and low frequency sound can cause adverse health effects, especially when dynamically modulated. Modern upwind industrial scale turbines of the types now being located in rural areas of North America require study. The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects***

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	upon the human body remains an open question - there is no settled medical science on this issue as of yet. ***Perhaps the most egregious conclusion is that no more research is required. That statement implies that the science is settled which quite simply is false. It also demonstrates a disdain for the scientific method itself.*** ***There is but one conclusion: independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur.*** ***In contrast to the statement of the A/CanWEA Panel Review, our view is that a great deal of research is required for the protection of people's health.***
6-1 6-9	SECTION 6 References ***The A/CanWEA Panel Review displays selective bias favouring the positions of CanWEA and AWEA by omitting relevant references.*** ***Examples of obvious omissions of the A/CanWEA Panel Review include the research conducted by Dr Amanda Harry (UK) or Dr Michael A. Nissenbaum (USA). Both are available on the web.*** ***The A/CanWEA Panel Review ignores that members of the Maine Medical Association passed a Resolution RE: Wind Energy and Public Health":*** ***"work with health organizations and regulatory agencies to provide scientific information of known medical consequences of wind development in order to help safeguard human health and the environment; and to 'work with other stakeholders to encourage performance of studies on health effects of wind turbine generation by independent qualified researchers at qualified research institutions;"*** ***and to***

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	"ensure that physicians and patients alike are informed of evidence-based research results." ***Preliminary findings of a controlled study (Mars Hill, Maine) being conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomatology, compared to a control group living 5000-6000 meters away.*** ***Significantly, they require increased prescription medications to deal with these symptoms compared to the control group. Most symptomatology appears attributable to the quality and persistence of the noise generated by the turbine installations. Additional investigation of the children living in close proximity to industrial wind turbines is urgently needed. Improvements in pre-construction sound modeling and siting ordinances are required to prevent the negative health effects observed in our study population. This is a work in progress.*** http://windvigilance.com/mars_hill.aspx ***Other important references ignored by the A/CanWEA Panel Review include but are not limited to:*** • ***"Minnesota Department of Health (MDH) 2009 Public Health Impacts of Wind Turbines"*** • ***"The Noise Association. 2006. Location, location, location. An investigation into wind farms and noise by The Noise Association"*** • ***Noise Radiation From Wind Turbines Installed Near Homes: Effects On Health With an annotated review of the research and related issues by Barbara J Frey, BA, MA and Peter J Hadden, BSc, FRICS*** • ***"Sleep Disturbance And Wind Turbine Noise" Dr Christopher Hanning BSc, MB, BS, MRCS, LRCP, FRCA, MD dated June 2009.***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
6-8	Alberts, D. 2006. Primer for Addressing Wind Turbine Noise. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***Relevant citations not cited in the A/CanWEA Panel Review include:*** ***The acknowledgment of the risk of sleep disturbance being a health risk.*** ***"a Dutch study that showed noise from a 30 MW wind farm becomes more noticeable and annoying to nearby residents at night. This study noted that although the noise is always present, certain aspects of turbine noise, such as thumping and swishing, were not noticeable during the day, but became very noticeable at night. Residents as far as 1900 meters from the wind farm complained about the night time noise."*** ***"For broadband noise, such as wind turbines produce, the low frequency components may travel further than the higher frequency components. Since low-frequency noise is particularly annoying to most people, it is important to specify limits for low frequency noise."*** ***"Wind direction also has an influence on sound propagation. Within 900 ft of a sound source, the wind direction does not seem to influence the sound. After about 900 ft., the wind direction becomes a major factor in sound propagation. Downwind (meaning the wind is moving from the noise source towards the receiver) of the source, sound volume will increase for a time before decreasing."*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise. Light weight building home structures will not attenuate these frequencies components as well as higher frequency components."***
6-8	Chatham-Kent Public Health Unit. 2008. The Health Impact of Wind Turbines: a Review of the Current White, Grey and Published Literature 2008. ***Regarding this reference Dr Colby stated:***

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	"The research and writing was done by April Rietdyk but I endorse and take full responsibility for the content." ***An October 2009 letter from The College of Physicians and Surgeons of Ontario, Inquiries, Complaints and Reports Committees Decisions and Reasons states that:*** ***"…the Committee observes, Dr. Colby's expertise is in medical microbiology and infectious diseases, an area quite distinct from audiology or other fields to the physical impact of wind turbines on human health. Thus the committee wishes to remind Dr. Colby, going forward, of the importance of fully disclosing the extent of his qualifications in a field that he has been retained as an "expert" and also to ensure he fully disclose to the public the organization or corporation by whom he has been retained by an expert."*** ***In addition:*** ***SkyPower, a wind energy developer advertised Dr Colby as one of their "representatives". Dr Colby has stated that he received an honorarium for this service.*** ***This document is an inadequate public health document. This statement is based on the following:*** ***The report displays selective bias favouring the wind energy industry in the presentation of the material referenced.*** • ***Heavy reliance on references from the wind energy industry (CanWEA, AWEA, BWEA, Danish Wind Energy Association)*** • ***Heavy reliance on references from listed members of CanWEA (Howe Gastmeier Chapnik Limited. Mississauga HGC Engineering)*** • ***The report displays selective bias favouring the wind energy industry by the omission of relevant references.*** • ***As a result of the above deficiencies the report provides incomplete risk assessments related to health including the failure to adequately consider the health impacts of annoyance, stress or sleep disturbance. (based on a key word searches of "annoyance", "stress" and "sleep disturbance")*** • ***The report uses pre-emptive stereotyping of individuals who***

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	have concerns about associated with wind turbine facilities. (ie "Those Opposed to Wind Power").
6-8	Copes, R. and K. Rideout. Wind Turbines and Health: A Review of Evidence. Ontario Agency for Health Protection and Promotion 2009 ***The power point slides contain few references and much of the material is similar to that used by the wind energy industry.*** ***The conclusion of the power point presentation is inconsistent as it states:*** ***"No evidence of noise-induced health effects at levels emitted by wind turbines"*** ***Then paradoxically concludes:*** ***" Stress and sleep disturbance possible"*** ***"Sound, flicker, aesthetics may affect annoyance + stress"*** ***"Health concerns are valid and must be addressed."*** ***"Any effects on health more likely related to annoyance/sleep disturbance than to direct effect of SPLs at residence."***
6-8	Draft New Zealand standard for wind turbine sound. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***Relevant citations not cited in the A/CanWEA Panel Review include:*** ***"Limits for wind farm noise are required to provide protection against sleep disturbance and maintain reasonable residential amenity."*** ***"In certain situations (see 5.3), consideration of a noise limit more stringent than 40 dB may be appropriate to further protect amenity for particular noise sensitive locations."*** ***As a result the draft standard recommends a secondary noise limit for quiet areas***

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	"Where a secondary noise limit is applicable, wind farm sound levels (LA90(10 min)) should not exceed the background sound level by more than 5 dB, or a level of 35 dB LA90(10 min), whichever is the greater." ***The New Zealand draft standard recommends improvement to sound modelling including testing being conducted at various temperature and atmospheric conditions.***
6-8	2009. Maine Osteopathic Association Resolution: Wind Energy and Public Health. ***The Maine Osteopathic Association Resolution: Wind Energy and Public Health dated September 25, 2009 and is listed under Additional References of the A/CanWEA Panel Review.*** ***The Maine Medical Association Resolution: Wind Energy and Public Health. September 12, 2009 is not listed in the A/CanWEA Panel Review.*** ***The A/CanWEA Panel Review displays selective bias by including the Maine Osteopathic Association Resolution but neglecting to include the Maine Medical Association Resolution: Wind Energy and Public Health***.
6-8	Keith, S. E., D. S. Michaud, and S. H. P. Bly. 2008. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control, 27 (4):253-265. ***This article acknowledges both annoyance and sleep disturbance may occur from wind turbines noise even at levels of 40dBA or 45dBA.***
6-9	Ramakrishnan, R. 2007. Acoustic Consulting Report Prepared for the Ontario Ministry of the Environment: Wind Turbine Facilities Noise Issues. Aiolos Engineering Corporation. ***In an email exchange Dr Ramani Ramakrishnan, the author of this reference states*** ***"I am not a medical doctor or a psychoacoustician or a physiological acoustician. I am an acoustician from the engineering science perspective. So, to comment on health issues is outside my area of expertise."***

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	This reference does however suggest scientific uncertainty by concluding ***"…additional concerns still need to be addressed in the next round of revisions to their assessment process. These revisions may need to be addressed after the results from future research provide scientifically consistent data for effects such as meteorology, human response and turbine noise source character."***
6-9	Rogers, A. and J. Manwell . Wright, S. 2002. Wind turbine acoustic noise. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***From Rogers, A. and J. Manwell . Wright, S. 2002. Wind turbine acoustic noise. Amended January 2006*** ***It concludes:*** ***"…noise is a primary siting constraint."*** ***"Community noise standards are important to ensure liveable communities. Wind turbines must be held to comply with these regulations."***
6-9	Soysai, H., and O. Soysai. Wind farm noise and regulations in the eastern United States. 2007. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***Relevant citations not cited in the A/CanWEA Panel Review include:*** ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise***

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	is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic." ***"Specific noise limits need to be developed by considering the characteristics of wind turbine noise. Especially the low frequency sound components and the modulation of the background noise resulting must be considered to represent the activity interference of the wind turbine sound. Adequate criteria to asses the wind turbine sound will greatly help the development the wind industry by reducing the community reaction based on subjective opinions."***
6-9	World Health Organization (WHO). 2009. Night Noise Guidelines for Europe. The World Health Organization, Geneva, Switzerland. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***The A/CanWEA Panel Review acknowledges that wind turbines may cause sleep disturbance.*** ***In 2009 World Health Organization released Night Noise Guidelines for Europe which is a 184 page peer reviewed summary of the risks to human health that may result from noise induced sleep disturbance. Some of the adverse health documented include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality.*** ***The A/CanWEA Panel Review's failure to include an analysis of this document in the context of wind turbine noise induced sleep disturbance is a conspicuous omission.***

END OF ANALYSIS

A Primer on Adverse Health Effects and Industrial Wind Turbines

March, 2010

Prepared by the Society for Wind Vigilance

www.windvigilance.com

Signed by (Alphabetical order)
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A Primer on Industrial Wind Turbines
and
Adverse Health Effects
March, 2010

The American Wind Energy Association and Canadian Wind Energy Association sponsored report entitled "Wind Turbine Sound and Health Effects" (A/CanWEA Panel Review) concludes that "sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans." [1] This denial does not withstand scrutiny.

On January 11, 2010 The Society for Wind Vigilance released a critique of the A/CanWEA Panel Review and concluded that it was "...neither authoritative nor convincing.." and "...independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur."[2]

On January 19, 2010 The UK National Health Service (NHS) released an independent critique of the A/CanWEA Panel Review and concluded "The link between psychological distress and physical symptoms has not been explored by this report. The acknowledgment that some people exposed to wind turbine noise suffer annoyance suggests that monitoring and maximum permitted levels need to be considered carefully in areas where turbines are planned. Overall, this review will probably not resolve this controversy as there was a lack of high-level evidence on which to base any solid conclusions. What is now needed are studies that compare people exposed to turbine noise with well-matched control subjects who have not had that exposure."[3]

The NHS critique is based on "the best scientific knowledge currently available".

To read the NHS editorial policy visit.
http://www.nhs.uk/aboutNHSChoices/aboutnhschoices/Aboutus/Pages/Editorialpolicy.aspx

Two independent critiques of the same industry sponsored report have come to remarkably similar conclusions.

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[1] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association
[2] The Society for Wind Vigilance, Wind Energy Industry Acknowledgement of Adverse Health Effects, An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009", 2010 http://windvigilance.com/awea_media.aspx
[3] UK National Health Service, Wind turbine sound 'needs research', Thursday January 28, 2010, http://www.nhs.uk/news/2010/01January/Pages/Wind-turbine-sound-and-health.aspx

Paradoxically the conclusions of the A/CanWEA Panel Review are not supported by its own contents in that it acknowledges wind turbine noise may cause annoyance, stress and sleep disturbance and as a result people may experience adverse physiological and psychological symptoms. [4]

In a radio interview one of the authors of the A/CanWEA Panel Review W. David Colby, M.D. stated:

"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick." [5]

The Ontario Ministry of Health and Long Term Care also acknowledge wind turbines may cause annoyance, stress and sleep disturbance.[6]

The A/CanWEA Panel Review acknowledges wind turbine noise induced symptoms may include palpitations, insomnia, nose bleeds, dizziness, nausea, eye strain, feeling vibration and headache. [7]

In 2010 Geoff Leventhall an author of the A/CanWEA Panel Review is quoted as stating "... there was no doubt people living near the turbines suffered a range of symptoms, including abnormal heart beats, sleep disturbance, headaches, tinnitus, nausea, visual blurring, panic attacks and general irritability....it's ruining their lives – and it's genuine...".[8]

"Health Canada advises...that there are peer-reviewed scientific articles indicating that wind turbines may have an adverse impact on human health."[9]

Peer reviewed studies of European industrial wind turbine facilities have documented high annoyance and sleep disturbance in respondents.[10],[11],[12]

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[4] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[5] W. David Colby, M.D., Sounding Board, 97.9 FM The Beach December 17, 2009

[6] Arlene King M.D., Ontario Ministry of Health and Long Term Care Memorandum, October 21, 2009, http://windvigilance.com/primer_ahe.aspx

[7] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[8] Countryside News, Wind turbines set to get bigger, January 28 2010 http://www.walesonline.co.uk/countryside-farming-news/countryside-news/2010/01/28/wind-turbines-set-to-get-bigger-91466-25701853/

[9] Safe Environs Program, Health Canada Environmental Assessment Nova Scotia, August 6, 2009, http://windvigilance.com/primer_ahe.aspx

[10] Pedersen, E. and K. Persson Waye. 2004. Perception and annoyance due to wind turbine noise: A dose–response relationship, Journal of the Acoustical Society of America 116: 3460–3470.

[11] Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and well being in different living environments

[12] Pedersen et al., 2008,Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents

World Health Organization recognizes annoyance and sleep disturbance as adverse health effects. [13]

In 2009 World Health Organization released a 184 page peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effect documented in the report include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality.[14]

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The NASA Technical paper "Wind Turbine Acoustics" states "People who are exposed to wind turbine noise inside buildings experience a much different acoustic environment than do those outside....They may actually be more disturbed by the noise inside their homes than they would be outside....One of the common ways that a person might sense the noise-induced excitation of a house is through structural vibrations. This mode of observation is particularly significant at low frequencies, below the threshold of normal hearing."[18]

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[13] World Health Organization, Guidelines for Community Noise,1999
http://www.euro.who.int/mediacentre/PR/2009/20091008_1

[14] World Health Organization, Night Noise Guidelines for Europe, 2009
http://www.euro.who.int/InformationSources/Publications/Catalogue/20090904_12

[15] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[16] DeGagne et al., Incorporating Low Frequency Noise Legislation for the Energy Industry in Alberta, Canada Source: Journal of Low Frequency Noise, Vibration and Active Control, Volume 27, Number 2, September 2008 , pp. 105-120(16)

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[18] Harvey Hubbard et al, NASA Technical Document, Wind Turbine Acoustics, 1990

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The Canadian Wind Energy Association claims that wind turbine "installations meet strict government regulations with respect to sound"[21] but at the same time acknowledges that noise modelling typically used does not purport to consider the worst case and that actual noise levels may exceed that predicted.[22]

According to the Ontario Ministry of Environment "There is currently no scientifically accepted field methodology to measure wind turbine noise to determine compliance or non compliance with a Certificate of Approval limits."[23]

In most jurisdictions there is no requirement for the wind energy industry to monitor or address for wind turbine low frequency noise.

The World Health Organization states:

"The precautionary principle. In all cases noise should be reduced to the lowest level achievable in a particular situation. When there is a reasonable possibility that the public health will be endangered, even though scientific proof may be lacking, action should be take to protect the public health, without awaiting the full scientific proof."[24]

To learn more visit The Society for Wind Vigilance at www.windvigilance.com

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[19] Leventhall HG. Low frequency noise and annoyance. Noise Health [serial online] 2004 [cited 2009 Dec 31];6:59-72. Available from: http://www.noiseandhealth.org/text.asp?2004/6/23/59/31663

[20] UK National Health Service, Are wind farms a health risk? Monday August 3 2009, http://www.nhs.uk/news/2009/08august/Pages/Arewindfarmsahealthrisk.aspx

[21] CanWEA Paper Addressing Concerns With Wind Turbines And Human Health, January 2009

[22] Howe Gastmeier Chapnik Limited, Wind Turbines And Sound: Review And Best Practice Guidelines, Submitted To: CanWEA Canadian Wind Energy Association, February 15, 2007

[23] Correspondence from Ministry of Environment September 30, 2009 ENV1283MC2009-4305, http://windvigilance.com/primer_ahe.aspx

[24] World Health Organization, Guidelines for Community Noise,1999 http://www.euro.who.int/mediacentre/PR/2009/20091008_1

A Frank Statement

to Cigarette Smokers

RECENT REPORTS on experiments with mice have given wide publicity to a theory that cigarette smoking is in some way linked with lung cancer in human beings.

Although conducted by doctors of professional standing, these experiments are not regarded as conclusive in the field of cancer research. However, we do not believe that any serious medical research, even though its results are inconclusive should be disregarded or lightly dismissed.

At the same time, we feel it is in the public interest to call attention to the fact that eminent doctors and research scientists have publicly questioned the claimed significance of these experiments.

Distinguished authorities point out:

1. That medical research of recent years indicates many possible causes of lung cancer.

2. That there is no agreement among the authorities regarding what the cause is.

3. That there is no proof that cigarette smoking is one of the causes.

4. That statistics purporting to link cigarette smoking with the disease could apply with equal force to any one of many other aspects of modern life. Indeed, the validity of the statistics themselves is questioned by numerous scientists.

We accept an interest in people's health as a basic responsibility, paramount to every other consideration in our business.

We believe the products we make are not injurious to health.

We always have and always will cooperate closely with those whose task it is to safeguard the public health.

For more than 300 years tobacco has given solace, relaxation, and enjoyment to mankind. At one time or another during those years critics have held it responsible for practically every disease of the human body. One by one these charges have been abandoned for lack of evidence.

Regardless of the record of the past, the fact that cigarette smoking today should even be suspected as a cause of a serious disease is a matter of deep concern to us.

Many people have asked us what we are doing to meet the public's concern aroused by the recent reports. Here is the answer:

1. We are pledging aid and assistance to the research effort into all phases of tobacco use and health. This joint financial aid will of course be in addition to what is already being contributed by individual companies.

2. For this purpose we are establishing a joint industry group consisting initially of the undersigned. This group will be known as TOBACCO INDUSTRY RESEARCH COMMITTEE.

3. In charge of the research activities of the Committee will be a scientist of unimpeachable integrity and national repute. In addition there will be an Advisory Board of scientists disinterested in the cigarette industry. A group of distinguished men from medicine, science, and education will be invited to serve on this Board. These scientists will advise the Committee on its research activities.

This statement is being issued because we believe the people are entitled to know where we stand on this matter and what we intend to do about it.

TOBACCO INDUSTRY RESEARCH COMMITTEE

500 EMPIRE STATE BUILDING, NEW YORK 1, N. Y.

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A Primer on Adverse Health Effects and Industrial Wind Turbines

March, 2010

Prepared by the Society for Wind Vigilance

www.windvigilance.com

Signed by (Alphabetical order)
Robert McMurtry, M.D., F.R.C.S. (C), F.A.C.S, Chair
Christopher Hanning, M.D., M.B
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Carmen Krogh, B.Sc. (Pharm.)
Michael A. Nissenbaum, M.D.
David L. White, EET, CMBB

A Primer on Industrial Wind Turbines
and
Adverse Health Effects
March, 2010

The American Wind Energy Association and Canadian Wind Energy Association sponsored report entitled "Wind Turbine Sound and Health Effects" (A/CanWEA Panel Review) concludes that "sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans." [1] This denial does not withstand scrutiny.

On January 11, 2010 The Society for Wind Vigilance released a critique of the A/CanWEA Panel Review and concluded that it was "...neither authoritative nor convincing.." and "...independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur."[2]

On January 19, 2010 The UK National Health Service (NHS) released an independent critique of the A/CanWEA Panel Review and concluded "The link between psychological distress and physical symptoms has not been explored by this report. The acknowledgment that some people exposed to wind turbine noise suffer annoyance suggests that monitoring and maximum permitted levels need to be considered carefully in areas where turbines are planned. Overall, this review will probably not resolve this controversy as there was a lack of high-level evidence on which to base any solid conclusions. What is now needed are studies that compare people exposed to turbine noise with well-matched control subjects who have not had that exposure."[3]

The NHS critique is based on "the best scientific knowledge currently available".

To read the NHS editorial policy visit.
http://www.nhs.uk/aboutNHSChoices/aboutnhschoices/Aboutus/Pages/Editorialpolicy.aspx

Two independent critiques of the same industry sponsored report have come to remarkably similar conclusions.

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[1] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association
[2] The Society for Wind Vigilance, Wind Energy Industry Acknowledgement of Adverse Health Effects, An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009", 2010 http://windvigilance.com/awea_media.aspx
[3] UK National Health Service, Wind turbine sound 'needs research', Thursday January 28, 2010, http://www.nhs.uk/news/2010/01January/Pages/Wind-turbine-sound-and-health.aspx

Paradoxically the conclusions of the A/CanWEA Panel Review are not supported by its own contents in that it acknowledges wind turbine noise may cause annoyance, stress and sleep disturbance and as a result people may experience adverse physiological and psychological symptoms. [4]

In a radio interview one of the authors of the A/CanWEA Panel Review W. David Colby, M.D. stated:

"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick." [5]

The Ontario Ministry of Health and Long Term Care also acknowledge wind turbines may cause annoyance, stress and sleep disturbance.[6]

The A/CanWEA Panel Review acknowledges wind turbine noise induced symptoms may include palpitations, insomnia, nose bleeds, dizziness, nausea, eye strain, feeling vibration and headache. [7]

In 2010 Geoff Leventhall an author of the A/CanWEA Panel Review is quoted as stating "... there was no doubt people living near the turbines suffered a range of symptoms, including abnormal heart beats, sleep disturbance, headaches, tinnitus, nausea, visual blurring, panic attacks and general irritability....it's ruining their lives – and it's genuine...".[8]

"Health Canada advises...that there are peer-reviewed scientific articles indicating that wind turbines may have an adverse impact on human health."[9]

Peer reviewed studies of European industrial wind turbine facilities have documented high annoyance and sleep disturbance in respondents.[10],[11],[12]

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[4] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[5] W. David Colby, M.D., Sounding Board, 97.9 FM The Beach December 17, 2009

[6] Arlene King M.D., Ontario Ministry of Health and Long Term Care Memorandum, October 21, 2009, http://windvigilance.com/primer_ahe.aspx

[7] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[8] Countryside News, Wind turbines set to get bigger, January 28 2010 http://www.walesonline.co.uk/countryside-farming-news/countryside-news/2010/01/28/wind-turbines-set-to-get-bigger-91466-25701853/

[9] Safe Environs Program, Health Canada Environmental Assessment Nova Scotia, August 6, 2009, http://windvigilance.com/primer_ahe.aspx

[10] Pedersen, E. and K. Persson Waye. 2004. Perception and annoyance due to wind turbine noise: A dose–response relationship, Journal of the Acoustical Society of America 116: 3460–3470.

[11] Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and well being in different living environments

[12] Pedersen et al., 2008,Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents

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Brief Overview of References

Noise including Industrial Wind Turbines

and Adverse Health Effects

March, 2011

By Carmen Krogh, BScPharm,
Member of the Society for Wind Vigilance

Excerpted from work compiled by Brett Horner, B.A, CMA,

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NOTICE TO READER

Authoritative references are cited as much as possible to support the assertions contained within this overview.

Every reasonable attempt was made to ensure the accuracy of this overview. Any errors or omissions contained within this overview are unintentional.

No financial compensation has been requested nor received for the compilation of this overview.

FORWARD

This overview may be used by other individuals as required.

Due to time and resource constraints this overview does not detail all the references available.

There is, however, ample evidence indicating a risk to health resulting from noise.

NOISE ANNOYANCE CAN AFFECT HEALTH

World Health Organization recognizes annoyance and sleep disturbance as adverse health effects. [1]

Regarding noise induced annoyance the US Environmental Protection Agency states "..."annoyance" can have major consequences, primarily to one's overall health." [2]

The health impacts of noise induced annoyance must not be underestimated.

The word annoyance may mean different things to different people; however in clinical terms annoyance is acknowledged to be a risk to human health.

A World Health Organization study "...confirmed, on an epidemiological level, an increased health risk from chronic noise annoyance." [3]

Noise induced annoyance contributes to stress, [4] sleep disturbance [5] and an increased risk of regulation diseases. [6]

Annoyance may adversely affect physiological health. Research indicates that for "chronically strong annoyance a causal chain exists between the three steps health – strong annoyance – increased morbidity." [7]

The subjective experience of noise stress can, through central nervous processes, lead to an inadequate neuro-endocrine reaction and finally to regulation diseases. [8]

"Adults who indicated chronically severe annoyance by neighbourhood noise were found to have an increased health risk for the cardiovascular system and

the movement apparatus, as well as an increased risk of depression and migraine...With children the effects of noise-induced annoyance from traffic, as well as neighbourhood noise, are evident in the respiratory system." [9]

To protect against adverse health effects noise level limits "...should be based on annoyance responses to noise." [10]

"Dose-response relations for different types of traffic noise (air, road and railway) clearly demonstrate that these noises can cause different annoyance effects at equal LAeq,24h values." [11]

NOISE AND STRESS

Noise is an environmental stressor [12] which can cause stress related adverse health effects. [13]

"The subjective experience of noise stress can, through central nervous processes, lead to an inadequate neuro-endocrine reaction and finally lead to regulatory diseases." [14]

Peer reviewed scientific research reveals "With children the effects of noise-induced annoyance from traffic, as well as neighbourhood noise, are evident in the respiratory system. The increased risk of illness in the respiratory system in children does not seem to be caused primarily by air pollutants, but rather, as the results for neighbourhood noise demonstrate, by emotional stress." [15]

"Also, recent epidemiological studies have shown a connection between disturbed sleep and later occurrence of stress-related disorders such as cardiovascular diseases...and diabetes type II..." [16]

Regarding stress Health Canada states [17]

> "...stress is considered to be a risk factor in a great many diseases, including: heart disease, some types of bowel disease, herpes, mental illness.
>
> ...Stress also makes it hard for people with diabetes to control their blood sugar.
>
> ...Stress is also a risk factor in alcohol and substance abuse, as well as weight loss and gain. Stress has even been identified as a possible risk factor in Alzheimer's Disease.
>
> ...Severe stress can cause biochemical changes in the body, affecting the immune system, leaving your body vulnerable to disease."

Other health effects associated with stress include becoming increasingly distressed, and irritable, unable to relax or concentrate, have difficulty thinking logically, and making decisions, depression, anxiety, sleep disorders, disorders of the digestive system, increases in blood pressure, headaches and musculo-skeletal disorders. [18], [19]

NOISE AND SLEEP DISTURBANCE

Difficulty falling asleep constitutes sleep disturbance which can have serious consequences. [20]

Sleep disturbance is acknowledged to be an adverse health effect. [21], [22]

The consequences of sleep disturbance can be serious.

In 2009 World Health Organization released a 184 page peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effect documented in the report include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality. [23]

LOW FREQUENCY NOISE AND INFRASOUND

It is widely affirmed that exposure to audible low frequency noise can cause adverse health effects in humans. [24], [25], [26], [27]

Low frequency noise can cause "...immense suffering to those who are unfortunate to be sensitive to low frequency noise and who plead for recognition of their circumstances." [28]

Annoyance is an acknowledged adverse health effect. [29], [30]

"Regulatory authorities must accept that annoyance by low frequency noise presents a real problem which is not addressed by the commonly used assessment methods." [31]

Literature reviews and scientific articles confirm the symptoms associated with low frequency noise exposure include annoyance, stress, sleep disturbance, headaches, difficulty concentrating, irritability, fatigue, dizziness or vertigo, tinnitus, heart ailments anxiety, stitch and beating palpitation. [32], [33], [34]

While there is a consensus on the symptoms caused by low frequency noise exposure the mechanism of action is not fully understood.

"Today we know that most illnesses, mental and physical, are influenced by a combination of biological, psychological and social factors." [35]

"In an integrated and evidence-based model of health, mental health (including emotions and thought patterns) emerges as a key determinant of overall health. Anxious and depressed moods, for example, initiate a cascade of adverse changes in endocrine and immune functioning, and create increased susceptibility to a range of physical illnesses." [36]

"Mental health is as important as physical health. In fact, the two are intertwined. Our mental health directly affects our physical health and vice versa...mental health factors can increase the risk of developing physical problems such as, diabetes, heart disease, weight gain or loss, gastrointestinal problems, reductions in immune system, efficiency, and blood biochemical imbalances." [37]

World Health Organization advises that "Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general...The evidence on low-frequency noise is sufficiently strong to warrant

immediate concern." and consequently "Noise with low-frequency components require lower guideline values." [38]

The effects of low frequency noise induced annoyance and stress are acknowledged to be serious as evidenced by "The claim that their "lives have been ruined" by the noise is not an exaggeration..." [39]

"...LFN *(low frequency noise)* does not need to be considered "loud" for it to cause such forms of annoyance and irritation." [40]

"The effects of infrasound or low frequency noise are of particular concern because of its pervasiveness due to numerous sources, efficient propagation, and reduced efficiency of many structures (dwellings, walls, and hearing protection) in attenuating low frequency noise compared with other noise." [41]

"Unlike higher frequency noise issues, LFN is very difficult to suppress. Closing doors and windows in an attempt to diminish the effects sometimes makes it worse because of the propagation characteristics and the low-pass filtering effect of structures. Individuals often become irrational and anxious as attempts to control LFN fail, serving only to increase the individual's awareness of the noise, accelerating the above symptoms" [42]

"Those exposed may adopt protective strategies, such as sleeping in their garage if the noise is less disturbing there. Or they may sleep elsewhere, returning to their own homes only during the day." [43]

"There is no doubt that some humans exposed to infrasound experience abnormal ear, CNS, and resonance induced symptoms that are real and stressful." [44]

There is no scientific consensus that infrasonic noise below the threshold of hearing will have no effect on health. There is scientific uncertainty regarding the understanding of human response to infrasound.

"There is no consensus whether sensitivity below 20 Hz is by a similar or different mechanism than sensitivity and hearing above 20 Hz..." [45]

The National Research Council states "Low-frequency vibration and its effects on humans are not well understood. Sensitivity to such vibration resulting from wind-turbine noise is highly variable among humans.... studies on human sensitivity to very low frequencies are recommended." [46]

The conclusions of a 2010 peer reviewed scientific article states

> "1) Hearing perception, mediated by the inner hair cells of the cochlea, is remarkably insensitive to infrasound.
>
> 2) Other sensory cells or structures in the inner ear, such as the outer hair cells, are more sensitive to infrasound than the inner hair cells and can be stimulated by low frequency sounds at levels below those that are heard. The concept that an infrasonic sound that cannot be heard can have no influence on inner ear physiology is incorrect.
>
> 3) Under some clinical conditions, such as Meniere's disease, superior canal dehiscence, or even asymptomatic cases of endolymphatic hydrops, individuals may be hypersensitive to infrasound.
>
> 4) A-weighting wind turbine sounds underestimates the likely influence of the sound on the ear. A greater effort should be made to document the infrasound component of wind turbine sounds under different conditions.

5) Based on our understanding of how low frequency sound is processed in the ear, and on reports indicating that wind turbine noise causes greater annoyance than other sounds of similar level and affects the quality of life in sensitive individuals, there is an urgent need for more research directly addressing the physiologic consequences of long-term, low level infrasound exposures on humans." [47]

Recent research on the issue of infrasound below the hearing threshold states:

"For years, people have been told that infrasound you cannot hear cannot affect you. This is completely WRONG.

As the inner ear DOES respond to infrasound at levels that are not heard, people living near wind turbines are being put at risk by infrasound effects on the body that no-one presently understands.

Until a scientific understanding of this issue is established we should not be dismissing these effects, but need to be erring on the side of caution." [48]

It is incorrect to assume that inaudible low frequency noise cannot cause adverse health effects as "...non-aural physiological and psychological effects may be caused by levels of low frequency noise below the individual hearing threshold." [49]

"Low-frequency noise may also produce vibrations and rattles as secondary effects." [50]

"Jung and colleagues (2008), in a Korean study, concluded that low-frequency noise in the frequency range above 30 Hz can lead to psychological complaints and that infrasound in the frequency range of 5–8 Hz can cause complaints due to rattling doors and windows in homes." [51]

Living conditions are acknowledged to be a key determinate of health. [52]

A World Health Organization epidemiology study confirms disturbed living conditions caused by noise increases the risk of ill health. [53]

Peer reviewed scientific research confirms "Pollution and degradation of the indoor environment cause illness, increased mortality, loss of productivity, and have major economic and social implications.... The health effects of indoor noise include an increase in the rates of diseases and disturbances... these illnesses, and the related reduction in human productivity, can result in substantial economic losses." [54]

"A limitation of much work on assessment of low frequency noise has been that long term averaged measurements were used and, consequently, information on fluctuations was lost. Many complaints of low frequency noise refer to its throbbing or pulsing nature." [55]

Research related to low frequency noise "...confirms the importance of fluctuations as a contributor to annoyance and the limitation of those assessment methods, which do not include fluctuations in the assessment." [56]

Low Frequency Noise is an issue that must be resolved quickly and accurately to improve the sound environment and quality of life for the residents. For this reason, it remains the duty of industry and authorities to implement regulations that will account for low frequency noise. [57]

It is widely affirmed that A-weighting underestimates the sound pressure level of noise with low-frequency components. [58], [59], [60], [61] "A-weighted level is very inadequate..." [62] when assessing low frequency noise and infrasound.

NOISE CHARACTERISTICS

"Noise is multidimensional. A one dimensional view of noise is the A - weighting, which considers only levels and neglects frequencies. Another one-dimensional view is to consider only frequencies and neglect levels. Developing the dimensions further, two dimensions include both frequency and level (the spectrum), three dimensions adds in the time variations of the noise, whilst higher dimensions include subjective response." [63]

Peer reviewed scientific research confirms "The capacity of a noise to induce annoyance depends upon many of its physical characteristics, including its sound pressure level and spectral characteristics, as well as the variations of these properties over time. [64]

"Noise measures based solely on LAeq values do not adequately characterize most noise environments and do not adequately assess the health impacts of noise on human well-being. It is also important to measure the maximum noise level and the number of noise events when deriving guideline values. If the noise includes a large proportion of low-frequency components, values even lower than the guideline values will be needed, because low-frequency components in noise may increase the adverse effects considerably. When prominent low-frequency components are present, measures based on A-weighting are inappropriate. However, the difference between dBC (or dBlin) and dBA will give crude information about the presence of low-frequency components in noise. If the

difference is more than 10 dB, it is recommended that a frequency analysis of the noise be performed." [65]

It is affirmed that modulated broad band noise, low frequency noise, infrasound, tonal noise, and impulse noise have a particularly pronounced effect on people exposed to them. [66], [67], [68], [69]

Peer reviewed scientific research confirms noise limits should be based on annoyance scientific dose responses to individual noise sources. [70]

To protect people from the adverse health effect of noise annoyance World Health Organization states "Noise with low-frequency components require lower guideline values." [71]

Research confirms is inadequate as A-weighting underestimates the sound pressure level of noise with low-frequency components. [72], [73], [74]

"A-weighted levels for assessment of environmental noise are normally taken outside a residential property. The complexities of low frequency noise, including uncertainties in the transmission loss of the structure and resonances within rooms, require low frequency noise to be assessed by internal measurements." [75]

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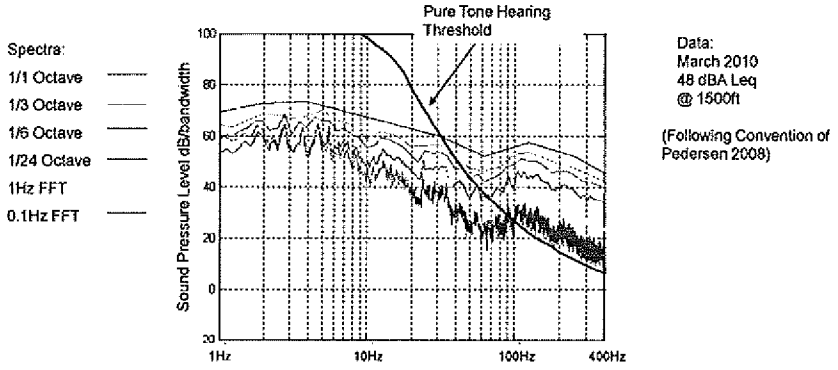
Fourth International Meeting on Wind Turbine Noise

Rome Italy 12-14 April 2011

The Audibility of Low Frequency Wind Turbine Noise

Dr M.A.Swinbanks,
MAS Research Ltd

The Problem: 2008 T.H.Pedersen Emphasized that Different Resolutions of the Same Wind Turbine Spectra lead to Different Conclusions



"..... it can be seen that a direct comparison of the hearing threshold and the spectrum of the wind turbine is not meaningful....." *

" ..... have been discussed with a number of researchers (Henrik Molter, Aaborg University, Torsten Dau, Danish Technical University, Hugo Fastl and Geoff Leventhall) and solutions have been sought for without result." *

* Reference [1]

Summary & Conclusions

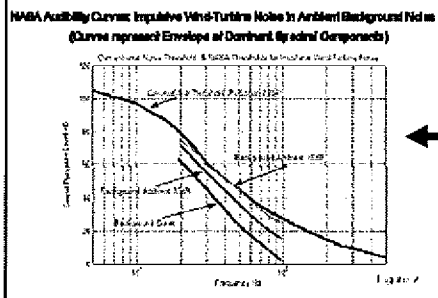
Low Frequency Noise & Infrasound Directly Impacts on Wind Turbine Communities Worldwide:
Accurate Assessment is Essential

- Pedersen (2008): Highlighted Unresolved Ambiguity in Evaluating Wind Turbine LF Noise.
- Present Author: Cumulative HT-Weighted Spectrum eliminates Ambiguity & Enables Unique Initial Comparison Based on RMS Levels
- Audible Energy Band lies to Left of Intersection with Threshold.

  Lower Limit: -6dB to -10dB for 75% to 90% Energy

- RMS Levels Underestimate Crest Factor, which Enhances Perception.
- Time-Domain Simulation Enables more Detailed Assessment of Crest Factor.
- Reveals Further Enhanced Perception (5dB to 11dB) for Random Noise & Infrasonic Impulses.
- Conclusions Consistent with 1980's NASA Studies, and On-Site Experience.

Prior Investigations of Audibility



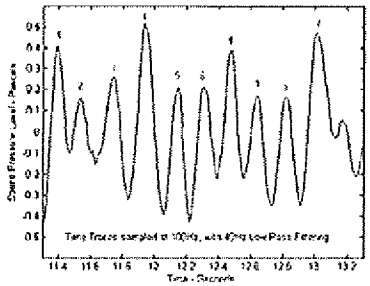
1982: NASA Tested Audibility of Impulsive Downwind Turbines.

Showed Envelope of Dominant Spectral Components Audible -20dB Below Hearing Threshold

1989: NASA showed Upwind Turbines Could Generate Low Frequency Impulsive Noise from Wind Gradients

Modern Windfarms can produce Impulsive Infrasonic Noise

Multiple Low-Frequency Impulses Measured Indoors in March 2010 at a Modern, Upwind-Rotor Windfarm. 6 Separate Turbines can be Identified



Peak Sound Pressure '4': 85dB Farthest Turbine '2': 1.2 miles
Approximately -3dB per Doubling of Distance

Industrial Gas Turbine 3rd Octave Spectra

1981 Author Demonstrated Silencing of Low Frequency Gas-Turbine Compressor Noise using Active Sound Control.

1987 Further Active Silencers Commissioned, at Lower Frequency.

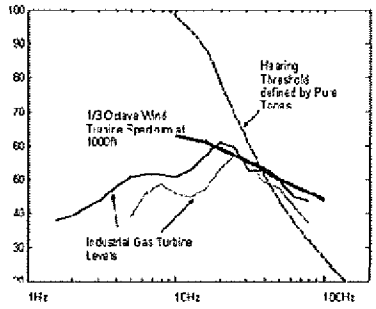


Figure 4

Example of LF Wind Turbine Spectrum, Considered to be not Audible to the Average Person up to about 31.5Hz – 40Hz (from [6]). Compared to Industrial Gas Turbines with Peak Levels at 20Hz & 25Hz, Reported as Audible.

Projected Noise Levels causing Complaints were directly comparable to Wind Turbine LF Noise now considered "below" the Threshold of Hearing

First Steps to Solution

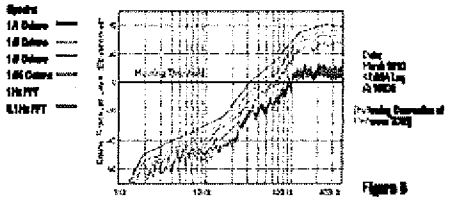


Figure 5

Pedersen: Weight Spectra by Inverse Hearing Threshold, & Integrate over Critical Hearing Bands: 0-100Hz, & 100Hz-200Hz

=> 2 Unique Values re 0dB Threshold

Does <u>not</u> identify frequency where Threshold is crossed.

Present Author: Impose Running, Cumulative Integration e.g. 1-2Hz, 1-3Hz, ... 1-50Hz etc.

Condenses Spectra to Single Common Curve.

At 0dB Intersection, LF Energy is equal to "just audible" Sine Wave.

75% Energy between -6dB & 0dB

90% Energy between -10dB & 0dB

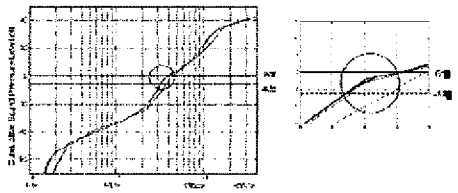
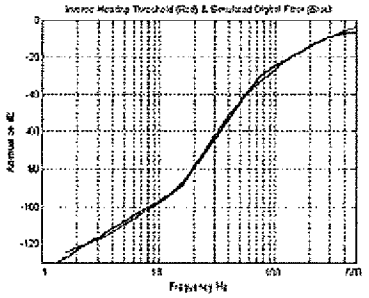


Figure 6

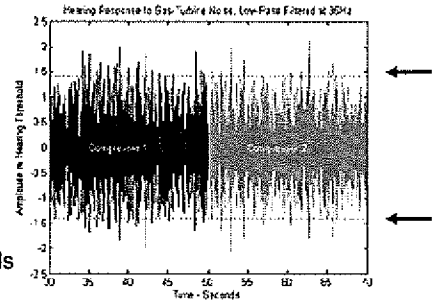
Note: Intersection is close to 1/3rd Octave Result

Importance of Crest Factor (Peak-to-RMS Ratio)

'First Steps' Equated Mean Energy Levels, defined by RMS Values
Typical Real Waveforms have Higher Crest Factor than Pure Sinusoids.
Peak Levels can "Punch Through" Threshold



Simulate Hearing Threshold Response using Digital Filter



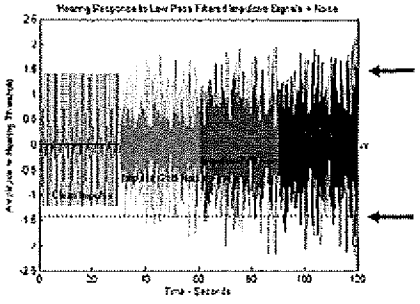
Simulate Random Signals for Gas Turbine, & Filter with Hearing Response

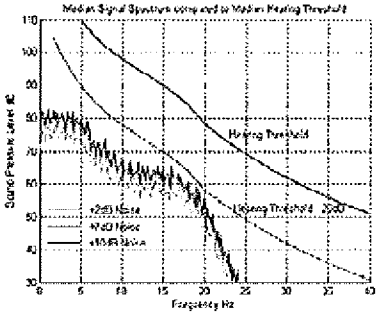
Amplitude at Hearing Threshold corresponds To +/- √2 = 1.4

Impulse at Hearing Threshold: Time History & Power Spectrum

Reproduce Infrasonic Impulse ~ NASA 1989, for Upwind Turbine in Wind Gradient

Filter with Simulated Hearing Response



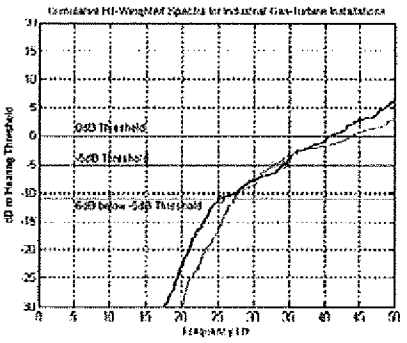


Spectrum for Impulse at Median Level lies -20dB below Median Threshold

Consistent with 1982 NASA Audibility Tests

Cumulative Inverse HT-Weighted Spectra for Simulations

Industrial Gas-Turbine Spectra



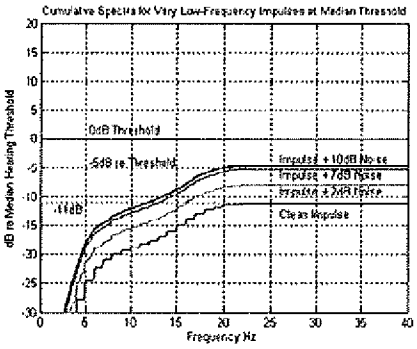
Gas Turbine Noise, Low-Pass Filtered below 35Hz met +/- 1.4 Limits at RMS Level -5dB

75% Lower Limit: -11dB at 25 Hz, 27Hz

90% Lower Limit: - 15dB at 22.5Hz, 25Hz

Consistent with Complaints

Impulsive Infrasonic WT-Spectra



Flattens-Out above 20Hz, since Infrasound Only

Clean Impulse met +/-1.4 Limits at RMS Level -11dB

+2dB Noise: Perception at -8dB

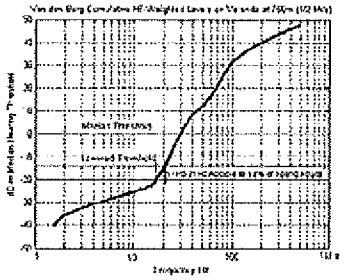
+10dB Noise: Perception at -5dB

(Asymptotes to Random Noise).

Application to Van den Berg 2004 Windfarm Data

1/3rd Octave Data Measured on Terrace of House at 750m from Nearest Turbine. (Data as Reported removed -3dB to yield Free-Field.)

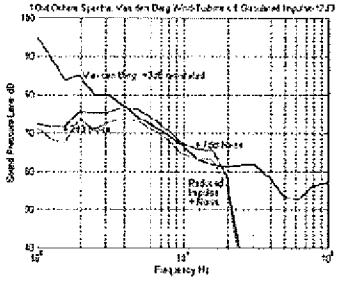
3dB Reinstated to Represent Actual Measured Sound Pressure Levels



Cumulative HT-Weighted Spectrum

Threshold Lowered -8dB for 10% Young Adults, plus -6dB for Impulsive Infrasound + Noise

Conclusion: 17Hz -21Hz Perceptible to 10% Young Adults



Hearing Threshold for 2.5% Adults: -12dB re Median

So Reduce Median Infrasonic Impulse by -12dB

Reduced 1/3 Octave 'Impulse + Noise' correspond to Measured Wind-Turbine Levels

Conclusion: Significant Infrasonic Noise Perceptible to 2.5% Adults

Summary & Conclusions

- Pedersen (2008): Highlighted Unresolved Ambiguity in Evaluating Wind Turbine LF Noise.
- Present Author: Cumulative HT-Weighted Spectrum eliminates Ambiguity & Enables Unique Initial Comparison Based on RMS Levels
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- Reveals Further Enhanced Perception (5dB to 11dB) for Random Noise & Infrasonic Impulses.
- Conclusions Consistent with 1980's NASA Studies, and On-Site Experience.

Consequently, this Analysis shows the Impact of Wind Turbine Low-Frequency Noise & Infrasound has been Significantly Underestimated.

WTN 2011

Fourth International Meeting on Wind Turbine Noise

Rome Italy 12-14 April 2011

Responses of the Inner Ear to Infrasound

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E-mail: salta@ent.wustl.edu.
2) Eaton-Peabody Laboratory, Massachusetts Eye & Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114 and Department of Otology & Laryngology, Harvard Medical School, Boston, Massachusetts 02115, USA.
E-mail: jeffery_lichtenhan@meei.harvard.edu

Abstract

Unweighted sound measurements show that wind turbines generate high levels of infrasound. It has been wrongly assumed that if subjects cannot hear the infrasound component of the noise then they cannot be affected by it. On the contrary, the mammalian ear is highly sensitive to infrasound stimulation at levels below those that are heard. Most aspects of responses to infrasound are far from well established. Measurements made within the endolymphatic system of the cochlea show responses that become larger, relative to measurements made in perilymph, as frequency is lowered. This suggests that endolymphatic responses to infrasound are enhanced in some manner. For high-frequency sounds, acoustic stimuli in the ear are summed. In contrast, the inner ear's responses to infrasound are suppressed by the presence of higher frequency stimuli. The complexity of the ear's response to infrasound leads us to the conclusion that there are many aspects that need to be better understood before the influence of wind turbine noise on the ear can be dismissed as insignificant.

Introduction

The effects of sounds on humans are typically evaluated through measurements made with instrumentation such as microphones and sound level meters. As the vast majority of these measurements relate to sounds that people can hear or which may damage the ear, measurements are routinely weighted according to the hearing sensitivity of humans (i.e. the A-weighting curve which is based on the 40 phon audibility curve in humans). As the ear represents the highly sensitive sound detector of the body, it has been widely assumed that if a sound is not detected (i.e. the sound is not heard by a listening subject) then the sound has no relevance to human physiology. This concept was further developed with respect to whether harm could arise from sounds and has been widely expressed in the form of statements along the lines of "what you can't hear, can't hurt you". The origins of this belief are

difficult to trace but it is believed to originate from the title of a newspaper article by an engineer making measurements of the "Kokomo hum" in 2001 (Alves-Pereiraa M, Castelo Branco, 2007). It is important to realize that the concept was not based on physiologic scientific studies in which "harm" was quantified or measured in some way that correlated with low-frequency sound measurements. Rather, the statement was a speculation without any fundamental consideration of how the ear works. Indeed, it is quite remarkable how such an erroneous concept could have gained such widespread acceptance when there is such a large amount of physiological data showing that the ear's response to low-frequency sounds is far more complex than that of a simple microphone (reviewed by Salt and Hullar, 2010).

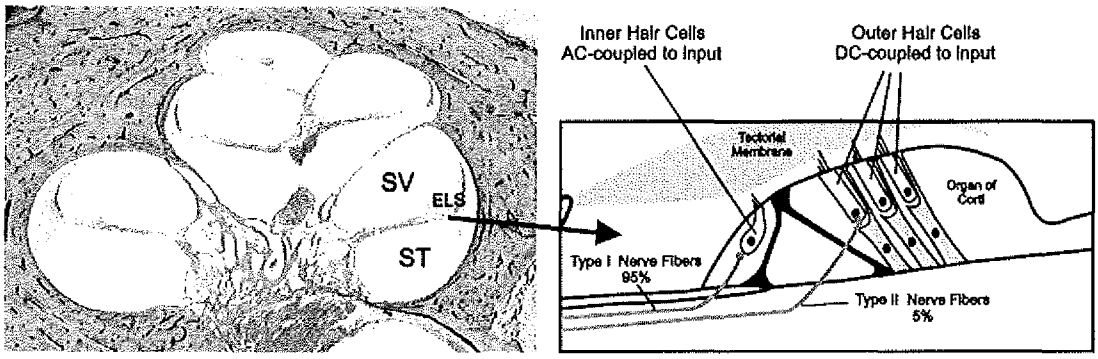

Figure 1: Anatomy of the Inner Ear. ***Left:*** *A mid-modiolar section of the human cochlea spiral with the compartments of one turn labelled. SV:scala vestibuli; ELS: endolymphatic space; ST: scala tympani. The structure containing the sensory cells, called the organ of Corti, is on the lower border of the ELS.* ***Right:*** *Enlarged schematic of the organ of Corti, which contains two types of sensory cells. The sensory hairs of the outer hair cells are embedded in the gelatinous tectorial membrane making them DC-coupled to the input stimulus. The hairs of the inner hair cells are free within the fluid space below the membrane, causing them to be AC-coupled to the input stimulus. Histological image courtesy of Saumil Merchant, MD, Otopathology Laboratory, Massachusetts Eye and Ear Infirmary and Harvard Medical School, Boston.*

The anatomic features of the inner ear that are relevant to its sensitivity to low-frequency stimulation are summarized in Figure 1. The important feature is that the sounds that are heard are mediated through the inner hair cells and transmitted to the brain through the Type I nerve fibers which make up the majority (95%) of the auditory nerve. In simple terms, the inner hair cells are AC-coupled to the mechanical stimulus, meaning that they respond well to high stimulus frequencies but are insensitive to very low-frequency or sustained displacements of the organ. Based on single nerve fiber recordings, Temchin et al., 1997 concluded that a high-pass filter was interposed before the site where auditory nerve excitation thresholds were determined. A consequence of this arrangement is that subjective hearing is insensitive to stimuli of infrasonic frequencies because of the high-pass filter/ AC coupling. However, because the outer hair cells of the ear are DC-coupled to the stimulus (sensitive to high-frequency stimulation, low-frequency stimulation and sustained displacements of the organ), their characteristics can indeed render the ear sensitive to infrasound. It has been shown that prolonged displacements of the

organ of Corti for 20 minutes or longer, by microinjection of gel into the cochlear apex, cause endocochlear potential changes that were sustained throughout the procedure (Salt et al, 2008). This confirms the ability of the outer hair cells to respond to slowly occurring or sustained displacements. The outer hair cells are mechanically coupled to the inner hair cells and are innervated by so called Type II fibers that make up 5% of the auditory nerve.

The fact that hearing is insensitive to infrasonic frequencies therefore does not indicate that the entire ear is insensitive to infrasound. This is analogous to viewing the electrical output of a low-frequency-capable sound level meter on an AC-coupled oscilloscope and concluding that the sound level meter is "insensitive" to low-frequencies. Similarly, because subjective hearing is based on an AC-coupled output from the ear, that does not mean that an unheard infrasound cannot influence the other components of the ear, such as the outer hair cells, and thereby influence heard sounds in a number of complex manners, as discussed below. Here we present a number of different measurements that characterize a number of aspects of the ear's sensitivity to infrasound.

Methods

The electrical measurements from the inner ear we present in this paper include data from guinea pigs and cats. In guinea pig experiments, stimuli were generated and responses were recorded using Tucker-Davis System 3 hardware controlled by custom-written software on a PC. Sound stimuli were generated in a closed system, using a hollow ear bar between the transducers and the external ear canal. Full technical details of stimulus generation are given elsewhere (Brown et al., 2009). Cochlear responses were measured from electrolyte-filled glass pipettes, inserted into the cochlear fluids spaces, via a high input impedance electrometer.

Single nerve fiber recordings in cats followed methods described by Kiang *et al.* (1965). Low-frequency (i.e., 50 Hz) tones were presented to cat ears with a DT48 headphone coupled to the ear through a hollow ear bar.

Guinea pig experiments were approved by the Animal Studies Committee of Washington University. Cat experiment protocols were approved by the Animal Care Committee of the Massachusetts Eye and Ear Infirmary.

Results

1) Endolymphatic enhancement of responses to low-frequency sounds.

In this study, we measured electrical responses from the basal turn of the guinea pig cochlea in response to tones of varying frequency. Sound levels were varied until a specific response amplitude (500 μV) was generated. These sound level thresholds were measured in scala media (endolymph) and scala tympani (perilymph) in the same animals. At 4 kHz, we found larger electrical responses in the endolymphatic system, requiring 10 dB lower sound level to achieve the criterion 500 μV response amplitude. The difference between endolymph and perilymph increased

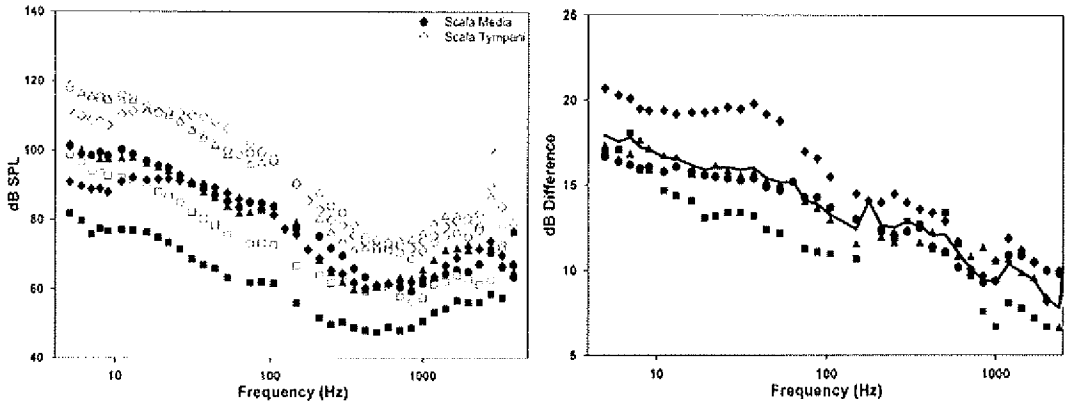

Figure 2: ***Left:*** *Thresholds of stimulation required to generate a cochlear microphonic amplitude of 500 uV in scala media (filled symbols) or scala tympani (open symbols) of the cochlea of 4 animals.* ***Right:*** *The difference between the thresholds measured in perilymph and endolymph. Positive values indicate that larger responses were generated (resulting in lower measured thresholds) in the endolymphatic space (scala media). The cutoff in sensitivity as frequency decreased was lower in the endolymphatic space. This demonstrates that low-frequency sensitivity varies in different parts of the ear, with the endolymphatic space showing relatively higher sensitivity to infrasound. The difference averaged 18 dB at 5 Hz.*

systematically as frequency decreased, with the difference approaching 20 dB at the lower frequencies tested. These measurements show that responses in the endolymphatic system were larger than those measured in perilymph. They vary in a frequency-dependent manner, generating relatively larger responses with infrasound stimulation. Even with the high (500 µV) response criterion, microphonic thresholds measured in the endolymphatic space were in the 80-100 dB SPL range.

2) Inner ear sensitivity to infrasound.

The sensitivity to infrasound was greater when measured in the higher cochlear turns, which predominantly respond to lower frequencies. In Figure 3 we show cochlear microphonic responses evoked from three stimulus frequencies and recorded from the endolymph compartment of the 3rd turn of the guinea pig cochlea. In this experiment, the responses were band pass filtered at the stimulus frequency, and 20 responses were averaged for each measurement to reduce noise levels. Although the ear is less sensitive to 5 Hz compared to 500 Hz (~37 dB higher level required to generate 100 µV at 5 Hz), the maximum voltages generated inside the ear were over 3x greater for 5 Hz (17.3 mV maximum) than for 500 Hz (5.5 mV maximum). This demonstrates that the ear is not only sensitive to infrasonic stimuli, but under some conditions can generate responses to infrasonic stimuli that are larger than those generated for stimuli that are more easily heard by the animal.

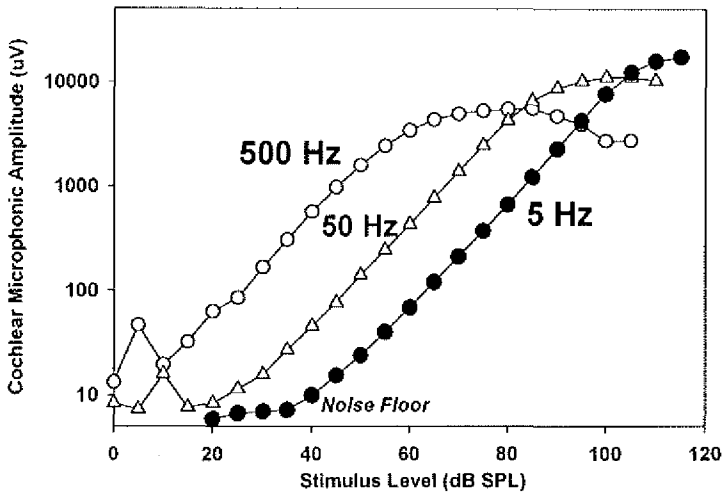

Figure 3: Amplitude of cochlear microphonics recorded from endolymph of the third turn for 3 stimulus frequencies. For each measurement point 20 responses were band-pass filtered and averaged to reduce background noise levels. Although lower sound levels are required to generate responses at 500 Hz, the maximum response amplitude is considerably higher at 5Hz (17.3 mV) than at 500 Hz (5.5 mV).

3) Infrasound responses are inhibited by sounds of higher frequency.

The large potentials generated in the endolymphatic system of the ear in response to infrasound have unique properties that differ from those in response to higher frequency sounds. When two sounds at high-frequency are presented simultaneously to the ear the cochlear microphonic response they generate is typically the sum of the responses to the two signals. This behaviour is analogous to that of a microphone and is the basis of the naming of this response as the cochlear "microphonic". Thus, at the level of the cochlear microphonic, one sound does not generally inhibit the other. The cochlear microphonic responses to infrasonic stimuli behave differently, however, and are sensitive to the presence of other sounds of higher frequency. In Figure 4 we show an experiment in which a 500 Hz probe tone was superimposed on a sustained 5 Hz stimulus. The recording shows that when the 500 Hz tone was present, the response to 5 Hz was markedly reduced. Analysis of these results shows that the low-frequency response amplitude was initially 8.4 mV peak and was reduced to 2.3 mV peak when the 500 Hz stimulus was present.

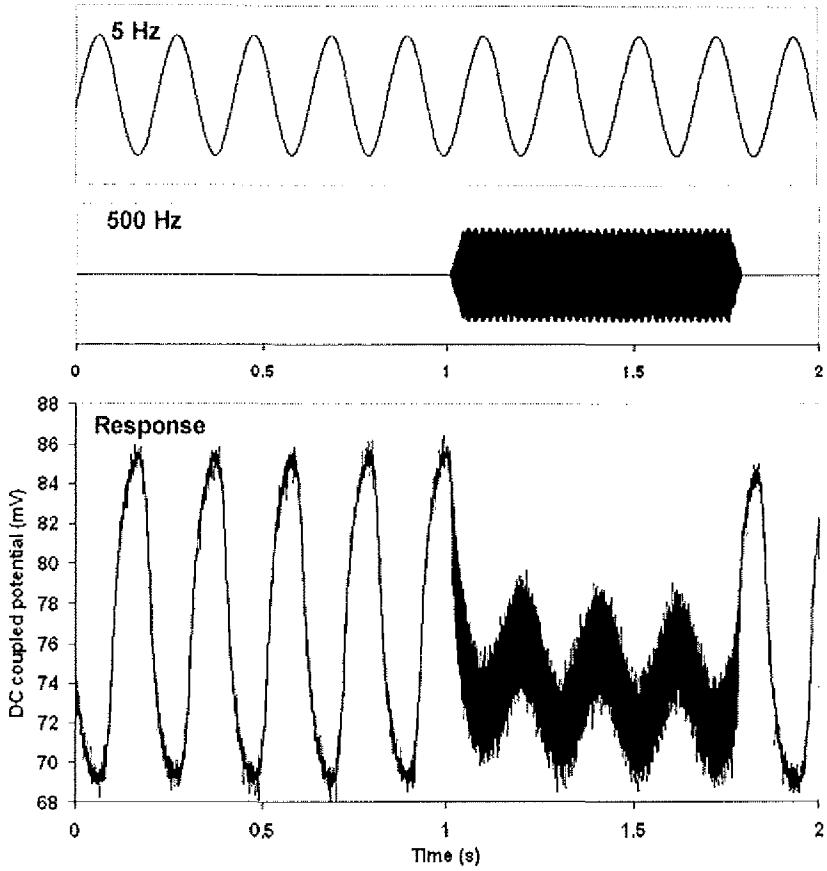

Figure 4: Cochlear microphonic responses from the endolymphatic space of the third turn of the guinea pig cochlea in response to a 5 Hz, 110 dB SPL, 2 s duration stimulus with a superimposed 500 Hz, 80 dB SPL stimulus commencing after 1 s as shown in the upper panels. The cochlear response to the 5 Hz stimulus was dramatically reduced for the duration of the 500 Hz stimulus. Responses were recorded as a single epoch with no averaging.

Although the example demonstrates the phenomenon with a high (110 dB SPL) infrasound level, a similar suppression of the infrasound response occurs with the infrasound at levels as low as 80 dB SPL, as shown in Figure 5. The level of probe tone needed to suppress the infrasound response was approximately 60 dB SPL.

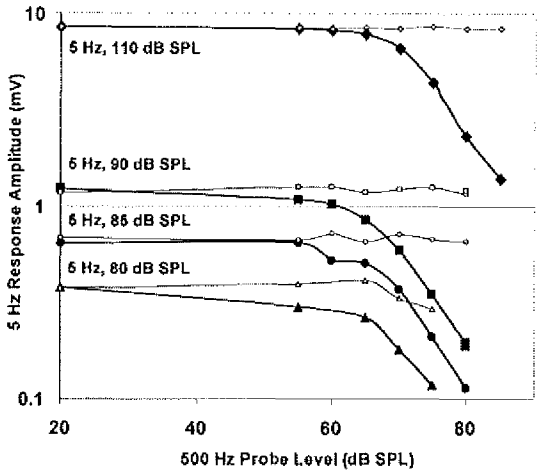

Figure 5: Suppression of cochlear microphonic responses to infrasound (5 Hz) with different levels of the infrasound and of a superimposed 500 Hz probe, as shown in the previous figure. Each curve shows measured responses at the infrasound level indicated. Open symbols show the 5 Hz response amplitude in the region preceding the probe, while solid symbols show the 5 Hz amplitude measured during the probe. Responses to both high (110 dB SPL) and low (80 dB SPL) levels of infrasound stimulation are suppressed by the presence of an audible tone.

4) Responses from the auditory nerve show how a low-frequency sound, that do not by itself excite a single-fiber, can amplitude modulate responses of higher frequency stimuli.

Approximately 30,000 fibers comprise the afferent portion of the cat auditory nerve. We measured single-fiber responses by inserting an electrode made from glass capillary tubing into the region between the ear and the brainstem. When a single-fiber was contacted, we recorded its response with no stimulus (to measure the fiber's "spontaneous rate"), with a high-frequency tone alone, a low-frequency tone alone, and combinations of a probe tone at constant level with a low-frequency tone that was varied in level (Lichtenhan, Guinan, and Shera, 2011). The right panel of Figure 6 shows the firing rate of one fiber under different stimulus conditions. This fiber had a low-spontaneous rate that did not increase (show excitation) when a low-frequency (50 Hz) tone was presented alone. A probe tone of 910 Hz, which was at the "best frequency" for this fiber, caused excitation (firing rate increased to approximately 250 spikes/s). As the level of the low-frequency tone was increased, it suppressed the responses to the higher frequency probe tone, even though the fiber did not respond to the low-frequency tone alone. The left panel of Figure 6 shows single-fiber histograms which demonstrate how the nerve fiber responses synchronize to particular phases of the low-frequency tone when the probe and low-frequency tone were presented together. The 20 ms time interval shown corresponds to one cycle of the low-frequency, 50 Hz tone. At the lowest level of the low-frequency tone (65 dB SPL) the responses are unaffected by the low-frequency and the responses occur uniformly throughout the cycle of the tone. As the level of the low-frequency is increased, it can be seen that not only does the firing rate decrease (as shown in the right panel), but also that the responses predominantly occurred at certain time points in the cycle of the low-frequency tone.

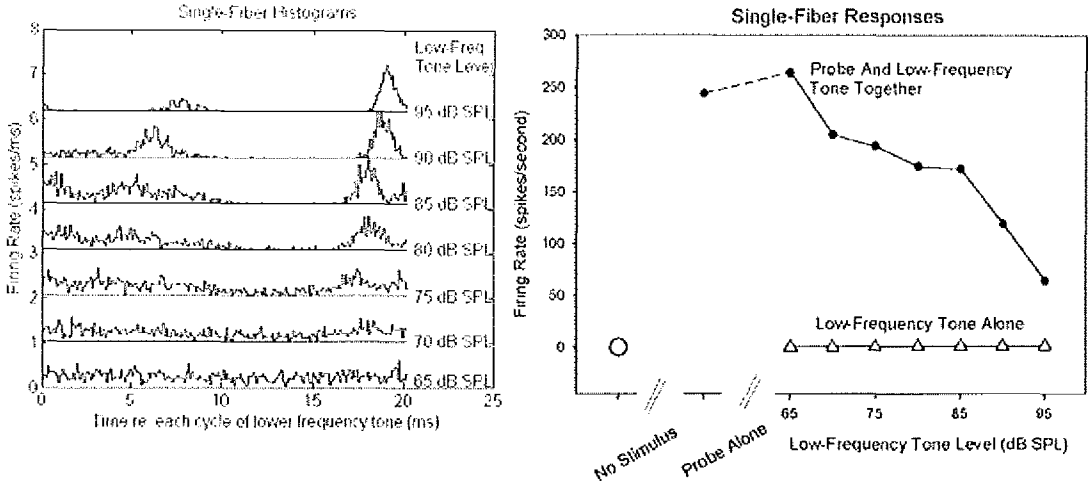

Figure 6: ***Left:*** *A single-fiber's firing rate histogram as a function of one cycle of the low-frequency tone. Here, a higher frequency probe tone (910 Hz – a frequency well above the fundamental frequency of a typical male's voice) and a low-frequency (50 Hz) tone were presented together. As the level of the low-frequency tone is increased, the firing rate is suppressed at particular phases of the low-frequency tone.* ***Right:*** *The low-frequency tone presented alone does not significantly alter the spontaneous-rate (measured by using no stimulus), while the probe alone did excite the fiber. When a 40 dB high-frequency tone and low-frequency are presented simultaneously, the response from the high-frequency tone is decreased as the level of the low-frequency tone is increased.*

The response of this fiber to the higher frequency tone was clearly modulated by the presence of the low-frequency. These data show that although a low-frequency stimulus, when presented alone, does not excite the fiber (and was therefore not necessarily "heard" by the fiber), the low-frequency stimulus had a marked influence on both the audibility and temporal characteristics of responses to higher frequency signals. This is because although the inner hair cells do not respond to very low-frequencies, they are affected by high-frequency responses of the outer hair cells, which are sensitive to and are modulated by the low-frequency tone

Conclusions

We have presented a number of measurements showing how the inner ear is sensitive to low-frequency and infrasonic sound stimuli presented at levels well below those that would be heard. Our results are consistent with the interpretation that hearing occurs through the inner hair cells which are AC-coupled to the stimulus, while the measured cochlear microphonic responses are generated by the outer hair cells that are DC-coupled to the stimulus. On the basis of these findings it seems reasonable to conclude that when a subject cannot hear a low-frequency sound, this cannot be taken as evidence that the sound cannot affect ear or the subject in other ways.

Our measurements from single-fibers of the auditory nerve show how low-frequency tones that do not by themselves stimulate nerve fibers, can modulate responses to higher frequency stimuli that certainly do stimulate the fiber.

Comparable findings from experiments in chinchillas were reported by Temchin et al., 1997. The frequency dependence they found led them to conclude "that a (high-pass) frequency filter is interposed between the site of origin of modulation and suppression and the site where auditory nerve excitation thresholds are determined". The most likely candidate for this high-pass frequency filter is the sub-tectorial fluid movement that couples outer hair cell movements to the inner hair cells, which in turn provide "hearing". Because the outer hair cell's stereocilia are imbedded in the tectorial membrane, their responses (and their ability to amplify high-frequency sounds) are affected by low-frequency or infrasonic tones while the inner hair cell's stereocilia are not. The inner hair cells can thus "see" the outer hair cells' amplitude modulated, high-frequency output and pass that representation to the auditory nerve which forms the basis of hearing.

This raises the possibility that there are multiple mechanisms by which infrasound or low-frequency sounds, at levels too low to be heard, could influence the representation of sounds in the brain. They can suppress and amplitude modulate responses to higher frequency sounds. By slowly displacing the organ of Corti, they can modulate harmonic distortions to higher frequency stimuli or two-tone emissions (Brown et al., 2009). Such modulation of distortion has been observed both in animals and in humans through acoustic emission measurements from the external ear canal (e.g., Marquardt et al., 2007). The outer hair cells could also stimulate their own afferent innervation directly. The stimulus conditions that cause excitation of the outer hair cell afferents remain largely unexplored. Some have suggested that the afferents may be used in a local network to synchronize the responses of outer hair cells (Thiers et al., 2008). Because these afferents have synapses in the cochlear nucleus of the brain (Benson and Brown, 2004), that central projection could provide an input which may be subconscious.

These findings are relevant to the perception of the "amplitude modulation" of sounds, and represent a biological form of modulation by low-frequency sounds that cannot be measured with a sound level meter. Indeed, some have described how low-frequency biasing can suppress the audibility of higher-frequency tones in the range of speech frequencies (e.g., Zwicker, 1976). A resulting consequence of amplitude modulation of speech sounds by wind turbine infrasound may perhaps be a more difficult, or perceptually taxing, listening environment. Such amplitude modulation of speech sounds may contribute to the "noise annoyance" and problems with "noise sensitivity" reported by Pedersen and Waye (2004)

Responses of the ear to infrasound are substantially greater when measured in the endolymphatic system. The greater sensitivity to infrasound probably results from alterations in ion transport during the relatively prolonged displacements of the organ of Corti during individual cycles of very low-frequency sounds. This is analogous to the voltages change in the battery of a device when sustained current is drawn, compared with those when current draw is modulated (both increasing and decreasing) at high-frequency.

The presence of high-frequency sounds suppresses some aspects of the ear's response to infrasound. This means that under conditions where infrasound levels are high, while ambient sounds are low, the ear may be maximally affected by the infrasound. This may be relevant to the exposure of people to wind turbine sounds in a quiet listening environment (such as a bedroom), where response to the infrasound

may be augmented relative to listening conditions where higher levels of other ambient sounds are present.

We conclude that the ear exhibits a number of complex physiological responses to infrasound stimulation at moderate levels that may exist in the vicinity of wind turbines under some operating conditions. Because the ear is undoubtedly responding to these sounds, it cannot be concluded that infrasound effects on the ear are insignificant because the sounds are not heard. It is therefore premature to assert that long term exposure to wind turbine noise can have no physiological effect on humans.

Acknowledgments

We thank Mr. Nikolas A. Francis, Dr. John J. Guinan Jr. and Dr. Christopher A. Shera for helpful discussion on this research. ANS was supported by grant RO1 DC01368 from the NIDCD, National Institutes of Health. JTL was supported by grant F32 DC010112 from the NIDCD, National Institutes of Health. Cat experiments were supported by grants RO1 DC00235, R01 DC03687, and P30 DC05029 from the NIDCD, National Institutes of Health.

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WTN 2011

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Rome Italy 12-14 April 2011

Wind turbine noise and health-related quality of life of nearby residents: a cross-sectional study in New Zealand.

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Abstract

Hearing allows humans to detect threats in the environment and to communicate with others. However, unwanted sound has the capacity to evoke reflexive and emotional responses, and can act a stressor. The World Health Organisation classifies noise as an environmental pollutant that degrades sleep, quality of life and general health. Previous research provides evidence of a relationship between wind turbine noise and both annoyance and sleep disturbance. However, wind turbines are a relatively new source of community noise, and as such their effects on health have yet to be fully described. We report a study exploring the effect of wind turbine noise on health and well-being in a sample of New Zealand residents living within two kilometres of a wind turbine installation. Our data provide evidence that wind turbine noise can degrade aspects of health-related quality of life and amenity. On this evidence, wind turbine installations should be sited with care and consideration with respect to the communities hosting them.

Introduction

Wind turbines transform wind energy into electricity. Over the last decade, the industrial-scale harvesting of wind energy has increased, driven by a desire to generate sustainable energy. Wind turbines were initially welcomed by communities, but public opposition to wind turbines has since increased,[1] largely because of the noise they produce and also their visual impact.

There has been considerable debate over whether wind turbines pose a significant health threat to those living in their vicinity. It has been suggested that wind turbines can directly impact health via the emission of low-frequency sound energy (i.e. infrasound), though this is currently an area of controversy.[2, 3]Additionally, wind turbines may compromise health by producing sound that is annoying and/or can disturb sleep. In this respect, it can be classified as community noise along with industrial and transportation noise. When built in rural settings, the visual impact of turbines can also degrade amenity and interact with turbine noise to exacerbate annoyance reactions.[4]

Figure 1 represents a simple model informed by the literature [5, 6] demonstrating that, in the rural context, there are feasible mechanisms by which wind turbine exposure can degrade health and well-being. Turbine noise can lead directly to annoyance and sleep disturbance (primary health effects), or can induce annoyance by degrading amenity. Additionally, the trait of noise sensitivity (being likely to attend to sound, evaluate sound negatively, and have stronger emotional reactions to noise) constitutes a risk factor. The secondary heath effects would be immediate reductions in general well-being and stress-related disease emerging from chronic annoyance and sleep disturbance. Chronic noise exposure is a psychosocial stressor that can induce maladaptive psychological responses and negatively impact health via interactions between the autonomic nervous system, the neuroendocrine system, and the immune system.[6] A chronic stress response will, in turn, degrade quality of life (Figure 1).

Quantifying the impact of wind turbines on individual health will inform wind turbine operational guidelines. One approach to health assessment involves a subjective appraisal of Health-Related Quality of Life (HRQOL), a concept that measures general well-being and well-being in the physical, psychological, social, and environmental domains. The WHO recommends the use of HRQOL measures as an outcome variable, arguing that the effects of noise are strongest for those outcomes classified under HRQOL rather than illness.[7] HRQOL is related to health by the WHO (1948) definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity", and can be considered as an operationalisation of the well-being concept.[8]

There is scientific evidence linking community noise to health problems.[6, 7, 8] The WHO reports that chronic noise-induced annoyance and sleep disturbance can compromise health and HRQOL.[7, 9, 10] However, there has been little research examining the relationship between noise and HRQOL. An exception is Dratva et

al.,[11] who, using the Short Form (SF36) health survey, reported an inverse relationship between annoyance from traffic noise and HRQOL. They argued that HRQOL would be expected to co-vary more with annoyance than with noise level as level is a poor predictor of the human response to noise, and its role in health is commonly over-emphasised. As alternatives to noise level, other factors associated with the listener should be considered,[5] including the perceived control a person has over the noise, as well as their attitudes, personality, and age.

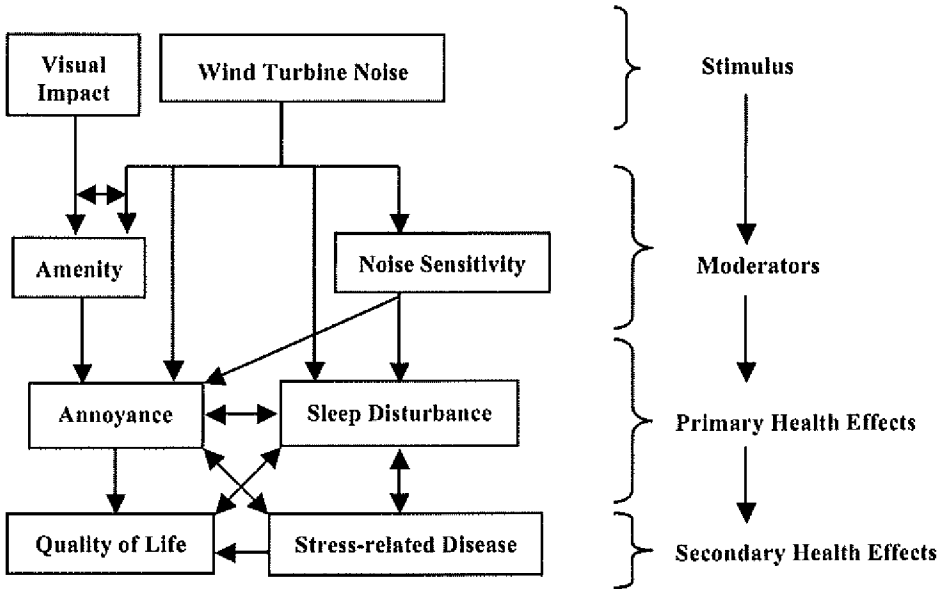

Figure 1 A schematic representation of the relationship between wind-turbines and health in a rural setting. The multiplicity of relationships emerges due to variability in the response of individuals to noise.

Case studies supported by qualitative analyses [2, 12, 13] suggest a negative relationship between wind turbine noise and wellbeing. There have been no previous quantitative investigations of the impact of wind turbines on HRQOL, though correlations have been observed between wind turbine noise, annoyance, and sleep disruption.[14, 15] Our study is the first to examine the association between HRQOL and the proximity to an industrial
wind turbine installation.

Method

A non-equivalent comparison group posttest-only study design was utilised. Strict socioeconomic matching was undertaken using the New Zealand Deprivation Index 2006,[16] as described elsewhere.[17] Both areas are classified as rural,[18] with a population density of less than 15 people per square kilometre.

Samples were drawn from two demographically matched areas differing only in their distances from a wind turbine installation in the Makara Valley, an area 10 kilometres west of New Zealand's capital city, Wellington. The Makara Valley is characterised by hilly terrain, with long ridges running 250 – 450 metres above sea level, on which sixty-six 125-metre-high wind turbines are positioned. The first sample (the Turbine group) was drawn from residents in the South Makara Valley who resided in 56 houses located within two kilometres of a wind turbine. A comprehensive noise survey of the area was undertaken independently, and indicated the intrusive nature of the turbine noise.[19] The Makara turbines, operational since May 2009, have measured levels that are consistent with levels reported in European studies,[15] which showed that typical noise exposures from wind turbines ranged from between 24 and 54 dB(A). The second sample (the Comparison group) was taken from residents in 250 houses in a geographically and socioeconomically matched area, but which were located at least eight kilometres from any wind turbine installation.

Each house received two copies of the questionnaire. The coversheet of the questionnaire bore the title 2010 Wellbeing and Neighbourhood Survey, designed to mask the true intent of the study. Potential participants were invited to participate in the research investigating their place of living and their wellbeing if they resided at the address to which the questionnaire had been delivered and if they were 18 years or older. The order of the questions was a prime consideration: HRQOL (26 items), amenity (2 items), neighbourhood problems (14 items), annoyance (7 items) demographic information (7 items), and a single item probing noise sensitivity. All scale items were presented on a numbered five-point scale with appropriate descriptors anchoring the terminals. Self-reported HRQOL was measured using the abbreviated version of the WHOQOL-BREF which affords composite measures of Physical (7 items), Psychological (6 items), Social (3 items) and Environmental (8 items) HRQOL. Additionally, the WHOQOL-BREF has two generic items asking about general health and overall quality of life. The two amenity items were: "I am satisfied with my neighbourhood / living environment" and "My neighbourhood / living environment makes it difficult for me to relax at home". A modified neighbourhood problem scale [20] consisted of 14 distracter items that were not relevant to the current study and were not included in the analysis. Seven items on annoyance were included, 4 distracter items asking about air quality, and 3 items probing annoyance to traffic, other neighbours, or other noise (please specify). Additionally, participants were asked if they were not noise sensitive, moderately noise sensitive, or very noise sensitive. The questionnaire terminated with an open-ended item asking "If you would like to share any comments relating to your neighbourhood or this survey then

please do so in the box below". Participants were asked to respond to all items and to return surveys by post in the prepaid envelopes provided.

Self-reported age and sex measures were obtained and self-reported level of educational status used as an indicator of socioeconomic status. Additionally, participants were asked what their current employment status was, and whether they were currently ill or had a medical condition. Participants were also asked how long they had lived at their current residence.

Analysis commenced after an evaluation of each scale's psychometric properties, including inspection for floor and ceiling effects and tests of internal consistency (Cronbach's alpha) and to validate dimensionality (corrected item-total correlations). Differences in HRQOL and amenity between the Turbine and Comparison groups were calculated using univariate Analysis of Covariance (ANCOVA), with length of residence selected a priori as a covariate. All testing was undertaken in accordance with Tabachnick and Fidell's [21] guidelines for testing between groups with unequal sample sizes, and Bonferroni corrections were applied where appropriate. Because of the unequal sizes between the two groups the assumptions of normality and homogeneity of variance were assessed carefully. Five cases were excluded from the Comparison group because they were multivariate outliers as defined by extreme Mahalanobis distances, with response set acquiescence clearly evident in all five cases.

Results

The response rates, 34% and 32% from the Turbine and Comparison groups, respectively, were typical for this type of research (e.g., van den Berg and colleagues' (2008) report a 37% response rate). Table 1 presents demographic information for the Comparison and Turbine groups. Prior to analyses the data were screened to identify potential confounds. The proportions of males and females in each area were equivalent (χ^2 (1) = .001, p = .967), while a Mann Whitney U indicated no age difference between the two areas (U(n1= 158 , n2 =39) = 16022.5, p = .802). Education (χ^2 (2) = 2.474, p = .291), noise sensitivity (χ^2 (2) = .553, p = .758), and self-reported illness (χ^2 (1) = .414, p = .562) were not associated with area.

Table 1 Demographic profile of the Turbine and Comparison groups

Variables	Turbine Group (n=39) n (%)	Comparison Group (n=158) n (%)
Sex		
Male	16 (41)	63 (41)
Female	23 (59)	91 (58)
Age group, years		
18 – 20	1 (2.6)	2 (1.2)
21 – 30	1 (2.6)	1 (0.5)
31 – 40	5 (12.8)	22 (13.9)
41 – 50	10 (25.6)	53 (33.5)
51 – 60	11 (28.2)	44 (27.8)
61 – 70	7 (17.9)	27 (17.1)
71+ –	3 (7.7)	9 (5.6)
Education (completed)		
High School	11 (28.2)	55 (34.8)
Polytechnic	11 (28.2)	48 (30.3)
University	17 (43.6)	54 (34.2)
Employment status		
Full time	21 (53.8)	83 (52.5)
Part time	0 (0)	3 (1.8)
Unpaid work	1 (2.6)	3 (1.8)
Unemployed	6 (15.3)	27 (17.1)
Retired	10 (25.6)	40 (25.3)
Noise sensitivity		
None	13 (33.3)	60 (37.9)
Moderate	21 (55.3)	76 (48.1)
Severe	5 (12.8)	20 (12.7)
Current illness		
Yes	10 (27)	50 (31.6)
No	27 (69.2)	104 (65.8)

Table 2 Pearson product-moment correlation coefficients (r) for noise-related and HRQOL variables. Statistics to the right of the major diagonal are for the Comparison group, while those to the left are for the Turbine group

					Health-Related Quality of Life				
	Sensitivity	Annoyance	Sleep	Health	Physical	Psychological	Social	Environment	Overall
Sensitivity	1	0.134	-0.017	0.082	-0.017	-0.069	0.006	-0.066	-0.109
Annoyance	0.440**	1	.042	0.258**	-0.209*	-0.135	-0.155*	-0.319**	-0.097
Sleep	-0.433**	-0.147	1	0.337**	0.378**	0.489**	0.327**	0.279**	0.198*
Health	-0.234	-0.308	0.471**	1	0.706**	0.493**	0.158*	0.284**	0.327**
Physical§	-0.24	-0.212	0.364*	0.524**	1	0.655**	0.29**	0.455**	0.475**
Psychological	-0.404*	-0.113	0.473**	0.329*	0.268	1	0.55**	0.606**	0.589**
Social	-0.359*	-0.236	0.116	-0.021	0.036	0.212	1	0.456**	0.457**
Environment	-0.235	0.028	0.404**	0.2	0.474*	0.468*	-0.17	1	0.546**
Overall	-0.203	0.16	0.471**	0.289	0.282	0.286	-0.162	0.380*	1

$p < .05$

** $p < .001$*

§ Item 16 (satisfaction with sleep) was removed from the Physical HRQOL domain when correlated with sleep satisfaction.

Table 2 displays correlation coefficients (Pearson's *r*) between noise-related and health-related variables for both groups. Of remark is the negative correlation between annoyance and self-rated health for both groups, and a different pattern of correlations between noise sensitivity and annoyance across the two groups. Separate ANCOVA's revealed differences and similarities between the two areas in terms of HRQOL (see Table 3). Firstly, the Turbine group reported a lower ($F(1,194) = 5.816$, $p = .017$) mean physical HRQOL domain score than the Comparison group. Scrutiny of the seven facets of the physical domain showed a difference in perceived sleep quality between the two areas ($t(195) = 3.089$, $p = .006$), and between self-reported energy levels ($t(195) = 2.217$, $p = .028$). Secondly, the Turbine group had lower ($F(1,194) = 5.694$, $p = .018$) environmental HRQOL scores than the Comparison group. This domain is the sum of eight items, and further analysis of these revealed that the turbine group considered their environment to be less healthy ($t(195) = 3.272$, $p < .007$) and were less satisfied with the conditions of their living space ($t(195) = 2.176$, $p = .031$). Thirdly, there were no statistical differences in social ($F(1,194) = 0.002$, $p = .963$) or psychological ($F(1,194) = 3.334$, $p = .069$) HRQOL, although the latter was marginal and the mean for the Turbine group was lower. Of the two generic WHOQOL-BREF items, the mean of the self-rated general health item was equivalent between Turbine and Comparison groups ($t(195) = 0.374$, $p = .709$), while the mean ratings for an overall quality of life item was lower ($t(195) = 2.364$, $p = .019$) in the Turbine group.

Table 3 Mean (M) and Standard Deviation (SD) statistics for the four HRQOL domains of the WHOQOL-BREF and Amenity total scores, presented for both the Comparison group and the Turbine group

	Turbine Group		*Comparison Group*	
Measure	*M*	*SD*	*M*	*SD*
Physical	27.38	3.14	29.14	3.89
Psychological	22.36	2.67	23.29	2.91
Social	12.53	1.83	12.54	2.13
Environmental	29.92	3.76	32.76	4.41
Amenity	7.46	1.42	8.91	2.64

The Turbine group reported lower amenity than the Comparison group ($F(1,194) = 18.88$, $p < .001$). There were no differences between groups for traffic ($t(195) = 0.568$, $p = .154$) or neighbourhood ($t(195) = 1.458$, $p = .144$) noise annoyance. A comparison between ratings of turbine noise was not possible, but the mean annoyance rating for Turbine group individuals who specifically identified wind turbine noise as annoying was 4.59 (SD = 0.65), indicating that the turbine noise was perceived as extremely annoying. For the Comparison group, seven 'other' annoying noises were identified: barking dogs (x2), farm machinery (x2), and racing cars (x3).

Discussion

Those residing in the immediate vicinity of wind turbines scored worse than a matched comparison group in terms of physical and environmental HRQOL, and HRQOL in general. The high incidence of annoyance from turbine noise in the Turbine group is consistent with the theory that exposure to turbine noise is the cause of these differences. Importantly, we also found a reduction in sleep satisfaction ratings, suggesting that both annoyance and sleep disruption may mediate the relationship between noise and HRQOL. These findings are consistent with those reported in relation to aviation noise [22] and traffic noise.[10, 11]

Of further interest are the likely mechanisms involved in the degradation of HRQOL when exposed to turbine noise. Studies show that the level of turbine noise is a poor predictor of human response, and dose-response relationships typically explain little of the association between turbine noise and annoyance.[23] Pedersen et al.[4, 23] and van den Berg et al.[15] show that for equivalent noise levels, people judge wind turbine noise to be of greater annoyance than aircraft, road traffic, or railway noise. This may be due to the unique characteristics of turbine noise, that is, clusters of turbines present a cumulative effect characterized by a dynamic or modulating sound as turbines synchronise. The characteristic swishing or thumping noise associated with larger turbines [19] is audible over long distances, 2 to 3 kilometres and beyond in some reports.[1]

van den Berg [15] showed that sound is the most annoying aspect of wind turbines, and is more of a problem at night. A large proportion (23/39) of respondents from the Turbine group identified turbine noise as a problem and rated it to be extremely annoying. It should be noted that, in contemporary medicine, annoyance exists as a precise technical term describing a mental state characterised by distress and aversion, which if maintained, can lead to a deterioration of health and wellbeing.[24] A Swedish study [23] reported that, for respondents who were annoyed by wind turbine noise, feelings of resignation, violation, strain, and fatigue were statistically greater than for respondents not annoyed by turbine noise. We also observed lower sleep satisfaction in the Turbine group than in the Comparison group, a finding which is consistent with previous research showing more sleep disturbances. [2, 4, 15]

Wind turbines were associated with degraded amenity. This is consistent with previous research showing that wind turbine noise was judged incongruent with the natural soundscape of the area.[23] Amenity values are based upon what people feel about an area, its pleasantness, or some other value that makes it a desirable place to live. There is an expectation of "peace and quiet" when living in a rural area, and most choose to live in rural areas for this reason. [1, 25] Furthermore, those who live in rural areas have different expectations about community noise than those living elsewhere.[4] Other studies [26, 27] report that wind turbines are viewed as eyesores and visual spoilers of the environment, and from an aesthetic perspective, those who

view the wind turbines as ugly are likely to disassociate them from the landscape and react more strongly to turbine noise.

Strengths and limitations

A strength of this study is the masking of the primary intent of the questionnaire by giving the impression that general neighbourhood factors (e.g., street lighting, rubbish collection), and not wind turbine exposure, constituted the study's core aims. Concealing the study's objectives should reduce response bias, and our placing of the HRQOL items at the beginning of the survey, well before the three items probing noise annoyance, would serve to elicit subjective ratings of HRQOL without first being primed with potentially upsetting noise items. The main limitation of the study is the size of the sample. While the response rate compares favourably to other wind turbine research reported in the literature,[15] the sparsely populated locations of wind turbine farms in rural New Zealand presents a recruitment challenge. A larger sample of residents exposed to wind turbines would have afforded more analytical options. However, that the effects were found with such a modest sample size is indicative of genuine differences between the two groups.

Assessing health using HRQOL rather than objective metrics such as blood pressure has it advantages and disadvantages, though the merits of the HRQOL approach have been noted by others researching air pollution.[28] While blood pressure and heart attacks are well defined and easily measured, sleep disturbance, fatigue, annoyance and similar subjective symptoms are less easily measured and distinguished from the background levels present in the population, and furthermore, may change only after decades of exposure .[7]

Conclusions

A thorough investigation of wind turbine noise and its effects on health is important given the prevalence of exposed individuals, a non-trivial number that is increasing with the popularity of wind energy. For example, in the Netherlands it is reported that 440,000 inhabitants (2.5% of the population) are exposed to significant levels of wind turbine noise.[29] Additionally, policy makers are demanding more information on the possible link between wind turbines and health in order to inform setback distances. Our results suggest that utility-scale wind energy generation is not without adverse health impacts on nearby residents. Thus, nations undertaking large-scale deployment of wind turbines need to consider the impact of noise on the HRQOL of exposed individuals. Along with others,[30] we conclude that night-time wind turbine noise limits should be set conservatively to minimise harm, and, on the basis of our data, suggest that setback distances needs to be greater than two kilometres.

Acknowledgements

We wish to thank Dr Robert Thorne for his insightful comments and the provision of information that guided both design and analysis. Chris Hanning reviewed this paper.

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NOISE RADIATION FROM WIND TURBINES INSTALLED NEAR HOMES: EFFECTS ON HEALTH

With an annotated review of the research and related issues

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February 2007 v.1
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Contents

Note: This paper limits its discussion to wind turbines taller than 50m or from 0.75MW up to 2MW installed capacity.

Section 1.0 ABSTRACT

Wind turbines are large industrial structures that create obtrusive environmental noise pollution when built too close to dwellings. This annotated review of evidence and research by experts considers the impact of industrial-scale wind turbines suffered by those living nearby. First, the paper includes the comments by some of the families affected by wind turbines, as well as coverage in news media internationally. The experiences described put a human face to the science of acoustics.

Second, the paper reviews research articles within the field of acoustics concerning the acoustic properties of wind turbines and noise. The acoustic characteristics of wind turbines are complex and in combination produce acoustic radiation. Next, the paper reviews the health effects that may result from the acoustic radiation caused by wind turbines, as well as the health effects from noise, because the symptoms parallel one another. Primarily, the consequent health response includes sleep deprivation and the problems that ensue as a result. In addition, this paper reviews articles that report research about the body's response not only to the audible noise, but also to the inaudible components of noise that can adversely affect the body's physiology. Research points to a causal link between unwanted sound and sleep deprivation and stress, i.e., whole body physiologic responses.

These injuries are considered in the context of Human Rights, where it is contended that the environmental noise pollution destroys a person's effective enjoyment of right to respect for home and private life, a violation of Article 8 of the European Court of Human Rights Act. Furthermore, the paper considers the consequent devaluation of a dwelling as a measure of part of the damage that arises when wind turbines are sited too close to a dwelling, causing acoustic radiation and consequent adverse health responses.

The review concludes that a safe buffer zone of at least 2km should exist between family dwellings and industrial wind turbines of up to 2MW installed capacity, with greater separation for a wind turbine greater than 2MW installed capacity.

Section 2.0 INTRODUCTION

1 Industrial wind turbines produce an intermittent flow of electricity but in the process also produce undesirable noise emissions when installed too close to people's homes, causing environmental noise pollution. (See Section 6.5 of this paper.)

2 Wind turbines located at a sensible distance from dwellings are unlikely to cause environmental noise pollution and health problems. When the State allows priority to commercial interests, the reasonable needs of families and their human rights are extinguished. There are questions of human rights and of industrial and governmental ethics when developers construct wind turbines too close to dwellings, especially when Government decision makers are fully aware that there is a high probability that families may lose the right of respect for their home and private life. In such instances, both the commercial groups and the State are party to the violation.

3 This Review seeks to bring together research evidence in the professional literature that addresses the substantive nature of the problem, both from the acoustical and biomedical perspectives. However, the Review would be incomplete without Section 3, Overview of the Problems – Personal Perspectives, which includes the observations and reflections by those living near wind turbines, as well as reports in the media. The Review also considers the possible infringement of human rights when developers build wind turbines in close proximity to dwellings.

4 Precision in predicting noise levels in homes neighbouring wind turbines has so far eluded the wind industry. As early as 1987, Glegg, Baxter, and Glendinning reported on the problems with predicting noise accurately:

> *'This paper describes a broadband noise prediction scheme for wind turbines. The source mechanisms included in the method are unsteady lift noise, unsteady thickness noise, trailing edge noise and the noise from separated flow ... [In] spite of these detailed predictions of the atmospheric boundary layer the noise predictions are 10dB below the measured levels ... [The upwind] support tower cannot be ignored, since significant acoustic scattering occurs when the rotor blade is close to the tower. This can be very important subjectively and so a theoretical model has been developed which allows for the increase in radiation due to this effect.'* [Glegg SAL, Baxter SM, and Glendinning AG. The prediction of broadband noise from wind turbines. Journal of sound and vibration 1987; 118(2): 217-39, pp 217-218]

5 In a recent (2006) Report the Dti found further studies of wind turbine noise were necessary:

> *'However, the presence of aerodynamic modulation which is greater than that originally foreseen by the authors of ETSU-R-97, particularly during the night hours, can result in internal wind farm noise levels which are audible and which may provoke an adverse reaction from a listener ... To take account of periods when aerodynamic modulation is a clearly audible feature within the incident noise, it is recommended that a means to assess and apply a correction the incident noise is developed.'* [Dti Executive

Summary of the Measurement of Low Frequency Noise at Three UK Wind Farms, contract number W/45/00656/00/00, URN number 06/1412, Contractor: Hayes McKenzie Partnership Ltd, 2006.]

The report states that '*... it may be appropriate to re-visit the issue of aerodynamic modulation and a means by which it should be assessed.*' [p 65]

6 The wind energy industry and its consultants – acoustical engineers – claim that the audible and inaudible noise effects have minimal consequence on humans and that infrasound (0Hz – 20Hz, part of the low frequency noise spectrum), is inaudible and weak and therefore not a human health risk. This review has not found any epidemiological evidence to support these suppositions.

7 As more wind turbines are installed near homes, more communities are affected by these complex sounds. Noise is the human face of the science of sound, and physicians are seeing the results. More people living close to wind turbines – within 1.5km – complain of sleep deprivation, headaches, dizziness, unsteadiness, nausea, exhaustion, mood problems, and inability to concentrate.

Physicians and researchers in the UK, Portugal, Germany, the USA, Australia, and New Zealand, among others, have observed a similar constellation of symptoms.

8 Although acousticians and engineers working for the wind energy industry conclude that audible noise and low frequency noise from wind turbines are unlikely to cause health effects, experts in biomedical research have drawn different conclusions.

9 Indeed, in 2006, the French National Academy of Medicine issued a report that concludes:

'The harmful effects of sound related wind turbines are insufficiently assessed ... People living near the towers, the heights of which vary from 10 to 100 meters, sometimes complain of functional disturbances similar to those observed in syndromes of chronic sound trauma ... The sounds emitted by the blades being low frequency, which therefore travel easily and vary according to the wind, ... constitute a permanent risk for the people exposed to them ... An investigation conducted by the Ddass [Direction Departementale des Affaires Sanitaires et Sociales] in Saint-Crepin (Charent-Maritime) revealed that sound levels 1 km from an installation occasionally exceeded allowable limits.'

The report continues:

'While waiting for precise studies of the risks connected with these installations, the Academy recommend halting wind turbine construction closer than 1.5 km from residences.'
[Chouard C-H. Le retentissement du fonctionnement des eoliennes sur la sante de l'homme (Repercussions of wind turbine operations on human health). Panorama du Medecin, 20 March 2006]

10 Warning signs of future problems with new technologies have been overlooked or ignored in the past, much to the detriment of the public's health. One has only to look at the history of asbestos and mesothelioma; tobacco and lung cancer and chronic pulmonary diseases; thalidomide and birth defects; mercury and neurotoxicity; x-rays and fluoroscopes and cancer; lead-based paint and childhood poisoning; and coal miners and black lung, to name but a few. The pattern of medical problems took time to emerge before a pattern of health complaints were observed, followed by epidemiologic studies and public health policy.

11 Human health effects may take years to emerge as a pattern, when the detrimental effects are past correction. As the numbers of wind turbine installations close to people's homes increase, reports of health effects have escalated, from sites across the globe. These problems do not appear to be present where wind turbines are located at a safe distance from homes.

12 This paper brings together research evidence on the characteristics of noise radiated by wind turbines and how that noise affects human health. As this is a public health issue, this paper also presents the advice and policy recommendations of medical and epidemiological experts.

This paper also considers whether as a result of reported health problems, the noise emission components of wind turbines should be regarded as an environmental noise pollution, which is a violation of basic Human Rights.

Section 3.0 OVERVIEW OF THE PROBLEMS: Personal Perspectives

'Britain should be considerably quieter than it is ... unless something is done the situation will soon become intolerable.' **[The *Times*, London, 3 July 1963]**

1 This section of the paper, perhaps more than any other, illustrates that noise is the human face of the science of acoustics. This section presents that essential – but often ignored – side of the equation: the voices of those directly affected by the construction of wind turbines near their homes.

2 In 1966, Dr Alan Bell observed that noise is much more than an occupational hazard:

> *'Noise is a sensory input, devoid of information, that nevertheless demands attention ... it is a public nuisance and a danger to mental and physical health ... The degree of annoyance is not necessarily directly related to the intensity of the sound ... The factors influencing community responses included lack of sleep ... The results of past lack of forethought are aggravated by situations still developing that will certainly create noise problems in years to come ... Even rural peace is often shattered.'* [Bell, A. Noise: an occupational hazard and public nuisance. Geneva: World Health Organization, 1966.]

3 Both the European and British Wind Energy Associations, in their Best Practice Guidelines, state that:

> ***'Wind turbines should not be located so close to domestic dwellings that they unreasonably affect the amenity of such properties through noise, shadow flicker, visual dominance or reflected light.'***

4 But these are only industry guidelines. Planning Policy Statement 22, section 22, says that:

> *'Renewable technologies may generate small increases in noise levels (whether from machinery such as aerodynamic noise from wind turbines, or from associated sources – for example, traffic).*
>
> ***Local planning authorities should ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels.***
>
> *Plans may include criteria that set out the minimum separation distances between different types of renewable energy projects and existing developments. The 1997 report by ETSU* [ETSU-R-97, The assessment and rating of noise from wind farms] *for the Dti should be used to assess and rate noise from wind energy development.'*

5 This guidance is scrupulously followed by wind turbine developers and Planning decision makers. Section 4.0 of this paper, Acoustics, addresses the limitations of ETSU-R-97; yet it is interesting to note here that the standards in ETSU-R-97 appear to provide less protection to people than the standards of the World Health Organisation *Guidelines for Community Noise 1999.*

6 ETSU-R-97 and subsequent policies based on that document fail to protect families living near wind turbines, as the following illustrates:

For a fortnight beginning 12 January 2004, complainants and witnesses gave evidence about their experiences living near the Askam, Cumbria, UK, wind turbines. These wind turbines are rather modest compared to the larger turbines of today: seven wind turbines, each 62.5m high.

Prior to the construction, the developers had assured the community that wind turbines near their homes would not create noise or visual disturbances. Background noise prior to the wind farm was as low as 16.5 dB, with a nighttime average of about 19 dB. The readings are now regularly in the middle to high 40's dB.

> *'Eventually the developers admitted everything that we had claimed – but still nothing has been done to resolve these problems to the satisfaction of those people who matter.'* [Brierley D., *Public Presentation,* Askam, Cumbria, 2006]

7 On seeking assistance from the local Council, the Askam residents were then informed that *'because of the court case of* ***Gillingham v Medway Council****, the classification of the area had changed with the passing of the planning permission'*. That is, the area where the wind turbines were built had been reclassified as a mixed rural/industrial area; local residents were unaware of this reclassification.

Consequently, their expectations of noise levels were considered *'unrealistically high'* for an industrialised area, according to the local authority. [Brierley, 2006]

8 Indeed, when the Askam residents brought a case against the developer PowerGen (E.oN), the judge eventually ruled against the residents, saying that ***"audibility and annoyance are not to be equated with nuisance."*** [Brierley D., *Public Presentation,* Askam, Cumbria, 2006]

9 The following are excerpts of statements of only a few who have lived near wind turbine installations. Some of these families have consequently moved home because they felt it impossible to enjoy a normal family life by remaining.

It is important to remember that some of these statements were written or presented several years after living with the daily, or nearly daily, intrusions of noise and/or shadow flicker / strobing caused by wind turbines.

Please note: In respect for the residents' confidentiality, the authors are identifying the families by number rather than by name.

10 *'Everything changed ... when the wind turbines arrived ...approximately 700 metres away from our property ... At this point we had no idea how this development (windfarm) was to effect [sic] our quality of life and cause so much pain and suffering. Within days of the windfarm coming into operation we began to hear a terrible noise, but didn't know, at first, where it was coming from. As it continued we eventually realised the noise originated from the windfarm. We were horrified. Were we the only ones suffering this noise?*

Would this continue for the proposed length of time the windfarm would be there i.e. for the next 20 years? The noise drove us mad. Gave us headaches. Kept us awake at night. Prevented us from having windows and doors open in hot weather, and was extremely disturbing.'
Member of Family 01

Some time after the wind turbines began operation, this resident learned that other people were experiencing the same problems; they attempted to voice their concerns and their distress:

'From that day, until the present, despite telephone calls, letters to, (and liaison meetings with), the owner, the operators, representatives of the Parish Council, the District Council, the local Planning Committee, the Environmental Health Department and our member of Parliament ... nothing has been resolved.'

11 On one occasion, several of the wind turbines were switched off on the morning of one bank holiday, to give this family some relief (this is 4 years on ...), but by evening, the turbines were operational, and the noise returned. This resident's statement continues with an anecdote: one of the wind turbine operators who lived several kilometres from the site said

'... quite openly, that he walked his dog on the foreshore ... and had identified noise from the wind turbines ...over 4 kilometres away from the site.'

Occasionally the family would request that one or more turbines could be switched off so that they could spend time in their garden, but:

'I found it beyond belief that after almost 4 years we still had to ask for time to work in our own garden and even then to be restricted to 4-5 hours.'
Member of Family 01

12 Other witnesses said that even without a view of the turbines, there is an audible impact:

'I cannot come to terms with the thought of this situation continuing for another 15 years. From our property we cannot see any of the turbines, but we can certainly hear them.' **Member of Family 02**

'They were noisy immediately, blades "whooshing" around ... if the wind is from the East, or the South, the noise is horrendous. You can't get away from the noise, where can you go? It's all around outside and you get it inside the house as well. It's worst during the night, I have to "bed hop" to get any sleep ... but it doesn't work ... This noise is like a washing machine that's gone wrong. It's whooshing, drumming, constant drumming, noise. It is agitating. It is frustrating. It is annoying. It wears you down. You can't sleep at night and you can't concentrate during the day ... It just goes on and on ... It's torture ... [4 years later] *You just don't get a full night's sleep and when you drop off it is always disturbed and only like "cat napping". You then get up, tired, agitated and depressed and it makes you short-tempered ... Our lives are hell.'* **Member of Family 03**

13 One resident near the wind farm, a mechanical engineer and his family, accepted the developer's assurance that the turbines would not be a noise nuisance. However, when the wind turbines became operational, they began to experience problems with noise. Following this, they then discovered that other families had similar problems. The developer denied that any problem existed:

> *'The wind farm was described as "inaudible", which clearly wasn't true. They also denied the existence of upwind noise, a fact they later retracted and admitted did exist ... at one of these meetings Mr ---, of ---, said ... that his company was not prepared to take any action to reduce or eliminate'* the phenomenon of shadow flicker. *'Throughout the negotiations with the developer's side, it has been disappointing to encounter the amount of "stonewalling" and intimidation, which culminated in the threat of legal action against us, when our sole intention was to remedy the problems inflicted on us by the presence of the wind farm, which caused the various nuisances.'* **Member of Family 04**

14 Another family living near the wind turbines, who had also been reassured by the developer prior to the installation that noise would not be a nuisance, did indeed experience a 'noise nuisance' when the turbines became operational. At a meeting, a representative of the developer, when asked about the problems with noise, especially after assurances that noise would not be a problem at this site, responded:

> *'... no wind farm was "inaudible". I suggested that any further correspondence publicising wind farms in general should, in future, be correctly worded and not mislead the general public in this way ... everything we were complaining about was being aggressively fought against by the developers ... My personal feeling is that the residents have been let down by all the parties involved, but specifically by the Environmental Health Department's apparent inability to resolve what is a genuine and distressing sequence of noise nuisances that have gone on now for over 4 years.'* **Member of Family 05**

15 Yet another resident living near the wind turbines, although not visible from his home, found the noise from the turbines disturbing, especially when the wind prevails from the East, which is frequent:

> *'It was like the Chinese water torture, it was constant pulsating noise. I also had to move bedrooms on occasions in an attempt to escape the noise. It's a feeling as much as a noise ... It's an irritating and tiring noise, especially when you have not had any sleep because of it.'* **Member of Family 06**

16 The litany continues: One resident, with many years work experience of oil and gas exploration, development, and production, including work as a consultant internationally, questioned the wisdom of installing wind turbines near homes. It was not the technology to which he objected. However, he felt reassured by the developer that the wind turbines would not create a nuisance, and that the developer would safeguard their 'continuing quality of life':

> *'It is not necessarily the noise level per se, but the nature of this noise. It may not be constant. It has lasted some 10 – 12 days without respite, with varying intensity such that even when not present you are waiting for it to re-occur.*

The most apt description is that it is an audio version of the Chinese Water Torture. The noise is such that the noise is felt as much as heard ... Developers have been informed ... that this noise is making people ill, although I have no experience of this. This, I believe, may be attributable to the low frequency element of noise created by the wind farm. This phenomenon is documented in a report published by DEFRA, where wind farms are confirmed as a source of low frequency noise.'
Member of Family 07

This particular resident was 'appalled' when the signatory of the developer's letter assuring the community that the wind turbines, when operational, would not create a noise nuisance, later admitted to him privately, that:

'There is noise with all wind farms. It is to be expected and you have to live with it.'

'This confirmed my worst fears that the residents had been misled ...'

17 Apparently, the developer eventually provided attempts at noise mitigation:

'This, I believe, is an admission that noise problems exist ... the developers want to dictate the times of day, duration and location of the residencies [sic] that will and will not be affected by noise emanating from their wind farm. This is entirely contrary to the [developer's] letter and the BWEA and EWEA guidelines ... It is also contrary to the EHO's mission statement as publicly depicted on their web site.' **Member of Family 07**

18 And from a farming family:

'The noise is a big "Whooshing" noise ... I hear it inside my home ... If I sit in the garden it's there, not always as it depends really on the wind direction and if the wind is from the west side of my property it is worse ... I am not against wind energy, but these are definitely in the wrong place. If only someone had come and looked at it or even if they came today, they would realise what I am trying to say.' **Member of Family 08**

19 One family has since moved away; their home was 680m from the nearest wind turbine.

Another family that has since moved away lived 700m from the nearest wind turbine.

Another family is moving away; they live 800m from the nearest turbine.

Of the other witnesses, distances from the nearest turbines range from 600m to 1000m. One resident, who lives 390 m away, sleeps with the radio on, but this person declined to testify.

20 In a paper known as "The Darmstadt Manifesto", published in September 1998 by the German Academic Initiative Group, and endorsed by more than 100 university professors in Germany, the German experience with wind turbines is described in graphic terms:

'More and more people are describing their lives as unbearable when they are directly exposed to the acoustic and optical effects of wind farms. There are reports of people being signed off sick and unfit for work, there is a growing number of complaints about symptoms such as pulse irregularities and states of anxiety, which are known to be from the effects of infrasound [sound frequencies below the normal audible limit].'

21 In Bradworthy, North Devon, UK, noise complaints lodged to the local environmental health officer after three wind turbines – each 85m high – became operational in 2005, are still unresolved. One resident, who lives as near as 533m to these three turbines, endures

'strobe or shadow flicker entering my Kitchen, Conservatory and Sitting room, all on the East side, when the sun rises in the east, in Autumn and Winter behind the wind turbines. This will last for three months and is NOT ACCEPTABLE ... The prolonged flicker causes a headache, affects my eyes and causes disorientation.'

This resident has observed and described the noise at various times of day, in all weather conditions, and rarely is there a lull in the noise, which is characterised, depending upon the strength and direction of the wind, as swooshing, swishing, whining, a constant aeroplane drone, a police siren, and like a spin dryer.

'That shadow flicker would cause problems was denied 3 times in the planning appeal book.' [MH, Bradworthy]

Yet, the developer's Planning Appeal stated:

'Shadow Flicker. As previously stated, this is not considered an issue due to the distance and orientation of the turbines to the nearest dwelling.'

Instead, this property owner explains that the shadow flicker *'actually reaches past my property and over a public highway ... 500 metres away is too close.'* [MH, Bradworthy]

22 In a letter to the *Western Morning News*, 16 October 2001, Patrick and Phoebe Lockett, of Wadebridge, Cornwall, UK, wrote:

'We live near the Bears Down windfarm in North Cornwall, where there are 16 turbines between 750 and 1400 metres from our home, and we are subjected to intrusive noise. When the wind direction is south to south-westerly, there is a rhythmic thumping sound which disturbs us and our neighbours, in our homes and gardens, day and night.

We are writing to residents in the areas of North Devon where there are proposed wind farm developments, advising them not to take reassurances from developers at face value.

I quote from a letter we received in October 1998 from National Wind Power's head of operations and technology, John Warren:

"We are 100 per cent confident that there will be no noise problem at any nearby residence."

NWP say that they do not know why the turbines are making this noise. They are monitoring it and tell us they will try some experimental adjustments to the turbine blades. Our only hope is that NWP's investigations will provide a solution to the distressing situation in which we and our neighbours find ourselves.'

23 Two years later, in a letter to the Western Morning News on 15 November 2003, Phoebe Lockett wrote:

'We are still experiencing noise problems with the turbines on Bears Down.'

24 *The Courier-Mail* (Queensland, Australia) reported on 4 October 2005, that a Queensland government-owned wind farm, which began operating in 2000, was creating sleep disturbances and noise problems at nearby properties. Jim and Dot Newman said:

'... the throbbing, thumping noise from the generators could be heard at all hours of the day. It was very frustrating in the beginning and makes us extremely upset, but there is nothing we can do about it.'

After a year, the couple decided to move, but could not find a buyer for their property. The newspaper reported that:

'A number of Victorian residents know exactly how the Newmans feel and are equally angry at Stanwell Corporation.'

Stanwell had assured residents that they would not be disturbed by the turbines.

With two 60m towers standing 750m and 810m from their homes, Keith and Terry Hurst said:

'It was terrible, we had real trouble sleeping and the worst part was we decided to move and it took 18 months to sell the place.' In a 'booming' property market, they lost money selling their house. One real estate agent said that 'it was nearly impossible to sell a property within one kilometre of a wind turbine or a proposed wind turbine.'

25 Stanwell's spokesperson said that:

'... independent experts and noise level monitoring had verified the Toora Wind Farm [as] fully compliant with its operating permit conditions.' (Gregg N. Wind energy not resident-friendly. The Courier-Mail, Queensland, Australia, 4 October 2005.)

26 A common thread runs through these observations by those who live near wind turbines: It is not necessarily only the loudness of the noise; it is also the character of the noise that is disturbing. The wind turbine noise is periodic; intermittent; 'whooshing' or 'swishing'; it interferes with outdoor activities at one's home and with sleep or studying, i.e., it severely disrupts normal family life.

As one of those living near the wind farm in Askam observed:

> ***'You think "Oh it's stopped" – then it starts up again.'***
> (Member of Family 09)

27 In New Zealand, a man may be forced from his home because noise from wind turbines will make his house 'uninhabitable'. After 20 years, it is understandable he is reluctant to leave. However, the nearest of the planned twelve turbines is only 500m from his boundary, and the decibel levels will exceed those allowable, according to the state-owned power company's representatives.

28 In 2005, a family living near the Te Apiti wind farm in New Zealand, had to move house because noise and vibration *'made it impossible for them to stay'*. [http://stuff.co.nz : *Turitea man fears he'll have to go.* 10 November 2006]

Indeed, those living near the Te Apiti wind turbines have first-hand experience with those problems:

> *'... in an easterly there is an intrusive rumble for days on end. They say the windmills emitted a low frequency noise for three days on end, making their lives a living hell.'*

At another time,

> *"... the rumbling was so bad it sounded like one of those street cleaning machines was driving up and down near the house. In fact it sounded like it was going to come through the house,"* said Wendy Brock.

29 According to Meridian, the developer:

> ***'... it's a small number of people making a big noise about nothing.'***

And another Meridian spokesperson, Alan Seay, said that:

> ***'... the monitoring has shown quite clearly they were well within the guidelines.'***
> [Flurry of complaints after wind change. TV1 News, New Zealand, 25 July 2005, http://tvnz.co.nz/view/page/411749/599657]

30 In Nova Scotia, Canada, one family and one wind farm developer have drawn different conclusions from similar noise readings at the family's home. Although the family insists that the noise from the 17 wind turbines – the closest is 400m from their home – has affected their well-being, the developer does not acknowledge any deleterious effects on the family. [Keller J. Nova Scotians flee home, blame vibrations from 17 turbines for loss of sleep, headaches. Canadian Press, 13 November 2006, http://thestar.com]

The d'Entremont family complained of noise and low frequency vibrations in their house after the wind turbines began operation in May 2005. The inaudible noise deprived his family of sleep, gave his children and wife headaches, and *'made it impossible for them to concentrate'*. They now live nearby; if they return to their home, the symptoms return.

31 *'But a study released this month by the federal natural resources department, which oversees funding for wind farm projects, found no problems with low-frequency noise, also known as infrasound.'*

The government report concludes that the measurements:

'indicate sound at infrasonic frequencies below typical thresholds of perception; infrasound is not an issue'.

The developer says he was not surprised by the report's findings:

'It essentially says that there's no issue whatsoever with infrasound.'

32 D'Etremont hired his own consultant to record the noise levels at his home:

'Gordon Whitehead, a retired audiologist with twenty years of experience at Dalhousie University in Halifax conducted tests.'

Whitehead's data was similar to that of the government's report. However, as a health professional, Whitehead reaches a different conclusion:

'They're viewing it from the standpoint of an engineer; I'm viewing it from the standpoint of an audiologist who works with ears ... The report should read that (the sound) is well below the auditory threshold for perception. ***In other words, it's quiet enough that people would not be able to hear it. But that doesn't mean that people would not be able to perceive it.'***

Whitehead explains that

'... low-frequency noise can affect the balance system of the ear, leading to a range of symptoms including nausea, dizziness and vision problems. It's not perceptible to the ear but it is perceptible. It's perceptible to people with very sensitive balance mechanisms and that's generally people who get very easily seasick.'

33 The developer has acknowledged that some questions remain:

'From our perspective, I think it's really up to the scientific community to really address and research such issues (as low-frequency noise) ... I know there is research that points to different directions.' [Keller J. Nova Scotians flee home, blame vibrations from 17 turbines for loss of sleep, headaches. Canadian Press, 13 November 2006, http://thestar.com]

34 In a newspaper article describing the d'Etremonts' situation and the wind power company's position, Michael Sharpe, a Dalhousie University audiologist, said that:

'Even if someone isn't affected directly by low-frequency noise, the constant swoosh of the blades, even at allowable levels, can have psychological effects.

"If the sound is audible and it annoys you, then it can seem louder," says Sharpe who compares it to a dripping tap that can keep someone awake at night.

"As your stress level increases, your awareness of the annoying sound increases as well. As we know, elevated stress levels for a prolonged period of time can have a negative health effect."' [Keller J. Turbines stir up debate. *The Chronicle Herald*, Halifax, Nova Scotia 21 May 2006.]

35 The d'Etremonts are unable to sell their home because of the wind farm. [Keller J. Nova Scotians flee home, blame vibrations from 17 turbines for loss of sleep, headaches. *Canadian Press*, 13 November 2006 http://thestar.com]

36 Dr Robert Larivee, a Professor of Chemistry who lives 3000m east of twenty wind turbines – commissioned in 2003 – in Meyersdale, Somerset County, Pennsylvania, USA, wrote to his County Commissioners (2005) after an acoustician measured noise at his property that rose to 75 dB.

'These levels are much higher than those predicted by the company. There are a number of reasons that may contribute to this. Probably the most significant factor is the topology of the area. Our area has many mountains and valleys ...'

Dr Larivee quotes the US Environmental Protection Agency, which says that

'noise levels above 45 dB(A) disturbs sleep and most people cannot sleep above the noise level of 70 dB(A). Emotional upset, irritability and other tensions, may also arise. Noise contributes to ailments like indigestion, ulcers, heartburn and gastrointestinal malfunction in the body.' [Letter from Dr Robert Larivee, Meyersdale, Pennsylvania, USA, to the County Commissioners http://www.pbase.com/wp/image/39285457]

37 Another resident of Meyersdale, who lives less than one mile from the twenty wind turbines, wrote a lengthy letter on 7 March 2006 to 'Interested Parties'. Karen Ervin felt she had to *'share the realities and impacts'* of living near a wind turbine facility. She calls her situation the **"Human Experimental Factor"**, as the community deals with *'the multiple nuisances and issues'* affecting her family, her neighbours, and local adjacent property owners during the two years the wind turbines have been operating:

'Prior to the building of the facility, our neighbors and we were never made aware of the nuisances that occur with a wind turbine facility. The noises emitted from the turbines have definitely changed our style of living. The noises produced from the blades turning on the turbines create a 'threshing' sound within and around our home as well as the adjacent properties ...'

'At times it is difficult to fall asleep with the "pounding" of the turbines. One is often awakened by the 'droning' noise of the turbines, finding it most difficult to fall back asleep. The noise becomes so disruptive; one can concentrate on nothing else but the constant droning. During the winter months, the noise is quite unbearable at times, sounding like drums beating constantly in the background. During the summer months, we cannot have our windows open ...'

'Advocates for these facilities will often compare this "threshing" noise to the "peaceful" sound of waves beating against the rocks at the seashore; but I

have been to the seashore and it certainly is in no way comparable to the "calming sound" of waves.'

Noise is not the only problem: flicker and 'strobing' are also nuisances. Ms Ervin concludes her letter with this observation:

'This industry without stringent regulations can be truly labelled a "Pandora's Box". Be careful for what is opened, and be prepared for the negative impacts that have occurred and continue to occur with this industry.' [Letter, Karen Ervin, Meyersdale, Pennsylvania, USA, 7 March 2006, www.pbase.com/wp/image/39285457]

38 Yet another resident living near the Meyersdale wind turbine facility, Mr Rodger Hutzell, Jr, and his family experienced

'... noise nuisance issues, specifically when trying to go to sleep at night. The noises are greater during the winter months. The noise appears to correlate to a continual droning sound. When awakened at night, there are times that is impossible [sic] to get back to sleep due to the threshing sounds produced by the wind turbines.' [Letter, Rodger A Hutzell, Jr, Meyersdale, Pennsylvania USA, 13 February 2005, www.pbase.com/wp/image/39285457]

39 In Mackinaw City, Michigan, USA, wind turbines rise 325 feet high, visible from nearby homes. Kelly Alexander's home is ¼ mile away from the nearest turbine. Initially Mr Alexander was in favour of the turbines, especially after the developer's assurances that the wind turbines would not be noisy. Flicker is also a problem, but this was never mentioned by the developer to Mr Alexander or the community.

Once the turbines became operational, Alexander heard

'a constant humming sound inside his home when the turbines are running, whether the windows are open or not. He said the situation was unliveable and all he wants is for things to be the way they were ...'

40 **The wind energy company representative said that it *'has lived up to ordinance requirements.'***

Alexander's response was:

'Stop lying about these turbines. Tell people the truth.' [Holland *Sentinel*, 31 December 2002]

41 In September 2002, the Mackinaw *Journal* reported on these turbines. Danny Dann and Kelly Alexander said that the turbines *'were exceeding a 60-decibel noise limit'*, and that ten other immediate neighbours were also concerned about the noise. The Mackinaw City Community Development Director said that they had sought legal advice because they did not have *'anything in our lease agreement to terminate the contract.'*

42 The owner, Bay Windpower, planned to erect at least two more wind turbines in the same area. [McManus S. Turbines still causing a problem, neighbors say. Mackinaw *Journal*, August 29 – September 26, 2002, p 3]

43 In 2004, Dr James LeFanu wrote that *'there have been some interesting comments on the substantial health problems – headaches, anxiety, sleep disturbances'* experienced by those living near wind farms:

> *'The cause seems to be the low-frequency noise generated by the incessant throb of their turbines ("like a concrete mixer in the sky"). "I like to think I know a bit about sound," writes Basil Tate, a recording engineer from Cornwall, "but it always amazes me how my wife can feel low-frequency sounds that are a long way away and be extremely distressed by them." Little wonder that some of those living close to wind farms have been forced to flee their homes.'* [LeFanu J, Dr. In sickness and in health. *Daily Telegraph* 14 March 2004]

44 Unhappily, this is not an exaggeration. Gwen Burkhardt was surprised when Dewi Jones, director of Winjen, which runs Blaen Bowi wind farm in Wales, UK, said:

> ***'There are a lot of wind farms operating in the UK and we haven't come across the complaint before.'*** ['Did turbines make you sick? Journal 18 May 2005, www.thisissouthwales.co.uk]

In her letter to the Journal [1 June 2005], Ms Burkhardt wrote that:

> *'I spoke to you and two of your employees on March 10 this year ... I explained to you in great detail about my own illness which was also brought on by the low frequency sound emitting from the very same turbines.*
>
> *It has caused me and my family a great deal of distress and has resulted in us having to move away from the area where I was born and where we have farmed for the last 27 years. Have you just forgotten our conversation? Do you simply not care? ... I do remember you sympathising with me and also telling me that you would not like to live near the turbines yourself.'* [Burkhardt G. Complaints are not new. *Journal*, 1 June 2005, www.thisissouthwales.co.uk]

45 In July 2005, Mr Murray Barber wrote to inform Energiekontor AG about the noise problems at the Forestmoor wind farm near Bradworthy, Devon, UK. His family's home, located 650m from the nearest of three turbines, is affected especially during calm days when the noise is very audible.

> *'The noise nuisance caused is irritating, distracting, stressful ... We do not understand why it is necessary for all three turbines to be driven at a high speed of rotation in absolute still air.'* [Letter from M Barber to Energiekontor AG, 12 July 2005]

In response, Energiekontor AG informed Mr Barber that:

> ***'The threshold of hearing is considerably lower than these levels, so noise from the turbines will be audible, however, at a level which is considered by the guidelines not to unduly affect amenity.'*** [Letter to M Barber from Energiekontor AG 19 July 2005]

46 In Fenner, New York, USA, when the trees are bare, Wayne Danley's wife 'flees' the living room of their house because of the flicker created by the turbine's rotating blades. Mr Danley lives 900 feet from the nearest wind turbine:

> *'It sounds like a train going through, except the train never comes through ... It's too close.'* [Neighbors complain of wind farm nuisances, The Albuquerque *Tribune,* 28 April 2006]

In response, Marion Trieste, publicist for the Alliance for Clean Energy New York, said:

> ***'There's a lot of misinformation, and a lot of inflamed discussion about negative encroachment.'*** (Neighbors complain of wind farm nuisances, The Albuquerque *Tribune* 28 April 2006)

And according to Laurie Jodziewicz, a policy specialist for the Alliance, **there are complaints about the *'strobe-light effects, but those occur only during certain months of the year and depend on the sun's angle to the turbine blades.'*** (Neighbors complain of wind farm nuisances, The Albuquerque *Tribune* 28 April 2006)

47 Given the sophistication of engineering design computer modelling, one might presume that these effects could be calculated prior to the construction of the wind turbines. However, Mr Danley had it right: the wind turbine was too close. With appropriate planning and distances between homes and wind turbines, these problems would not only be attenuated, they would cease to exist.

> *"It's not there all the time, but you're always waiting for it ... [It's] totally infuriating.'*

The thump-thump-thump 'reverberates up to 22 times a minute,' said Les Nichols, who lives beside a wind farm in Furness, UK. When seeking permission for the seven turbines, the developers *'guaranteed there would be no noise nuisance.'* (Garrett A. Ugly side of wind power. The Observer, Sunday, March 2, 2003)

48 Yet Bruce Allen, a director of Wind Prospect, the management company for the owner, PowerGen Renewables, said that:

> ***'The wind farm "had not breached its planning requirements. It's a subjective thing – like living beside a busy road." '*** (Garrett A. Ugly side of wind power. The Observer, Sunday, March 2, 2003)

Garrett's article continues:

> Giant wind turbines *'planted on your doorstep ... can transform a tranquil neighbourhood overnight into a menacing industrial site ... there are no rules about how close they can be to homes.'*
>
> *'The Welsh Affairs Select Committee recommended they shouldn't be less than 1.5 kilometres (0.93 miles) from any house, but developers generally go as close as between 500 metres (1,640 ft) and 600 metres (1,968 ft) ... '* (Garrett A. Ugly side of wind power. *The Observer*, Sunday, March 2, 2003)

49 As Phoebe Lockett, who lives near the Bears' Down wind farm in Cornwall, UK, wrote in a personal communication:

> *'There seems to be little known of what noise there may be from wind turbines and very few people who have genuine expertise in this area. The planning guidelines and studies carried out beforehand are, in my opinion, of little use.'*
>
> *'Please let me know if I can be of further assistance, as I do not like to think of others having to go through the same distress.'* [Letter, personal communication, 15 November 2003]

50 Eleven wind turbines, 121m high, have been operating in Taurbeg, Cork, Ireland, since February 2006, where residents *'are anything but happy ...'* The noise from the turbines are causing sleepless nights; one resident said the noise was like a *'plane which consistently hovers but never lands.'*

Another resident told the newspaper that *'The thought of another six going up within 500 metres of my front door is just a nightmare ... The noise from the windmills kept everybody in the area awake.'*

There were a number of complaints about the inaccuracies of the photomontages produced by the developer during the application process. Residents also suffer flicker, and one person labelled the result *'visual chaos'*.
[Herlihy M. Windmills 'are a nightmare'. The Corkman, 6 April 2006]

51 In the summer of 2006, eight wind turbines with an installed capacity of 16MW became operational at Deeping St Nicholas, Lincolnshire, UK. The noise from these turbines transformed the lives and the livelihood of the Davis family, living in a farmhouse only 907m from the nearest turbine. Jane and Julian Davis, who farm at Deeping St Nicholas and who learned of the development while reading their local newspaper, did not object to the development. They support wind energy and believe that renewable energy sources are essential to preserving the environment.

Although the Davis family cannot see the wind turbines from their home, the noise – both inside and outside their home, and which also caused vibrations within the structure of their home – has had a deleterious impact on their health and sense of well-being. Prior to the wind farm, they had no problems sleeping through the night. Now, when the wind blows from the southeast or the southwest, the noise from the acoustic radiation seriously disturbs their sleep.

> *'They have spent more than 60 nights in the last six months sleeping at friends' houses', and when home, they 'are existing on less than four hours sleep a night and sometimes a lot less.'* [Couple driven out of home by wind farm. Spalding Today (UK) 21 December 2006]

After taking its own acoustic readings, the local Council confirmed the noise problem, and it is investigating the matter further. [Davis J. Personal communication, 19 January 2007]

Local land agents have told them that their property is 'unsaleable'. Although consultants for the developer are evaluating the issue, and the Dti are investigating wind farm noise, that does not alleviate the impact on the family. [Tasker J. 'Wind farm noise is driving us out of our house.' Farmers Weekly 12 January 2007]

As the noise established itself as an ongoing problem, the Davis family learned that developers had used only predicted levels for their home without taking actual baseline measurements. Indeed, background noise most often measured below 20 dB at night (and usually in the range of 14 dB); now noise in the range of 40 dB occurs when the wind shifts to the southeast or the southwest, and on occasion, the noise has measured over 60 dB. [Personal Communication, 19 January 2007]

Quite generously under these circumstances, the Davis family continue to support wind energy but believe that wind turbines must be sited further from homes because the noise level and the impact of the noise cannot be accurately predicted. Jane Davis says that:

> *'More needs to be done if wind power is to become a viable alternative source of energy. It is a national issue and the Government ought to be doing more about this if we need lots more wind power.'* [Spalding Today (UK) 21 December 2006]

The Environmental Statement that accompanied the developer's application said that there would be no noise. [Davis J. Personal communication, 19 January 2007]

Meanwhile, Jane Davis says that she and her family are literally ***'fighting for our lives.'*** [Personal communication, 19 January 2007]

52 These are the voices and concerns of people who are despairing. However, with civic spirit, they speak out to alert others to the realities of living near wind turbines. As Bell noted in his 1966 report on noise for the World Health Organization:

> *'Anti-noise campaigns serve a useful purpose in focusing public attention on the matter; they provoke discussion and are often a stimulus to positive control measures.'*

53 According to Dr Dilys Davies, consultant clinical psychologist:

> *'Noise problems can lead to ill health'*, leaving the person *'more easily disturbed by noise in the future ... There is pressure on the heart, your breathing and whole arousal system. Your muscles tense as you wait for the noise, and if you are not careful you get used to being in that state constantly ...'* [Aitch, I. Keep It Down. Telegraph, 2 December 2006]

54 Many of those affected by wind turbine noise believe that the developers and decision-makers of the State have misled them. One explanation might be that the methodology for calculating the disturbance levels created by wind turbines at nearby homes is woefully inadequate, concentrating almost entirely on audible sound levels while dismissing other noise characters with a 'penalty in the

condition' [Planning Approval], which has produced unreliable information. The consequent release of noise pollution on people's homes produces sleep deprivation and other health injury, and the adverse effects are entirely avoidable.

There appears to be a total 'disconnect' between the experiences of those living near wind turbines and those who have a commercial interest.

55 The natural commercial instinct of developers is to maximise development potential from land, thereby leaving the minimum distance between turbines and homes. This presumes reliability and certainty in determining the physical impacts on families. However, such reliability and precision in calculating the effects does not exist, as the wind energy industry itself notes in its professional literature. (See Section 4.0, Acoustics, of this paper.)

56 It is too easy to dismiss the reports of noise disturbances and flicker effects by people living near turbines. Yet these problems emanate from many people in many countries, living in varied topographies, with one thing in common: they all live in close proximity to wind turbines.

57 It is somewhat hypocritical of public officials to decry the despoiling of the environment on a global basis, while ignoring the despoiling of the environment – including noise pollution – on a local level. At what point will officials and government agencies respond to these issues that involve the genuine – and avoidable – suffering of those living near wind farms? **At the least, further investigation into the health effects is warranted, with a minimum buffer zone of 2km between the nearest wind turbine and any dwelling.**

Section 4.0 ACOUSTICS

Acoustic Radiation experienced by people living near commercial wind turbines

1 In 2004, a small group met to consider the likely cause of adverse health effects reported by families where developers built wind turbines too close to their homes. Prof James Lovelock, retired NASA scientist and Harvard Medical School; Prof Ralph Katz, Chair, Department of Epidemiology and Health Promotion, New York University; Dr Amanda Harry, physician; and Dr David Coley, acoustician, Exeter University, decided the relationship was most likely to be an acoustic radiation of sound characters, which in combination unbalanced the natural function of the human body.

2 The reason for this is that the human ear responds not only to 'loudness', that is, sound pressure, measured in decibels – dB – with which many people are familiar, but also to sound frequency, measured in Hertz (Hz). [WHO Fact Sheet No 258, 2001]. In addition, sound affects the human body itself; even when a sound is 'inaudible' to the ear, the character of the sound may affect the body.

3 While the wind energy industry seeks to dismiss the adverse health effects reported by families living near wind turbines, there is ample evidence from medical research that noise in diverse circumstances can indeed have a negative impact on health. Noise can induce adverse physical and/or psychological symptoms. The qualities of the symptoms are similar to the complaints of those living near wind turbines. The phenomena may be produced intentionally, e.g., in a laboratory or in a specific instance, or unintentionally by the interaction of technical events, as with wind turbines.

4 Military weaponry exists that relies on low-frequency sound to disperse crowds or control crowd behaviour. [The Cutting Edge: Military Use of Sound, The Toronto Star (Canada), 6 June 2005] The effect of low-frequency noise at high intensities creates discrepancies in the brain, producing disorientation in the body:

> *'The knees buckle, the brain aches, the stomach turns. And suddenly, nobody feels like protesting anymore. The latest weapon in the Israeli army's high-tech tool kit.'*
>
> *'The intention is to disperse crowds with sound pulses that create nausea and dizziness. It has no adverse effects, unless someone is exposed to the sound for hours and hours.'* [The Toronto *Star*, 6 June 2005]

5 Hillel Pratt, a professor of neurobiology specializing in human auditory response at Israel's Technion Institute, said,

> *'It doesn't necessarily have to be a loud sound. The combination of low frequencies at high intensities, for example, can create discrepancies in the inputs to the brain.' Such technologies produce 'simulated sickness'.*
> [Pratt H. Personal communication, 14 March 2006]

In a subsequent communication, Prof Pratt explained that:

> *'... by stimulating the inner ear, which houses the auditory and vestibular (equilibrium) sensory organs with high intensity acoustic signals <u>that are</u>*

BELOW the audible frequencies (less than 20Hz), the vestibular organ can be stimulated and create a discrepancy between inputs from the visual system and somatosensory system (that report stability of the body relative to the surroundings) and the vestibular organ that will erroneously report acceleration (because of the low-frequency, inaudible sound). This will create a sensation similar to sea or motion sickness. Such cases have been reported, and a famous example is workers in a basement with a new air-conditioning system that all got sick because of inaudible low frequency noise from the new system.'
[Pratt H. Personal communication, 15 March 2006]

6 Wind turbines create these unintentional acoustic effects via the confluence of their design and operation. Noise, including low frequency noise, are long-standing issues with wind turbine design and operation. The wind turbine interacts with the topography, meteorology, spatial structure of the site, and with other wind turbines on the site. As an example of this unintentional confluence: Wind turbines produce visual flicker and strobe effects at certain times of the day, an effect similar to driving by a stand of trees when the sun is behind them. Acoustic characters and visual characters can combine and induce body 'disharmony'. Dr Bucha first identified this effect in the 1950s, after he was asked to investigate a series of unexplained helicopter crashes.

7 The pilots surviving the crashes reported feeling fine until the sudden onset of nausea and dizziness. During the episode, pilots lost control of their aircraft. Bucha found that when the blades maintained a rotational rate for sufficient time, the resulting strobe effect of sunlight closely matched human brainwave frequencies. The 'Bucha effect' is a seizure-inducing effect of light flashing in high frequency, similar to epilepsy but without being restricted to a small fraction of the population.

8 In "Present Status of Aeroelasticity of Wind Turbines", a report by Flemming Rasmussen and his colleagues at the Riso National Laboratory, Denmark, the authors observed:

> *"The term aeroelasticity is inherited from aeronautical engineering, and applying this with respect to wind turbines also makes an association to the high level of technology. From this perception the wind turbine is a helicopter. The operation of the flexible rotor in the turbulent atmospheric boundary layer is influenced by the control actions involves many of the same phenomena."* [Rasmussen F; Hartvig Hansen M; Thomsen K; Larsen TJ; Bertagnolio F; Johansen J; Aagaard Madsen H; Bak C; Melchior Hansen A. Present status of aeroelasticity of wind turbines. *Wind Energy* 2003; 6(3):213-228]

9 The military has made use of the combination of visual and acoustic characters to control behaviour. A report of the United States Air Force Institute for National Security Studies identifies and describes numerous non-lethal techniques. Among those that pertain to acoustic and/or optical effects on human physiology, several share characteristics with wind turbine noise and visual effects. [Bunker RJ, ed. Nonlethal Weapons. USAF Institute for National Security Studies, INSS Occasional Paper 15, July 1997].

'Acoustic infrasound: very low frequency sound which can travel long distances and easily penetrate most buildings and vehicles. Transmission of long wavelength sound creates biophysical effects, nausea, loss of bowels, disorientation, vomiting, potential organ damage or death may occur. Superior to ultrasound because it is 'inband', meaning it does not lose its properties when it changes mediums such as air to tissue. By 1972 an infrasound generator had been built in France, which generated waves at 7Hz. When activated it made the people in range sick for hours.'

Techniques include:

a. Bucha effect: high intensity strobe lights that flash at near human brain wave frequency causing vertigo, disorientation and vomiting.

b. Stroboscopic device: devices employed against demonstrators that use stroboscopic flashing; same principle as a discotheque strobe. In the 5 – 15Hz range, these devices can cause various physical symptoms and in a small portion of the population may trigger epileptic seizures.

c. Lag time: The physiological time lag that occurs between the time a stimulus is perceived until the body responds. In a healthy, well-rested human, this takes about three-quarters of a second.

d. Sensory overload: A temporary inability of an organism to correctly interpret and appropriately respond to stimuli because of the volume of the input.

10. Although the military examples use acoustic and visual devices that intensify physiological reactions, the noise and visual effects of wind turbines produce similar physiological reactions. Indeed, the physical complaints of those living near wind turbines share symptoms, though fortunately, not at the levels induced by the military devices. Unfortunately, those individuals living near wind turbines experience the adverse effects without remission. Additionally, military use relies upon high dosage over a short time span. Unintentional occurrence, as with wind turbines, produces a small dose over a long time-span with apparent compounding similar effects.

11. Another example of military use of LFN is called SONAR (SO(und) NA(vigation and R(anging). In *"Navy adapts sonar to protect whales"*, The Sunday Times reported on 26 March 2006, that amid evidence that navy sonar was causing whale and dolphin deaths by confusing them so that they would surface too quickly *'that they suffer fatal attacks of the 'bends'*:

'Navy warships are to be equipped with a £2.5m scanning system to spot marine mammals after post-mortem tests linked the death of beached whales to military sonar.

The use of military sonar appears to interfere with the echo-location system the animals use to navigate, leaving them so disorientated they misjudge depths and swim to the surface too quickly.

The low frequency system will operate at long range and the MOD admits it has the potential to be harmful to marine life. Liz Sandeman, co-founder of

Marine Connection, a conservation group, said, "Low frequency sonar can travel for hundreds of miles, yet the marine animal detection system will only work for two miles".'

12. Following the publication 'Noise annoyance from wind turbines – a review' [Pedersen E, August 2003], Pedersen et al published an article in August 2004, 'Living close to wind turbines – a qualitative approach to a deeper understanding'. [Pedersen E; Persson Waye K; Hallberg LRM. Proceedings of InterNoise2004, Prague, 2004]

    The authors state that:

    a. *'Informants annoyed by wind turbine noise perceived the impact of turbines as a serious intrusion of their privacy. The force of the violation experienced was partly determined by the informants' conception of the living environment as a place where audible and visual impact from wind turbines did not belong. Categories increasing or decreasing the intrusion were experiences of not being believed, being subjected to injustice, lacking influence, and being out of control.'*

    b. *'Surprisingly many respondents reported themselves as annoyed by wind turbine noise at rather low A-weighted sound pressure levels (dB), compared to other sources of community noise such as traffic noise ... One hypothesis is that wind turbine sound has special characteristics such as amplitude modulations that are easily perceived and that could lead to annoyance even at low sound pressure levels (dB). Furthermore, in earlier laboratory studies where noise from different wind turbines were compared, the most annoying noises were predominantly described by the subjects as "swishing", "lapping", and "whistling".'* [Persson Waye K and Ohrstrom E. Psycho-acoustic characters of relevance for annoyance of wind turbine noise. Journal of sound and vibration 2002; 250(1): 65-73]

    c. *'An interesting observation was that other responses due to wind turbines, such as annoyance of shadows from rotor blades, seemed to interact with the noise dose-response relationship indicating that exposure to noise from wind turbines should be studied within its context'.* [Pedersen E and Persson Waye K. Audio-visual reactions to wind turbines. Proceedings of Euronoise 2003; 5th European Conference on Noise Control, May 19-21, 2003, Naples, Italy, 2003]

    d. In describing the results of interviews with the study group living close to wind turbines, the report says that:

    'For some informants, the exposure reached further, not only intruding their home environment but also into themselves, creating a feeling of violation of them as a person. They expressed anger, uneasiness, and tiredness, disclosing being under strain, using a tense voice and sometimes crying when talking about the impact of the wind turbines.

    To be affected by the turbines to such a high degree, not being able to protect oneself from the intrusion that constantly raised negative emotions was experienced as a serious decline in well-being and life quality.'

13. In their article, 'Aeroacoustics of large wind turbines', Hubbard and Shepherd observe that buildings are affected by noise transmitted by wind turbines:

> *'The transmitted noise is affected by the mass and stiffness characteristics of the structure and its dynamic responses and the dimensions and layouts of the rooms. Minimum noise reductions occur at frequencies near 10Hz, probably because of associated major house structural resonances. This frequency range of low noise reductions unfortunately coincides generally with the frequency range of the intense rotational harmonics.* ***Noises in this low-frequency range will probably not be heard by human observers but may be observed indirectly as a result of noise induced vibrations of the building structure or furnishings.'***
> [Hubbard HH; Shepherd KP. Aeroacoustics of large wind turbines. JASA Journal of the acoustical society of America 1991 June; 89(6): 2496 – 2508, p 2505]

14. In 'Noise induced house vibrations and human perception', Hubbard's research indicates that:

    a. ***'A person inside the house can sense the impingement of noise on the external surfaces of the house by means of the following phenomena: noise transmitted through the structure ...*** *vibrations of the primary components of the building such as the floors, walls and windows; the rattling of objects ...'*

    b. Addressing the issue of 'whole body perception', Hubbard refers to the ISO Guidelines and says that a noise level outside a building between 55 – 60 dB (around 0.001 rms) in a frequency range of 0.1 HZ – 80 Hz, is the *'Most sensitive threshold of perception of vibratory motion by humans'.*
    [Hubbard HH. Noise induced house vibrations and human perception. Noise control engineering 1982; 19(2): 49 – 55]

15. In 'Do wind turbines produce significant low frequency sound levels?' [2004], GP van den Berg, observes that:

> *'Windows are usually the most sensitive elements as they move relatively easy because of the low mass per area. Perceptible vibrations of windows may occur at frequencies from 1 Hz to 10 Hz when the incoming 1/3 octave band sound pressure level is at least approaching 52 dB; at higher or lower frequencies a higher level is needed to produce perceptible vibrations. As can be seen in figures 1 –3 sound pressure levels above 60 dB at frequencies below 10 Hz occur close to a* ***turbine as well as 750 m distance and further.*** *'* [van den Berg GP. Do wind turbines produce significant low frequency sound levels? 11th International Meeting on Low Frequency Noise and Vibration and its Control, Maastricht, The Netherlands, 30 August – 1 September 2004. See also Stephens DG; Shepherd KP; Hubbard HH; Grosveld F. Guide to the evaluation of human exposure to noise from large wind turbines. NASA National Aeronautics and Space Administration, Langley Research Center, Hampton, Virginia (USA), NASA-TM-83288, March 1, 1982.] [emphasis added]

16. In 2003, the new International Standard for 'Equal Loudness Level Contours' was agreed (ISO 226:2003). In a comparative study with previous curves, Advanced Industrial Science and Technology (AIST) observed:

> *'Between the new and the previous standards, very large differences are recognised up to about 15dB (decibels) for a wide area of frequency region lower than 1KHz (1,000Hz).*
>
> ***A difference of 10dB means a 10 fold difference in sound energy and that of 15dB corresponds to a 30 fold difference (fig 1).'***

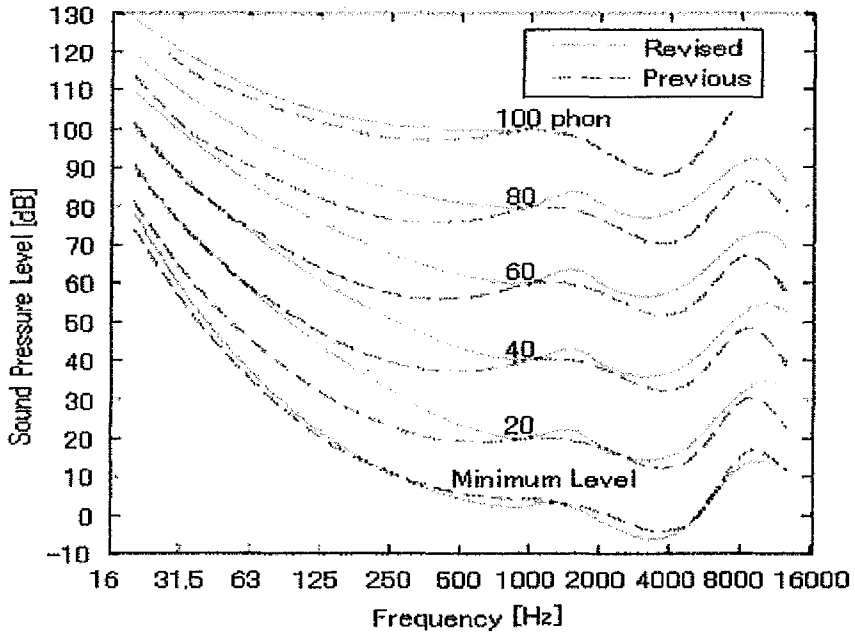


Fig. 1. Comparison between the new and the previous characteristics of equal-loudness-level contours. Remarkable differences are observed in the low frequency range.

Source: AIST. Full revision of International Standards for Equal-Loudness Level Contours (ISO 226), 2003 http://www.aist.go.jp

[Note: The threshold of hearing at about 20 Hz is circa 75dB.]

17. In a report by Dr D Manley and Dr P Styles, "Infrasound Generated by Large Sources", the authors discussed a test conducted near a wind farm in October 1994, using only vibration analysis equipment. Measurements were taken between 0.75 miles and 2 miles downwind of the wind farm at the same elevation:

> *'Wind speed was about 20 knots, and it was possible to hear turbines with a characteristic 'beat' (at about 0.8Hz) ...*
>
> *The blade rotation was usually timed at 43 rpm and therefore the main seismic wave is related to the rotational period of the three bladed machine.*
>
> *All three transducers show (from a typical frequency spectra) that there are odd numbered harmonics of the fundamental blade rotation frequency (0.8Hz, 2.4Hz and 4.0Hz being examples).*

In March 1995 experiments were repeated in eight places, in a location 0.75 miles UPWIND of the wind farm, with a 20 knot wind. The speed of turbine blades was visually measured at 43 rpm. The results clearly show a second harmonic (a higher harmonic) spaced 2.15 Hz ...
[Manley DMJP; Styles P. Infrasound generated by large sources. Proceedings of the Institute of Acoustics 1995; 17:239 – 246]

18. Wind turbines radiate noise not only above ground; they also radiate noise below ground. Following his investigations of ground vibration at the Eskdalemuir seismic monitoring facility in Scotland, Professor Peter Styles, in a summary report to the Defence Estate, made these recommendations:

    a. *To 'define an exclusion zone of 10 km within which no windfarm / turbine development is acceptable.'*

    b. *'Between 10 and 50 km the TOTAL permitted windfarm / turbine generated seismic rms amplitude should not exceed 0.25 rms measured at Eskdalemuir' [the recipient].*

    c. *'This is best illustrated with two hypothetical examples:*

        i. *'A single windfarm of 3 (no.) x 1.8 MW turbines located at 15 km from Eskdalemuir will produce a predicted rms amplitude of 0.20 nm.'*

        ii *'A single windfarm of 17 (no.) x 2.5 MW turbines located at 26 km from Eskdalemuir will produce a predicted rms amplitude of 0.11 nm.'*

    d. In the final report, Prof. Styles shows that while at a distance of 17 km from the wind farm, the amplitude might only be 3 nm/sec, **at a distance of only 1.2 km, the amplitude could be 1,800 nm/sec.** The figure indicates that the law of decay of surface seismic signals diminishes in impact with distance. [Styles (Keele University). Summary Report to Defence Estates. 3 March 2004]

19. The July 2005 Report by Prof P Styles, et al, "Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms" commented:

    "When the windfarm starts to generate at low wind speeds, considerable infrasound signals can be detected at all stations out to c 10km. Clear harmonic components which are the second multiple and up of 1.4Hz (the blade passing frequency) can be seen although interestingly and somewhat enigmatically the blade passing frequency itself is not so strongly detected". [p 66]

    "We have clearly shown that both fixed speed and variable speed wind turbines generate low frequency vibrations which are multiples of blade passing frequencies and which can be detected on seismometers buried in the ground at significant distances away from the wind farms even in the presence of significant levels of background seismic noise (many kilometres)." [p 76]

In answer to the question: *"If we have a wind farm of N turbines, how does the seismic amplitude increase as compared to 1 turbine?"*
Answer: *"We have shown it varies as the square root of N and this is to be expected because the turbines are not all in phase and neither are they operating at exactly the same frequency because of the slight possible variations in rotation speed and also wind conditions across the farm. There is also a possible 10% variation in speed (Optislip) which will cause broadening of the spectral peaks . They are quasi-random sources and therefore add as square root of N. Therefore 100 turbines are 10 times as noisy as one, not 100 times."* [p 77]
[Styles P; Stimpson I; Toon S; England R; Wright M. Microseismic and infrasound monitoring of low frequency noise and vibrations from windfarms: recommendations on the siting of windfarms in the vicinity of Eskdalemuir, Scotland. Keele University (UK), Report for the Ministry of Defence, 18 July 2005]

'*The Effect of Windmill Farms on Military Readiness*', a 2006 report by the US Department of Defense for the US Congressional Committees, supports Styles et al for the seismographic methods and devices used to measure low frequency noise and vibration at Eskdalemuir.

However, the Department of Defense report recommends that the United States modify the approach:

'Measurements of seismic noise generated by wind turbines that Styles made must be updated to reflect the increased size of SOA wind turbines.'
(SOA = State Of the Art) [United States Department of Defense. The effect of windmill farms on military readiness. Report to the Congressional Defense Committees. Office of the Director of Defense Research and Engineering, US Department of Defense, 2006, p 62]

20. Moreover, Hubbard and Shepherd ('Aeroacoustics of large wind turbines', 1991) observe in their discussion on Atmospheric Propagation,

'Acoustic refraction that arises from sound-speed gradients associated with atmospheric wind and temperature gradients, can cause non-uniform propagation around a sound source.'

In an *'illustration of the effects of atmospheric refraction, or bending of sound rays, caused by vertical wind sheer gradient over flat homogeneous ground for an elevated point source'*, the rays are bent toward the ground in a downwind direction. That is, the ground can act as a large and effective microphone at low frequencies.

21. The WHO *Guidelines for Community Noise 1999* (S.4.2.1) say that:

"Reverberation times below 1 s are necessary for good speech intelligibility in smaller rooms; and even in a quiet environment a reverberation time below 0.6 s is desirable for adequate speech intelligibility for sensitive groups."
[Authors' note: See also Section 3.51 of this Review]

22. Research by GP van den Berg, of the University of Groningen in the Netherlands, examines how wind turbine sound acts in the environment. In 'The Beat is Getting Stronger: The Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines' [*Journal of Low Frequency Noise, Vibration, and Active Control* 24(1), March 2005], van den Berg writes:

    a. *'Our experience* ***at distances of approximately 700 m to 1500 m from the Rhede Wind Farm****, with the turbines rotating at high speed in a clear night and pronounced beating audible, is that the sound resembles distant pile driving. When asked to describe the sound of the turbines in this wind farm, a resident compares it to the surf on a rocky coast. Another resident near a set of smaller wind turbines, likens the sound to that of a racing rowing boat (where rowers simultaneously draw, also creating a periodic swish). Several residents near single wind turbines remark that the sound often changes to clapping, thumping or beating when night falls, like a washing machine.'* (p.14)

    b. *'Part of the relatively high annoyance level and the characterisation of wind turbine sound as lapping, swishing, clapping or beating may be explained by the increased fluctuations of the sound [2.21]. Our results in table 2 show that in a stable atmosphere measured fluctuation levels are 4 to 6 dB for single turbines, and in long term measurements (over many 5 minute periods) near the Rhede Wind Farm fluctuation levels of approximately 5 dB are common but may reach values up to 9 dB.'* (p.14)

    c. *'It can be concluded that, in a stable atmosphere, the fluctuations in modern wind turbine sound can be readily perceived. However, as yet it is not clear how this relates to possible annoyance. It can however be likened to the rhythmic beat of music: pleasant when the music is appreciated, but distinctly intrusive when the music is unwanted.'* (p.15).

    d. *'The hypothesis that these fluctuations are important, is supported by descriptions of the character of wind turbine sounds as 'lapping', 'swishing', 'clapping', 'beating', or 'like the surf'.'*

    e. *'Those who visit a wind turbine in daytime will usually not hear this and probably not realise that the sound can be rather different in conditions that do not occur in daytime. This may add to the frustration of residents'.* [See also Persson Waye et al, "Living close to wind turbines – a qualitative approach to a deeper understanding"] (p.15)

    f. *'Fluctuations with peak levels of 3 – 9 dB above a constant level may have effects on sleep quality.* ***The Dutch Health Council ['Effects of Noise on Sleep and Health', pub. No. 2004/14] states that 'at a given L night value, the most unfavourable situation in terms of a particular direct biological effect of night-time noise is not, as might be supposed, one characterised by a few loud noise events per night. Rather, the worst scenario involves a number of noise events all of which are roughly 5 dB (A) above the threshold for the effect in question'.*** [emphasis added]

    g. *'For transportation noise (road, rail, air traffic) the threshold for motility (movement), a direct biological effect having a negative impact on sleep quality, is a sound exposure level per sound event of SEL=40 dB (A) in the*

bedroom [Dutch Health Council]. The pulses in figure 6 have SEL-values up to 50 dB (A), but were measured on the façade. With an open window facing the wind turbines indoors SEL-values may exceed the threshold level.' (p15)

23. GP van den Berg concludes:

    a. *'Atmospheric stability has a significant effect on wind turbine sound, especially for modern tall turbines.'* (p 15)

    b. *'First, it is related to a change in wind profile causing strong, higher altitude winds, while at the same time wind close to the ground may become relatively weak. High sound immission levels may thus occur at low ambient sound levels, a fact that has not been recognised in noise assessments where a neutral or unstable atmosphere is usually implied. As a result, wind turbine sound that is masked by ambient wind-related sound in daytime, may not be masked at night time.* [van den Berg GP. Effects of the wind profile at night on wind turbine sound. Journal of sound and vibration 2004; 277 (4-5): 955 – 970]

    c. *Secondly, the change in wind profile causes a change in angle of attack on the turbine blades. This increases the thickness (infra) sound level as well as the level of trailing edge (TE) sound.*

       'The calculated rise in sound level during swish then increases from 1 – 2 dB to 4 – 6 dB. This value is confirmed by measurements at single turbines in the Rhede Wind Farm where maximum sound levels rise 4 to 6 dB above minimum sound levels within short periods of time.' (p 15 – 16)

    d. Third, van den Berg notes that *'atmospheric stability involves a decrease in large scale turbulence ... As a result turbines in the farm are exposed to a more constant wind and rotate at a more similar speed with less fluctuations. Because of the near-synchronicity, blade swishes may arrive simultaneously for a period of time and increase swish level.*

       Sound level differences ($L_{A\,max} - L_{Amin}$) (corresponding to swish pulse heights) within 5 minute periods over long measurement periods near the Rhede Wind Farm show that level changes of approximately 5 dB occur for an appreciable amount of the time and may less often be as high as 8 to 9 dB. This level difference did not decrease with distance, but even increased 1dB when distance to the wind farm rose from 400 m to 1,500 m. The added 3 – 5 dB, relative to a single turbine, is in agreement with simultaneously arriving pulses from two or three approximately equally loud turbines.' (p.16)

24. In 2001, Casella Stanger produced "Low frequency Noise", a report for DEFRA (Technical Research Support for Defra Noise programme). Section 4 addresses the 'Possible Effects of LFN':

    'As with any noise, reported effects include annoyance, stress, irritation, unease, fatigue, headache, possible nausea and disturbed sleep.

Low frequency noise is sometimes confused with vibration. This is mainly due to the fact that certain parts of the human body can resonate at various frequencies. For example the chest wall can resonate at frequencies of about 50 to 100Hz and the head at 20 to 30Hz.' [S.4.1]

25. In the U.K., decision-makers are guided by the State according to Planning Policy Statement 22 (2004).

    PPS 22 'Noise' states:

    "The 1997 report by ETSU-R-97 for the Dti ***should*** *be used to assess and rate noise from wind energy developments."* [emphasis added]

    (Note: "should" is not a command statement.)

26. There were 14 Members of the ETSU-R-97 Noise Working Group (NWG), including the Chairman from the Dti. Nearly 60% were either from Power companies involved in wind farm schemes, wind energy trade associations, or specialist advisors to wind farm developers. [Preface, p. i]

    Indeed, the following statement appears in the introduction to ETSU-R-97:
    "While the Dti facilitated the establishment of this Noise Working Group this report is not a report of Government and should not be thought of in any way as replacing the advice contained with relevant Government guidance." [Preface p.i]

27. ETSU-R-97 states in its Executive Summary that:
    a. *"This document describes a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours,* ***without placing unreasonable restrictions on wind farm development*** *or adding unduly to the costs and administration burdens on wind farm developers or local authorities."* [emphasis added] [Summary S. 1]

    b. *"The NWG ... wind farms are usually sited in the more rural areas of the UK where enjoyment of the external environment can be as important as the environment within the home."* (Summary S. 3)

    c. *" The NWG considers that absolute noise limits applied at all wind speeds are not suited to wind farms in typical UK locations and that limits set relative to the background noise are more appropriate in the majority of cases."* [Summary, S.8]

    d. *"The* ***recommendation*** *of the NWG is that, generally the noise limits should be set relative to the existing background noise at nearest noise-sensitive properties ... We have considered whether the low noise limits which this could imply in particularly quiet areas are appropriate and have concluded that it is not necessary to use a margin above background approach in such low-noise environments.* ***This would be unduly restrictive on developments*** *..."* (emphasis added) [Summary S.11]

    e. *Separate noise limits should apply for day-time and for night-time. The reason for this is that during the night the protection of external amenity*

becomes less important ***and emphasis should be on preventing sleep disturbance.*** *Day-time noise limits will be derived from background noise data taken during quiet periods of the day and similarly the night-time limits will be derived from background noise data during the night"* (night-time is defined as 11pm-7pm)

f. *"The NWG recommends that the fixed limit for night-time is 43 dB(A). This is derived from the 35 dB(A) sleep disturbance criteria referred to in PPG24. An allowance of 10 dB(A) has been made for attenuation through an open window (free-field to internal) and 2dB subtracted to account for the use of LA90.10min rather than LAeq.10min."* [Summary S.23]

g. *"Lower limit"*
Applying the margin above background approach to some of the very quiet areas in the UK would imply setting noise limits down to say 25 – 30 dB(A) based upon background levels perhaps as low as 20 – 25 dB(A). ***Limits of this level would prove very restrictive on the development of wind energy.*** *As demonstrated below, it is not necessary to restrict wind turbine noise below certain lower fixed limits in order to provide reasonable degree of protection of the amenity."* (emphasis added)

28. In contrast, two years after ETSU-R-97, the WHO *Guidelines for Community Noise 1999* set tighter maximum permitted levels for community noise, yet ETSU-R-97, page 20 refers to *"the WHO document Environmental Health Criteria 12 – WHO 1980(14).* Clearly, ETSU-R-97 does not reflect the latest World Health Organisation *Guidelines for Community Noise.*

29. Independent experts researched and wrote the WHO Guidelines for Community Noise 1999. In brief, the Guidelines state:

"In these Guidelines for Community noise only guideline values are presented. These are essentially values for the onset of health effects from noise exposure." (5th paragraph S. 4.1)

"For each environment and situation, the guideline values take into consideration the identified health effects and are set, based on the lower levels of noise that effect health (critical health effects). (6th paragraph S. 4.1)

"In dwellings the critical effects of noise are on sleep, annoyance and speech interference. To avoid sleep disturbance, indoor guideline values for bedrooms are 30 dB LAeq for continuous noise and 45dB LAmax for single sound events. Lower levels may be annoying, depending on the nature of the noise source...." (S 4.3.1 & see also S 3.3 sleep disturbance)

"Thus when assessing the effects of environmental noise on its people it is relevant to consider the importance of the background noise level, the number of events, and noise exposure level independently." (3rd paragraph S 4.1)

"Most problems occur at lower frequencies, where most environmental noise sources produce relatively high sound pressure levels." (S 2.6)

"If noise includes a large proportion of low-frequency components, values even lower than the guideline values will be needed, because low-frequency components in noise may increase the adverse effects considerably." (S 4.3)

"More regular variations of sound pressure levels with time have been found to increase the annoying aspects of the noise. For example, noises that vary periodically to create a throbbing or pulsating sensation can be more disturbing than continuous noise. (Bradley 1994b). Research suggests that variations at about 4 per second are more disturbing (Zwicker 1989)." (3rd paragraph S 2.3.2)

"At night sound pressure levels at the outside facade of the living spaces should not exceed 45 dB LAeq and 60 dB LAmax, so that people may sleep with bedroom windows open. These values have been obtained by ***assuming*** *that the noise reduction from outside to inside with the window partly open is 15 dB."*

30. It may seem that 15dB is a high level of attenuation through the external envelope especially for timber-framed buildings and high glazed areas. However, the guideline for the onset of sleep deprivation is 30dB, reduced if low frequency noise characters are present and further reduced if throbbing/pulsating characters are present – both of which are present for wind turbine noise. This lower figure represents a new base level to which is added the noise attenuation factor for the external envelope, with a window partially open, to give the outside façade level.

    [Note: the 30dB max for a bedroom is a continuous maximum noise level, which is substantially different to the ETSU-R-97 guideline that allows 5dB above background noise.]

31. The importance of an 'in the bedroom at night maximum level' is emphasised by the findings of GP van den Berg. Van den Berg's research reveals that [van den Berg GP. *Effects of the wind profile at night on wind turbine sound.* Journal of sound and vibration 2004; 277(4-5): 955-970]:

    'Since the start of the operation of a 30 MW, 17 turbine wind park, residents living 500 m and more from the park have reacted strongly to the noise; residents up to 1900 m distance expressed annoyance. To assess actual sound immission, long term measurements (a total of over 400 night hours in 4 months) have been performed at 400 and 1500 m from the park. In the original sound assessment a fixed relation between wind speed at reference height (10 m) and hub height (98 m) had been used. ***However, measurements show that the wind speed at hub height at night is up to 2.6 times higher than expected, causing a higher rotational speed of the wind turbines and consequentially up to 15 dB higher sound levels, relative to the same reference speed in daytime.*** *Moreover, especially at high rotational speeds the turbines produce a 'thumping', impulsive sound, increasing annoyance further. It is concluded that prediction of noise immission at night from (tall) wind turbines is underestimated when measurement data are used (implicitly) assuming a wind profile valid in daytime.'*

32. During stormy weather, the background wind noise sometimes disturbs sleep, but to suffer wind turbine noise in addition (as per ETSU-R-97) is likely to make sleep intermittent if not impossible.

'Many acoustical environments consist of sounds from more than one source. For these environments, ***health effects are associated with the total noise exposure,*** *rather than with the noise from a single source (WHO 1980b.)"* [WHO Guidelines for Community Noise 1999, S.3.8, The effects of combined noise sources]

33. In assessing how a level of below 30 dB is achieved (WHO S. 4.3.1 & S. 3.3), allowance must be made for a window to be open in order to provide ventilation, especially in warm weather. In addition, the sound reduction index of the external wall is only part of the consideration. The construction of the ceiling might only be a 15mm sheet of plaster, some thermal insulation (not sound insulation), a paper-thin vapour barrier, and thin roofing slate. The transmission **loss** through the ceiling or roof is slight.

'The evidence on low-frequency noise is sufficiently strong to warrant immediate concern. Various industrial sources emit continuous low-frequency noise (compressors, pumps, diesel engines, fans, public works); and large aircraft, heavy duty vehicles and railway traffic produce intermittent low-frequency noise. Low-frequency noise may also produce vibrations and rattles as secondary effects. Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general (Berglund et al. 1996).'

'Since A-weighting underestimates the sound pressure level of noise with low-frequency components, a better assessment of health effects would be to use C-weighting.' [WHO Guidelines for Community Noise 1999, S.3.9, 'The effects of combined noise sources'.]

'To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB LA_{eq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB LA_{eq}. These values are based on annoyance studies, ***but most countries in Europe have adopted 40dB LA_{eq} as the maximum allowable level for new developments (Gottlob 1995). Indeed the lower level should be considered the maximum allowable sound pressure level for all new developments whenever feasible.'*** (WHO S.4.3.1.)

34. It should be noted that:

a The 30 dB LAeq is not variable with external weather conditions – it is a fixed level regardless of external weather conditions and external background noise.

b The nature of the pulsating beat of the wind turbine, together with probable ground vibration, and the low frequency noise character, are clear reasons to support a lower level than 30 dB LAeq, especially at night.

c WHO *Guidelines for Community Noise 1999* does not provide for measurements limited to background noise plus 5 dB as per ETSU-R-97, but clearly states that noise in a bedroom above 30 dB causes sleep disturbance.

d It is possible to conceive of a position where a lightly constructed dwelling with minimal sound transmission loss between bedroom ceiling and the external wall is subjected to an external wall sound of 45 dBA at night. If the WHO 30dBA maximum bedroom level is applied but reduced to reflect the pulsating character and the low frequency character, the actual measurement inside the bedroom, with the window open for ventilation, will be only marginally less than 45 d BA, potentially creating a 15 dBA excess of sound **which is a staggering 30 fold difference in sound energy.** (See S. 4.18 & S. 4.40 of this review.)

35. The WHO Guidelines for Community Noise 1999 are shown on the following chart:

Table 1: Guideline values for community noise in specific environments:
WHO *Guidelines for Community Noise 1999*

Specific Environment	Critical Health Effects	LAeq [dB(A)]	Time Base [hours]	LAmax fast [dB]
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 16	- -
Dwelling, indoors Inside bedrooms	Speech intelligibility & moderate annoyance, daytime & evening Sleep disturbance, night-time	35 30	16 8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
School classrooms & pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	during class	-
Pre-school bedrooms, indoor	Sleep disturbance	30	sleeping-time	45
School, playground outdoor	Annoyance (external source)	55	during play	-
Hospital, ward rooms, indoors	Sleep disturbance, night-time Sleep disturbance, daytime and evenings	30 30	8 16	40 -
Hospitals, treatment rooms, indoors	Interference with rest and recovery	as low as possible		

The WHO *Guidelines for Community Noise 1999* also examine the acoustic measurement of sound:

'The A – weighting (dBA) is most commonly used and is intended to approximate the frequency response to our hearing system ... C – weighting (dBC) is also quite common and is nearly a flat frequency response with the extreme high and low frequencies attenuated. When no frequency analysis is possible, the difference between A weighted and C weighted levels gives an indication of the amount of low frequency content in measured noise.' (WHO S.2.1.2)

'Noise measures based solely on LAeq values do not adequately characterize most noise environments and do not adequately assess the health impacts of noise on human well-being. It is also important to measure the maximum noise level and the number of noise events when deriving guideline values. ***If the noise includes a large proportion of low-frequency components, values even lower than the guideline values will be needed, because low-frequency components in noise may increase the adverse effects considerably.*** *When prominent low-frequency components are present, measures based on A-weighting are inappropriate. However, the difference between dBC (of dBlin) and dBA will give crude information about the presence of low-frequency components in noise. If the difference is more than 10 dB, it is recommended that a frequency analysis of the noise be performed.'* (WHO S.4.3)

36. In August 2006, the Dti (UK) published 'The Measurement of Low Frequency Noise at Three UK Wind Farms' [Report for Dti by Hayes McKenzie Partnership Ltd].The report measured LFN at three wind farm sites in the UK, and although unidentified in the report, these sites are believed to be:

    Site 1: Askam, Cumbria 7 x 0.66 MW wind turbines of 4.62 MW installed capacity, built 1999.

    Site 2: Bears Down, Cornwall 16 x 0.6 MW of 9.62 MW installed capacity, built September 2001.

    Site 3: Blaen Bowi, Carmarthenshire 3 x 1.3 MW of 3.9 MW installed capacity, built July 2002.

37. For the purpose of its Report, the Dti defined low frequency noise sources as between 20 – 250 Hz [S.1.3]. The Dti stated: *'Infrasound is noise at frequencies below the normal range of human hearing, i.e., less than 20 Hz.'* [S.1.2] The report stated that *'noise sources associated with these frequencies are generated by unsteady loading of the wind turbine blade.'*

    Hubbard and Shepherd also make this observation. Their paper, 'Wind turbine acoustics' [NASA Technical Paper 3057, 1990, p 2496], considered three upwind and four downwind turbines. The upwind MODS.B and WWG-0600 machines measured between 60 dB – 70 dB below 20 Hz [p 2499; p 2502].

38. The Dti Report supports the Hubbard and Shepherd measurement of upwind machines:

> *'Measurements of infrasound [below 20 Hz] in the vicinity of wind farms, and confirmed within this study, indicate typical sound pressure levels between 1 – 10 Hz of 60 – 80 dB, which falls well below the normal environmental infrasound levels experienced by all humans.'* [p 12]

39. The Dti Report observes:

> *'The common cause of complaints associated with wind turbine noise at all three wind farms is not associated with low frequency noise, but is the audible modulation of the aerodynamic noise, especially at night.'* [p 3]

In the Report, the Dti does not provide evidence to support this statement as the sole cause of complaints. There is little doubt that audible modulation is a contributory cause, but as Professor James Lovelock, Professor Ralph Katz, Dr Amanda Harry, and Dr David Coley suggested, the "common cause" will be the acoustic radiation of sound characters of which a cocktail strikes the human body, the responses mainly being of a physiological (biologic/medical) nature, producing both short-term and long-term effects.

40. Section 2.10 of this Review noted several examples of public health concerns that emerged only after time, when a pattern of human exposure and adverse response could be observed, e.g., as reflected by the public health history with tobacco, mercury, asbestos, and thalidomide. It is therefore unsafe for the Dti to conclude that there is no environmental noise pollution from wind turbines without first conducting an independent acoustic and epidemiologic assessment.

41. The Dti Report uses the word *"perception"* and as this does not appear to be defined, one has to presume the authors are referring to *"perception of the auditory system"*, i.e., whether a sound is audible. The WHO *Guidelines for Community Noise 1999* states in S.2.1.6:

> *"Sound is a sensory perception evoked by physiological process in the auditory brain."* [That is, the process of 'perceiving' sound is a biologic/ physiologic process.]

42. The Dti Report Conclusions [August 2006] state, on page 66:

> *"Community Noise, WHO 'there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects."*

The Dti report repeats this quotation on pages 2, 10, 46 and 66. However, this quotation is taken from the ***WHO Community Noise Paper 1995*** **and does not appear in the final document of 1999.**

In fact, the WHO *Guidelines for Community Noise 1999* clearly states in Section 3.8:

> ***"The evidence on low frequency noise is sufficiently strong to warrant immediate concern."***

"Health effects due to low frequency components in noise are estimated to be more severe than for community noises in general (Berglund et al 1996)."

43. Other conclusions of the Dti Report on page 66 include:

> *"Infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range."* (Below 20Hz)

There is significant medical evidence that infrasound is perceived by other organs in the human torso with negative health responses. (See Section 5, Health Effects, in this Review). The Dti Report measured at Site 2, Appendix 6C, levels of 40 – 50 dB between 10Hz-20Hz. The UKNA survey (S.4.52) measured 70dB below 20Hz on three wind farms. Both measurements are inaudible to the auditory brain (the ear), yet may medically have an impact on body organs.

44. Another conclusion from the Dti Report on page 66 states:

> *"It may therefore be concluded that infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to health of a wind farm neighbour."*

There is no substantive epidemiological or physiological evidence in the Dti Report to support this conclusion.

The Dti Report does not address the physiological or biological responses of the human body. Acousticians – with experience working as consultants to the wind industry – produced the Dti report, and as acousticians, they focus on acoustic analysis, identifying the sound power levels [dB] down to around the threshold of audibility.

45. The Dti Report considered the 'individual thresholds of hearing', observing that:

> *'Measurements of the equal-loudness contours at frequencies below 20 Hz have been investigated by Moller and Andresen, and Whittle et al.'* (p. 26)

In a comparison of the results of these studies, the '*measurements indicate good agreement between the two papers and indicate a continuing tendency for the contours to become closer as the frequency reduces. Therefore,* ***in the infrasonic range, an increase of the sound pressure level by 10 dB may be perceived as an 8 – 16 fold increase in loudness as compared to a doubling, 2 fold increase at 1 kHz [1,000 Hz]. The result of this change in perceived loudness with change in sound pressure level in the low frequency region is that small changes in the pressure level may be experienced as a large change in perceived loudness.***" [emphasis added] [Moller H; Andresen J. Loudness of pure tones at low and infrasonic frequencies. Journal of low frequency noise and vibration 1984; 3(2): 78 – 87; and Whittle LS; Collins SJ; Robinson DW. The audibility of low frequency sounds. Journal of sound and vibration 1972; 21: 431 – 448]

> ***'Therefore, when infrasound and low frequency are of sufficient level to be detected, then a small change in pressure level above this threshold will quickly become perceived as a large change in loudness which may be considered unacceptable.*** *The experience of the low frequency sufferers within the Salford Study* [Proposed criteria for the assessment of low frequency noise disturbance. Report for Defra by Dr Andy Moorhouse et al, February 2005] *indicated that once the subject has been 'sensitised' to low frequency noise, then only a small increase in pressure level above the hearing threshold is required to be considered unacceptable.'* [Dti S.3.3, p. 27]

46. The Dti Report compares the difference in sound power level (dB) at infrasound frequency, between downwind and upwind wind turbines:

> *'Infrasound noise emissions were identified within a paper by Shepherd and Hubbard* [Physical characteristics and perception of low frequency noise from wind turbines. Noise control engineering journal 1991 Jan/Feb; 36(1): 5 – 15] *which provided field data from a number of upwind and downwind rotor configuration wind turbines. The generation of blade passage frequency (BPF) energy and associated harmonics were found to be more dominant for downwind rotor configurations. This was due to the effect of the supporting tower wake interaction as the blade passed behind the tower and would experience a sudden and significant change to the airflow.'* [Dti S.5, p 32]

However, if one refers to Hubbard and Shepherd's '*Aeroacoustics of Large Wind Turbines*' [JASA Journal of the Acoustical Society of America 1991, figure 8, p 2499], the upwind wind turbines show a similar noise spectra, indicating sound pressure levels (dB) between 60 – 70 dB in the 1Hz – 20 Hz range. This compares with the Dti Report on upwind machines of between 50 – 60 dB in the 6 – 20 Hz range.

47. The Dti Report refers to infrasound noise immissions:

> *'The measured data indicates that wind turbines do increase the level of infrasound acoustic energy within the environment but that this energy is below the perception threshold.'* [Dti p 36]

While the Dti Report provides evidence to support the view that the sound pressure level (dB) when below 20 Hz is below the threshold of audibility, the report provides no evidence to support the view that the noise is below the threshold of human perception. Indeed, a purely acoustics report cannot provide evidence in that regard, because humans are physiologically affected by inaudible sound. Inaudible sound affects not only humans, but also animals; e.g., animals retreated from the coastal areas of the tsunami that devastated parts of Asia in 2004, and sonar can affect whales and dolphins. [Mott M. Did animals sense tsunami was coming? National Geographic News, 4 January 2005. See also Section 4.11 of this paper.]

48. In identifying complaints from the three wind turbine sites where measurements were taken, the Dti Report noted: (pages 56-57)

> *'In general, the occupants of Site 1: Location 1 and Site 3: Locations 1 & 2, have described wind farm noise as being most intrusive within the dwellings during the night-time or early morning periods. The occupants have also indicated that the amplitude modulation of the aerodynamic noise is a character that draws their attention to the noise and which makes it readily identifiable when heard within an internal living space. The levels of external noise when the wind farms were considered to give rise to audible noise within the dwellings and specifically identified by the occupants ranged as follows:*

Site 1 Location 1: 38.5 – 41.0 dB LAeq 10 min : 36.3 – 38.7 LA90, 10 min

Site 2 Location 1: 37.5 – 40.2 dB LAeq 10 min : 36.2 – 38.1 LA90, 10 min

Site 3 Location 1: 40.4 – 45.5 dB LAeq 10 min : 39.0 – 39.8 LA90, 10 min

> *'Irrespective of the existing background noise level at the time of the measurements, the external noise levels associated with the operation of the wind turbines meet the requirements of ETSU-R-97 for night-time operations'* – the greater of 43 dB L_{A90} (or background + 5 dB) – *'i.e., noise levels are lower than 43 dB L_{A90}. This level provides protection against the awakening of an occupant, based upon the recordings, where no occupant was noted to awaken due to noise associated with the operation of the wind turbine.'*
>
> *'Measured internal noise levels for the same measurement periods detailed above are as follows:* (page 60)

Site 1 Location 1: 22.7 – 24.6 L_{Aeq} 10 min : 21.8 – 22.5 dB L_{A90}, 10 min

Site 2 Location 1: 27.6 – 36.7 L_{Aeq} 10 min : 25.9 – 30.1 dB L_{A90}, 10 min

Site 3 Location 1: 42.5 – 53.1 L_{Aeq} 10 min : 41.6 – 42.0 dB L_{A90}, 10 min

> *Site 1, location 1 is within a double glazed conservatory with no windows open.*
>
> *Site 2, location 1, is within a room with windows open.*
>
> *Site 3, location 1, is within a room with windows open with the internal measurement location having a direct line of sight down to the stream in the valley below and the microphone placed within 0.3 m of the open window.'*
>
> [Authors' note: Compliance with the noise limits based on ETSU-R-97 does not imply that there will be no significant noise impact on local residents.]

49. The following are further examples of measurements forming part of the Dti report Appendix:

For example, Site 1, measurements taken on 16 May 2005, are within the frequency range of 10 Hz – 20 Hz, an L_{eq} dB of between 40 dB – 45 dB 'Low frequency noise audibility external façade', location 1:00:00 – 1:02:35 (figures 1 and 32).

For example, Site 2 measurements taken on 14 June 2006, '*Low frequency noise audibility internal before windows open*', an L_{eq} dB within the frequency range of 10 Hz – 20 Hz of between 40 – 45 dB was measured, Location 1:21:00 – 1:21:15 (figures 1 and 4).

50. This, however, portrays just a small part of the picture. To be useful, all wind turbine acoustic measurements should include the following information. This is because the rotation speed of the blades can be controlled remotely, especially when a noise management scheme is in place. The rotation speed (rpm) has a direct bearing on the noise emission from the wind turbine.

i. Distance of the measured point from nearest wind turbine;
ii. Measured point relative to the wind turbines (array impact);
iii. Wind speed and direction at the hub height;
iv. Actual revolutions per minute of the blades at the time of measurement – as this does not necessarily correlate to wind speed;
v. Difference in altitude between the measured point and the wind turbine;
vi. A definitive description of the terrain; and
vii. A dB(A) and dB(C) measurement of frequency down to 1 Hz.

51. Referring to Site 1, the Dti report [p 81] comments:

> *'It should be noted that the description of the noise by the awoken occupant was that the noise was "intolerable". The range in levels in the 400 – 500 Hz third octave bands was measured to lie between 9 – 10 dB and to be 17 dB above the B.S. ISO 226:2003 Threshold Criterion Curve. In this event,* ***the perceived change in level in this frequency range would be a doubling of the perceived loudness, with levels potentially rising in and out of the Threshold of Audibility.*** [emphasis added] *This would give rise to a sound of a muffled swish that could be described as a heart beat type sound as the sound may only be audible for part of the time, i.e., as the noise associated with the wind farm is aerodynamic in origin and is associated with the rotation of the blades, then this will appear at 3 times the rotational speed also known as the blade passage frequency (bpf). The turbines operate with a rotational speed of 26 rpm, which equates to a blade passage frequency = 78 bpf. This is in the normal range of a heart beat.'* [p 81]

According to 'Measuring Sound', a publication from Bruel and Kjaer, a company that manufactures acoustical measuring and calibrating equipment used by many researchers and industries, when noise levels are too high and no other means of attenuation has worked or is feasible, then:

> *'Shut down the offending machinery. In severe cases, this step must be considered. It is also possible to limit the hours of operation.'*
> [Bruel and Kjaer. Measuring Sound, September 1984 (rev)]

52. In August 2006, the United Kingdom Noise Association (UKNA) published a report by John Stewart, ***'Location, Location, Location'***. This report, believed to be the first produced with input and evidence from both acoustic and medical resources and experts, addresses the cause of the suffering of families when wind turbines have been built too close to their homes:

    'Our own conclusion, after reviewing the evidence ... So much depends on the location of the wind farm relative to where people live.'

    The UK Noise Association measured noise levels around three wind farms: Bears Down (October 2005) in Cornwall; Bradworthy (December 2005) in Devon; and Blaen Bowi (October 2005) in Wales. (As previously mentioned it is believed that the Dti took its measurements at Bears Down– its Site 2; and Blaen Bowi – its Site 3.)

53. UKNA summarised its findings of wind turbine noise measured outdoors:

    'At 10 Hz, the noise from the wind farms ranged from negligible (upwind from the turbines) to 75 dB (C) (downwind). Because 'Watanabe and Moller' figures are 'G' weighted and the UK Noise Association used 'C' weighting, only approximate comparisons are possible. But these findings are well within the 97 decibels where it would become a noise problem at 10 Hz, whatever the weighting.'

    'At 20 Hz, the noise from the wind farms ranged from a low of 10 dB (C) (upwind of the turbines) to a high 82 dB (C) (downwind), with the great majority of the results falling in the 40 – 70 dB (C) range.' [p 14]

54. UKNA also tested for low frequency noise indoors. A house close to the Blaen Bowi wind farm was used (p 15):

    "The results we obtained were these:

    'At 10 Hz, the noise levels ranged from 44 to 48 decibels, well below the levels at which the noise could be heard. At 20 Hz, the noise levels ranged from 40 to 48 decibels, again well below audible levels. At 60 Hz, the noise levels ranged from 44 to 63 decibels, which suggests that low-frequency noise is being heard at times. At 100 Hz, the decibel levels ranged from 42 to 52 decibels, which indicates that the 'swish' sound is being heard, containing low frequency content.' "

55. The UKNA Report also stated:

    On page 19: *'Conclusions on Noise and Health.*

    Pedersen's arguments are persuasive that the dancing shadows and the rotating blades can significantly add to the annoyance and stress caused by noise from the turbines. The questions being asked by some in the medical profession as to whether this cocktail of effects – the noise, low frequency, rotating blades, the shadows and the strobing – is leading to ill health out of proportion to the noise turbines make, needs serious examination.'

On page 20 - first conclusion: *'Overall Conclusions.*

> *1. Wind farm noise, in common with noise generally, affects different people in different ways, but the evidence suggests there is rarely a problem for people living more than 1 – 1.5 miles from a turbine.'*

On page 21- first recommendation. *'Overall Recommendations.*

> ***It would be prudent that no wind turbine should be sited closer than 1 mile away from the nearest dwelling.*** *This is the distance the Academy of Medicine in Paris is recommending, certainly for the larger turbines and until further studies are carried out.* ***There may even be occasions where a mile is insufficient depending on the scale and nature of the proposed development.'***

56. The following charts from the UKNA survey confirm the presence of LFN. Using the WHO alternative measure (*Guidelines for Community Noise 1999*, S 2.1.2), *"when no frequency analysis is possible, the difference between A-weighted and C-weighted levels gives an indication of the amount of low frequency content in the measured noise."* The difference in two sample readings at Bradworthy (005 & 007), between A and C weighting was 29 and 30 decibels; at Bears Down (05 & 06), the difference was between 25 and 30 decibels; and at Blaen Bowi (005 & 006), the difference was between 26 and 27 decibels.

BRADWORTHY 05 Wind Direction SW speed 9 – 19 MPH Shielded from Wind

Location Hillside Farm SS 294 135

Microphone – 1Hz

Shielded from Direct Wind

Instrument:	2250
Application:	BZ7223 Version 1.2
Start Time:	07/12/2005 19:53:13
End Time:	07/12/2005 19:56:20
Elapsed Time:	00:03:07
Bandwidth:	1/3-octave
Max Input Level:	140.50

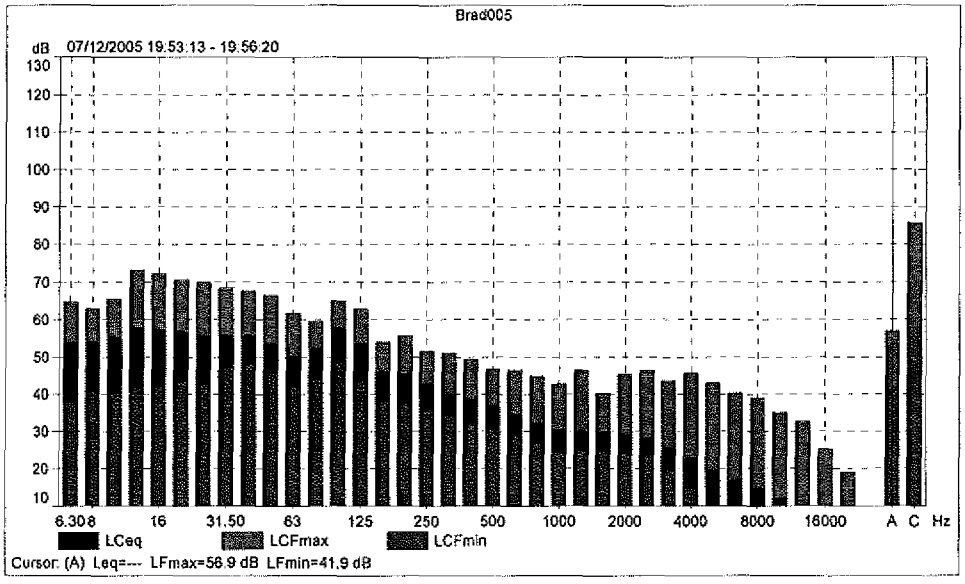
	Time	Frequency
Broadband (excl. Peak):	FSI	AC
Broadband Peak:		C
Spectrum:	FS	C

Instrument Serial Number:	2505941
Microphone Serial Number:	2508682
Input:	Top Socket
Windscreen Correction:	None
Sound Field Correction:	Free-field

Calibration Time:	07/12/2005 14:47:11
Calibration Type:	External reference
Sensitivity:	52.78 mV/Pa

Brad005 Text

	Start time	End time	Elapsed time	Overload [%]	LAleq [dB]	LAFmax [dB]	LAFmin [dB]
Value				0.00	47.7	56.9	41.9
Time	19:53:13	19:56:20	0:03:07				
Date	07/12/2005	07/12/2005					



BRADWORTHY 07 Wind Direction NW speed 9 – 23 MPH Shielded from Wind

Location SS 304 135

Microphone – Normal

Audio File – Track Brad02

Instrument:	2250
Application:	BZ7223 Version 1.2
Start Time:	08/12/2005 11:19:27
End Time:	08/12/2005 11:24:07
Elapsed Time:	00:04:40
Bandwidth:	1/3-octave
Max Input Level:	141.24

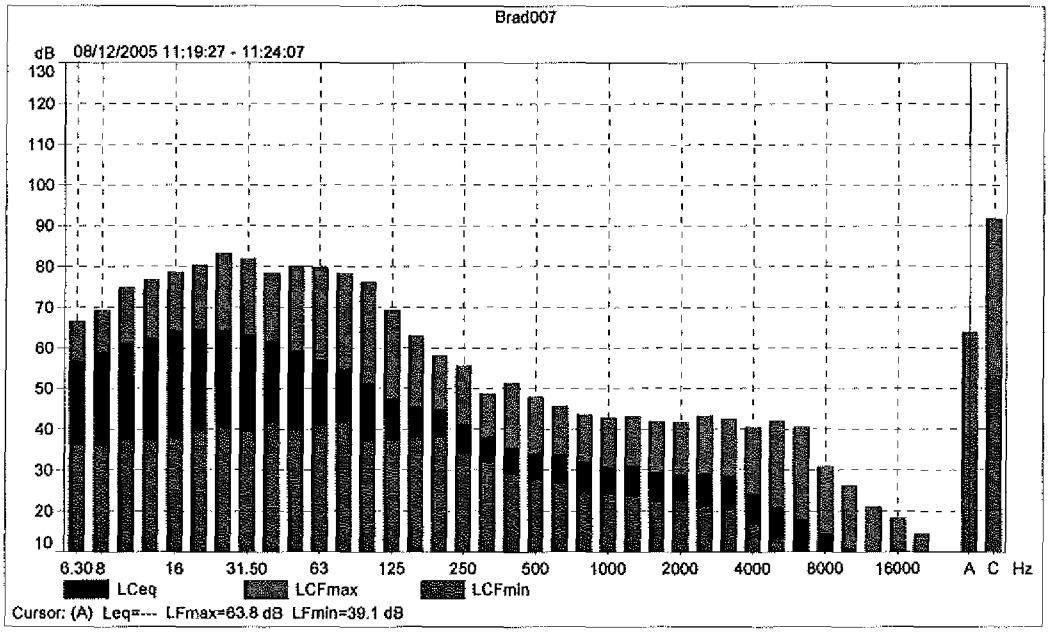
	Time	Frequency
Broadband (excl. Peak):	FSI	AC
Broadband Peak:		C
Spectrum:	FS	C

Instrument Serial Number:	2505941
Microphone Serial Number:	2508682
Input:	Top Socket
Windscreen Correction:	UA 1650
Sound Field Correction:	Free-field

Calibration Time:	08/12/2005 09:45:31
Calibration Type:	External reference
Sensitivity:	48.41 mV/Pa

Brad007 Text

	Start time	End time	Elapsed time	Overload [%]	LAleq [dB]	LAFmax [dB]	LAFmin [dB]
Value				0.00	49.5	63.8	39.1
Time		11:19:27	11:24:07	0:04:40			
Date	08/12/2005		08/12/2005				



BEARSDOWN 05 Location SH 904 685

Wind Speed	12 – 15 MPH
Wind Direction	S
Microphone	Normal

Instrument:	2250
Application:	BZ7223 Version 1.2
Start Time:	07/12/2005 15:22:25
End Time:	07/12/2005 15:24:27
Elapsed Time:	00:02:02
Bandwidth:	1/3-octave
Max Input Level:	140.50

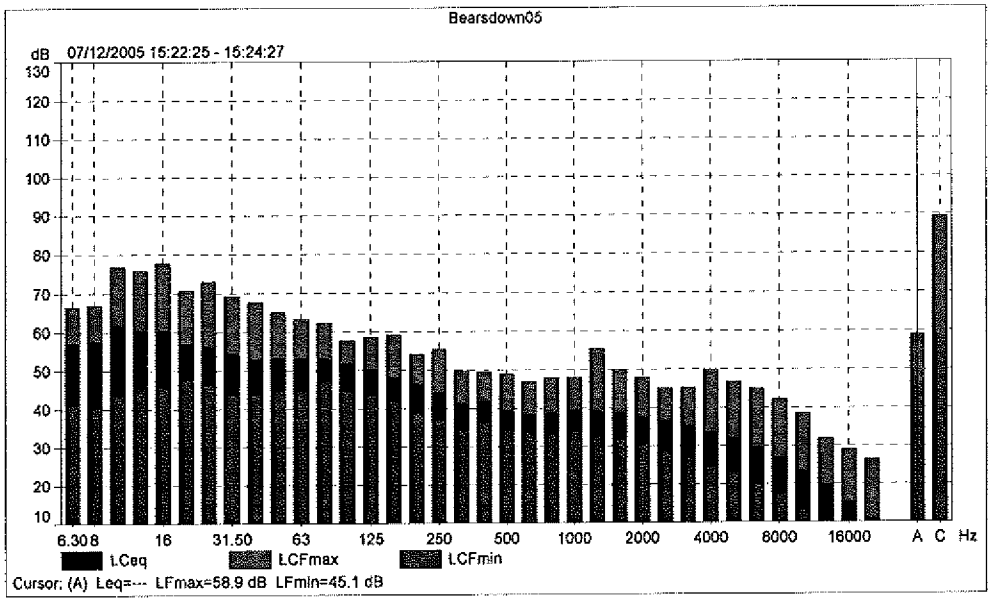
	Time	Frequency
Broadband (excl. Peak):	FSI	AC
Broadband Peak:		C
Spectrum:	FS	C

Instrument Serial Number:	2505941
Microphone Serial Number:	2508682
Input:	Top Socket
Windscreen Correction:	None
Sound Field Correction:	Free-field

Calibration Time:	07/12/2005 14:47:11
Calibration Type:	External reference
Sensitivity:	52.78 mV/Pa

Bearsdown05 Text

	Start time	End time	Elapsed time	Overload [%]	LAleq [dB]	LAFmax [dB]	LAFmin [dB]
Value				0.00	52.6	58.9	45.1
Time	15:22:25	15:24:27	0:02:02				
Date	07/12/2005	07/12/2005					



BEARSDOWN 06 Location SH 904 685

Wind Speed	10 – 18 MPH
Wind Direction	S
Microphone	1 Hz

Instrument:	2250
Application:	BZ7223 Version 1.2
Start Time:	07/12/2005 15:26:33
End Time:	07/12/2005 15:28:39
Elapsed Time:	00:02:06
Bandwidth:	1/3-octave
Max Input Level:	140.50

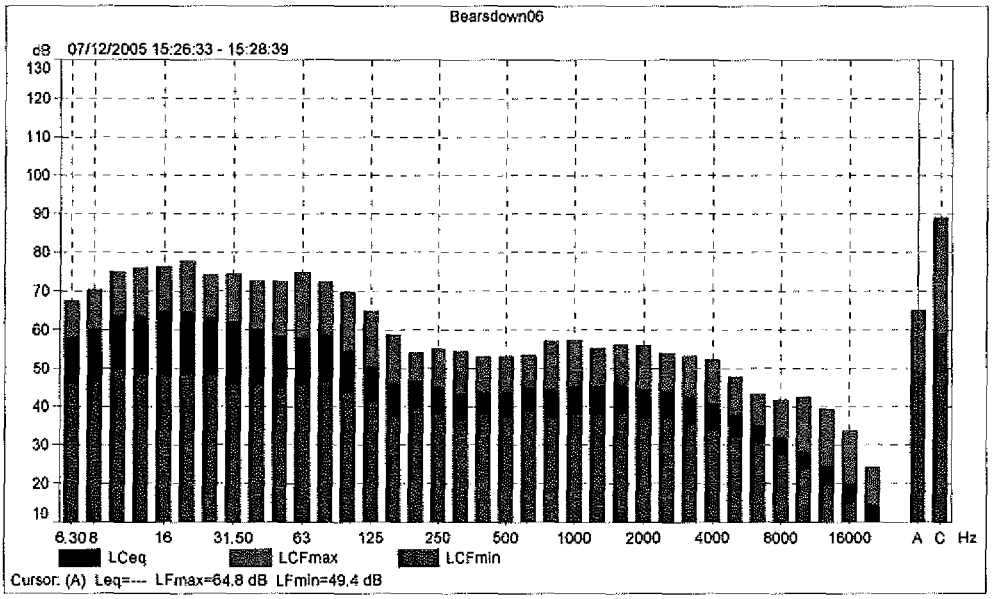
	Time	Frequency
Broadband (excl. Peak):	FSI	AC
Broadband Peak:		C
Spectrum:	FS	C

Instrument Serial Number:	2505941
Microphone Serial Number:	2508682
Input:	Top Socket
Windscreen Correction:	None
Sound Field Correction:	Free-field

Calibration Time:	07/12/2005 14:47:11
Calibration Type:	External reference
Sensitivity:	52.78 mV/Pa

Bearsdown06 Text

	Start time	End time	Elapsed time	Overload [%]	LAleq [dB]	LAFmax [dB]	LAFmin [dB]
Value				0.00	57.2	64.8	49.4
Time		15:26:33	15:28:39	0:02:06			
Date	07/12/2005		07/12/2005				



BLAEN BOWI 005 No Filter Installed Location SN 32314 BNG 36829

Instrument:	2250
Application:	BZ7223 Version 1.2
Start Time:	01/12/2005 11:55:22
End Time:	01/12/2005 11:57:32
Elapsed Time:	00:02:10
Bandwidth:	1/3-octave
Max Input Level:	140.67

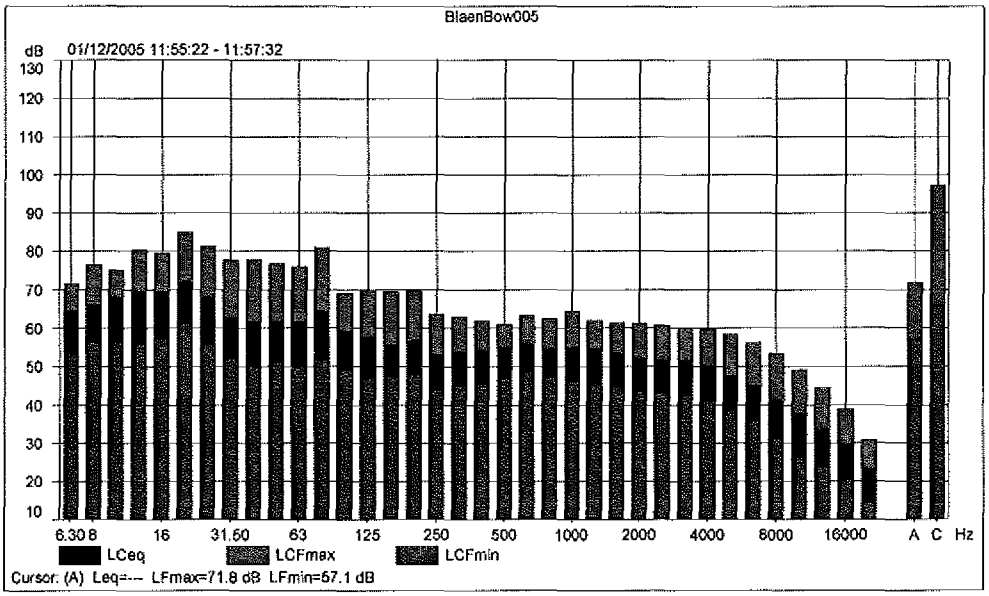
	Time	Frequency
Broadband (excl. Peak):	FSI	AC
Broadband Peak:		C
Spectrum:	FS	C

Instrument Serial Number:	2505941
Microphone Serial Number:	2508682
Input:	Top Socket
Windscreen Correction:	UA 1650
Sound Field Correction:	Free-field

Calibration Time:	01/12/2005 10:12:59
Calibration Type:	External reference
Sensitivity:	51.65 mV/Pa

BlaenBow006 Text

	Start time	End time	Elapsed time	Overload [%]	LAleq [dB]	LAFmax [dB]	LAFmin [dB]
Value				0.00	65.4	71.8	57.1
Time	11:55:22	11:57:32	0:02:10				
Date	01/12/2005	01/12/2005					



BLAEN BOWI 006 Location SN 33081 BNG 35867

Wind Speed 17 – 24 mph

Instrument:	2250
Application:	BZ7223 Version 1.2
Start Time:	01/12/2005 11:55:22
End Time:	01/12/2005 11:57:32
Elapsed Time:	00:02:10
Bandwidth:	1/3-octave
Max Input Level:	140.67

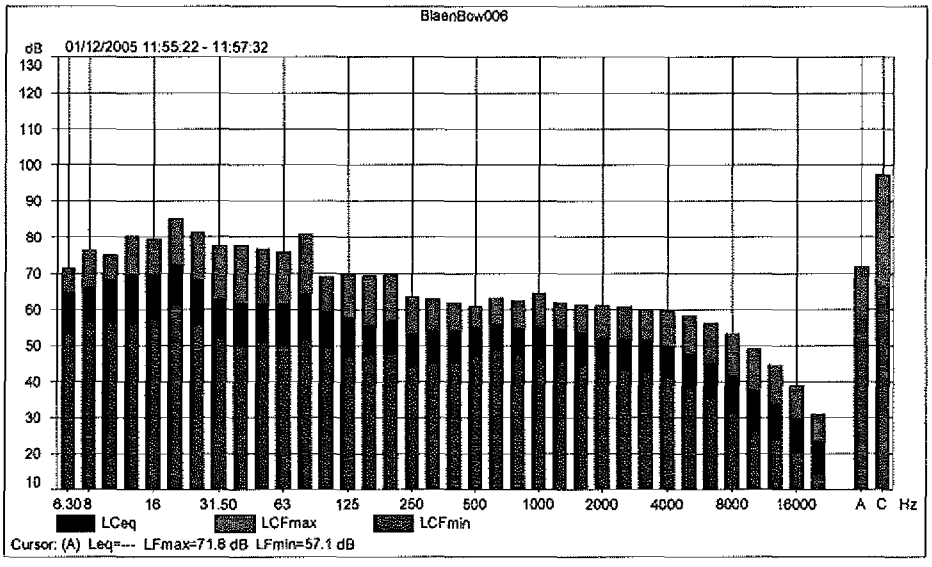
	Time	Frequency
Broadband (excl. Peak):	FSI	AC
Broadband Peak:		C
Spectrum:	FS	C

Instrument Serial Number:	2505941
Microphone Serial Number:	2508682
Input:	Top Socket
Windscreen Correction:	UA 1650
Sound Field Correction:	Free-field

Calibration Time:	01/12/2005 10:12:59
Calibration Type:	External reference
Sensitivity:	51.65 mV/Pa

BlaenBow006 Text

	Start time	End time	Elapsed time	Overload [%]	LAleq [dB]	LAFmax [dB]	LAFmin [dB]
Value				0.00	65.4	71.8	57.1
Time	11:55:22	11:57:32	0:02:10				
Date	01/12/2005	01/12/2005					



57. The following chart is an analysis of low frequency noise from a DAT tape prepared by Delta, consultants for 'Bonus' of a Bonus 1.3MW wind turbine. The chart formed part of "A Report to Vale of the White Horse District Council"(UK) by Dr G Leventhall, March 2004:

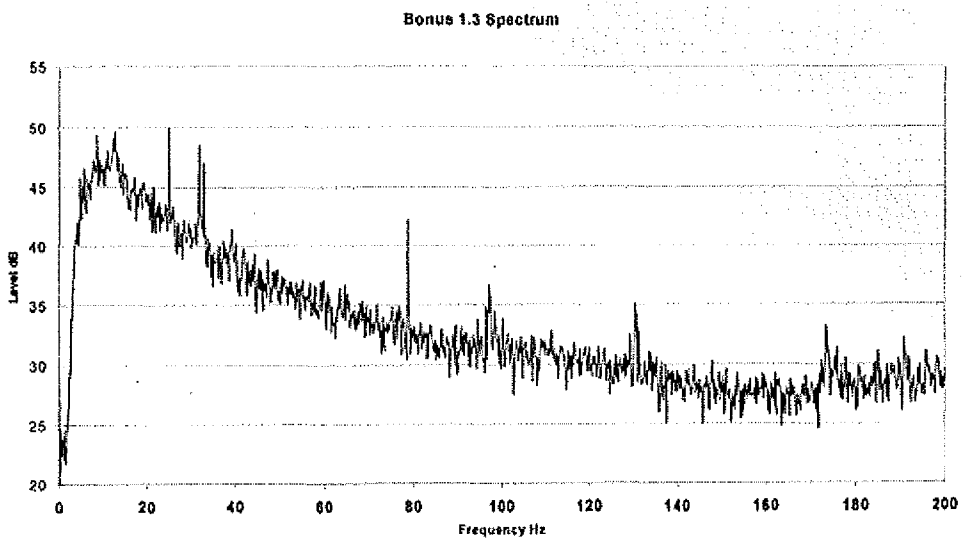


Fig 4 analysis of low frequency noise from the DAT tape of noise from the Bonus 1.3MW wind turbine

It is significant that the noise measurements taken by UKNA correlate with the noise chart in the low frequency noise range, of the Bonus 1.3 MW wind turbine. However, the fall-off at 0Hz – 6Hz is a surprise and may be due to the instrumentation.

58. In a recent publication [Leventhall G. Infrasound from wind turbines – fact, fiction and deception. Canadian acoustics 2006 Jun; 34(2): 29 – 36], Geoffrey Leventhall, acoustician and consultant to Defra and Dti, writes that:

> *'Infrasound from wind turbines is below the audible threshold and of no consequence.'*

However, Leventhall does acknowledge that wind turbine noise can be problematic:

> *'Low frequency noise is normally not a problem, except under conditions of unusually turbulent inflow air.'*
>
> *'Turbulent air inflow conditions cause enhanced levels of low frequency noise, which may be disturbing, but the overriding noise from wind turbines is the fluctuating audible swish ...'*
>
> A wind turbines' main noise source is produced by the *'repeating sound of the blades interacting with the tower. This is the noise which requires attention, both to reduce it and to develop optimum assessment methods.'* [See also section 4.19 of this paper: Report by Styles et al; report by the US Department of Defense]

59. The suitability of using ETSU-R-97 as a guide for reasonableness is challenged by Dick Bowdler in *'ETSU-R-97: Why it is Wrong'* [July 2005]. The Bowdler Report comments:

On page 61 of ETSU-R-97, the Noise Working Group stated that:

> *'During the night one can reasonably expect most people to be indoors and it will not be necessary to control noise to levels below those required to ensure that the restorative process of sleep is not disturbed. A night-time absolute lower limit is therefore appropriate based upon sleep disturbance criteria.'* [ETSU-R-97]

Bowdler counters this assumption by the Noise Working Group [NWG] with the following:

> *'What this says is that a turbine noise level inside peoples' houses of just less than the World Health Organisation say is necessary to get back to sleep if you wake up in the night is satisfactory. It seems to me this must be the very upper limit of acceptability, not one that is well balanced. Since then, the WHO has revised its guidance 5 dB lower. So the ETSU night standard is now higher than WHO say you need to get back to sleep.'* [Bowdler, 3.15]

60. On page 62 of ETSU-R-97, the NWG wrote:

> *'It is also the opinion of the Noise Working Group that there is no need to restrict noise levels below a lower absolute limit of LA90, 10min = 33db(A); if an environment is quiet enough so as not to disturb the process of falling asleep or sleep itself then it ought to be quiet enough for the peaceful enjoyment of one's patio or garden.'* [ETSU-R-97]

Again, this conclusion relies on presumption; Bowdler responds:

> *'This is a bizarre statement. It seems that the 33dBA is the 35dB sleep restoration level set out by the World Health Organisation for inside bedrooms at night. They seem to be saying that there is no need for noise levels during the day to be any lower than is necessary to allow you to go to sleep on your patio on a sunny afternoon.'* [Bowdler, 3.16]

> *'Having suggested that 33dB would be satisfactory because people could get to sleep on their patio – they now say that "This level would however be a damaging constraint on the development of wind power in the UK as the large separation distances required to achieve such low noise levels would rule out most potential wind farm sites" [ETSU-R-97]. There is absolutely no evidence brought forward to justify this.* ***A margin of 2km would normally easily achieve this even with the noisier modern turbines.*** *They argue that "Wind farms have global environmental benefits which have to be weighed carefully against the local environment impact" [ETSU-R-97]. So do many other things. They argue that "Wind farms do not operate on still days when the more inactive pastimes (e.g. sunbathing) are likely to take place" [ETSU-R-97]. The suggestion seems to be that the protection of*

people's amenity does not include protecting them whilst sunbathing in their gardens on a slightly windy day or sleeping on the patio.' [Bowdler, 3.17]

'Then, on page 63 [of ETSU-R-97] there is another leap of credibility: "There is no evidence for or against the assertion that wind farm noise with no audible tones is acceptable up to and including LA90, 10min levels of 40dB(A) even when background noise levels are 30dB or less". This is just nonsense. There most certainly is evidence against this assertion. The 40dB is actually 42dB in BS4142 units. This is at least 12dB above background noise level of "30dB or less" and BS4142 says there are likely to be complaints at turbine levels of plus 10dB. Furthermore there is no argument that BS4142 is not applicable. Even BS4142:1990 (which was current when ETSU-R-97 was written) might easily be applicable here. If the wind speed is 5m/s, the background noise 30dB and the turbine noise 42dB(LAeq) then there is no reason not to use BS4142, it does not exclude itself in these circumstances. ***This noise level is also 12dB more than (twice as loud as) the WHO considers necessary for you to be able to get to sleep.'*** [Bowdler, 3.18]

61. In August 2005, the Renewable Energy Foundation (REF) released a statement that commented on the new report by GP van den Berg, *"The beat is getting stronger: the effect of atmospheric stability on low frequency modulated sound of wind turbines"* [Journal of Low Frequency Noise and Vibration 2005; 24:1-24].

    Prof. Ffowcs-Williams, Emeritus Professor of Engineering, Cambridge University, one of the UK's leading acoustical experts and an advisor to REF said [REF Studies on wind turbine noise raise further concerns, 4 August 2005]:

    'Van den Berg's paper adds weight to the criticisms frequently offered of the UK regulations covering wind turbine noise, ETSU-R-97. The regulations are dated and in other ways inadequate. It is known that modern, very tall turbines, do cause problems, and many think the current guidelines fail adequately to protect the public."

62. "Wind Energy" (published by John Wiley & Sons), a technical bimonthly journal of wind turbine engineering papers, provides evidence that confirms just how imprecise the forecasting of wind turbine performance is:

    a *"Challenges in modelling the unsteady Aerodynamics of wind turbines"* by JG Leishman, Department of Aerospace Engineering, University of Maryland (USA) [Wind Energy 2002;5;85-132]:

    "Such problems include the challenges in understanding and predicting the unsteady blade airloads and rotor performance, as well as predicting the dynamic stresses and aeroelastic response of the blades. Wind turbines are also subjected to complicated environmental effects such as atmospheric turbulence, ground boundary layer effects, directional and spatial variations in wind shear, thermal stratification, and the possible effects of an upstream unsteady, bluff body-like wake from support structure (tower shadow).

    Fig. 1 [in original document] *summarises the various aerodynamic sources that may affect air loads on a wind turbine, which can be decomposed into a variety of mostly periodic and mostly periodic contributions.* ***The net effect***

is that the wind turbine operates in an adverse unsteady aerodynamic environment that is both hard to define using measurements and also to predict using mathematical models."

b "Survey of modelling methods for wind turbine wakes and wind farms" by A Crespo, J Hernandez, and S Frandsen [Wind Energy 1999;2;1-24]:

"The final report (intensified study of wake effects behind single turbines and in wind power wakes, National Power, London), indicates that the experimental and analytical studies reported (annex) point to significant energy losses in arrays spaced at less than seven turbine diameters. Similarly, turbulence may increase in arrays, sufficiently to cause measurable damage to fatigue and dynamic loads."

[Comment: In these circumstances, noise characters become more clearly pronounced.]

63. Morris et al further explain the difficulties [Morris PJ; Long LN; Brentner KS. An aeroacoustic analysis of wind turbines. American Institute of Aeronautics and Astronautics: AIAA-2004-1184; 42nd AIAA Aerospace Sciences Meeting, 5-8 January 2004, Reno, Nevada, 2004]:

'Since the wind turbine noise problem is very challenging, only some of the important noise sources and mechanisms are being considered [in this particular study]. *These are airfoil self-noise, the effects of blade rotation, and the propagation of sound over large distances.'*

Their research encompasses *'two aspects of airfoil self-noise ... The first is the relatively low frequency noise generated by deep stall and the second is trailing edge noise. The noise associated with blade rotation includes the effects of blade rotation on the blade aerodynamics, incoming gusts, incoming atmospheric turbulence and wind shear.'*

The authors add that:

'Wind turbines have aerodynamic and aeroacoustic behaviors with unique characteristics that make their prediction more challenging in many ways than already complicated aeroacoustic problems such as rotorcraft or propeller noise.'

Some of the challenges are due to the unpredictable and sudden changes in *'blade / inflow / tower wake interactions.'* Moreover, wind turbine flows are complex, moving through *'a varying atmosphere over an irregular terrain', with 'the blade speed varies linearly from root to tip'*:

'It would be unrealistic to suggest that all aspects of the wind turbine noise problem could be simulated within the framework of a single aerodynamics/ aeroacoustics code. The computational resources required to perform such a simulation will remain beyond the capabilities of available computers for many years.'

(Note: Interestingly, Morris et al use the permeable surface Ffowcs Williams-Hawkings formulation to couple unsteady flow simulations to the radiated noise

field; see item 61 of this section, Acoustics, for Professor Ffowcs Williams's comments on ETSU-R-97.)

The authors further note that:

> *'While discrete frequency noise is certainly an important component of wind turbine noise (especially at low frequencies), broadband noise sources are also very important (especially at the higher frequencies).'*

Additionally:

> *'However, the sound generated by wind turbines, particularly the low frequency components, may propagate large distances through an unsteady, non-uniform atmosphere over an irregular terrain. Atmospheric absorption can also be significant for the high frequency noise components. Thus, for wind turbine applications, sound propagation is an important component of the complete aeroacoustic problem.'*

64. Sezer-Uzol and Long concur with Morris et al and observe that:

> *'... the acceptance of wind turbines by the public depends strongly on achieving low noise levels in application ... Furthermore, the acoustic propagation is of interest at relatively large distances from the wind turbine.'* [Sezer-Uzol N; Long LN. 3-D time-accurate CFD simulations of wind turbine rotor flow fields. American Institute of Aeronautics and Astronautics: AIAA Paper No. 2006-0394, 2006; CFD = Computational Fluid Dynamics]

65. If the measure for setting a noise standard lacks credibility to many professionals, it is understandable why it lacks credibility to those suffering adverse health consequences. If the methodology is inadequate, then an impartial team of experts should redesign the measure. Moreover, until there are newly defined measures that conclusively work beyond reasonable doubt, the old measure should be withdrawn from use immediately and **an immediate minimum 2km zone placed between people's homes and wind turbines**. Greater separation may be necessary in specific circumstances or with a wind turbine of greater than 2MW installed capacity.

66. Moreover, as Paul Schomer noted in 2002 [Schomer PD. For purposes of environmental noise assessment, A-weighting needs to be retired. JASA Journal of the acoustical society of America 2002 Nov; 112(5, pt 2): 2412]:

> *'... for the purposes of environmental noise assessment, A-weighting needs to be retired ... A-weighting fails to properly assess multiple noise sources ... and it fails to properly assess sound with strong low-frequency content. It performs better outdoors than indoors even though the receivers are indoors. It certainly cannot be used for room noise criteria. A-weighted Leq cannot assess the audibility of sound, and in fact, Leq in fractional octave bands cannot be used to assess the audibility of sounds at low frequencies.'*

[See also WHO *Guidelines for Community Noise 1999*, s.1.2 & s.3.9]

Schomer continues:

> *'There are better measures for all of these functions such as loudness-level rating using ISO 226. At low frequencies, data show some people (about one-third) are "C-weighted" listeners. For all noise, it may be that one model just does not fit all. Experiments show that a majority of listeners make categorical judgments and merely count events based on level with the minority of subjects fitting three other models. There are many ways to clearly move forward but we must give up our A-weighting, it has now reached old age.'*

67. According to Berglund et al [Berglund B; Hassmen P; Soames Job RF. Sources and effects of low-frequency noise. JASA Journal of the acoustical society of America 1996 May; 99(5): 2985 – 3002]:

> *'Low frequency noise is common ... as an emission from many artificial sources: road vehicles, aircraft, industrial machinery, artillery and mining explosions, and air movement machinery including wind turbines, compressors, and ventilation or air-conditioning units. The effects of low-frequency noise are of particular concern because of its pervasiveness to numerous sources, efficient propagation, and reduced efficacy of many structures (dwellings, walls, and hearing protection) in attenuating low-frequency noise compared with other noise ... Although the effects of lower intensities of low-frequency noise are difficult to establish for methodological reasons, evidence suggests that a number of adverse effects of noise in general arise from exposure to low-frequency noise ...* [p 2985]
>
> *... standards should consider the option of allowing less noise in the low-frequency range since the possibility exists that a stimulus may have an effect even without conscious (auditory) detection. Definitive solutions to these problems would require unethical exposures to low-frequency noise ... The balance of probability would appear to favour the conclusion that low-frequency noise has a variety of adverse effects on humans, both physiological and psychological ... The evidence provided ... warrants concerned action without the potentially extremely lengthy delay that may be occasioned by waiting for definitive proof which may never arise.* [p 2998]

68 Noise from wind turbines combines with visual phenomena such as shadow flicker, which compounds the adverse impact on those living nearby. R Bolton, who is president of a company that develops engineering software, observes in his report on shadow flicker:
[Bolton R. Evaluation of Environmental Shadow Flicker Analysis for "Dutch Hill Wind Power Project". Environmental Compliance Alliance, New York, USA, 30 January 2007]

> *'Large scale shadow flicker is a new phenomenon, not experienced by people on an "industrial scale", with football field sized shadows moving across their home or through their local views. As a new source of environmental pollution extra care is needed when evaluating the long term consequences.'*

For example, on elevated ridges with wind turbines that are 400 feet high, the turbines *'will cast shadows for thousands of feet, well above any vegetative screening'.*

Shadow flicker is not only a day-time phenomenon; night-time flicker is also problematic. Conditions for shadow flicker include moon-lit nights, with the rising and setting of the moon. Moreover, ridgeline wind turbines can cast shadows that *'easily extend 2 to 4 miles'*:

> *'Residents and passers-by (highway traffic) not immediately within the shadow will nevertheless readily observe the shadow flicker ...'*
>
> *'Often numerous wind turbines are sited linearly if placed on a ridgeline and nearby residents will be exposed to numerous shadow flickers simultaneously.'*

That is, all three blades of each wind turbine will create flicker, and the flicker from all the wind turbines will not be synchronised.

According to the UK's Planning Guide for Renewable Energy: a companion guide to PPS22 (2004), *'flicker effects have been proven to occur only within ten rotor diameters of a turbine'.* Meridian Energy, a wind farm developer, recommends that *the 'nearest affected receptors'* to a wind turbine producing shadow flicker, *'should be no closer than 10 turbine rotor diameters'.*

For a wind turbine with a 300-foot rotor diameter, the nearest receptor to shadow flicker should be no closer than 3000 feet.

In New York State (USA), the Department of Environmental Conservation Program Policy provides guidance for the phenomenon of shadow flicker:

> *'A properly sited and designed project is the best way to mitigate potential impacts.'*

The guidance specifies that:

> *'It is the burden of the applicant to provide clear and convincing evidence that the proposed design does not diminish the public enjoyment and appreciation of the qualities of the listed aesthetic resource.'*

Recognising the impact of shadow flicker, the Swedish building authority introduced a rule that the calculation of shadow flicker should be made for the building lot (garden), instead of only the window of a façade.

Bolton concludes that:

> *'... shadow flicker is a serious environmental pollutant that can have significant harmful effects on the welfare of persons subjected to it.*

When coupled with the noise pollution and visual degradation that many residents will be subjected to, it is clear that wind farm turbine setbacks should be increased to a minimum of 3,000 feet from any residence.'
[Bolton R. Evaluation of Environmental Shadow Flicker Analysis for "Dutch Hill Wind Power Project". Environmental Compliance Alliance, New York, USA, 30 January 2007]

69 This Section of the Review, **Acoustics**, provides evidence that the noise radiation from wind turbines is made up of a number of sound characters, which include low frequency noise (0Hz – 200Hz), infrasound (0Hz – 20Hz), vibration, rhythmic pulsation, and tonal qualities. Moreover, the noise combines with visual phenomena, such as strobe effects and shadow flicker, which can act synergistically with the acoustic qualities in the effects on people nearby. A prolonged dose at an appropriate level of any of these characters individually can evoke serious physiological changes in the human body, with health consequences.

Wind turbines emit a cocktail of acoustic characters and are delivered with a rhythmic, pulsating character, all of which can combine to create serious health responses from people if the wind turbines are constructed too close to their dwellings.

The ETSU-R-97 guidelines endorsed by the Dti do not protect families from the sleep deprivation and the consequent health effects where wind turbines are built too close to their homes.

Peter Hadden

Section 5.0 HEALTH EFFECTS

1 Levels of sound, both audible and inaudible (including that in the low frequency range) can have an adverse effect on health, not only psychologically, but also physiologically, with medical consequences. As previously discussed, wind turbines emit noise radiation, both audible and inaudible (including that in the low frequency range). The industry has struggled to accurately predict and control wind turbine noise and its impact on people in nearby dwellings, with inconsistent results. When installed near homes, the noise is not merely a persistent, unremitting nuisance. Whether in the UK, the US, Canada, the Netherlands, Australia, or elsewhere, those living near wind turbines share similar health and medical complaints.

2 Measuring the audibility of noise does not take into consideration that the human body also receives sound characters without the involvement of the auditory system.

3 Merely focusing on audible sound ignores the harmful impacts on human body organs of low frequency noise, vibration, and the whole combination of characters – e.g., pulsations – that act in combination to exacerbate the impact on the body's organs.

4 Acousticians measuring noise near wind turbines do not take into account the physiologic/medical aspects of the effects of noise, as this is not their area of expertise; only those with backgrounds in medicine, the human biologic sciences, and epidemiology can properly study the effects and responses of the human body to wind turbine noise.

5 Moreover, measuring the audibility of a sound, its loudness, and its characteristics does not account for the dose received. Dosimetry is an important part of the equation when considering the effects of noise on human health. Although one may acclimatise to certain noises, wind turbine noise, with its pulsating nature, varying harmonics and low frequency components, does not have a time-limit factor, and continues day after day and year after year, unlike noise at work, e.g., which has a time-limit factor. Because the impact on body organs builds over a long period of time, wind turbine noise is difficult to replicate in laboratory experiments. Moreover, it would be unethical to subject people to extended exposure in the laboratory setting.

6 According to 'Occupational and Community Noise', World Health Organisation Fact Sheet No 258 (February 2001, drawn from the WHO *Guidelines for Community Noise 1999*):

> *'The noise problems of the past are incomparable with those plaguing modern society ... the thumps and whines of industry provide a noisy background to our lives. But such noise can be not only annoying but also damaging to the health, and is increasing with economic development.*
>
> ***Health Impact.*** *The recognition of the noise as a serious health hazard as opposed to a nuisance is a recent development and the health effects of the hazardous noise exposure are now considered to be an increasingly important public health problem.*

- *Prolonged or excessive exposure to noise whether in the community or at work, can cause permanent medical conditions, such as hypertension ... (ref WHO Guidelines p XII).*
- *Noise can adversely affect performance, for example in reading, attentiveness, problem solving and memory. Deficits in performance can lead to accidents (ref WHO Guidelines p XII).*
- *A link between community noise and mental health problems is suggested by the demand for tranquillizers and sleeping pills ...'*

7 The WHO fact sheet continues:

> Noise may *'interfere with communication, disturb sleep, cause cardiovascular and psycho-physiological effects, reduce performance, and provoke annoyance responses and changes in social behaviour ... Many countries have regulations on community noise from rail, road, construction and industrial plants based on emission standards, but few have any regulations on neighbourhood community noise, probably owing to difficulties with its definition, measurement and control. This and the insufficient knowledge of the effects of noise on people handicap attempts to prevent and control the problem.'*

Environment	Critical Health Effect	Sound Level dB(A)*	Time hours
Outdoor living areas	Annoyance	50 – 55	16
Indoor dwellings	Speech intelligibility	35	16
Bedrooms	**Sleep disturbance**	**30**	**8**
School classroom	Disturbance of communication	35	During class

Source: Who Fact Sheet No 258, Occupational and Community Noise, February 2001.

The WHO *Guidelines for Community Noise 1999* state that:

> *"The potential health effects of community noise include hearing impairment; startle and defense reactions; aural pain; ear discomfort; speech interference; sleep disturbance; cardiovascular effects; performance reduction; and annoyance responses. These health effects, in turn, can lead to social handicap; reduced productivity; decreased performance in learning; absenteeism in the workplace and school; increased drug use; and accidents. In addition to health effects of community noise, other impacts are important such as loss of property value.*

8 Indeed, the human body does emanate measurable 'sound', which can be detected by various testing equipment, as is used for excluding the presence of or for diagnosing disease. For example, in 'EEG measurement', G Blundell notes that

The brain operates	Normal activity	13 – 30 Hz
	Relaxed	8 – 13 Hz
	Drowsiness	4 – 7 Hz
	Deep sleep	0.5 – 4 Hz

[See also Hedge, A. 'Whole body vibration', Cornell University, April 2002; SafetyLine Institute, Government of Western Australia, 'Whole body vibration effects on health', 1998]

9 In the paper, "Human Body Vibration Exposure and its Measurement", G. Rasmussen looked at body vibration exposure at frequencies of 1 Hz – 20Hz. This chart details some of the findings:

Symptoms	**Frequency**
General feeling of discomfort	4Hz – 9Hz
Head symptoms	13Hz – 20Hz
Influence on speech	13 Hz – 20 Hz
Lump in throat	12 Hz – 16Hz
Chest pains	5Hz – 7Hz
Abdominal pains	4Hz – 10Hz
Urge to urinate	10Hz – 18Hz
Influence on breathing movements	4Hz – 8Hz

10 Rasmussen's 'mechanical man' illustrates these distributions:

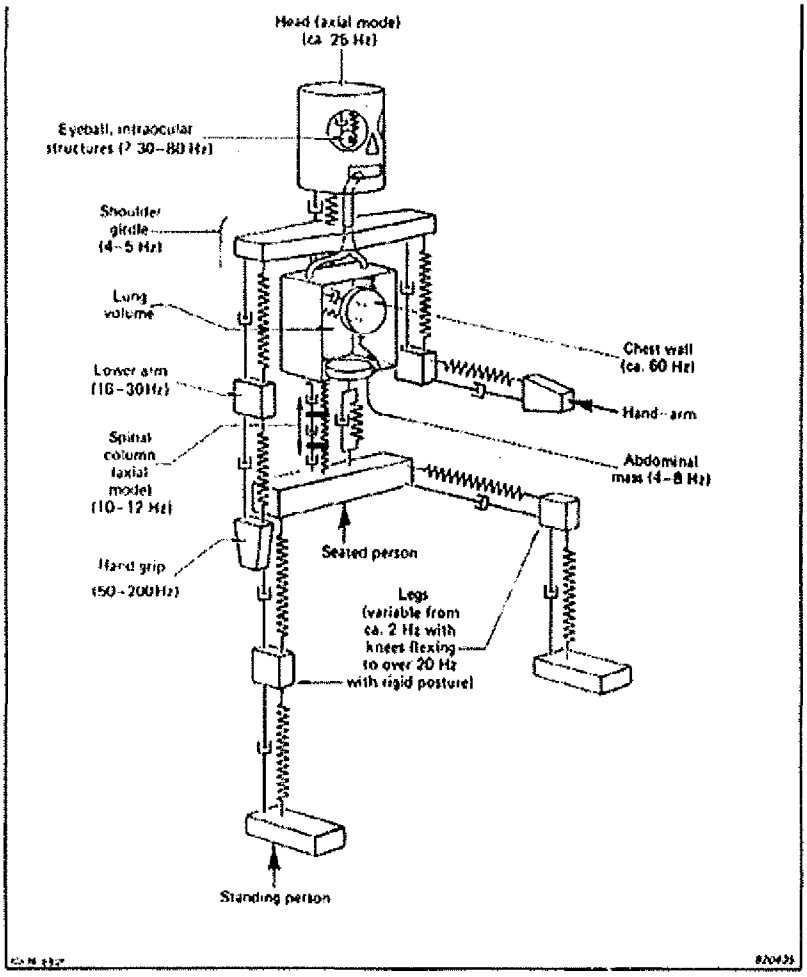


Fig. 1. Simplified mechanical system representing the human body standing on a vertically vibrating platform

Note that the head will vibrate at about 25 Hz and the chest wall at 60 Hz.

> *"Also, in the region 60 to 90 Hz disturbances are felt which suggest eyeball resonances, and a resonance effect in the lower jaw-skull system has been found between 100 and 200Hz."*

11 In "Community Noise Rating" [2d ed, Applied Science Publishers, 1982], the author, Theodore Shultz, wrote that the International Standards Organisation (ISO) had recently (1982) adopted a "Guide for the Evaluation of Human Exposure to Whole-Body Vibration".

In evaluating low frequency noise and vibration, he noted that there are:

> *"... four physical factors of primary importance in determining the human response to vibration: the **intensity**, the **frequency**, the **duration**, (exposure time) and the **direction** of the vibration."*

12 Shultz gives limits for longitudinal (2–axis) and for transverse (x–and y–axis) vibration respectively. Each curve, or boundary, represents a limit beyond which exposure to vibration carries a significant risk of fatigue or impaired working efficiency. Shultz comments:

> *"The 'exposure limit' boundaries are similar in general form to those for fatigue: but they lie 6 dB higher and the boundaries for reduced comfort have a similar form but lie 10dB lower than the fatigue boundaries."*
>
> *"The Standard mentions in a note that the criteria of acceptability in residential contexts, particularly at night, may lie near the threshold of detectability; for frequency bands of greatest sensitivity (4 – 8Hz for longitudinal, and 1 – 2 Hz for transverse vibration), this lies in the vicinity of* ***0.01m/s****, (though it varies greatly in individual circumstances)."*

Merely as a rough guide, the longitudinal acceleration limits for fatigue indicates that for 0.20 rms between 10Hz – 20Hz, the limits of exposure should not exceed 24hrs – 30hrs. For transverse exposure, the limit is only 10hrs. [Authors' note: See also Section 4.18 or this Review]

13 In his coursework description of "Whole Body Vibration", Prof Alan Hedge of Cornell University writes:

> *"Vibrations in the frequency range of 0.5Hz to 80Hz have significant effects on the human body.*
>
> *Individual body members and organs have their own resonant frequencies and do not vibrate as a single mass, with its own natural frequency. This causes amplification or attenuation of input vibrations by certain parts of the body due to their own resonant frequencies.*
>
> *The most effective resonant frequencies of vertical vibration lie between 4Hz and 8Hz.*
>
> *Vibrations between 2.5 and 5Hz generate strong resonance in the vertebra of the neck and lumber region with amplification of up to 240%.*
>
> *Vibrations between 4 and 6Hz set up resonances in the trunk with amplification of up to 200%.*
>
> *Vibrations between 20 and 30Hz set up the strongest resonance between the head and shoulders with amplification of up to 350%.*
>
> *Whole body vibration may create chronic stresses and sometimes even permanent damage to the affected organs or body parts."* [Hedge A. Whole body vibration. DEA350, April 2002, c January 2006]

14 The SafetyLine Institute (Government of Western Australia) notes in its documentation and coursework:

> *"Prolonged exposure to whole body vibration at frequencies below 20Hz results in hyperventilation, increased heart rate, oxygen intake, pulmonary ventilation and respiratory rate.*

Digestive system disease often observed in persons exposed to whole body vibration over a long period of time. Associated with the resonance movement of the stomach at frequencies between 4 and 5 Hz.

Spinal column disease and complaints, perhaps the most common disease associated with long term exposure to whole body vibration, where the back is especially sensitive to the 4 – 12Hz range."

15 One of the most important parts of the body with respect to vibration and shock appears to be the abdomen with the resonance occurring in the 4 – 8 Hz range. The other main resonant effect is found in the head and neck region, with a range of 20 – 30 Hz. Eyeball resonance is similar, with vibration in the range of 25 – 90 Hz. *'The skull itself has a fundamental mode of of vibration in the region of 300 – 400 Hz.'* [SafetyLine Institute of WorkSafe Western Australia, Department of Consumer and Employment Protection, Government of Western Australia. 'Identification of whole-body vibration: Effects on Health', SLI 1998]

16 Another study concurring with these results looked at human body vibration induced by low frequency noise in the range of 20 – 50 Hz:

"The level and rate of increase with frequency of the vibration turned out to be higher on the chest than on the abdomen." [Takahashi Y; Yonekawa Y; Kanada K; Maeda S. A pilot study on the human body vibrations induced by low frequency noise. Industrial health 1999 Jan; 37(1): 28-35]

17 Berglund, Hassmen, and Job, in "Sources and effects of low frequency noise", [Berglund B, Hassmen P, Job RF. JASA Journal of the acoustical society of America 1996 May; 99(5): 2985 – 3002] made these observations:

"The setting of the arbitrary lower limit of human hearing determines the lower limit of low frequency noise and the upper bound of infrasound. Such a setting is not a matter of absolutes. The threshold of hearing for tones and frequency bands depends on the loudness as well as the frequency and duration. In this sense, logically, human hearing capacity extends well below the 20 Hz range if one considers a signal that is sufficiently loud. Thus the threshold of absolute hearing extends well into the nominal infrasound range. It has been suggested that at very low frequencies human detection does not occur through hearing in the normal sense. Rather, detection results from nonlinearities of conduction in the middle and inner ear which generate harmonic distortion in the higher, more easily audible frequency range (von Gierke and Nixon 1976). This account does not dictate that the noise is not heard but rather that the method of hearing is indirect, as indeed is the mechanical method of all hearing (i.e. the relevant nerves are fired by changes in other biological structures in the ear, not directly by noise itself)."

"Second, regardless of the process by which a sound wave is detected, it is critical to consider waves which are detected through skeletal bones, the ear, harmonics, tactile senses or resonance in body organs. Detection raises the possibility of subjective reactions such as annoyance, and annoyance

may contribute in complex ways to other biological and psychological effects of the signal (Job 1993, Stansfield 1992.)"

"Third, determination of health and other effects of LFN must consider field data. Real occurrences of low frequency noise will often include considerable energy below 20Hz as well as energy in what is usually considered the LFN range. Thus the arbitrary setting of a cut off at 20Hz is not conducive to analysis of such data."

"The determination of precisely what constitutes LFN is also not perfectly clear in terms of its upper limit. Sound up to 250Hz are sometimes referred to as LFN although others have set the upper limit of the range to 100Hz (e.g. Backteman et al 1983a)."

18 In referring to impulsive noise, Berglund et al commented:

"... impulsive noise generates greater levels of subjective reactions such as annoyance and dissatisfaction than does non-impulsive noise of the same energy level."

The authors referred to the fact LFN travels extended distances with very little energy loss:

"... as the frequency wave is lowered, more of the energy enters the ear, the body and other objects (von Gierke & Nixon 1976). Thus LFN transmission extends into many objects allowing it to set up resonant vibration in our dwellings and our possessions as well as our chest cavities, sinuses, and throat." [Berglund et al]

19 Although within the aircraft industry, in extensive research on vibroacoustic disease (VAD, i.e., LFN-induced pathology), Dr M Pereira found that:

'... when continuous LFN is present in the home it can cause VAD. When pulsating LFN is experienced in the home it can aggravate the LFN induced pathology, either by making particular signs and symptoms more severe or by accelerating the onset of other signs and symptoms.

'Mainstream concepts hold that acoustical phenomena impact the human body through the auditory system. While this may be true for certain regions of the acoustical spectrum, there are other regions of the acoustical spectrum (0 – 250Hz – LFN) where acoustical phenomena impact the human body ***without*** *the involvement of the auditory system.* ***So any study that tries to understand the effects of LFN, as it is perceived by the auditory system is missing the point.'***

20 For those in work environments with extended exposure to large pressure amplitude and LFN (LPALF), e.g., for aircraft technicians, vibroacoustic disease is an occupational health hazard, a disease process that was studied extensively after patterns of health problems were observed.

21 In one study by Castelo Branco et al [Castelo Branco NA, Rodriguez E, Alves-Pereira M, Jones DR. Vibroacoustic disease: some forensic aspects. Aviation, space, and environmental medicine 1999 Mar; 70(3 Pt 2): A145-51], among 236

aircraft technicians, the disabilities manifested themselves after a minimum of 16 years. Disabilities included neurological (34%), psychiatric (9.7%), cardiovascular (6.8%), and osteoarticular (5.9%). Echocardiograms (EEGs) showed 'characteristic changes in pericardial structures', with five pericardial layers instead of three.

Among the study participants, 73% were disabled after an average of 24 years.

22 An important aspect of these studies is the observation that not only can noise have adverse health effects, but also that low frequency noise can adversely impact the human body. This is because, to reiterate, although people perceive sounds and noise via the auditory system:

> ***"Acoustical phenomena impact the human body without the involvement of the auditory system"*** and ***"any study that tries to understand the effects of LFN, as it is perceived by the auditory system is missing the point".*** [M Alves-Pereira]

23 In 2002, Moller and Lydolf [Moller H and Lydolf M. A survey of complaints of infrasound and low frequency noise. Journal of low frequency noise, vibration and active control 2002; 21(2): 53-63] reported on 198 persons who had reported complaints about noise, identified as infrasound and low frequency noise:

> *"Their verbal reports often described the sound as deep and humming or rumbling, as if coming from the distant idling engine of a truck or pump. Nearly all respondents reported a sensory perception of sound. In general they reported that they perceived the sound with their ears, but many mention also the perception of vibration, either in the body or external objects."*

The authors continue:

> *"The sound disturbs and irritates during most activities, and many consider its mere presence as a torment to them. Many of the respondents reported secondary effects, such as insomnia, headache and palpitation. Typically, measurements have shown that existing limits (and hearing thresholds) are not exceeded."*

Moller and Lydolf suggest that there is ample evidence to pursue this research issue further, including the frequencies and levels involved.

24 Research published in 2003 on low frequency and broadband noises and annoyance [Pawlaczyk-Luszczynska M, Dudarewicz A, Waszkowska M, Sliwinska-Kowalska M. Assessment of annoyance from low frequency and broadband noises. International journal of occupational medicine and environmental health 2003; 16(4): 337-43] shows that:

> *"LFN was rated as significantly more annoying than BBN at the comparable A-weighted sound pressure levels. The annoyance assessment of either noise did not depend on age, length of employment or the level of exposure to noise at a current workplace. LFN presents a high risk of influencing human well-being ..."*

Indeed, additional studies, most in controlled environments and laboratories, have confirmed their findings.

25 In a 2004 study conducted at the Nofer Institute of Occupational Medicine in Lodz, Poland, the authors wrote [Pawlaczyk-Luszczynska M, Dudarewicz A, Waszkowska M, Szymczak W, Kamedula M, Sliwinska-Kowalska M. The effect of low frequency noise on human mental performance [article in Polish]. Medycyna pracy 2004; 55(1):63-74]:

> *'There is a growing body of data showing that low frequency noise (LFN) defined as broad band noise with dominant content for low frequencies (10 – 250 Hz) differs in its nature from other noises at comparable levels. The aim of this study was to assess the influence of LFN on human mental performance. Subjects were 193 male paid volunteers ... LFN at 50 dB(A) could be perceived as annoying and adversely affecting mental performance (concentration and visual perception) ...*

26 In another study by this group of 96 men and women, [Pawlaczyk-Luszczynska M, Dudarewicz A, Waszkowska M, Szymczak W, Sliwinska-Kowalska M. The impact of low frequency noise on human mental performance. International journal of occupational medicine and environmental health 2005; 18(2): 185 - 198], the authors note that:

> *"Low frequency noise differs in it nature from other environmental noise at comparable levels, which are not dominated by low frequency components."* [See also Berglund et al, Sources and effects of low frequency noise, JASA 1996]

In addition:

> *"Recent investigations show that low frequency noise at relatively low A-weighted sound pressure levels (about 40 – 45 dB) can be perceived as annoying and adversely affecting the performance, particularly when executing more demanding tasks. Moreover, persons classified as sensitive to low frequency noise may be at a higher risk."*
>
> The results of this study *"supports a hypothesis that LFN at levels normally occurring in the control rooms (at about 50 dB(A)) might adversely influence the human mental performance and lead to work impairment."*
>
> These authors also note *that "previous studies on the effects of community LFN (in dwelling rooms) showed that subjects sensitive to this type of noise were not necessarily sensitive to noise in general as measure by noise sensitivity scales ... Sensitivity to this special type of noise [LFN] was somewhat different from sensitivity in general."*
>
> *"LFN at relatively low A-weighted SPL (about 40 dB) could be perceived as annoying and adversely affecting the performance, particularly when mentally demanding tasks were executed ..."* [see also Persson Waye et al, Low frequency noise pollution interferes with work performance. Noise and health 2001 Oct-Dec; 4(13): 33 – 49]

The subjects *"reported a higher degree of annoyance and impaired working capacity during exposure to LFN ... LFN adversely affected performance in two tasks sensitive to reduced attention in a proof-reading task."* [see also Bengtsson et al. Evaluation of effects due to low frequency noise in a low demanding work situation. Journal of sound and vibration 2004; 278(1/2): 83 – 99]

The authors conclude *that "the adverse effect of LFN at 50 dB(A) (compared to reference noise without dominant content of low frequencies) on performance was found in tasks demanding perceptiveness and concentration ... Moreover, during exposure to LFN, differences in performance between higher and lower sensitive-to-noise subjects were observed in tasks requiring visual differentiation and selective or continuous attention; the persons categorized as high-sensitive to LFN achieved worse results than low-sensitive ones."* [Pawlaczyk-Luszczynska M, Dudarewicz A, et al, 2005]

27 Subsequent research reinforces the WHO *Guidelines for Community Noise 1999*. Pedersen and Persson Waye [Pedersen E, Persson Waye K. Perception and annoyance due to wind turbine noise – a dose-response relationship. JASA Journal of the acoustical society of America 2004 Dec; 116(4): 3460-70] studied the dose-response relationship of perception and annoyance caused by wind turbines. Their results conclude that:

"a significant dose-response relationship between calculated A-weighted SPL from wind turbines and noise annoyances was found. The prevalence of noise annoyance was higher than what was expected from the calculated dose."

The authors recommend further studies, to include the effect of visual impact.

In their paper, Pedersen and Persson Waye identify a factor that supports the WHO Guidelines in its discussion of sleep disturbance:

This *"wind turbine study was performed in a rural environment, where a low background level allows perception of noise sources even if the A-weighted SPL are low."*

"Wind turbine noise was perceived by about 85% of the respondents even when the calculated A-weighted SPL were as low as 35.0 – 37.5 dB. This could be due to the presence of amplitude modulation in the noise, making it easy to detect and difficult to mask by ambient noise. This is also confirmed by the fact that the aerodynamic sounds were perceived at a longer distance than machinery noise."

Although Pedersen and Persson Waye found that "*visual and/or aesthetic interference influenced noise annoyance*", they also found that *"the influence of noise exposure was still a significant factor for noise annoyance."*

As the authors note:

> *"The high prevalence of noise annoyance could also be due to the intrusive characteristics of the aerodynamic sound ... The verbal descriptors of sound characteristics related to the aerodynamic sounds of swishing, whistling, pulsating/throbbing, and resounding were – in agreement with this hypothesis – also reported to be most annoying."*

The extent of the impact of noise is pervasive:

> *"Most respondents who were annoyed by wind turbine noise stated that they were annoyed often, i.e., every day or almost every day. The high occurrence of noise annoyance indicates that the noise intrudes on people's daily life."*

Although their data was not extensive enough to draw conclusions on wind turbine noise and sleep disturbance, based on their observations they recommend that:

> *"... the probability of sleep disturbances due to wind turbine noise can not be neglected at this stage."* [Pedersen and Persson Waye, 2004]

28 There are numerous studies addressing the problems of noise causing sleep disturbance. The noise may be an annoyance but may also trigger physiologic changes that are signs of physiologic (bodily) stress.

29 In an article published in 2004, Griefahn and Spreng [Griefahn B, Spreng M. Disturbed sleep patterns and limitation of noise. Noise and health 2004 Jan-Mar; 6(22): 27-33] note that because of:

> *"... the indisputable restorative function of sleep, noise-induced sleep disturbances are regarded as the most deleterious effects of noise. They comprise alterations during bedtimes such as awakenings, sleep stage changes, body movements and after-effects such as subjectively felt decrease of sleep quality, impairment of mood and performance. The extents of these reactions depend on the information content of noise, on its acoustical parameters, and are modified by individual influences and by situational conditions."*

In context with the described nature of wind turbine noise, Griefahn and Spreng note that intermittent noise "*is particularly disturbing and needs to be reduced.*"

30 When the human body responds to stress, there are biological functions activated:

> These functions *"serve an important role in the organism's adaptation to the environment by protecting and restoring the body but may, under certain conditions, also have health damaging consequences."* [Lundberg U. Coping with stress: neuroendocrine reactions and implications for health. Noise and health 1999; 1(4): 67-74] Lundberg writes that *"knowledge about these psychobiological pathways is of considerable importance for the possibilities to prevent and treat environmentally induced ill health."*

31 Further research by Ising et al [Ising H, Babisch W, Kruppa B. Noise-induced endocrine effects and cardiovascular risk. Noise and health 1999: 1(4): 37-48] reiterates that:

> *"Noise has the potential to cause stress reactions. Chronic noise-induced stress accelerates the ageing of the myocardium and thus increases the risk of myocardial infarction."*

The authors note that:

> *"The involved pathomechanisms include acute increase of catecholamines or cortisol under acute noise exposure and an interaction between endocrine reactions and intracellular Ca/Mg shifts."*

Furthermore:

> *"Recent epidemiological studies support the importance of noise as a risk factor in circulatory and heart diseases, especially in myocardial infarction."*

32 As Spreng notes [Spreng M. Possible health effects of noise induced cortisol increase. Noise and health 2000; 2(7): 59-64]:

> *"The auditory system is permanently open – even during sleep ... Thus noise causes the release of different stress hormones (e.g., corticotrophin releasing hormone: CRH; adrenocorticotropic hormone: ACTH) especially in sleeping persons during vagotropic night/early morning phase. These effects occur below the waking threshold of noise and are mainly without mental control."*
>
> For example, *"Increased cortisol levels have been found in humans when exposed to aircraft noise or road traffic noise during sleep."*
>
> As a consequence, this imbalance has possible adverse health outcomes. *"The effects of longer-lasting activation of the HPA-axis, especially long-term increase of cortisol, are manifold"*, and include cardiovascular diseases.

Spreng also found that:

> *"Longer lasting activation of the HPA-axis, especially abnormally increased or periodically elevated levels of cortisol ... may lead to disturbed hormonal balance and even severe disease."* [Spreng M. Central nervous system activation by noise. Noise and health 2000; 2(7): 49-58]

33 Wust et al, in their research published in 2000 [Wust S, Wolf J, Hellhammer DH, Federenko I, Schommer N, Kirschbaum C. The cortisol awakening response – normal values and confounds. Noise and health 2000; 2(7): 79-88], state that:

"When measured with strict reference to the time of awakening the assessment of this endocrine response is able to uncover subtle changes in hypothalamus-pituitary-adrenal (HPA) axis activity, which are, for instance, related to persisting pain, burnout and chronic stress."

The HPA axis changes may serve as an indicator *"in subjects exposed to prolonged environmental noise."* The authors looked at four separate studies with a total of 509 subjects to *"provide reliable information on normal values for the free cortisol response to awakening. Corresponding with earlier findings, a mean cortisol increase of about 50% within the first 30 minutes after awakening was observed."*

This reinforces the determination of cortisol levels as a useful tool in identifying physiologic changes that may have clinical significance. *"The cortisol awakening response can be assessed under a wide variety of clinical and field settings, since it is non-invasive, inexpensive and easy-to-employ."*

34 In their review on the acute and chronic endocrine effects of noise [Ising H, Braun C. Acute and chronic endocrine effects of noise: review of the research conducted at the Institute for Water, Soil and Air Hygiene (Berlin, Germany). Noise and health 2000; 2(7): 7 – 24], Ising and Braun cover research results from the early 1980s, during which time:

"... mechanisms of acute noise-induced stress reactions as well as long-term increase of stress hormones in animals and persons under chronic noise exposure were studied."

They note that:
"... habituated noise caused a chronic increase of noradrenaline from the sympathetic synapses under longterm noise exposure at work. Environmental noise exposure (Leq >/= 60 dB(A) caused catecholamine increase if activities such as conversation, concentration, recreation etc. were disturbed through noise."

However, for a sleeping person, *"... traffic noise with only Leq >/= 30 dB(A) and Lmax >/= 55 dB(A) caused significant acute increase of cortisol, which developed into chronic increase if the noise exposure was repeated consistently."*

35 In 2002, Babisch [Babisch W. The noise/stress concept, risk assessment and research needs. Noise and health 2002; 4(16): 1-11] states that:

"In principle, the noise/stress hypothesis is well-understood: Noise activates the pituitary-adrenal-corticol axis and the sympathetic-adrenal-medullary axis. Changes in stress hormones including epinephrine, norepinephrine and cortisol are frequently found in acute and chronic noise experiments."

"Cardiovascular disorders are especially in focus for epidemiological studies on adverse noise effects ... The relative importance and significance of health outcomes to be assessed in epidemiological noise studies follow a hierarchical order, i.e., changes in physiological stress indicators, increase

in biological risk factors, increase of the prevalence or incidence of diseases, premature death."

"Magnitude of effect, dose-response relationship, biological plausibility and consistency of findings among studies are issues of epidemiological reasoning."

Babisch identifies the need for further research:

"The cardiovascular risk is a key-outcome in non-auditory noise effects' research because of the high prevalence of related diseases in our communities. Specific studies regarding critical groups, different noise-sources, day/evening/night comparisons, coping styles and other effect-modifying factors, and the role of annoyance as a mediator of effect are issues for future research in this field."

36 Babisch emphasises these points [Babisch W. Stress hormones in the research on cardiovascular effects of noise. Noise and health 2003 Jan-Mar; 5(18): 1-11]:

"Since endocrine changes manifesting in physiological disorders come first in the chain of cause-effect for perceived noise stress, noise effects in stress hormones may therefore be detected in populations after relatively short periods of noise exposure."

Therefore, *"Stress hormones can be used in noise studies to study mechanisms of physiological reactions to noise and to identify vulnerable groups."*

37 Maschke and Hecht underscore the association of changes in stress hormones and sleep disturbances [Maschke C, Hecht K. Stress hormones and sleep-disturbances – electrophysiological and hormonal aspects. Noise and health 2004 Jan-Mar; 6(22): 49-54]:

"Frequent or long awakening reactions endanger therefore the necessary recovery in sleep and, in the long run, health. Findings derived from arousal and stress hormone research make possible a new access to the noise induced nightly health risk."

The author adds that, "*Frequent occurrences of arousal triggered by nocturnal noise*" disturbs the circadian rhythm. *"Additionally, the deep sleep phases in the first part of the night are normally associated with a minimum of cortisol and a maximum of growth hormone concentrations."*

The physical well-being and *"psychic recovery of the sleeper"* rely on the circadian rhythms *"of sleep and neuroendocrine regulations."*

"Noise exposure during sleep which causes frequent arousal leads to decreased performances capacity, drowsiness and tiredness during the day. Long-term disturbances of the described circadian rhythms have a deteriorating effect on health, even when noise induced awakenings are avoided." [Maschke C and Hecht K, 2004]

38 Spreng [Spreng M. Noise induced nocturnal cortisol secretion and tolerable overhead flights. Noise and health 2004 Jan-Mar; 6(22): 35-47] notes that:

> *"repeated noise events (e.g., overflights during night times) may lead to accumulation of the cortisol level in blood."*
>
> *"This fact and the unusual large permeability of cortisol through the cell membranes opens a wide field of connections between stress-dependent cortisol production and the disturbance of a large number of other endocrine processes, especially as a result of long-term stress activation by environmental influences such as environmental noise."*

39 Initial research into low frequency noise in a workplace [Bengtsson J, Persson Waye K, Kjellberg A. Evaluations of effects due to low-frequency noise in a low demanding work situation. J Sound Vibration 2004; 278: 83-99] was tested on subjects using two ventilation noises at 45 dB(A), one with low-frequency noise character. Most of the tasks required of the subjects were routine and undemanding.

> *"The major finding was that low-frequency noise negatively influenced performance on two tasks sensitive to reduced attention and on a proof-reading task, while performance of tasks aimed at evaluating motivation were not significantly affected. The negative effects on performance were not reflected by the subjective reports."*

40 Further research has shown that noise with a low-frequency component also has an effect on cortisol levels. In a work environment experiment with *"exposure to ventilation noise, with dominant low frequencies (low-frequency noise) or a flat frequency spectrum (reference noise)"*, with both noises at 40 dB(A): [Waye KP, Bengtsson J, Rylander R, Hucklebridge F, Evans P, Clow A. Low frequency noise enhances cortisol among noise sensitive subjects during work performance. Life sciences 2002 Jan 4; 70(7): 745-58]

> *"The normal circadian decline in cortisol concentration was however significantly attenuated in subjects high-sensitive to noise in general, when they were exposed to the low frequency noise. This noise was rated as more annoying and more disruptive to working capacity than the reference noise. The study showed physiological evidence of increased stress related to noise sensitivity and noise exposure during work."*
>
> This study demonstrates the *"effect of moderate levels of noise on neuroendocrine activity."*
>
> The authors conclude that *"The impact of long-term exposure to moderate noise levels, and particularly low frequency noise, in the workplace deserves further investigation."*

41 Noise and noise with a low frequency component influence cortisol levels during sleep as well. [Waye KP, Clow A, Edwards S, Hucklebridge F, Rylander R. Effects of nighttime low frequency noise on the cortisol response to awakening and subjective sleep quality. Life sciences 2003 Jan 10; 72(8): 863 – 875]

42 Waye et al studied traffic noise or low frequency noise (LFN) and night-time effects on the cortisol awakening response and subjective sleep quality:

> *"A significant interaction between night time exposure and time was found for the cortisol response upon awakening. The awakening cortisol response following exposure to LFN was attenuated at 30 minutes after awakening. Subjects took longer to fall asleep during exposure to LFN."*
>
> *"This study thus showed that night time exposure to LFN may affect the cortisol response upon wake up and that lower cortisol levels after awakening were associated with subjective reports of lower sleep quality and mood."*

43 The WHO *Guidelines for Community Noise 1999* address sleep disturbance caused by noise:

> *'Measurable effects of noise on sleep begin at LAeq levels of about 30 dB. However, the more intense the background noise, the more disturbing is its effect on sleep. Sensitive groups mainly include the elderly, shift workers, people with physical or mental disorders and other individuals who have difficulty sleeping.*
>
> *Sleep disturbance from intermittent noise events increases with the maximum noise level. Even if the total equivalent noise level is fairly low, a small number of noise events with a high maximum sound pressure level will affect sleep. Therefore, to avoid sleep disturbance, guidelines for community noise should be expressed in terms of the equivalent sound level of the noise, as well as in terms of maximum noise levels and the number of noise events. It should be noted that low-frequency noise, for example, from ventilation systems, can disturb rest and sleep even at low sound pressure levels.*
>
> *When noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided. For noise with a large proportion of low-frequency sound a still lower guideline value is recommended. When the background noise is low, noise exceeding 45 dB LAmax should be limited, if possible, and for sensitive persons an even lower limit is preferred. Noise mitigation targeted to the first part of the night is believed to be an effective means for helping people fall asleep. It should be noted that the adverse effect of noise partly depends on the nature of the source. A special solution is for newborns in incubators, for which the noise can cause sleep disturbance and other health effects.' (WHO Guidelines for Community Noise, p xiii, 1999)*

44 Physicians, particularly general practitioners who are community-based, are often the first to detect patterns of symptoms described by their patients. Thus was the situation for Dr Amanda Harry, a physician in Cornwall, who in 2003 noted that patients began complaining of poor sleep, headaches, stress, and anxiety. [Harry A. Wind Turbines, Noise and Health. In process for publication, 2007] For example, further discussion with one couple revealed that their health problems coincided with the commissioning of wind turbines, approximately 400 meters from their home. Their symptoms were relieved when they were away from their home, and from the wind turbines. Their symptoms occurred

when the wind blew in certain directions: the noise was sometimes so disrupting that they would go to a nearby bed and breakfast, just far enough away to sleep undisturbed.

45 As a result of her initial clinical observations, Dr Harry investigated further, finding that physicians elsewhere had noted – as had those living near wind turbines have reported – a similar constellation of symptoms. Dr Harry's research included contact and interviews with respondents from a number of sites near wind turbines in the UK – Wales, Cornwall, and the north of England; her international contacts have included among them, France, Germany, Portugal, the Netherlands, and the USA.

Based on her research, Dr Harry concludes that *'further independent research is warranted'*, although she also notes reluctance for those affected to participate:

> *'There is much concern within communities that if one is seen to complain about the noise that if they decide to move away their properties will be difficult to sell and possibly devalued as a result. Therefore they feel that they are in a "Catch 22" situation.'*

46 As a concerned and inquisitive health professional, Dr Harry initiated her own independent pilot study, as she noted a dearth of research on the health effects of wind turbine noise.

The three key areas surveyed by Dr Harry included:

1. *Has your health in any way been affected since the erection of these turbines?*
   -- 81% of the 42 respondents reported that their health had been affected.

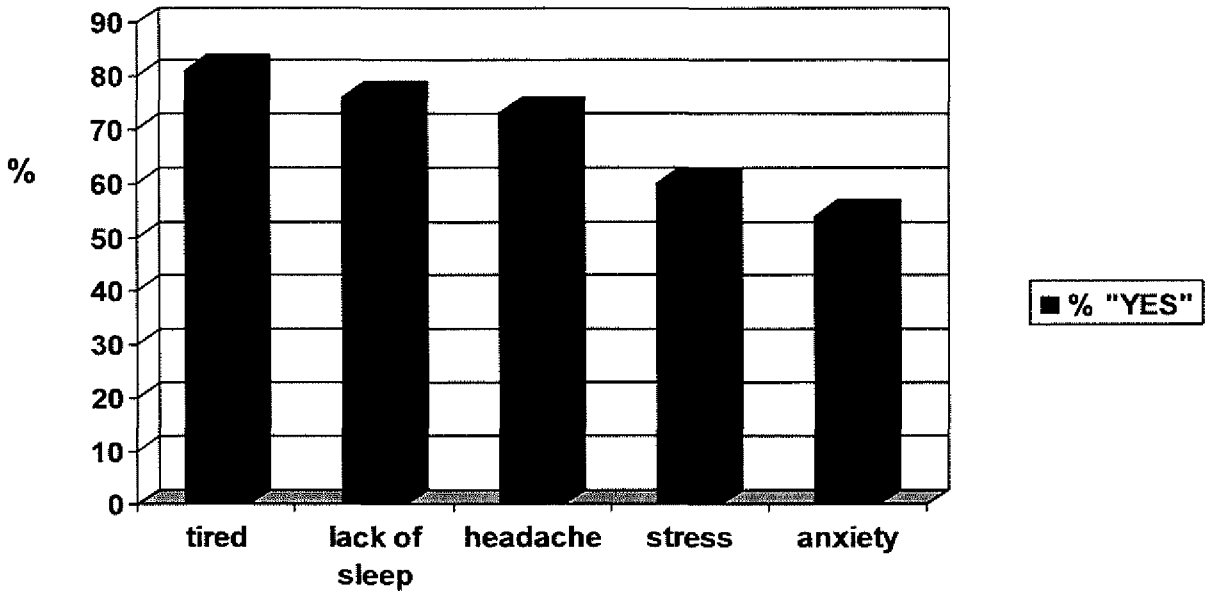
2. *As a result, have you gone to see your doctor?*
   -- 76% of the respondents felt that the effects had been severe enough to initiate a visit to a physician.

3. *Do you feel that your quality of life has in any way been altered since living near the wind turbines?*
   -- 73% of these respondents reported that their quality of life had been adversely impacted.

The following charts summarise the responses by those included in this pilot phase.

Note that 80% of respondents felt that the presence of wind turbines had precipitated at least one symptom that impelled them to visit their physicians.

"Do you feel that since living near a wind turbine you have experienced an excess of any of the following symptoms?"

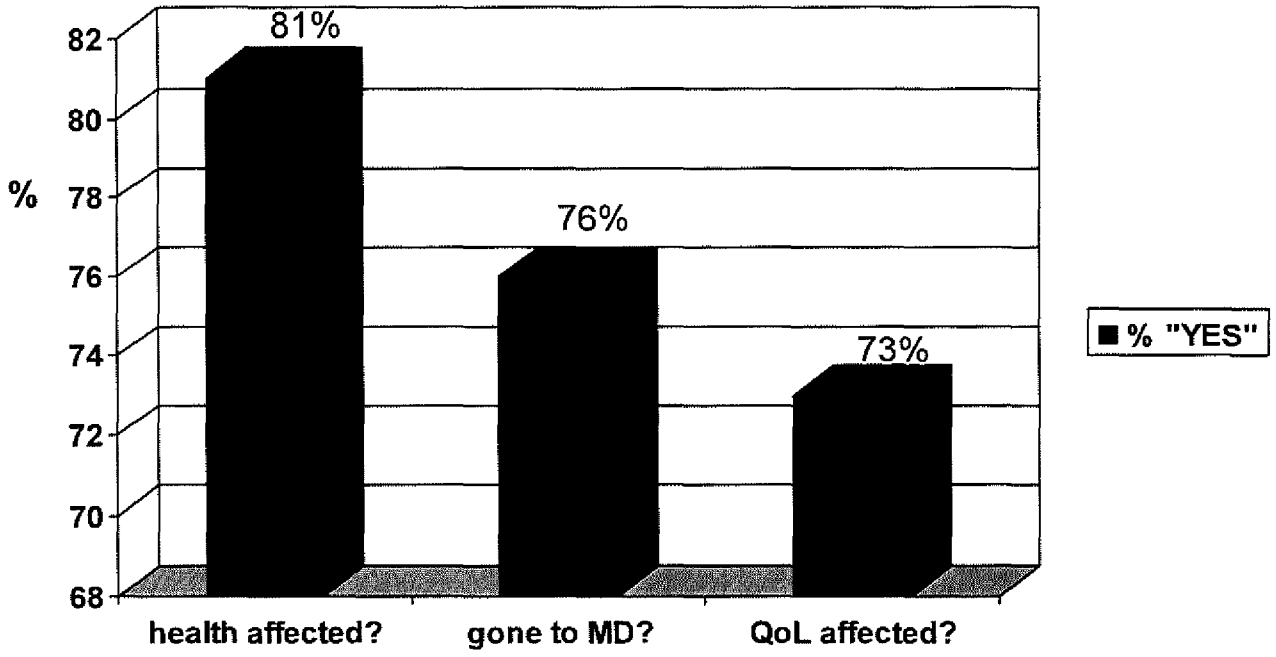


Top 5 Self-reported Health Symptoms

2006 UK Wind Turbine Survey (n = 37)

2006 UK Wind Turbine Health Survey: 3 Key Questions

1. *Has your health in any way been affected since the erection of these turbines?*
2. *As a result, have you gone to see your doctor?*
3. *Do you feel that your Quality of Life has in any way been altered since living near the wind turbines?*



Top 5 Self-reported Health Symptoms

2006 Devon Wind Turbine Survey (n = 42)

47 Dr Harry's inquiries led her to conclude:

'There are people living near turbines who are genuinely suffering from health effects from the noise produced by wind turbines. These neighbours of turbines clearly state that at times the noise from turbines is unbearable. The developers are usually heard to say that noise is not a problem. Clearly this cannot be the case.'

'Some of these acoustic experts have made statements categorically saying that the low frequency noise from turbines does not have an effect on health. I feel that these comments are made outside their area of expertise and should be ignored until proper medical, epidemiological studies are carried out by independent medical researchers.'

48 **As a result of her observations and investigation, Dr Harry concluded that wind turbines should be sited not less than 1.5 miles (2.4 km) from the nearest home or residential facility.**

49 The impact of wind turbines on health has commanded the attention of physicians elsewhere. On the basis of patient contacts and research into existing medical evidence, Nina Pierpont, MD, PhD, a physician with a practice in New York State [USA], has suggested that the emerging pattern of complaints by those living near wind turbines is not coincidental. Dr Pierpont supports renewable energy but says that the place for wind energy *'is not near people's homes or near schools, hospitals, or other locations where people have to sleep or learn'.*

50 As Pierpont notes, wind farms are *'large industrial installations' that produce 'large scale, industrial noise'.* [Pierpont N. Wind Turbine Syndrome: testimony before the New York State Legislature Energy Committee, March 7, 2006] Pierpont summarises the constellation of symptoms as 'Wind Turbine Syndrome'; these symptoms include:

1. Sleep problems. Noise or physical sensations of pulsation or pressure make it difficult to go to sleep and cause frequent awakening;
2. Headaches. Headaches increase in frequency or severity;
3. Dizziness, unsteadiness, nausea;
4. Exhaustion, anxiety, anger, irritability, and depression;
5. Problems with concentration and learning; and,
6. Tinnitus (ringing in the ears).

'Chronic sleep disturbance is the most common symptom. Exhaustion, mood problems, and problems with concentration and learning are natural outcomes of poor sleep.'

Pierpont also notes that *'Deciding whether people have significant symptoms is not within the expertise of engineers or specialists in acoustics ...'* Moreover, *'not everyone near turbines has these symptoms ... there are differences among people in susceptibility. These differences are known as risk factors ...'*

51 Pierpont mentions several risk factors:

1. Sensitivity to low frequency vibration, which is highly variable in people, and poorly understood [lack of research].

2. Pre-existing migraine disorder – migraines are not merely severe headaches. Migraines are a *'complex neurologic phenomenon which affects the visual, hearing, and balance systems'*, and can affect motor control and consciousness. Many people who experience migraines have heightened sensitivity to noise and to motion.

People rely on the input from three sources in order to maintain balance: the eyes; the 'stretch receptors in joints and muscles'; and 'balance organs in the inner ear'. To maintain balance, two of these systems must be working in agreement. If not, *'one feels both ill and unsteady'*, as with vertigo or seasickness.

> *'Wind turbines impinge on this system in two ways: by the visual disturbance of the moving blades and shadows, and by noise or vibration impacting the inner ear.'*

3. Age-related changes in the inner ear – *'Disturbing the inner ear disturbs mood, not because a person is a whiner or doesn't like turbines, but because of neurology.'*

Pierpont continues:

> *'Data from a number of studies and individual cases document that in rolling terrain, disturbing symptoms of the Wind Turbine Syndrome occur up to 1.2 miles from the closest turbine. In long Appalachian valleys, with turbines on ridge-tops, disturbing symptoms occur up to 1.5 miles away. In New Zealand, which is more mountainous, disturbing symptoms occur up to 1.9 miles away.'*

52 As with other health professionals and those other professionals and organisations who have scrutinised the health effects of wind turbine noise, **Pierpont recommends a minimum setback of 1.5 miles (2.4 km) of wind turbines from people's homes, schools, hospitals, and similar institutions**, while also urging appropriate epidemiologic studies and analysis of clinical data by qualified, independent medical researchers.

53 Indeed, the medical research literature supports the clinical observations of Drs Harry and Pierpont, as well as those by researchers such as Pedersen, Persson Waye, Berglund, and van den Berg. Moreover, as already mentioned, the symptoms described by those living near wind turbines coincide with those symptoms described in the broader literature examining noise and its health effects. Those living near wind turbines complain not only of noise, but also of the character of that noise (impulsive, pulsating, periodic), as well as the impact and synergy of the 'visual noise' of wind turbines, i.e., the shadow flicker and strobe effect from the motion of the blades.

54 Earlier research in the area of headache and migraine showed that patients with tension headaches or migraine are more sensitive to light (photophobia) and

sound (phonophobia) than those who are not prone to headaches. Those who are prone to tension headache or migraine are more sensitive to light and noise even during the intervals between headache occurrences. (Those with cluster headaches are more sensitive during headache, but not during remission.) [Drummond PD. Sensitivity to light and noise in tension-type and cervicogenic headache. Cephalalgia 1998; 18: 303]

Drummond also states that:

> *'Mechanisms that normally suppress photophobia are disrupted during the headache-free interval as well as during migraine. The persistence of phonophobia in various forms of headache implies that a similar process modifies sensitivity to sound ...'*

55 Many who live near wind turbines complain of headaches and migraines (new onset of problem or exacerbation), e.g., as with more than 70% of Dr Harry's respondents. (See also Section 3.0 of this paper, Overview of the Problems.) Indeed, researchers have studied phonophobia and photophobia (including flicker) and their association with headache and migraine, which may help explain some of the clinical symptoms shared by those living near wind turbines – although epidemiologic studies are clearly urged.

Moreover, researchers have also noted that learning can be affected by noise; for example, Wolach and Pratt found that:

> *'Processing was prolonged when the distracter items were phonological.'* [Wolach I; Pratt H. The mode of short-term memory encoding as indicated by event-related potentials in a memory scanning task with distractions. Clinical neurophysiology 2001 Jan; 112(1): 186 – 197]

56 Between 70% – 83% of migraine patients are phonophobic during an attack, and 76% remain more sensitive between attacks. Headache patients – both tension-type and migraine – were hypersensitive to sound both with and without pain. [Vanagaite Vingen J, Pareja JA, Støren O, White LR, Stovner LJ. Phonophobia in Migraine. Cephalalgia 1998; 18: 243-249]

Furthermore, Vanagaite Vingen et al found that:

> *'... the results of the questionnaire study refute the argument that anxiety about provoking attacks is the main cause of the increased sensitivity to sound outside attacks.'*

57 Researchers have also studied how trigger factors acquire the capacity to precipitate headache. In one study [Martin PR. How do Trigger Factors acquire the capacity to precipitate headaches? Behaviour Research and Therapy 2001; 39: 545-554], participants were exposed to validated trigger factors:

> *' "visual disturbance" (flicker, glare and eyestrain) induced by a very bright, stroboscopic light'*:
>
> *'The headache sufferers experienced more visual disturbance and head pain in response to the stimulus than the non-headache individuals.'*

Martin concludes that *'more research is needed urgently to clarify the processes by which trigger factors acquire and lose their capacity to precipitate headaches'* – some studies recommend avoidance of triggers, while others recommend desensitisation.

58 In 2003, McKendrick and Badcock analysed flickering stimuli between migraine attacks. [McKendrick AM, Badcock DR. An analysis of the factors associated with visual field deficits measured with flickering stimuli in-between migraine. Cephalalgia 2004; 24: 389-397] In this study, the authors measured flicker perimetric performance in a broad group of migraine sufferers and found that:

> *'The migraine groups showed significantly lower general sensitivity across the visual field and higher incidence of localized visual field deficits relative to controls.'*
> (Note: The most severe migraine sufferers, those on preventative therapy, were not included in this study.)

The authors also suggest that *'there is some contribution of both migraine frequency and cumulative migraine history in determining general sensitivity to flickering stimuli across the visual field.'*

In addition, the authors found *'a weak, but statistically significant, correlation between decreased generalized sensitivity and increased migraine frequency. Abnormalities in cortical neuronal function that increase susceptibility to migraine, thereby resulting in more frequent attacks, may manifest as decreases in generalized visual sensitivity ...'* This implies *'... some cumulative effect of migraine on visual processing'.*

59 It is not only migraine sufferers whose attacks may be triggered or exacerbated by light or noise. One study looked at headaches triggered by negative affect or by noise, analysing physiologic responses,

> *'including 'headache intensity ratings, forehead electromyographic activity, heart rate, blood pressure, and temporal pulse amplitude (TPA).' ('TPA is thought to be a measure of arterial distension caused by the passage of the pressure pulse.')* [Martin PR, Todd J, Reece J. Effects of Noise and a Stressor on Head Pain. Headache 2005; 45: 1353-1364]

The authors note that physiologic changes occur during an episode of headache:

> *'... both stressor and visual disturbance could trigger headaches. The stressor was associated with increases in blood pressure, heart rate, and temporal pulse amplitude (TPA), while visual disturbance was associated with increases in blood pressure only.'*

One group of subjects, the Stressor group, was given highly difficult anagrams to solve, accompanied by failure feedback to create anxiety and mood change. Another group of subjects was exposed to a 'Noise Challenge', a white noise that resembled a loud and un-tuned television set. As the authors observe, those exposed to the Noise had an aversive response.

A third group, exposed to both Stressor and the Noise Challenge simultaneously, rated noise levels as higher than the group exposed only to the noise, even though the noise levels were identical.

The authors found that *'79% of subjects exposed to noise developed a headache.'*

> Significantly: ***'Increased headache ratings occurred during the noise challenge relative to the control condition and continued through the recovery period even though the noise was no longer present.'*** [emphasis added]
>
> Moreover, while 'Negative Affect' (those exposed only to the Stressor of the anagrams) was not associated with physiologic changes when compared to controls:
> *'The Noise Challenge led to elevated TPA [Temporal Pulse Amplitude].'*

60 Martin, Todd, and Reece note that in a previous study, Martin and Teoh had found that visual disturbance as a trigger for headache was also associated with physiologic changes, specifically increases in blood pressure, heart rate, and TPA. [Martin PR, Teoh H-J. Effects of visual stimuli and a stressor on head pain. Headache 1999; 39: 705-715]

Martin, Todd, and Reece conclude that:

> ***'... none of the physiological changes associated with headache induction were in terms of muscle tension – all were in terms of cardiovascular variables.'*** [emphasis added]

61 Martin, Reece, and Forsyth looked more closely at headaches and noise exposure and sensitivity. Headache sufferers most commonly report stress, anxiety, glare, and noise, as triggers; negative affect, visual disturbance, hunger, and noise are experimentally validated triggers. [Martin PR, Reece J, Forsyth M. Noise as a trigger for headaches: relationship between exposure and sensitivity. Headache 2006; 46: 962-972]

In this study, the authors consider whether those who suffer headaches should endure short exposure to triggers to desensitise themselves to the trigger (hypothetically), although this might lead to increased sensitivity (again, hypothetically).

The authors used Noise for their study as it is commonly cited as a trigger for headache, and it has been experimentally validated. The 'white noise' consisted of multiple frequencies similar to an un-tuned television set, at high intensity (but with no threat to the auditory systems of the participants).

The authors conclude:

> *'Through the study, headache patients reported that they found the noise stimulus more aversive and it resulted in reports of more pain, than non-headache patients ... For individuals who do not suffer from regular headaches, the analyses strongly supported the avoidance theory ... However, for individuals who do suffer from regular headaches, the results were less clear-cut.'*

Significantly for those who live near wind turbines and suffer headaches, the authors observe:

> *'In the 'very long' noise exposure condition, the non-headache group showed further desensitization beyond the 'long' exposure condition whereas the headache group showed sensitization relative to the 'long' exposure condition.'*

However:

> *'The findings from individuals who suffer from regular headaches do not provide clear guidance as to whether avoidance or exposure to trigger factors is a better strategy from the perspective of desensitization/sensitization.* ***The data hint at the possibility that for the trigger factor of noise, 'long' exposure may be helpful but 'very long' exposure may be unhelpful.*** *This paper has argued for the potential benefits of exposure to triggers* ***but it seems likely that exposure at too high a level will be counterproductive.'*** [emphasis added]

62 On 17 January 2007, The Planning Inspectorate dismissed an appeal to allow two wind turbines at Penpell Farm, Par, Cornwall, near Lanlivery, UK. The Inspector cited these four as among the most significant considerations:

i. The impact upon the landscape, a nearby World Heritage Site, ancient monuments, and listed buildings;
ii. The impact on the quality of life, including the visual and noise effects on those who would live near the wind turbines;
iii. The impact upon the local economy, including tourism, recreation, and a local day centre for the disabled;
iv. The benefit of the proposal to meet Government, Regional, County, and local policy aims for renewable energy.
(emphasis added)

However, critical issues also revolved around the health concerns for a young man with severe autism, who lives with his family in a home that would have been one of the nearest to the wind turbines, as well as the health concerns for the attendees of the day centre for the disabled.

The Inspector concluded that the young man would face serious difficulties adapting to the presence of the wind turbines, which would then have serious consequences and hardship for the family, who are the caregivers:

> *'... there is likely to be harm, and that these are exceptional circumstances that carry some weight as a material consideration against the appeal proposal.'*
> [The Planning Inspectorate, Bristol. Appeal Decision, by RD Hiscox. Appeal ref: APP/Q0830/A/05/1189328, Penpell Farm, Par, St Austell, Cornwall, PL24 2SA, 17 January 2007]

63 It appears that those living near wind turbines and experiencing sleep disturbance, headache, migraine, and/or anxiety and the accompanying physiologic effects are enduring adverse health effects outside their sphere of control. To reiterate the advice of health professional organisations, e.g., the French National Academy of Medicine; health professionals, researchers, and reports such as UKNA's *Location, Location, Location*, **wind turbines should be sited no closer than 2km to a place of residence (with some recommending even greater separation, i.e., 2.4 km).**

64 Indeed, after learning about Dr Harry's pilot study, media reports of noise problems from wind turbines, and research on the adverse effects of noise on health, Prof Ralph Katz, Chair of the Department of Epidemiology and Health Promotion, New York University (USA), expressed concern that wind turbines had been constructed in close proximity to homes without research into their potential effects on health.

> *'No one knows the prevalence of health syndromes where there are pockets of people living next to turbines, so what would be the effects where there are clusters?'*

In 2004, Prof Katz recommended a two-year moratorium on wind turbine construction near dwellings in order 'to allow for a multi-disciplinary team of scientists to research all the health and environmental concerns.' [Young N. Wind power debate blows near and far. Western Morning News, 23 January 2004] A two-year moratorium would give epidemiologists enough time to gather and analyse data in order to determine if there is a causal link, although research beyond two years may be required. Moreover, this would avert needless adverse health impacts and an additional burden on the National Health Service in 15 to 20 years time. [Katz R. Personal communication, 3 February 2007]

65 According to Deepak Prasher, Professor of Audiology at the Ear Institute of University College London:

> ***'Noise not only annoys, it causes stress that can have an impact on our health and well-being. It can lead to anxiety, sleep problems, communication difficulties, even cardiovascular and immune changes, of which, the individual is usually unaware.'*** (emphasis added)
> [Prasher D. Widex Noise Report: traffic noise in England 2007. University College London (UK) and Widex, January 2007, www.widex.co.uk]

66 Wind turbines are not only a matter of renewable energy policy, but also – and no less significantly – a matter of public health policy.

The World Health Organisation's Guidelines for Community Noise 1999 included these recommendations:

> Governments should *"include noise as an important issue when assessing public health matters and support more research related to the health effects of noise exposure.*
>
> *Municipalities should develop low-noise implementation plans.*
>
> *Governments should support more policy-relevant research into noise pollution*
>
> *Development of continuous monitoring systems for direct health effects in critical locations.*
>
> *Development of instruments appropriate for local/regional surveys of people's perceptions of their noise/sound environments.*
>
> *Procedures for evaluating the various health effects of complex combined noise exposures over 24 hours on vulnerable groups and on the general population.*

65 The WHO report also recommended further research related to direct and/or long-term health effects:

> *Identification of potential risk groups.*
>
> *Studies of dose-response relationships for various effects.*
>
> *Studies on the perception of control of noise exposure, genetic traits, coping strategies and noise annoyance as modifiers of the effects of noise on the cardiovascular system, and as causes of variability in individual responses to noise.*
>
> *Knowledge on the health effects of low-frequency components in noise and vibration.*
>
> *Studies on the influence of noise-induced sleep disturbance on health, work performance, accident risk and social life.*
>
> *Development of a methodology for the environmental health impact assessment of noise that is applicable in developing as well as developed countries.*
>
> *Studies to assess the effectiveness of noise policies in maintaining and improving soundscapes and reducing human exposures.*

66 Thus, the evidence strongly supports those who complain of adverse health effects when living within close proximity of wind turbines, particularly the impacts from noise and shadow flicker/strobe effects. Their symptoms parallel those found in other areas of research into the physiologic and medical impact of noise on people. Various noise characters, low frequency noise, infrasound, and shadow flicker, all delivered with a pulsating character, over a prolonged period, pose health risks when developers site wind turbines too close to homes.

Section 6.0 HUMAN RIGHTS

1. Landowners have many rights pertaining to their property, but there are legal restrictions, requirements, and liabilities. A property related activity that produces an environmental pollution escaping onto a neighbour's property, causing a mischief and health problems, may trigger an interference with Article 8 of the European Human Rights Act, enacted in the UK as The Human Rights Act 1998. In the UK, a liability may arise in Tort (Rylands v Fletcher). The Environmental Protection Act 1990 (Part 3) may trigger a Statutory Nuisance. This Section of the review looks at the European Community Human Rights Act as a measure of acceptability of the level of violation and in particular considers its application to the UK.

2. In a speech to the Human Rights Lawyers Association in London on 29 September 2006, Lord Falconer of Thornton, Constitutional Affairs Secretary and Lord Chancellor, said:

> *"We in government will campaign passionately and defiantly for human rights for everyone in Britain. Because we believe it is the foundation of both our security and our prosperity."*
>
> *"It (Democracy) is an acceptance of the values of equality, tolerance and freedom. We are all equal. We are all entitled to have our individual freedoms protected. We can only safeguard our democracy and our freedoms by the rule of law. Those values must be protected and given effect by law." The freedoms set out in the European Convention on Human Rights reflect those values. They are not the property of lawyers."*

3. In discussing UK Government departments' responsibilities, the Lord Chancellor said:

> *"In essence this involves ensuring an individual's human rights addresses the issues of possible infringement, justification and proportionality."*

4. Environmental Pollution becomes significant when the pollution threatens or affects people's health. The UK is party to many Policy initiatives that give a high priority to environmental issues. For example, Article 37 of the European Union's Charter of Fundamental Rights provides:

> *"A high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in accordance with the principle of sustainable development."*

   These principles are based on Articles 2, 6, &174 of the EC Treaty.

5. Increasingly, noise is recognized as a serious environmental problem. For example, EC Directive 2002/49/EC states: *"Whereas: (1) It is part of the Community Policy to achieve a high level of health and environmental protection, and one of the objectives to be pursued is protection against noise. In the Green Paper on Future Noise Policy,* ***the Commission addressed noise in the environment as one of the main environmental problems in Europe."***

The Human Rights Act and Environmental Pollution.

6 There are two areas of the Human Rights Act 1998 that particularly address Environmental Pollution:

i) Article 8, Right to Respect for Private and Family Life

a) Everyone has the right to respect for his private and family life, his home and his correspondence.

b) There shall be no interference by a public authority with the exercise of this right except as in accordance with the law and as necessary in a democratic society in the interests of... the economic well-being of the country for the protection of disorder or crime, or for the protection of health or morals, or for the protection of the rights and freedoms of others.

7 Article 8 is a Qualified right, i.e., it can be interfered with if the interference is justified. The interference:

i. must be **lawful** (e.g., decisions that the planning acts allow);
ii. must serve one of the **legitimate aims** in Article 8 (2); and,
iii. must be **proportionate**.

The **Legitimate aims** under Article 8 (2) include:

i. National security,
ii. Economic well-being,
iii. Prevention of disorder or crime,
iv. Protection of health or morals,
v. Protection of rights and freedoms of others, e.g., the right of a developer to develop his own land and the right of a neighbour to be protected from noise nuisance, and,
vi. Protection of environment and the interests of the community.

Proportionality must consider:

i. Is the interference the minimum necessary to achieve the legitimate aims being pursued?
ii. Has a fair balance been struck?
iii. Interference with a human right must go no further than is strictly necessary in a pluralistic society to achieve its permitted purpose; or more succinctly, must be appropriate and necessary to its legislative aims.

8. **ii) Article 1 of the First Protocol, Protection of Property.**

a) Every natural or legal person is entitled to the peaceful enjoyment of his possessions. No one shall be deprived of his possessions except in the public interest and subject to the conditions provided for by law and by the general principles of international law.

b) The preceding provisions shall not in any way impair the right of the State to enforce such laws as it deems necessary to control the use of property in accordance with the general interest or to secure the payment of taxes or other contributions or penalties.

i. Article 1 of the First Protocol is a qualified right;
ii. Property and possessions include land, rights, planning permissions, licences and goodwill (business);
iii. Everyone is entitled to peaceful enjoyment of his possessions;
iv. Prevention of development may infringe the right;
v. Diminution in value of property may be relevant; and,
vi. Justification for interference:

   a. must be lawful,
   b. must serve one of the legitimate aims in the Article, and,
   c. must be proportionate.

9. Are there circumstances when a wind turbine, or a cluster of wind turbines, will be a violation of the Human Rights Act? The European Court of Human Rights is the final arbiter of this question, but there are a number of important considerations of fact that should be addressed, and Case Law provides a lead as to how the Court might consider the question.

Evidence supports the proposition that wind turbines create environmental noise pollution, posing a serious health risk to families where wind turbines are built too close to their homes.

10. **Section 3** of this Review, **"The Overview of the Problems"**, reviews the nature of the impacts on people's lives where wind turbines are built too close to their homes.

    The common complaints in response to the noise of wind turbines include: sleep deprivation, fatigue, depression, insomnia, headaches, inability to concentrate, agitating – frustrating – annoying (no escape, infrequent remission, unpredictability of noise), all of which trigger more serious health problems.

11. **Section 4** of this Review, **Acoustics,** reviews research and reports on acoustic radiation from wind turbines. The papers reviewed indicate that UK acousticians working in the wind industry seem to have concentrated their studies upon audible sound. The research and reports confirm that it is the combination of audible sound, infrasound, and vibration, in a pulsating character, that appear to trigger serious reported health problems in those families living near wind turbine installations.

    The health problems appear to be aggravated when at certain times of the year strobing light and shadow flicker from the rotating blades projects at the same pulsation rate as the noise. The UKNA report, ***Location, Location, Location*** [August 2006], which considered both acoustic and medical advice, concluded:

> ***"It would be prudent that no wind turbine should be sited closer than 1 mile away from the nearest dwellings. This is the distance the Academy of Medicine in Paris is recommending, certainly for the larger turbines and until further studies are carried out. There may even be occasions where a mile is insufficient depending on the scale and nature of the proposed development."***

Wind turbines located too close to dwellings will cause environmental noise pollution.

12. **Section 5** of this Review, **Health Effects**, reviews research and reports on Health. The medical research included in this section is international in scope; most of the citations were retrieved via the databases of the US National Library of Medicine (The National Institutes of Health, Bethesda, Maryland, www.nlm.nih.gov), with additional citations from the major engineering and biologic science databases, e.g., Web of Science. These resources are among the most comprehensive and authoritative available, and articles were published in peer-reviewed journals.

Among the findings of the effects of noise on health, sleep deprivation emerges as a significant factor, which is likely to trigger more serious medical conditions. Some of the physiological changes may be cumulative or irreversible, which can have critical consequences not only in terms of individual health, but also in terms of community health, when the source of the problem is community-based.

The Courts appear to acknowledge that health, as a state of physical, mental and social well-being, is a precondition to any meaningful privacy or intimacy, and inseparable from it. The Courts also recognise that sleep deprivation is a serious condition to the extent that it might be considered as an element of inhuman and degrading treatment under Article 3. In ***Ireland v The United Kingdom,*** the Court held that: *"...holding the detainees in a room where there was a continuous loud and hissing noise ..."* constituted inhuman and degrading treatment.

13 The cause of the violation is shown but the **Legitimate Aims, Article 8 (paragraph 7 above)** need to be considered:

i) **National Security**:
The National Security of a country is not going to be impacted if an onshore wind farm is not built. In fact, it may be argued that because the flow of electricity from a wind farm to the National Grid is not in the control of the Nation, but subject to the control of the weather, in a National emergency the supply of electricity from an onshore wind farm can never be relied upon. Furthermore, electricity flowing to the National Grid from a wind farm is neither secure nor reliable in delivery.

14 ii) **Economic Well-being**:
The viability of the National Economy will not be impacted if an onshore wind farm is not built. The National Audit Office have questioned the viability of the ROC (Renewable Obligation Certificate), introduced by the State, which provides the attractive financial investment returns to onshore wind farm developers; moreover, the system is not providing value for money to the consumer. [National Audit Office, Auditor General, HC624 Session 2002-2003. The New Electricity Trading Arrangements in England and Wales, 9 May 2003; also NAO HC 210 session, 2004-2005, 11 Feb 2003] Many argue the introduction of ROCs has been an important influence in stimulating rising electricity prices to consumers, which in turn contributes to increasing inflation which is not in the economic well-being of the country. [Refer also to

Renewable Energy Foundation (REF) The Oswald Research, 2006; also REF submission to the Yelland Wind Farm, Devon, Planning Appeal, 2 April 2006]

In 2006, Professor James Lovelock captured the attention of the international community with his book on global warming, 'The Revenge of Gaia'. On page 83, he comments:

> *'According to the Royal Society of Engineers' 2004 report, onshore European wind energy is 2 – 5 times, and offshore wind energy over 3 times, more expensive per kilowatt hour than gas or nuclear energy. No sensible community would ever support so outrageously expensive and unreliable an energy source were it not that the true costs have been hidden from the public by subsidies and the distortion of market forces through legislation.'* [Lovelock J. The Revenge of Gaia: Why the Earth is Fighting Back – and How We Can Still Save Humanity. Allen Lane (Penguin), 2006]

The Dti Report "Our Energy Challenge 2006" refers to the work of Prof David Simpson in his April 2004 report for the David Hume Institute. The Paper: *"Tilting at Windmills: The Economics of Wind Power" (No. 65)*, states:

> *"At the present time the cost of generating electricity from wind power is approximately twice that of the cheapest alternative conventional cost."*
>
> *"But projections by Government advisers, using relatively optimistic assumptions, show that even by the year 2020 a generation portfolio containing 20% wind power will still be more expensive than a conventionally fuelled alternative."*
>
> *"No matter how large the amount of wind power capacity installed, the unpredictably variable nature of its output means that it can make no significant contribution to the security of energy supplies."*

There is no evidence to show that onshore wind power makes any real contribution to the economic well being of the UK. If all the onshore wind turbines in the UK were shut down, there is no evidence that this shut down would have any impact on the National economy.

15 iii) **Prevention of Disorder or Crime:**
This is not influenced by wind farm developments.

16 iv) **Protection of Health and Morals:**
Wind farms built too close to peoples' homes are unlikely to have any impact on peoples' morals, but they do create very real health problems as set out in **Section 5, Health Effects.**

Section 4, of this Review, **Acoustics**, contends that the use of guidance ETSU-R-97 fails to protect families where wind turbines have been built too close to their homes, noting that The World Health Organisation's upper limit for bedroom noise at night offers greater protection to people, family life, and amenity. In considering whether a scheme will be a violation of the Human Rights Act, it is necessary for the decision-maker to seriously consider the advice of The World Health Organisation on standards for Community Noise, as its maximum noise levels are designed to limit noise impact on health.

The WHO limits bedroom noise at night to a **combined (total)** noise level of 30dB, and the level is reduced when low frequency content is present and reduced even further when pulsating noise is present. On windy nights, it is the total noise, including background noise, that enters the bedroom, and that should not exceed the maximum level. The difference in approach between ETSU and WHO probably accounts for much of the sleep deprivation described in **Section 3** of this Review, **Overview of the Problems.**

17 In deciding the status of ETSU-R-97 in terms of the Human Rights Act, it is important to remember that the membership of the Committee that produced the ETSU report in 1997, appeared weighted towards members working in or for the wind industry. This may account for the Committee's recommendation of the high level of environmental noise pollution that would have to be suffered by neighbouring families. While admitting the importance of preventing sleep deprivation, the ETSU Committee recommendation was instead weighted at a level that the Committee felt would not restrict the development of wind energy. As a result, it would seem that the Committee tipped the balance disproportionately in favour of wind farm developers over the impact on community quality of life and the protection of the health of people living nearby.

18 Case law has shown that the violation is the key factor; and if the State has a 'bylaw' that fails to provide adequate protection, then the State remains liable.

The Minutes of the new ETSU-R-97 Noise Working Group, (Committee formed by the State and chaired by the State), dated 02 August 2006, fails to mention any discussion on:

1) The need to comply with The Human Rights Act
2) The World Health Organisation ***"Guidelines for Community Noise 1999"***
3) The Report from the National Academy of Medicine, France (March 2006)
4) The Report by the United Kingdom Noise Association ***"Location, Location, Location"*** (Aug 2006).

Evidence shows that families suffer sleep deprivation and other health problems when wind turbines are built too close to dwellings; this is indicative of the State failing to provide adequate health protection. Interference to this extent is not justified.

19 v) **Protection of Rights and Freedom of Others:**
Clearly, the site owner has the right to develop his land in accordance with the provisions of the County and Local Development Plans under the Town Planning Acts.

However, apart from arguments of a Town Planning nature, the landowner has to recognize that the neighbours also have rights. The development of land that creates an environmental noise pollution, which escapes onto a neighbour's land, may create a violation of the Human Rights Act 1998, as well as an infringement of The Environmental Protection Act, and the nuisance might be classed as a strict liability in Tort ***(Rylands v Fletcher)***.

20 Regarding a wind farm, it is incumbent on the site owner to produce a layout design that prevents or limits to reasonable levels the environmental pollution entering the neighbours' properties, which is most likely achieved by ensuring a suitable distance between the noise source and the neighbours' properties.

The landowner may argue that the State has set Guidance on the level of noise pollution that the State believes is at an acceptable level to neighbours. However, compliance with these Guidance levels may not satisfy the Human Rights Act. The status of the Guidance is worth considering:

> Planning Policy PPG24: Planning & Noise – General principles (2), states:
> *"The Planning system has the task of guiding development to the most appropriate locations. It will be hard to reconcile some land uses, such as housing, hospitals and schools, with other activities which generate high levels of noise but the Planning system should ensure that, wherever practicable, noise sensitive developments are separated from major sources of noise (such as road ... and certain types of industrial development). It is equally important that new development involving noisy activities should, if possible, be sited away from noise sensitive land uses."*
>
> Planning Policy Statement 22 (2004) S.22 'Noise', states:
> *"Renewable technologies may generate small increases in noise levels ... Local Planning authorities* ***should*** *ensure that renewable energy developments have been located and designed in such a way to minimize increases in ambient noise levels ... The 1997 report by ETSU for the Dti* ***should*** *be used to assess and rate noise from wind energy developments".*

The use of the word "**should**" – rather than the phrase 'will be used' – allows the decision maker to use ETSU-R-97 together with any other relevant considerations.

21 vi) **Protection of the Environment and the Interests of the Community.**
The attempt to reduce one form of pollution (carbon) by the creation of a new pollution (noise pollution) and visual pollution is not credible. (Visual pollution is mentioned because many will argue that a fixed, motionless, wind turbine standing in a field is unlikely to provoke much interest. The moment the blades start to rotate, the structure captures the eye and it has the ability to mesmerize or distract some people.)

22 A wind farm does not create new jobs, as one engineer can service a number of wind farms. Rural areas depend mainly on agriculture and tourism as the key employment. Countryside Tourism, by its very title, is supported by people seeking solitude, walking, and a contrast to urban and suburban living. Tourism customers will not find solitude and unspoilt rural landscape where wind farms have industrialised the area. Although some wind farm developers make a token financial contribution to a community, this is 'de minimus' compared with the potential loss in property values resulting from the environmental pollution and industrialisation created by the wind turbines. [The Small Business Council. UK Energy Policy: *The Small Business Perspective and the Impact on the Rural Economy.* Report by Whitmill C for the SBC, February 2006] (See also this paper's **Appendix on Property Values**)

23 Referring again to the Report from The David Hume Institute (S6.13), Prof Simpson commented:

> *"Because of the cost of providing additional stand-by generating capacity, it is unlikely that wind power will ever account for more than 20% of electricity generation through the National Grid. That being the case, its development can make no substantial contribution to an overall reduction in carbon emissions."*

The Dti acknowledges that wind turbines require separate balancing power provided by conventional power stations, in order to balance the flow of electricity to the National Grid. Nuclear power is not suitable because of its slow response time. Conventional power, therefore, provides balancing power in the form of gas, oil, or coal. In the UK, it is normally gas (methane). The construction of onshore wind farms with high volatility in supply of electricity require near similar (MW) balancing power. This has the effect of increasing demand for methane. The transportation of methane has inherent issues, since the leakage is about 4% by volume. **Methane is 24 times more destructive as a greenhouse gas than carbon dioxide.** [Lovelock J. The Revenge of Gaia, 2006, pp 74-5]

24 Having in mind the similar MW capacity 'balancing power' will be constantly fired up, demanding methane gas of which about 4% by volume will disperse into the atmosphere, it is difficult to comprehend how onshore wind farms can be considered as protecting the environment – especially when the noise pollution is added to the equation.

25 Many local communities support the production of renewable energy, but they do not support the creation of environmental pollution as an acceptable consequence. Onshore wind turbines built in sparsely populated, wide-open spaces, around the world, cause few noise problems. However, schemes proposed in well-populated areas are those most likely to evoke a huge swell of community objection. In the final equation, the excessive environmental noise pollution escaping onto neighbouring property, plus the visual pollution from the constant rotation of the blades nearby, plus the reliance on back-up balancing power fuelled by methane gas, balanced against a small saving in carbon (using the National power balance rather than coal as the carbon measure), shows the cost imposed on neighbouring families is not justifiable.

Case Law

26 The European Court of Human Rights has made it very clear that environmental considerations may involve a breach of Article 8, even after allowing a margin of appreciation to the State.

27 In ***Lopez Ostra v Spain*** (1994) 20 EHRR 2777:

> *S.51 Naturally, severe environmental pollution may affect individuals well-being and prevent them from enjoying their homes in such a way as to affect their private and family life adversely, without, however, seriously endangering their health.*
>
> *S.58 Having regard to the foregoing, and despite the margin of appreciation left to the respondent State, the Court considers that the State did not*

succeed in striking a fair balance between the interest of the town's economic well-being – that of having a water treatment plant – and the applicant's effective enjoyment of her right to respect for her home and her private and family life.

28 In ***Guerra & Others v Italy*** (1998) 26 EHRR. 3577:

S.58 The Court considers that Italy cannot be said to have " interfered" with the applicants private or family life: they complained not of an act by the State but of its failure to act. However, although the object of Article 8 is essentially that of protecting the individual against arbitrary interference by the public authorities, it does not merely compel the State to abstain from such interference: in addition to this primary negative undertaking, there may be positive obligations inherent in effective respect for private or family life.

S.60 The Court reiterates that severe environmental pollution may affect individuals well being and prevent them from enjoying their homes in such a way as to affect their private and family life adversely ...The Court holds, therefore, that the respondent State did not fulfill its obligation to secure the applicants' right to respect for their private and family life, in breach of Article 8 of the Convention.

29 In ***Fadeyeva v Russia*** (June 2005) ECHR 55723

S.64 The applicant alleged that there had been a violation of Article 8 of the Convention on account of the State's failure to protect her private life and home from severe environmental nuisance arising from the industrial activities of the Severstal steel-plant.

S.132 The Court finds the following. The State authorized the operation of a polluting enterprise in the middle of a densely populated town. Since the toxic emissions from this enterprise exceeded the safe limits established by the domestic legislation and might endanger the health of those living nearby, the State established that a certain territory around the plant should be free of any dwelling. However, these legislative measures were not implemented in practice.

S. 133 It would be going too far to state that the State or the polluting enterprise were under an obligation to provide the applicant with free housing, and, in any event, it is not the Court's role to dictate precise measures which should be adopted by the States in order to comply with their positive duties under Article 8 of the Convention. In the present case, however, although the situation around the plant called for a special treatment of those living within the zone, the State did not offer the applicant any further solution to help her move from the dangerous area. Furthermore, although the polluting enterprise at issue operated in breach of domestic environmental standards, there is no information that the State designed or applied effective measures which would take into account the interests of the local population, affected by the pollution, and which would be capable of reducing the industrial pollution to acceptable levels.

S 134 The Court concludes that, despite the wide margin of appreciation left to the respondent State, it has failed to strike a fair balance between the interests of the community and the applicant's effective enjoyment of her

right to respect for her home and her private life. There has accordingly been a violation of Article 8.

30. In ***Moreno Gomez v Spain*** (16 November 2004) 4143/02
In this case, the applicant had lived in a residential quarter of Valencia since 1970. In June 1996, the City Council approved a bylaw on noise and vibrations. Article 8 of the bylaw says that in a family residential area (such as the one in which the applicant lives) external noise levels were not to exceed 45 dBA Leq between 10pm and 8am. Article 30 of the bylaw defines 'acoustically saturated zones' as areas in which the large number of establishments, activity of the people frequenting them and passing traffic expose local residents to high noise levels and cause them serious disturbance. The applicant was exasperated by the situation, which prevented her from sleeping and resting and caused her insomnia and serious health problems.

S 57 The present case does not concern interference by public authorities with the right to respect for the home, but their failure to take action to put a stop to third-party breaches of the right relied on by the applicant.

S 60 In view of its volume – at night and beyond permitted levels – and the fact that it continued over a number of years, the Court finds that there has been a breach of the rights protected by Article 8.

S 62 In theses circumstances, the Court finds that the respondent State has failed to discharge its positive obligation to guarantee the applicants right to respect for her home and her private life, in breach of Article 8 of the Convention.

31 The above Cases reveal how the European Court of Human Rights has considered breaches of Article 8 where the root cause of the issue is an environmental pollution. A loss of a view that has triggered a loss in property value has not, in itself, been considered a breach of Article 8 and Article 1 of the First Protocol. This was shown in the Case of ***Lough & Ors v Secretary of State and Bankside Developments***, July 2004, in the UK Court of Appeal, before Pill LJ, Keene LJ, and Scott Baker LJ. The Appellants were objectors to a development proposal that had been permitted following a Planning Appeal. The Appellants submitted that the Inspector had erred, it was claimed, in failing to consider three of the complaints made by the Appellants: loss of a view, interference with television reception during the construction of the proposed building and the diminution in value of 15% to 20% in the properties. The Court of Appeal upheld the previous Court's decision that there was no breach of Article 8. The Court found the creation of a diminution of value as a separate and distinct breach of Article 8 and Article 1 of First Protocol was not proven.

32 However, diminution in value has been an important consideration when noise pollution is the interference: In ***Dennis and Dennis v Ministry of Defence*** (2003) EWHC 793 (QB), Mr Justice Buckley found an interference with the Convention rights of the Claimants whose enjoyment of their home (and its value), Walcott Hall, was impaired by the noise of overflying Harrier jets during pilot training exercises from nearby RAF base at Wittering. Also in ***Hatton v UK*** (2003) 37 EHRR 288, the Court had to consider, in the context of Article 8, the level of noise caused by night flights at Heathrow Airport and its effect on nearby residents.

In S.96:

> *Article 8 protects the individual's right to respect for his or her private and family life, home and correspondence. There is no explicit right in the Convention to clean and quiet environment, but where an individual is directly and seriously affected by noise or other pollution, an issue may arise under Article 8.*

33 The **Hatton** judgment also clarifies the nature of the State – or regulatory authority's "positive obligations" to regulate private parties and the balancing exercise it is called upon to perform.

> *S118: It is clear that in the present case the noise disturbance complained of were not caused by the State or State organs, but that they emanated from the activities of private operators. It may be argued that the changes brought about by the 1993 Scheme are to be seen as a direct interference by the State with the Article 8 rights of the persons concerned. On the other hand, the State's responsibility in environmental cases may also arise from a failure to regulate private industry in a manner securing proper respect for the rights enshrined in Article 8 of the Convention. As noted above (S98), broadly similar principles apply whether a case is analysed in terms of a positive duty on the State or in terms of an interference by a public authority with Article 8 rights to be justified in accordance with paragraph (2) of the provision...The question is whether, in the implementation of the 1993 policy on night flights at Heathrow airport, a fair balance was struck between the competing interests of the individuals affected by the night noise and the community as a whole.*

34 Mr Justice Buckley in ***Dennis & Dennis v MOD*** **[2003]** made a further point on "proportionality". The decision established an important principle in domestic law in relation to proportionality and compensation. First, he found that the evidence of severe noise nuisance and consequent loss in value of the estate established an interference with both Article 8 and Article 1 of the First Protocol. In these circumstances, he held that a fair balance would not be struck in the absence of compensation.

> *"I believe it is implicit in the decision **S v France**, that the public interest is greater than the individual private interests of Mr and Mrs Dennis but it is not proportionate to pursue or give effect to the public interest without compensation for Mr and Mrs Dennis ... in my view, common fairness demands that where the interests of a minority, let alone an individual, are seriously interfered with because of an overriding public interest, the minority should be compensated."*

35 Without an acceptable scheme for compensating those directly or seriously affected by the noise and economic loss, a proposed development of wind turbines cannot be said to achieve a fair balance, as per ***S v France***. As a consequence, if there is a violation of Article 8, it follows there is most likely to be a violation of Article 1 of the First Protocol, and it is submitted that the damage will flow from the escape of the environmental noise pollution plus an element of value directly attributable to the visual pollution (flicker/strobing).

36 **Justification for Interference**
Once an interference with the families' Convention rights is considered likely, the question is then whether that interference can be justified in order to avoid a violation of the Convention right. To justify the interference it must be shown to be "in accordance with the law and ... necessary in a democratic society" in the interests of one of the recognized categories listed in Article 8(2) or in the public interest under Article 1 of the First Protocol. It is accepted that if the decision makers for the State approved the development by granting a Planning permission, in accordance with the Town and Country Planning Act, it would be in accordance with the law. However, the development may not satisfy other elements of justification.

37 The interference might be "necessary in a democratic society" only if:

a) It was in response to a pressing social need; and,
b) It involved no greater interference than required to address that need (this is the proportionality principle).

38 It is difficult to see how a wind farm development satisfies any of the Article 8(2) social need categories: "national security, public safety, the economic well-being of the country, the prevention of disorder or crime, the protection of health or morals or for the protection of the rights and freedoms of others".

39 The stated purpose of most wind farm developments is to promote renewable energy in order to reduce carbon emissions and thus protect the global environment. Conceivably this could involve protecting the rights or freedoms of others, but it would be a weak claim and not sufficient to justify interfering with an individual's valuable rights of privacy under the Article 8.

Moreover, it could be argued that the wind turbine developer could attain the same goal of reducing carbon emissions, with an increased buffer zone between homes and the wind turbines. Thus, the developers' and communities' needs would both be met.

Other options might include using smaller wind turbines, fewer wind turbines, controlling blade rotation speed, and turning them off at night.

40 Whether onshore wind turbines satisfy the "public interest" requirement of Article 1 of the First Protocol is a separate question. It is arguable that the wind turbines do not satisfy primary Government Energy Policy and are therefore not in the public interest.

41 Government Policy, as set out in the Energy White Paper [Dti. *Energy White Paper: Our Energy Future: Creating a Low-Carbon Economy.* Dti: London, 2003], strives to maintain the ***"reliability of energy supplies"*** (S. 1.18.) and states that ***"reliable energy supplies are fundamental to the economy as a whole and to sustainable development. An adequate level of energy security must be satisfied at all times in both the short and long term futures."***

42 The national importance of reliability in energy supply is taken forward in *"Our Energy Challenge"*, the Dti consultation document issued in 2006. The State set several goals for the country's energy supply:

a. *"To maintain the reliability of energy supplies."* [p 11, S.1]
b. *"The Regulatory framework must give high priority to reliability."* [p 32, S.2.2.2, Reliable energy supplies]
c. *"Maintaining the reliability of electricity supplies will require very substantial levels of new investment ..."* [p 50, S.3.1., Looking ahead]

The key feature of onshore wind generation is its total unreliability in the supply of electricity. Furthermore, because the Dti 2006 document is a major review of UK energy policy, within its 72 pages, there is little mention of onshore wind power, which demonstrates just how insignificant it is to the State as a future electricity-generating source.

43 Furthermore, in his report, *"Power to the People"*, Professor MA Laughton noted the innate unreliability of wind as a secure source of energy:

> *"... a more detailed examination of one aspect is necessary, namely that concerning the interaction of random, intermittency of supply with security, bearing in mind that security of electricity requires continuity of power delivery, not energy."*
>
> *"Large weather systems, particularly high pressure windless systems, can cover most of the country, as seen during the January 2003 cold spell for several days and again during the subsequent July heatwave. At such times the contribution from any wind ... are severely curtailed."*
> [Laughton MA. Power to the People: future-proofing the security of UK power supplies. ASI Adam Smith Institute, London 2003]

44 The unreliability of electricity supply and flow from wind turbines is further emphasised in the following reports:

a) *"An Engineering Appraisal of the PIU Energy Review"*, The Royal Academy of Engineering for the Energy Minister, August 2002; and,

b) *"Energy at the crossroads, The Chemical Engineering Contribution to the UK Energy Debate"*, The Institution of Chemical Engineers for the Energy Minister, September 2002.

45 The generation of electricity from wind turbines depends entirely upon the weather. Because this resource is uncontrollable by man, the electricity flow is unreliable and unpredictable. In failing to provide a reliable and secure electricity supply, wind turbine generation thus does not comply with Government Energy Policy.

46 It is however necessary to recognize that the Dti Energy Review [2006] supports offshore wind farms because firstly the wind offshore is more reliable than onshore wind, thereby producing substantially higher effective electricity generation. Secondly, an array of several hundred wind turbines linked to a central collecting pod on the seabed can feed electricity by a single cable to the shore, where a hydrogen generation plant could be located. With a large hydrogen storage capacity, this hydrogen plant would then generate electricity by burning hydrogen in a controlled, reliable, and sustainable form supplying electricity directly to the National Grid. This combination only then meets the National Policy for the reliability and security of electricity supply, i.e., the source of electricity supply is from hydrogen storage.

47 It is also necessary to recognize that the Dti Energy Review supports onshore solace wind turbines serving an industrial unit, commercial premises and small communities. This works because the amount of electricity generated is 'de minimus' and destined for direct commercial consumption. This system allows the National Grid to act as provider of balancing power to the industrial/commercial user without disruption to the network supply.

48 Wind turbine developers often argue that wind turbines are State Policy. It has not been possible to find documentation to support this proposition. It may be more correct to say that State Policy takes the form of setting targets for renewable energy generation and that industry's response to meeting these targets is the wind turbine as it is available technology. Furthermore, the State has set targets in the form of 'installed capacity', and apparently it matters not to the State that in some locations, actual electricity production on an annualised basis is merely circa 24% of installed capacity. While State Policy clearly identifies 'reliability' and 'security' of supply as critical objectives, wind turbines will not satisfy this Policy. The EU Court of Human Rights might wonder at the remoteness of wind turbines from fulfilling Policy.

49 There is **no justification** in allowing wind turbines to be built so close to peoples' homes with the result that they fail to meet the noise limitations set out by the World Health Organisation *Guidelines for Community Noise 1999*, a consequence of which is to create serious health damage and a likely violation of the Human Rights Act 1998.

50 In considering the question of Tort, it is a well established principle of UK law that if a landowner collects something onto his land that is likely to do mischief if it escapes onto adjoining land; then if it does escape, the landowner is liable for the damage ***(Rylands v Fletcher)*** (L.R.1. Ex 265, 279 – 80):

> *"The person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape."*

51 In the House of Lords, Lord Cairns added that in order for the Rule to apply, the defendant's use of the land must be "non-natural". P James on Law of Torts points out:

> *"The Rule applies to things likely to do mischief if they escape, e.g. water, gas, electricity, fumes, rusty wire from fencing, explosions.... To give liability there must be an escape from the premises/land."*

52 The owner of land operating a wind turbine to generate electricity is performing an industrial activity by installing the turbines, collecting the wind, using the wind to manufacture electricity, and discharging the wind (and the resulting wind vortices) over his land. During the manufacturing process, the wind changes its form, velocity, and character, and collects sound characters of its own and in combination with the design and engineering of wind turbines, creates environmental pollution. Over distance, the pollution dissipates and within large sites, the pollution dissipates before leaving the land boundaries. However, on small sites in well-populated areas, the pollution will still be present when the wind – and the resulting wind vortices created by the wind turbines – enters a neighbour's property, mischief is likely to occur with consequent damage to health. The liability may be a strict liability under the Rule of ***Rylands v Fletcher*** and not covered by indemnities or insurance cover. Cases that are more recent include: ***Bottomley v Todmorden***, High Court 2003, and ***Transco v Stockport Metropolitan Borough Council***, House of Lords 2003.

53 Others have noted that perhaps the wind farm developers' contractual indemnities are qualified by the requirement of proof of negligence and based upon strict liability under ***Rylands v Fletcher***, which would mean that in such circumstances liability falls on the landowner.

54 The failure of the State to properly protect the health of people from environmental noise pollution that is a consequence of development permitted by the State, is not justified.

55 This section considered the application of the EU Human Rights Act, Article 8 and Article 1 of the First Protocol, to the physiological and medical suffering of families caused by a decision by the State that allows developers to build wind turbines too close to homes. The weakness of the Human Rights Act is exposed by the fact that decision makers of the State rely on the argument 'balance in favour of the State', to justify serious violations of family to the right of respect for private and family life. Yet applying the dictum of Justice Buckley (S.6.34), if the State considers wind turbines are public policy, then the 'minority' interest should be compensated. If wind turbines are not State policy, then decision makers may be challenged when they use the 'balance in favour of the State' to justify giving an approval that risks a violation of basic Human Rights.

The UK Lord Chancellor has said that:

> *"We in Government will campaign passionately and defiantly for human rights for everyone in Britain. Because we believe it is the foundation of both our security and our prosperity."* [S. 6.02]

On 10 May 2006, The British Consulate, New York, sent an email entitled, *"UK Elected to UN Human Rights Council"*. The last paragraph states:

> *"The UK remains committed to striving for the highest standards of human rights both at home and around the world. We are committed to fulfilling the detailed pledges we made as part of our election campaign to promote and protect human rights in the UK and globally. We will play the fullest part in making the new Human Rights Council a success."*

It is for the reader to judge the evident disparity between the words and the deeds of the UK State when it permits developers to build wind turbines too close to dwellings. The disparity might possibly be explained by the enthusiasm of Departments of State to achieve renewable energy targets set by the State, and in order to achieve those targets, treat the Human Rights Act as an obstacle to circumvent.

Peter Hadden

[Note: Sentences emboldened within quotations are the author's emphases.]

Section 7.0 CONCLUSION

The environmental noise pollution from wind turbines built too close to dwellings causes serious discomfort, and often health injury, to families. Oftentimes those affected did not object to the construction, accepting the developer's assurances that noise would not be problematic.

Section 4 of this Review, **Acoustics**, explores the research on noise radiation from wind turbines. Locating wind turbines close to families demands a precision, accuracy, and certainty of acoustic prediction and calculation that is just not available to the wind energy engineers and acousticians. The ETSU-R-97 Noise Working Group (UK) concluded that it would be too restrictive on wind farm developments to provide the protection necessary [i.e., to prevent sleep deprivation].

The challenges in designing a predictive model for wind turbine noise are complex. Factors include the very nature of wind turbine design itself, e.g., the rotation of the blades through the air, each passing the tower rhythmically, creating a characteristic pulsating sound as well as a vortex of air; moreover, there is an interaction among the turbines, so the placement of each turbine within an array can influence noise emission. Other factors include the constantly changing atmosphere and wind speed, temperature, and terrain. Noise, particularly low frequency noise, travels not only seismically but also airborne over terrain. On occasion, the local geography can act like a giant microphone. Thus, when wind turbines are located too close to dwellings, their noise may have an adverse impact on residents, because the methods and models used to predict wind turbine noise have distinct design limitations.

The result is an adverse impact not only to quality of life, but those who live near wind turbines may also suffer adverse health effects. Research links noise to adverse health effects, e.g., sleep deprivation and headache. Sleep deprivation itself may lead to physiologic affects, such as a rise in cortisol levels, a sign of physiologic stress, as well as headache, mood changes, and inability to concentrate. Initial research into the health impact of wind turbine noise (including the 'visual noise' of shadow flicker) reveals similar findings. Indeed, while many studies in work environments or laboratory simulations confirm these responses, those living near wind turbines endure continuous, long-term exposure.

Thus, the personal and media reports, emerging clinical evidence, and published research combine to offer urgent and compelling reasons for Government to reconsider policy on wind turbine developments. Several reports offer guidance, including the World Health Organisation *Guidelines for Community Noise 1999*; the UK Noise Association's report, *Location, Location, Location* (2006); and the statement by the French National Academy of Medicine (2006).

These are also compelling reasons for the Government to seek expert independent medical advice and epidemiologic research to assess the health impacts in order to prevent additional injury and to redress the injury to those already affected. Indeed, to express this more forcefully: The question the Government must address is whether they – the Government – are prepared to knowingly subject its people to substandard conditions when these could easily have been avoided, e.g., by following the level of health protection advised by the World Health Organisation *Guidelines for Community Noise 1999.*

Although the Government may conclude that they must wait for the scientific evidence to unfold, this approach ignores those many families – and those who will unfortunately and inevitably follow – who are experiencing genuine distress, and whose predicament could so easily have been avoided.

As this is a matter of public health policy, proceeding with wind turbine developments and applications that violate the public's health may also be a violation of the Human Rights Act by the landowners, the wind turbine developers, and the State.

The Review addresses the issue of Human Rights in Section 6. Although European States have 'Bylaws' or 'Guidances' and the United States has 'Ordinances' that provide guidance to Planning decision makers, in the final analysis it is contended that the responsibility of the decision maker is not merely to seek compliance with a Bylaw/Guidance/Ordinance in arithmetical terms, but also to establish beyond reasonable doubt that the families' right to respect for their homes and their private lives is not violated. If the State decides that the public interest in building wind turbines is greater than the individual private interest, then the violation is not proportionate without compensation for the individual (S6.34).

RECOMMENDATIONS:

- The Government would be prudent to institute an immediate and mandatory minimum buffer of 2km between a dwelling and an industrial wind turbine, and with greater separation from a dwelling for a wind turbine with greater than 2MW installed capacity.

- There is a need for a multidisciplinary team of experts – independent of the wind energy industry – to assess clinically and to investigate epidemiologically, the health impacts on people where industrial wind turbines have been located too close to their dwellings.

- Governments are appealing to the social and ethical conscience of commerce to become carbon neutral and mitigate the effects of global warming. In an appeal to the ethical and social conscience of bankers and investment institutions, we recommend that before providing finance to wind turbine developments that are near family homes, the Investors should demand from the developers a Guarantee Bond that unreservedly guarantees that the operation of the wind turbines will not violate the families' right to respect for their homes and private lives. This would be a prudent caution to take in order to lessen the risk of potential environmental and medical claims at some future time.

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APPENDIX – PROPERTY VALUES

1. INTRODUCTION

This Appendix provides global evidence of the negative impact of wind farms on residential property values where the wind turbines are built nearby.

The valuation of a residential property is what it will fetch in an open market sale. The value will depend upon a number of factors and not least will be the number of potential buyers in the market for that type of property in that location. More than one buyer is likely to trigger a bidding-up situation. Wind farms are normally built in rural locations, therefore apart from accommodation size, important influences on value will often be the view, the peace and serenity, and a rural environment.

It is established that in many rural locations a wind farm will reduce the value of properties located nearby; but as the distance between wind turbines and dwellings increases, the valuation impact is lessened and the prospect of consequent health problems reduced. A part of the loss in value will be attributable to the loss of a quality view. However, a substantial apportionment of the loss in value flows directly from the environmental noise pollution and indeed the consequent health impact that flows directly from the environmental noise pollution. A further smaller part of the loss will be attributable to the rotation of the turbine blades, which in certain circumstances will cause strobing light/shadow flicker, which again can have health repercussions. In a high value area of the country, the potential valuation impact is likely to be higher.

It is important to establish the part of the valuation loss that directly flows from the environmental noise pollution as this, in most instances, will reflect the property damage resulting from the escape of the noise pollution. In a well-populated rural area the cumulative financial damage, the loss imposed on the community, will substantially exceed the 'de minimus' public interest that will be served from the wind farm. The following are samples of reported property devaluations from three continents.

2. U.K.

Case A

TURBINE PLAN CUT VALUE OF OUR HOME BY A THIRD

Western Morning News (Plymouth) 9 December 2004

"A Westcountry farming couple have seen the value of their home slashed by a third since controversial plans were submitted to build three giant wind turbines in one of the region's beauty spots, it has been revealed.

Richard and Lynne Lethbridge say they discovered the devastating news after deciding to sell the home their family has farmed from for decades, because of the plans for the turbines.

Two independent agricultural valuers, which visited the large four bedroom bungalow in East Allington last week, both concluded that since the planning application for the turbines at Goveton was submitted earlier this year, the price of the Lethbridge's near £500,000 home had fallen by £165,000.

NPower's plans, which have been submitted to South Hams District Council, are for three generators, each 100 metres high, to be built on land off the A381 between Kingsbridge and Totnes, next to the turning for Goveton.

Mrs Lethbridge, 57, whose property is the closest to the proposals at just 540 metres away from the development, said she had envisioned living in the area with her husband Richard, 58, for the rest of their lives. But she said that it looked extremely likely they would have to move on. "If the plans go through we will have to sell," she said.

"We're upset because it's detrimental to our health and we are so close that we would hear them and to me it would also be a great eyesore. We decided to have the house valued with a view to selling because we're concerned about our livelihood. Richard is a farmer and has been all his life and for the last 15 years or so I've been a farmer's wife. His parents have been here for over 60 years and he was born here and built the home we are in at the moment on the same land in the early 1970s. I thought we would live here all of our lives and this would then go to our family. We would not have thought of moving but we feel we are being forced out because of this. Mrs Lethbridge said the only way the family would consider staying at their home would be if the plans did not go ahead.

"When we found out about the application we realised it was just 540 metres away. It's too close to us. If the plans go ahead we will move. I don't think anyone could change our minds, which is really sad. Her husband Richard added: "I don't really want to leave here, but the noise will be a big problem and with the health issues and the loss of view it will be too much. It doesn't matter how much compensation we would get, if any, because it would be the view and the way of life we would lose."

Case B

In a survey of its members in November 2004, **The Royal Institution of Chartered Surveyors** issued 1942 questionnaires and received 405 responses, of which 20% (81) had dealt with transactions affected by wind farms. The Report stated:

"Actual effect:

-- there are negative influences on the values of residential properties, though a sizeable minority report no impact on prices.
-- nowhere is it considered that wind farms positively affect residential property values ...."

"The regional results vary from 44% of surveyors in Wales reporting that residential property values are lower as a result of wind farm developments to a high of 77% in the South West."

"Conclusions:

The three main reasons for this negative impact on property values are the visual impact after completion, the fear of blight and the proximity of residential property to a wind farm development"
The negative impact of wind farms on property values appears to decline over time. This may suggest that the impact lessens as wind farms become more established."

The last conclusion appears tentative and there is no evidence in the report to support this view.

Once the zone of pollution falls in value its lower relative position to other nearby similar but unaffected properties becomes established. From this new relationship of property values, the market residential property inflation will apply to the polluted zone, but in some locations, it may be argued that the pollution is sufficiently severe that a lower inflation level will apply.

A simple example:

Consider similar properties, one in village A valued at £460,000 and a second in village B valued at £460,000. A wind farm is built close to the property in village A decreasing the price the property would fetch in a sale to £280,000. The property in village B is unaffected. After 5 years of 6% compound property inflation, the village A property will rise in value to £374,700 but the house in village B will have risen in value to £615,580, a loss to the house in village A of £240,880.

Some might argue that the rise in value of the house in village A represents a recovery from the initial impact of the wind farm. Others will contend the damage in terms of financial loss remains with the property.

Case C

WINDFARM BLOWS HOUSE VALUE AWAY

Westmorland Gazette, 9 January 2004

"Barry Moon and his partner, Gill Haythornthwaite, live in the shadow of the wind turbines at the controversial Ireleth windfarm near Askam. When they bought Poaka Beck House in 1997, the couple were unaware the arrival of the windfarm was imminent. Previous owners, David and Diane Holding failed to tell the prospective buyers in spite of the fact that they had vigorously opposed the initial application for the wind farm in 1995.

District Judge Buckley decided that this amounted to material misrepresentation and ordered the Holdings to pay compensation of 20% of the market value of the house in 1997, £12,500 plus interest, because of damage to visual amenity, noise pollution, and the 'irritating flickering' caused by the sun going down behind the moving blades of the turbines 550 metres from the house."

Case D

In a letter to a client about the effect of wind turbines on property values, dated May 1998, Estate Agent **FPD Savills** [Norfolk Office] concluded:

"Generally, the higher the value of the property the greater the blight will be... As you go up the value scale, buyers become more discerning and the value of a farmhouse may be affected by as much as 30 per cent if it is in close proximity to the wind turbine."

Case E

PRICES FALLING

Lynwen Evans, Cambridge News, 11 April 2005

"I would like to put my statement to you loud and clear in response to your article "properties not hit by wind farm" (News, April 5).

I for one am in the same position as lots of people in the UK at this moment with the wind farm growing in popularity.

The first thing I did when the news got out about the proposed wind farm, was invite an estate agent to value my property. You can imagine my response when I was told that the value of my "basic three-bedroom bungalow" was going to drop £45,000.

With that, I had a discussion with one of the farmers involved in this wind farm, and she herself told me that they have had their property valued, and yes, it will lose value, but of course the land will gain value because of the wind farm.

One of the villagers put their property on the market as soon as the news came out. They had three people interested, until they were told there was a proposed wind farm. At that, they all pulled out.

These estate agents don't like admitting that there is a fall in property values. Needless to say, they themselves will be out of pocket.

Two of the villagers went into an estate agent asking about the prospects of selling properties in the villages concerned, only to be told that "these areas are now a no-go area!"

It's time devaluation is made known, everyone should know of what's going to happen to all that they have worked for.

Lampeter
Ceredigion
Wales
http://www.cambridge-news.co.uk/news/letters/2005/04/11/529e6c57-a1ec-428b-ad0c-855515b543cc.lpf

Case F

In a letter to the ***Brecon and Radnor Express and Powys County Times***, 27 July 1995, Mrs Moores of Bucks wrote:

"My mother lives in Wales within sight of a wind factory. For two years we have been trying to sell her house as she is old and frail and wishes to buy a place near us in Bucks ... So be warned – it seems that once a wind factory is built within sight of your home , the value drops considerably. We have been forced to drop nearly to half the original price and have still not sold."

Case G

The Managing Director of Bradleys, (Chartered Surveyors), wrote the following letter in November 2004, to the Denbrook Valley Action Group, which is opposing wind turbines in Mid Devon.

"Dear Sirs
Thank you for your e.mail dated 3rd November 2004, with respect to a proposal to develop a site of 10 or more (approximate) 300-400 foot wind turbines in the Denbrook Valley between Spreyton, Bow and North Tawton.

You have requested that I comment on various matters with respect to this proposed development.

There is no doubt that no added value would be brought to a property sited within the locality of such a development.

It is likely that properties sited within the locality of such a development will be devalued , although the amount of devaluation will depend heavily on not just the proximity but also on individual matters affecting the uniqueness of each property such as spoiling the view or being affected by noise pollution. If, for example, a wind turbine is only 300 metres away from a property it may be in such a position that it cannot be heard or seen. But another property, say 800 metres away could be in full view of the turbine and also subject to its noise pollution.

Under certain circumstances it would be possible for a property within 600 - 800 metres to be devalued by some 30%, property within 1 mile possibly 20% and property within 2 miles possibly 10%. It is important to stress that each individual property would be affected in a different way.

Although it is conceivable that a property within 600/800 metres of such a development would be un-saleable there is no doubt that the property could be significantly devalued, and no doubt its marketability adversely affected.

It should be taken into account that the area in question is one of high desirability and high value and one of the most important reasons for this is its beautiful mid Devon countryside location. Therefore the area around the proposed development would be significantly affected.

With regard to the two comments that "there is no evidence of a general devaluation of local property prices caused by a wind farm", and "the lack of

a house price affect is also confirmed by the Royal Institution of Chartered Surveyors who state that there are no studies that suggest an affect either way", these comments are not actually saying that property prices are not being devalued, they are only stating that there are no studies which have been carried out with regard to the price affect.

I would also point out that any Chartered Surveyor carrying out a valuation on a property in the West Country, where in the proximity there are features such as electricity pylons, radio masts and wind turbines, then there will be a comment in that report that it could affect value, marketability, and/or resaleability.

Yours sincerely
BRADLEYS SURVEYORS

Case H

In a letter of 22 October 2003, South West Estate Agent J Carslake of **Kivells Estate Agents**, Holsworthy, wrote to a client advising:

"It is the case that a wind turbine within sight or sound of a residential property will affect the value of the property detrimentally. The affect on value would, in my opinion, be up to 50% of ordinary open market value, but it is difficult to provide proof of this."

"It is certainly also the case that the threat of a windfarm close to a property can make it un-saleable (I have a case in Bradworthy for example) and would certainly assert that the marketing becomes much more problematic when a wind turbine is situated within sight or sound."

Case I

Evidence of reduced house prices as a direct result of the threat and/or presence of wind turbines can be found on the website of the **Mynydd Llansadwrn Action Group (Wales)** [http://www.turbineaction.co.uk/wind-turbine-facts.htm#refs]

"In May 2005, a local resident near Brechfa reported in the Carmarthen Journal that:

"Our property, in the middle of the proposed TAN8 site (Strategic Area G) had a firm offer of £318,000. One week later our prospective purchaser, who incidentally knew about the turbines and had no problem with them, said they would do us a favour and 'take it off our hands at a big financial risk - for a reduced £250,000 which was higher than the 40 per cent we could expect to get, being near turbines!' "

Case J

Surveyor and Valuer Gareth Scourfield inspected a number of properties in July 2005 near a proposed development of 10 wind turbines at Esgairwen Fawr, Lampeter Wales.

In his report entitled *'Report on a sample of properties inspected near a proposed wind farm at Esgairwen Fawr, near Lampeter, Ceredigion'* (July 11, 2005), he wrote:

"The proposed development also towers over houses in Mydroilyn village. Given a sample of properties inspected and reported as above [i.e., in his Report] *this represents an immediate loss of £1,528,000 for the 8 properties mentioned, let alone all those which may be affected by the turbines, both by seeing them and hearing them."*

Case K

Giant blades are slicing prices

Sunday Telegraph, 17th October 2004, House and Home supplement, page 2
[Excerpts from article by Ross Clark]

Homeowners on the damp expanses of Romney Marsh in Kent have long had to contend with the presence of Dungeness nuclear power station, asking themselves what would happen if it blew its top. Rather less might they have suspected that they would one day find themselves cursing the nuisance posed by "green" renewable energy. Last week, the DTI began an inquiry into plans for a wind farm whose 27 turbines will spread over 1,000 acres of the marsh and stretch into the sky 370ft.

Much of the recent debate over wind farms has revolved around whether they lower the value of nearby properties. Until earlier this year, the British Wind Energy Association (BWEA) maintained that wind farms do not affect values - in fact, the association listed this as one of the "top 10 myths about wind farms" on its website.

In January, however, came the case of Barry Moon, who won £15,000 in damages against the previous owners of his four- bedroom home at Marton, near Ulverston, Cumbria. The vendors had failed to warn Moon about plans for a wind farm on a nearby hill. After hearing evidence from chartered surveyors, the judge made an award on the basis of a 20 per cent reduction in value of Moon's home due to the visual impact of the turbines and the annoying, low-frequency hum. "I've lived a similar distance from the M3 as we live from the wind turbines," says Moon, "but this was a lot worse. What is irritating is the way the whooshing keeps increasing and decreasing in magnitude."

While the Moon case established in law for the first time that a wind farm can lower the value of a home, it did nothing to help homeowners win compensation from the builders and operators of wind farms.

What residents can do is ask the environmental health officer at their local authority to measure the sound produced by the turbines and declare a statutory noise nuisance. As a result of measurements taken by Barrow District Council, Moon managed to persuade Powergen, the operator of the wind farm,

to install a noise management system, which shuts down three of the turbines when the wind is coming from a certain direction.

Three other couples, who live within half a mile of the turbines, had a less happy experience. In January, they took Powergen to Kendal Magistrates Court to win a noise abatement order - and lost. "We were told that our evidence lacked specificity, even though we had 26 recorded cases of noise nuisance," says David Brierley, a former policeman who wasn't named in the case, but who helped the residents compile their evidence.

"The noise management system doesn't work. I live 1,000m south of the wind farm and my wife, who is asthmatic, gets very distressed when the wind is coming from the north because she can feel her breathing trying to synchronise with the thump of the blades."

If the experience of Cumbrian homeowners is anything to go by residents within a mile or so of the proposed Romney Marsh wind farm will have an uphill struggle selling their properties from now on.

Kyle Blue, a Penrith estate agent, runs a protest group objecting to a proposed 27-turbine wind farm at Whinash, Cumbria. In May, the Advertising Standards Authority (ASA) upheld a complaint against him by the BWEA for claiming, on the group's website, that the wind farm would affect property values (the ASA indicated it would have been happy with <u>might</u> affect property values).

Yet when his company auctioned Bretherdale Hall, a semi-derelict farmhouse half a mile from the proposed turbines; it fetched £200,000 - £80,000 less than its valuation before the plans for wind farms were announced.

Another nearby property, a freshly restored £340,000 farmhouse, found a buyer who said the wind farm wouldn't bother him because he was keen on renewable energy. "Then, he went away, did some research and changed his mind," says Blue. The house remains unsold.

<u>Case L</u>

In May 2000, Estate Agents Russell Baldwin & Bright, Brecon in Powys, wrote the following to letter a client:

> *"Further to our telephone conversation last week I confirm that I have withdrawn your property from the market.*
>
> *As discussed since the proposed Wind farm planning application was published enquiries for your property have fallen off dramatically. It is obviously very disappointing that this situation has arisen after such a promising response to earlier marketing which resulted in an excellent number of viewings. There is however, little point in continuing to market your property as any serious purchaser will be immediately put off by the prospect of a nearby windfarm.*
>
> *On a more general note I have a prospective purchaser at Merthyr Cynog having serious doubts over its proximity to the proposed site.*
>
> *I will keep the file pending until planning application is resolved at which time I trust we will be able to re-market the property."*

3. AUSTRALIA

Case A

HOUSE VALUES DECLINE WITH TURBINES
CLOUDS GATHERING OVER WIND FARM PLAN

The Australian, January 9, 2006, by Natasha Robinson

The picturesque fields of Foster North, in Victoria's South Gippsland, have become a battleground with farmers and residents divided over a proposal to build a massive wind farm. Farmers who will benefit from the 125m turbines being built on their land are pitted against their neighbours who bitterly oppose the 48-turbine, 2000-hectare Dollar Wind Farm project. And as state governments grapple with energy demands amid a looming coal crisis, it is a fight likely to be played out in communities around the country.

Victoria's Government had "ridden roughshod" over the Foster North and Dollar communities in refusing to give their council a say on whether the proposal went ahead, Federal Environment Minister Ian Campbell said yesterday. The Victorian Government made its decision before Christmas on the project, planned for the northern side of the South Gippsland Highway at Foster North and Dollar. It is yet to publicly announce if it approved the wind farm. Premier Steve Bracks has pledged to source 10per cent of the state's energy from renewable sources by 2010. The Dollar Wind Farm project was previously the work of a New Zealand-owned company but the project was sold last year to Australian company AGL. The proposal is now with Senator Campbell, who will consider if it poses national environmental concerns.

In Frank and Theresa Cicero's quiet, winding, street in Foster North, local opposition to the wind farm -- which will see a turbine built 800m from their bush retreat -- is easy to find. Almost every property in their street, apart from those of the farmers on whose land the turbines are being built, is for sale.

'I've watched my husband work all his life to build this home," Mrs Cicero said. "We've never had loans, we've always worked and saved. And now we find everything that we've put in here, it's all worth nothing.'

The Ciceros had their home valued at $410,000 before the wind farm was taken into account. Afterwards, the estimated value dropped to $270,000. They have not received one offer for their property in two years. They say if the turbines are erected, they will have to cope with an incessant sun flicker, noise, and a viewing platform.

A spokeswoman for the Victorian Government said it was a complex issue and the Government understood that the community had concerns.
*Web link: http://www.theaustralian.news.com.au/common/story_*

Case B

In **'Research of property devaluations'**, the author, Eleanor Tillinghast (Green Berkshires, Inc, Massachusetts, 2004), reports:

"In a vacation area near the Toora wind power plant in South Gippsland, Australia, a real estate agent told a news reporter that the 12 turbines were 'definitely' having an impact on values. 'If they are near the property, buyers are staying away,' Wesfarmers Landmark Leongatha agent Glen Wright said. 'If I had to put a figure on it, I would say (a reduction of) 25 to 30 per cent on the going value.'

Another real estate sales manager had major difficulties selling a property near the Toora plant. 'I would have shown 50 or 60 people through that property and I would say half of those wouldn't even look at the place once they realize it's in the vicinity of wind turbines,' Bruce Falk said. 'And half of the other 50 per cent were concerned about *resale so they offered 20 per cent less than the price the owners would accept'*
In another part of southwest Australia, John Denham, who had leased his farm for eight turbines, found that their presence hindered his efforts to find a buyer when ill health forced him to sell the land."

4. Denmark

In Denmark, Erwin Thorius, president of the National Association of Neighbours to Wind Turbines, said recently that *'people living near windmills found it impossible to sell their homes'.*

A study in Denmark about 10 years ago found that housing prices decreased near wind power plants, ranging from about US $2,900 at that time for a one-turbine facility to US $16,800 for a 12-turbine site. [Tillinghast, 2004]

5. Germany

Case A

The Darmstadt Manifesto (1 Sept. 1998), signed by more than 100 university professors in Germany, states:

"Falling property values reflect the perceived deterioration in quality of life – not just in areas close to the turbines, but even all over Schleswig-Holstein. More and more people are describing their lives as unbearable when they are directly exposed to the acoustic and optical effects of wind farms. There are reports of people being signed off sick and unfit for work ..."

Case B

FIGHT AGAINST WIND POWER

Olympic and World Champions have got together: they demand that Wind Power Stations be Built Away from Riding Stables

"Riders, friends of the riding community and owners of equestrian and breeding businesses are anxiously watching the encroachment of wind power installations over the landscape both in the Lander and throughout the country as a whole - chief among them Judith and Klaus Balkenhol. They want to prevent wind power stations from creeping even closer to riding stables. The signatories of the Memorandum are particularly concerned that equestrian businesses which will be affected are not consulted during the application process. The construction of wind power stations close to such establishments puts into jeopardy the livelihoods of numerous businesses and endangers many jobs. Constructions in the open countryside threaten not only trekking but also recreational riding. Noise and flicker from the turbines do considerable harm to horse and rider and endanger them equally. It is not for nothing that a statutory separation was made compulsory over 200 years ago between windmills and open roads, otherwise the horse shies ("spooks"). The effect of breeding means that there is now a considerably greater number of highly sensitive horses." (Quote from the Memorandum).

The riding community demand a separation of 2,500 - 3,000 metres [2.5 - 3.0 kilometres] between horses and windfarms.

All sensible people are in favour of alternative energy. But when these wind mills – which may be environmentally but not visually friendly – shoot out of the ground like mushrooms right before your very door, then it is quite a different matter. They are particularly unloved by horse people because the noise the blades make at various times and at various volumes, drives the horses wild, at least in the case of sensitive types such as dressage horses. Klaus Balkenhol, former Federal (German) trainer and now a national US team trainer, has himself now experienced this. The wind turbine which is 1 km away from his stables at Rosendahl in Munsterland often irritates the horses he is training to such an extent that any sensible work, to say nothing of hacking in the vicinity of the turbine, is out of the question.

A further 6 turbines are now being planned – something that Balkenhol discovered only by accident. "The Americans are not willing to train under these conditions," Balkenhol's wife, Judith said. "The (US National) team has made that clear to us.

The equestrian establishment, which lies in the shadow of the wind mills, is up for sale, "only at half the price, at the most, of what we invested in it."

A petition signed by numerous top German riders and 17 thoroughbred studs is expected to draw the attention of the authorities to the dangers and damage caused to riding establishments by wind installations. Not only competition riders but recreational riders as well, find little joy in riding beneath the whirlwind. "And all the time Munsterland advertises its ideal conditions for riders," said Judith Balkenhol.

6. New Zealand

TURITEA MAN FEARS HE'LL HAVE TO GO

The Daily News Watch, New Zealand, by Helen Harvey, November 10, 2006

A Turitea man says he will be forced from his home because Mighty River Power told him noise from wind turbines in the reserve will make his house uninhabitable.

Mark Nicholls has been living in his slice of paradise for 10 years. He has 20 hectares of native bush, 13ha of pasture, which he farms, and a view to die for. It is so private that he can bathe on his veranda.

He doesn't want to move, he said. "It's hard to achieve what I have here on my budget."

He first heard the news 12 months ago that four wind turbines from the proposed Mighty River Power/Palmerston North City Council wind farm would be 500m from his boundary.

The state-owned power company's representatives told him the noise from the turbines would make his house uninhabitable, he said.

In city council documents on the wind farm, it said that at 500m from a turbine, the accepted standard of noise should be between 40 and 50 decibels.

The report, presented at the infrastructural well-being committee on October 18, said 40 decibels is equivalent to that of a public library and a loud radio would be 70 decibels. An Ashhurst family had to leave their house last year because noise and vibration from the Te Apiti wind farm made it impossible for them to stay.

Mr Nicholls said his life has been on hold for a year and he is angry that an SOE (Mighty River) and a city council (he lives in the Tararua district) can destroy his idyllic rural paradise.

"Mighty River Power has made a lot of noise that in the fullness of time they will discuss a relocation package. This has been going on for 12 months."

He has asked the energy company what is happening, because he wants to get on with his life. "(They say) talks will take place in due course when the final location of the turbines has been established," he said.

"When you are told you can't live in your property, it changes your life. It's being told your life is going to change, but there is no qualification, no time frame. I don't know where I'm going to be in six months' time, one year's time. I can't plan. I feel that it's frustrating that one's life can be put on hold, not just mine, but my family's as well."

7. U.S.A.

Case A

Potential lessors get warning letters about turbine plan

Several residents oppose wind project in Cherry Valley
by Tom Grace Cooperstown News Bureau [New York, USA] 03/30/05

The attorney for residents opposed to wind turbines in Cherry Valley has sent warning letters to those who might lease their land for the project. The letters are intended to dissuade prospective lessors from participating in the project, said the writer, lawyer Peter Henner of Clarksville.

In the event the project, under consideration by Reunion Power of Montvale, N.J., goes forward, lawsuits may be filed. Henner said Tuesday that his clients want to be in the position of having warned their neighbors in advance.

Among the recipients of a letter from Henner is Daniel Wightman of Portlandville. His property east of the village of Cherry Valley is under active consideration by Reunion.

In a letter dated March 23 and provided to The Daily Star, Henner wrote to Wightman:

"I represent Raymond J. and Susan C. Rivard, Andrew and Kathleen Minnig, Linda VanSchaick, Philip and Leila Durkin, Patrick Shearer, Lynae Quimby, Steven and Angela Witham, Mark and Eliza Oursler, Diana Wells, Roy J. Hall and Paul Petersen, who own property that is in close proximity to your property in the town of Cherry Valley."

"It is my understanding that you are considering leasing a portion of your land to be used for the construction of wind turbines. Because these turbines may have an adverse impact upon my clients, I am writing to you to warn you that my clients will hold you responsible for any damage to their property that may result from these wind turbines."

Henner wrote that the windmills might cause his clients' property to depreciate, in which case, they "may have little choice but to commence an action to recover for the diminution in value of their property. They may also hold you liable for any adverse impacts, including the diminution of the quality of life that may result from the wind turbines."

Even if the windmills are built out of sight of his clients' homes, they may sustain a loss if the turbines can be heard from their residences, Henner said."

http://www.thedailystar.com/news/stories/2005/03/30/win5.html

Case B

Wind farm opponents speak out
More testimony set for tonight

By Mike Johnston, Kittitas Valley News [Washington, USA]
12 January 2006

Opponents of the Kittitas Valley Wind Power Project dominated Wednesday's second hearing on the wind farm proposed for 12 miles northwest of Ellensburg. They said the damage to scenic views from the wind turbines can't be lessened and will reduce property values.

Horizon has applied for up to 80 turbines ranging in height from 250 to 410 feet high, but company officials say they will only build 64.

The Desert Claim project, proposed by EnXco USA Inc. and centered eight miles north of Ellensburg, planned 120 turbines.

Slothower said those factors include conflicts with an increasing number of rural residences being built nearby and the subdivision of land for future homes and recreation, damage to the scenic views and others.

Colleen Anderson of Peavine Road, a real estate agent with Coldwell Banker-Kittitas Valley Realty, said she has compared average land sales near the wind farm with overall average county land sales involving parcels ranging from three to 20 acres. The sales took place in the last six months.

Anderson said land sales near the project area averaged $66,038, but the average countywide sale price was $126,223, a difference of $60,185. She also said lands for sale near the project area linger on the market longer.

'Based on this information,' Anderson said, 'it is my professional opinion that real estate values are adversely affected by the wind farms.'

She called on the two commissions to deny the project.

http://www.kvnews.com/articles/2006/01/12/news/news02.txt

Case C

The Wayward Wind

by Jon Boone, Silver Lake, New York, USA, 19 June 2006

"Do you believe industrial facilities stretching many miles across your landscape, with 105 spinning sky-scraper sized structures creating a cascade of noise are not going to negatively affect property values for those in the neighborhood, as the wind industry maintains a government study proves? One of the most validated real estate precepts is that prominent natural views and historic scenery have premium value, and intrusions restricting those views erode value ...

There are few windplants in the world, let alone the United States, with turbines over 400 feet tall placed so prominently near a resort community ...

Independent inquiry in Britain, Denmark, and New England suggest the likelihood of significant property devaluations. In his June 10, 2005 direct testimony before the Wisconsin Public Service Commission, Kevin Zarem, an appraiser, estimated that residential property near a proposed windplant "will likely be in the 17% -- 20% loss range." And this is based solely upon visual impact. He did not assess potential loss due to wind turbine noise, motion, or shadows.

Russell Bounds, one of Garrett County's leading realtors in large property transactions ... has already lost sales in the area of proposed windplants. Mr. Bounds testified in a PSC hearing that, over the last several years, he has had at least 25 people who expressed interest in buying land in the area targeted by wind developers. However, when he advised them about the plans for wind facilities, not one of those people expressed further interest."

... I have seen contracts which require land owners and encourage neighbors to sign a "memorandum of non-disturbance easement agreement," which absolves the wind company from liability for what the owners might regard as wind turbine-related nuisances."

Case D

Hearing for a proposed wind turbine development in Maryland, in 2006,

The panel heard the testimony of Russell Bounds, Railey Realty, McHenry, Garrett County, Maryland, a licensed estate agent and property appraiser.
The following is taken from his recorded testimony at the hearing.

'In 2004, Mr Bounds' sales totaled more than $15,000,000; his volume of sales has averaged about $12,000,000 per year. His work in Garrett County covers mountain or acreage properties in a place of natural beauty. In his testimony, Mr Bounds was asked if had visited areas where wind turbines are in place:

"Yes. I have been to sites in nearby Pennsylvania, experienced the visual impact near the turbines and heard the noise impact from various distances ... I do not know the markets in West Virginia or Pennsylvania very well. If we were to move those turbines to Garrett County, however, value would be impacted. Any time you take a thing of natural beauty and you insert industrial development there is an adverse impact on what the property offers. It not only devalues but quite frankly, from my experience in Garrett County anyway, it may render the property unsaleable."

Mr Bounds had viewed properties with the turbines at a distance of three miles to "very close by." Asked "What effect, if any, has the wind turbines had on the special characteristics of properties that are nearby the wind turbines?", Mr Bounds responded:

"Within the view shed it ruins the horizon. The closer you get to the turbines the greater the visual impact. Those people who are looking for the natural views of the mountains find they are diminished or no longer exist. The turbines not

only have a visual impact but, also impact the quality of life. The ones that I visited were very noisy. They impact a country setting with a rather large industrial wind plant that takes away from anything I would call heritage views, peace and quiet."
Mr Bounds answered "Yes," when he was asked if he had heard from people living near wind turbines and if they had told him about any problems:

"The primary complaint is noise. Second is the visual impact of the turbines. Going into the house and closing the door eliminates the view. It does not eliminate the sound. The constant drone cannot be escaped ... Their greatest concern is the substantial loss of value of their property. They do not believe they can sell without substantial loss and cannot afford to sustain the loss and move."

When asked if the noise had any substantial impact on the use of the property, Mr Bounds replied:

"Yes. It takes away the enjoyment of their property. It doesn't allow them to sleep at night."

"It takes a property of substantial value and takes away all of the characteristics that are the strengths of that property. The visual impact takes away value. The noise takes away value. The property owners complain that the wind turbines take away value and there is no way for them to escape."

Mr Bounds testified that he knew of property transactions in Somerset, Pennsylvania that were sold for substantially less than their prior sale price because of the proximity and impact of wind turbines. Mr Bounds continued,

"Two properties specifically that sold for substantially less than their original purchase price because of the nuisance issues that were created by wind turbines. The parcels adjoin property with wind turbines. (The deeds of the properties were presented as exhibits.) Somerset Windpower, LLC purchased the property of David Ray Sass for $104,447.50 and sold it to Jeffrey A. Ream for $65,000 ... Keith and Billie Sarver sold their property to Somerset Windpower LLC for $101,049.00. Shortly thereafter it sold for only $20,000."

'Another property -- unimproved, was purchased for $12,600 only a few years earlier, The house was five years old when sold for $67,000, at about the same time as the other houses were sold. Mr Bounds noted that, "the property appears to have been sold for less than market value of the same home not located in proximity to the wind turbines. The wind turbines clearly had an adverse impact on the value of nearby properties."

Mr Bounds also replied that he had heard the wind turbine noise himself:

"It was not what I expected. When you are right underneath, it doesn't seem to make much noise, just a swish. Further away from the structure the noise is more noticeable. It seems that it can echo through a hollow or a valley. Sometimes homes that are closer might not have the same noise impact as homes that are further out. I understand the noise changes day to day depending upon which way the wind is blowing and how the blades are

positioned. Some days it may be noisier than others and some days it might not be as noisy."

With his research and professional expertise, Mr Bounds concluded:

"That property values of the natural and scenic properties within one-half mile and probably within a mile of the wind turbines will be negatively impacted. I cannot judge for certain how far the serious negative impact will extend. The visual impact and the noise impact will substantially diminish special attributes of a mountain view, scenic view, natural setting and peace and quiet. Undeveloped properties will be rendered un-developable. Some parcels may be rendered un-saleable. The visual impact beyond a mile will likely adversely impact value. The sound impact will apparently vary outside one mile but, if the results of the study attached as Exhibit 9 are correct, the value of some properties outside one mile will be adversely impacted by the noise."

Case E

In Michigan, David Maturen, a real estate appraiser and Kalamazoo (Michigan) County Commission, wrote the following letter to the Michigan Wind Working Group, 9 September 2004:

MATUREN & ASSOCIATES, INC.
Real Estate Appraisers – Consultants
1125 E. Milham Avenue
Portage, Michigan 49002
269-342-4800

DT: September 9, 2004

TO: Michigan Wind Working Group
c/o John Sarver, Energy Office

RE: Impact of Wind Turbine Generators on Property Values

First of all I wish to thank you for including me in your email distribution list relative to the proceedings of the Wind Working Group. I have an interest in the topic as a Kalamazoo County Commissioner concerned with land use and regulation and as real estate appraiser interested in the issue of external obsolescence (loss or depreciation to property value from outside the property boundary). That economic obsolescence can come from adverse (nuisance) impacts such as visual (loss of viewshed), blade flicker (strobe effect), noise, ice throw from blades in winter, and other environmental impacts from ancillary installations. I am not aware of any plans to put a wind farm in the vicinity of any property that I own, so I have no personal interest one way or the other in this matter, other than wanting the rights all parties to be respected and protected.

I understand that you have as an item of discussion at your September 9, 2004 meeting the issue of property values. I have had some experience with research on this matter. Unfortunately, I have a prior commitment that day and will likely not be able to attend your meeting. Perhaps your committee is already aware of these valuation issues and studies, but I think that they are important to note in the context of promoting wind farms in our state.
As the Vice Chair of the International Right of Way Association's Valuation Committee, I had the opportunity to moderate a session at our International Education Conference in Philadelphia this June. I invited the authors of the two most often quoted studies on the issue of wind farms and property values. Fred Beck of the Renewable Energy Policy Project (REPP) and Dr. David Tuerck of the Beacon Hill Institute at Suffolk College both

presented the findings of their respective studies. Both studies are available on the internet: www.repp.org and www.beaconhill.org.

The REPP study, The Effect of Wind Development on Local Property Values, is a 78 page report which was published in May 2003. They studied 10 areas of the country. The study surveyed assessed values and properties within 5 miles of a wind farm and showed no diminution in value to those properties due to the presence of the wind farms. Critiques have been made regarding the methodology used in that study.

The Beacon Hill Institute issued an initial 53 page report in October 2003 - Blowing in the Wind: Offshore Wind and the Cape Cod Economy and a follow up 34 page report in March 2004 - Free but Costly: An Economic Analysis of a Wind Farm in Nantucket Sound. The studies focus on Nantucket Sound in Massachusetts relative to the Cape Wind Associates proposed 130 wind turbine generator (WTG) offshore wind farm. The 2003 study projected 1) a small decline in tourism resulting in a loss of 1,173 to 2,533 jobs and 2) a decline in property values of 4.6% (10.9% for waterfront property) or $1.35 billion and a concomitant loss in tax revenue to the area of $8 million. Criticisms of that report have also been made.

The Tennessee Valley Authority (TVA) study on a proposed wind farm in Tennessee consisting of 13 to 16 WTGs reviewed literature on the issue. Appendix F of the study cites several studies on wind farms and their impacts. Among those are:

1. The April 1996 Danish study: Social Assessment of Windpower – Visual Effect and Noise from Windmills – Quantifying and Evaluation. It concluded that 13% of people living near windmills considered them a nuisance. Property values showed a loss in housing prices from $2,900 (for one WTG) to $16,000 (for a 12 unit wind farm).
2. The ongoing study in Wisconsin thought to be done in 2003. My conversation with Steve Brick of the Energy Center of Wisconsin indicated that as of this Spring their study was not finished.
3. The TVA study does mention the value of a viewshed as a percentage of the value of improved property at 8% in Fairfax, Virginia and a South Carolina analysis regarding vacant lot premiums of 147% for an ocean view, 115% for a creek or marsh view, and 39% for a golf course view.

The 2002 Strutt & Parker study of the Edinbane Windfarm on the Isle of Skye notes that the proposed 41 turbines would have a major impact on the locality. They estimated that nearby property values would decline by over $1 million. They also note at 6.18 of their report that "In Germany, Estate Agents report diminution in values of between 20% to 30% for properties in sight of wind farms. We understand that FPD Savills have reported similar levels of depreciation for properties in Norfolk."

The report of the Township of Lincoln Wind Turbine Moratorium Committee, Kewaunee, Wisconsin (2000 to 2002) notes that the Town of Lincoln building inspector compiled a list of home sales. The list compared the property's selling price as a function of the distance to an existing 22 WTG farm in the area. His conclusions were 1) Sales within 1 mile of the wind farm prior to the installation were 104% of the assessed values and properties selling after the wind farm introduction in the same area were at 78% of the assessed value.

Anecdotal evidence from real estate agents near Victoria, Australia indicates a 20% to 30% decrease in property values for homes near WTGs.

A court case referenced in the February 14, 2004 edition of the Daily Telegraph (UK) refers to a house near Askam in the Lakes District. The buyers were not informed of the pending installation of 4 WTGs which were 360' tall and 550 yards from their new home. No mention was made in the seller's disclosure form, despite the fact that the seller had protested the proposed wind farm installation to the local government indicating a large loss in value to their property. The court, after listening to chartered surveyors (appraisers) for both sides, concluded that the property had suffered a 20% decline in value.

The above listing is not exhaustive, but a brief mention of studies that discuss the impact on communities and nearby property values by WTGs.

Is the "jury" still out on the impact of WTGs on property value? Yes, though there do appear to be several indications that a loss in value to neighboring properties is real possibility. Can any state agency conclude that wind farms do not have the potential for causing a nuisance and devalue nearby properties and cause a "taking"? No. Whatever report the Wind Working Group comes up with, it should be informational only, include the differing opinions that are out there, not be used to usurp local land use authority in regulating WTGs just like any other land use nor to deny property owners their rights. In our quest for "energy independence" for our society in general, let us not forget the potential for economic loss to individuals as an unintended consequence. We should be prepared to compensate adjacent owners for any property rights (value) taken as a result of the introduction of wind farms.

Sincerely,

David C. Maturen, SR/WA
Certified General Real Estate Appraiser
Kalamazoo County Commissioner

Case F

"Wind turbines don't make good neighbors : some problems of wind power in the Berkshires"

By Eleanor Tillinghast, Green Berkshires, Inc., Massachusetts, May 14, 2004

Here in the U.S., at a public meeting on Enxco's proposal for a wind power plant in Lowell, Vermont, a realtor trying to sell a farm near the site told Mr. Zimmerman that his claim that land values won't decrease is 'ludicrous.' Don Maclure said that when he tells people interested in buying the farm about the proposed project he never hears from them again.

Other realtors are similarly skeptical. "They say there will be no effect on property values. That is absolutely incorrect," said real estate agent Roger Weaver of Kittitas County, Washington. "There is no way wind farms won't affect property values in the Kittitas Valley. In a tremendously scenic area like the valley, the view is a major consideration in what people want."

Mr. Weaver explained that people from Puget Sound are purchasing country lands for homes while still working in Puget Sound. "They want a beautiful place to live and retire," he said. "Wind farms will have a real negative effect on the property values because the scenic views are a big deal, a real big deal to these people."

As part of a study of the proposed Cape Wind [Massachusetts] project, 45 real estate professionals operating in towns around Nantucket Sound were contacted and asked about anticipated effects of the wind power project on property values.
49% of realtors expect property values within the region to fall if the Cape Wind power plant is erected.

501 home owners in the six towns that would be most affected by the Cape Wind project were also surveyed. 68% said that the turbines would worsen the view over Nantucket Sound 'slightly' or 'a lot'.

On average, they believed that Cape Wind would reduce property values by 4.0%. Those with waterfront property believed that it would lose 10.9% of its value. The study concluded that, based on the loss of property value expected by home owners, the total loss in property values resulting from the construction of Cape Wind would be $1.35 billion, a sum substantially larger than the approximately $800 million cost of the project itself.

As the study noted, any reduction in property values would, in turn, lead to a fall in property tax collections in the affected towns; the drop in these tax collections would be $8 million annually. If the tax rates were raised to maintain revenue, this would shift some of the property tax burden off waterfront residents (whose property values would fall the most) and on to the (less affluent) island residents.

In the home owner survey, in response to the statement: It is important to protect an uninterrupted view of Nantucket Sound, 76% strongly agreed, 18% somewhat agreed, 3% were neutral, 2% somewhat disagreed, and 1% strongly disagreed.

It's worth noting that of the home owners surveyed, 94% did not have homes with a view of the Sound. 76% were not members of a conservation or environmental organization. Regardless, their main reasons for living in the area were the 'beauty of the region,' 'the beaches,' and 'the ocean views.'

Comment

In the various reports included in this Appendix, it is clear that individuals from rural communities within the three Continents considered in this **Appendix** are experiencing or are likely to experience economic loss through the potential or actual impact of wind turbines located close their homes.

The continual economic survival of rural communities depends both on 'old' and 'new' wealth creation. Many rural communities have enjoyed economic growth and social benefits from the influx of 'life style' families, young and old, who have brought with them wealth and economic opportunity to their chosen new communities. 'Life style' families are often seeking the pleasures of rural life and unspoilt countryside, away from the commercial and industrial development that is characteristic of our towns and cities. The devaluation of assets such as property by rural industrialisation is likely to deter further migrations to the countryside, and over time, this will inevitably reduce new economic injection into these areas.

State development-control decision-makers, who allow the industrialisation of rural settlements, with the consequent environmental pollution, are likely to trigger a slide back into rural economic deprivation as the lifetime savings of people living in these communities are eroded by the devaluation of their properties.

Peter Hadden

ACKNOWLEDGEMENTS

We would like to acknowledge the help and guidance freely given by many experts within their fields. Their generosity was invaluable. Our gratitude extends even more broadly, but special thanks to:

Dr Mariana Alves-Pereira (Biomedical Engineering)
New University of Lisbon, Portugal

Dick Bowdler, BSc, CEng, CPhys, FIOA, FCIBSE, MCIArb
New Acoustics; Member, Dti Noise Working Group (2006 -), UK

David Brierley and the neighbours of Far Old Park Wind Turbines
Askam, Cumbria, UK

Geoffrey Cox, QC, Barrister, MP (West Devon and Torridge, Devon)

Robert Davis, Acoustician
RD Associates; Member, Dti Noise Working Group (2006 -), UK

Prof John E Ffowcs Williams, Emeritus Professor
Engineering Acoustics, Cambridge University, UK

Dr Amanda Harry, MB, ChB, PG, Dip ENT
West Hoe Surgery, Plymouth, UK

Prof Ralph V Katz, DMD, MPH, PhD, Chair
Department of Epidemiology & Health Promotion, New York University, NY, USA

Prof James Lovelock, CH, PhD, DSc
Physician, scientist, author, and founder of the Gaia Theory
Devon, UK

Dr David Manley, PhD

Nina Pierpont, MD, PhD, Paediatrician
Malone, New York, USA

Prof Hillel Pratt, PhD, Unit of Behavioural Biology
Technion-Israel Institute of Technology, Haifa, Israel

John Stewart, Chair, UK Noise Association

Frits van den Berg, Acoustic Engineer & Teacher
Science Shop for Physics, Groningen University, The Netherlands

In the early days of preparing the Human Rights Section, we were grateful for the guidance given to us by Marina Wheeler, Barrister, One Crown Office Row, Temple, London EC4; Susan Ring, Partner, Richard Buxton Solicitors, Environmental and Public Law; and John Campbell, QC. We are also appreciative for the help given to us by Eja Pedersen, who provided her publications and initial guidance.

WASCO COUNTY

wcplanning wcplanning <wcplanning@co.wasco.or.us>

Setbacks; Energy Ordinance Update

1 message

Mark Womble <womble@gorge.net> **Tue, Feb 7, 2012 at 5:11 PM**
To: Sherry Holliday <SherryH@co.wasco.or.us>, Rod Runyon <RodR@co.wasco.or.us>, Scott Hege <ScottH@co.wasco.or.us>, wcplanning@co.wasco.or.us

Please see the attached regarding the LUBA decision on two mile setbacks in Umatilla County.
Thank you,
Mark Womble

E-Mail.doc
51K

MARK WOMBLE, P.C.
Attorney at Law

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Hood River, Oregon 97031

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The Dalles (541) 298-7700
Fax: (541) 298-7701

February 7, 2012

Via email to wcplanning@co.wasco.or.us
Wasco County Board of Commissioners
C/o Wasco County Planning and Development
2705 E. Second Street
The Dalles, OR 97058

Re: Setbacks; Legislative Text Amendments to WCLUDO Chapter 19

Dear Commissioners:

On January 12, 2012, LUBA reviewed the two mile setbacks for wind facilities established by the Umatilla County Board of Commissioners. Cosner et al v. Umatilla County (LUBA No. 2011-070-072). Opponents of the setbacks, consisting of persons who had signed leases with wind companies, appealed the county ordinances claiming there was no evidence that two mile setbacks were necessary for the protection of residences from noise impacts. LUBA disagreed, and held that the evidence in the record was sufficient to establish that a two mile setback was necessary to protect residences from the noise impacts of wind facilities. LUBA stated:

> "* * * According to petitioners, there is no evidence or justification in the record to support a two-mile setback, as opposed to a lesser setback.
>
> The county responds that the county chose to expand the existing 3,250-foot setback from residential zones to a two-mile setback from rural residences and urban growth boundaries, based on voluminous testimony regarding noise impacts up to two miles from wind facilities. Based on the testimony cited to us by the county, we agree with the county that the record provides an adequate factual base supporting the county's choice to impose a two-mile setback from wind facilities.* * * * * (LUBA opinion at 21-22).

LUBA also held that a provision allowing for waivers of setbacks was an invalid delegation of county authority because there were no standards governing the exercise of such waivers. LUBA suggested that "modest changes" setting standards for the exercise of such waivers would cure this defect. LUBA remanded the case to the county to address the waiver issue, and to formally adopt findings regarding the comprehensive plan policies cited by the county in support of the ordinance.

I continue to urge adoption of two mile setbacks from non-resource zone boundaries and resource zone residences. Thank you for your consideration of these matters.

Very truly yours,

Mark S. Womble

WASCO COUNTY

Brenda Jenkins <brendaj@co.wasco.or.us>

Re: meeting Feb 15, 2012 re: setbacks of wind turbines

1 message

John Roberts <johnr@co.wasco.or.us> Fri, Feb 10, 2012 at 2:11 PM
To: Don Phillips <dxp1516@gmail.com>
Cc: brian.welsh@iberdrolaren.com, Brenda Jenkins <brendaj@co.wasco.or.us>

Don: Your comments will be forwarded to our County Commissioners.

Thx...

On Fri, Feb 10, 2012 at 1:55 PM, Don Phillips <dxp1516@gmail.com> wrote:

> Sir:
>
> We own a ranch property in southern Wasco County at 90606 Wilson Road, Maupin, Ore.
>
> We wish to go on record that we object to any proposed change in County ordinances, by County vote or administratively that changes the current State approved setbacks of wind turbines from personal residences. The State of Oregon has rules and regulations in effect that adequately address the setbacks. Under their rules, any variance to those rules can only be approved by the home/land owner. We believe such opportunity for variance is fundamental to land ownership and should not be superceded by local ordinance or administrative decision. These are, and should continue to be fundamental property rights.
>
> Please enter this letter as being in opposition to any changes that the County may attempt to pursue
>
> Due to scheduling conflicts and prior commitments, we will be unable to attend your meeting on Feb. 15, and we wish to have our opposition to any changes to the current State rules be entered into the record.
>
> Signed/
>
> Don W. Phillips
>
> Patricia A. Phillips

--

John Roberts, AICP
Planning Director, Wasco County Planning Department

"Service, Sustainability & Solutions"
Ph: (541) 506-2563 · johnr@co.wasco.or.us

WASCO COUNTY

Energy Ordinance Update Comments

Inbox x

Phil Swaim pswaim3300@yahoo.com
to me

Please add this information to the public record.

Thank you,

Phil Swaim

8 attachments — Download all attachments

SWV%20Critique%20of%20CANAWEA%20Whitepaper,%20Part%201%20
109K View Download

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A_Primer_on_Adverse_Health_Effects[1][1].pdf
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The%20Audibility%20of%20Low%20Frequency%20Wind%20Turbine%20(
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Responses%20of%20the%20Inner%20Ear%20to%20Infrasound,%20wtn20(
805K View Download

Shepherd%20et%20al,%20Wind%20turbine%20noise%20&%20Quality%(
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11-07-15%20Simplified%20statement%20on%20Noise%20Con%20report,
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Wind Energy Industry Acknowledgement of Adverse Health Effects

Part 1 Conclusion and Executive Summary

An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009"

Prepared by
The Society for Wind Vigilance

January 2010*

In alphabetical order:

Authored by
Brett Horner, BA, CMA
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Christopher Hanning, BSc, MB, BS, MRCS, LRCP, FRCA, MD
John Harrison, PhD

** Appended January 18, 2009 to include document production details.*
Note: the contents of this analysis have not been altered.

FORWARD

Wind Turbine Sound and Health Effects, An Expert Panel Review (A/CanWEA Panel Review) was prepared for and sponsored by the American Wind Energy Association (AWEA) and the Canadian Wind Energy Association (CanWEA).

In response, an analysis was conducted by The Society for Wind Vigilance of the A/CanWEA Panel Review. Details of the analysis are included in Table 1 of this document.

The summary and related points cover a broad spectrum of claims. For convenience the remainder of the analysis and critique is done in a tabulated format of point - counter point. The volume of material necessitated this approach and hopefully will enhance the clarity of the critique being put forward.

The method utilized was to excerpt each of the claims and place it in the context of authoritative and contrary information. In addition an effort has been made to identify the errors of omission as well as those of commission.

CONCLUSION

It is apparent from this analysis that the A/CanWEA Panel Review is neither authoritative nor convincing. The work is characterized by commission of unsupportable statements and the confirmation bias in the use of references. Many important references have been omitted and not considered in the discussion. Furthermore the authors have taken the position that the World Health Organization standards regarding community noise are irrelevant to their deliberation - a remarkable presumption.

There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This is settled medical science.

There are many peer-reviewed studies showing that infra and low frequency sound can cause adverse health effects, especially when dynamically modulated. Modern upwind industrial scale turbines of the types now being located in rural areas of North America require study. The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects upon the human body remains an open question - there is no settled medical science on this issue as of yet.

Perhaps the most egregious conclusion is that no more research is required. That statement implies that the science is settled which quite simply is false. It also demonstrates a disdain for the scientific method itself.

There is but one conclusion: independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind

turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur.

In contrast to the statement of the A/CanWEA Panel Review, our view is that a great deal of research is required for the protection of people's health.

EXECUTIVE SUMMARY

The conclusions of the A/CanWEA Panel Review are not supported by its own contents nor does it have convergent validity with relevant literature.

The A/CanWEA Panel Review acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms. It then ignores the serious consequences.

World Health Organization identifies annoyance and sleep disturbance as adverse health effects.[1]

In 2009 the World Health Organization released a peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effects documented include fatigue, memory difficulties, concentration problems, mood disorders, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, impaired immune system function and a reported increased risk of mortality to name a few.[2]

Health Canada acknowledges the health consequences of stress and considers it a to be a risk factor in a great many diseases, such as heart disease, some types of bowel disease, herpes, mental illness and difficulty for diabetics to control blood sugar. It states severe stress can cause biochemical changes in the body, affecting the immune system, which leaves the body vulnerable to disease.[3]

Despite the acknowledgement that wind turbine noise may cause annoyance, stress and sleep disturbance the A/CanWEA Panel Review fails to offer any science based guidelines that would mitigate these health risks.

On the contrary the A/CanWEA Panel Review concludes by suggesting that the authoritative health based noise guidelines of the World Health Organization should be ignored and that wind turbine noise limits be based on public policy.[4]

---

[1] World Health Organization, Guidelines for Community Noise, 1999
http://www.euro.who.int/mediacentre/PR/2009/20091008_1
[2] Night Noise Guidelines for Europe, World Health Organization (2009)
www.euro.who.int/document/e92845.pdf
[3] Health Canada http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/stress-eng.php

The A/CanWEA Panel Review concludes by stating that it does not "advocate for funding further studies."[5]

Others do not agree.

In November 2009 the Japanese Ministry of Environment announced a four year study into the effects of wind farms on health.[6]

In September 2009 members of the Maine Medical Association passed a resolution which among other things calls for independent study and authoritative guidelines.[7]

Preliminary findings of a controlled study (Mars Hill, Maine) being conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomatology, compared to a control group living 5000-6000 meters away. This controlled study is a work in progress.[8]

The A/CanWEA Panel Review can only be viewed for what it is. It is an industry association convened and sponsored attempt to deny the adverse health effects being reported.

[4] W. David Colby, M.D. et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association
[5] W. David Colby, M.D. et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association
[6] http://www.yomiuri.co.jp/dy/national/20091129TDY02309.htm
[7] Maine Medical Association Resolution re Wind Energy and Public Health September 2009
[8] http://windvigilance.com/mars_hill.aspx

SUMMARY OF FINDINGS

The A/CanWEA Panel Review:

- appears to value quantity over quality – it consists largely of filler material including 22 of 85 pages (26%) blank or title pages.
- is not a study: it is an incomplete literature review.
- was prepared for and sponsored by AWEA and CanWEA which raises questions about its objectivity.
- displays selective bias favouring the positions of AWEA and CanWEA in the presentation of the referenced material.
- displays selective bias favouring the positions of AWEA and CanWEA by omission of relevant references.
- displays a negative bias regarding references that do not favour the interest of the AWEA and CanWEA.
- misquotes references.
- contains incomplete risk assessments related to health.
- contains misleading statements.
- contains statements without appropriate supporting references.
- contains conclusions which are not supported by cited references.
- ignores the authoritative research and noise guidelines of the World Health Organization.
- contains pre-emptive stereotyping of those who have concerns about health risks associated with wind turbine facilities. Terms such as “detractors” and “opponents” are used. This pre-emptive stereotyping extends to concerned medical professionals who are calling for authoritative guidelines designed to protect human health. This pre-emptive stereotyping dismisses the claim that the panel is independent and unbiased.

Wind Energy Industry Acknowledgement of Adverse Health Effects

Part 2 Detailed Analysis

An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009"

Prepared by
The Society for Wind Vigilance

www.windvigilance.com

January 2010*

In alphabetical order:

Authored by
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John Harrison, PhD

** Appended January 18, 2009 to include document production details and pagination.*
Note: the contents of this analysis have not been altered.

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
Notice to Reader **The analysis contained in this table is not intended be exhaustive and does not address all the inadequacies contained in the A/CanWEA Panel Review.**	
Title Page	"Prepared for: American Wind Energy Association and Canadian Wind Energy Association" ***Industry trade associations convening and sponsoring a literature review cannot be considered independent or unbiased.*** ***This approach is reminiscent of the now discredited "Tobacco Industry Research Committee" created in the 1950's and sponsored by the tobacco industry.*** ***http://www.sourcewatch.org/index.php?title=Tobacco_Industry_Research_Committee***
ES1	"Wind energy enjoys considerable public support, but it also has its detractors, who have publicized their concerns that the sounds emitted from wind turbines cause adverse health consequences." ***The A/CanWEA Panel Review uses biased pre-emptive stereotyping by labelling individuals or groups who have concerns about the adverse effects from exposure to industrial wind turbines as "detractors". The pre-emptive stereotyping attempts to invalidate legitimate concerns at the onset.*** ***Detractor is defined as "somebody who disparages or devalues somebody or something".*** ***Encarta® World English Dictionary [North American Edition] © & (P)2009*** ***This pre-emptive stereotyping extends to concerned medical professionals such as members of the Maine Medical Association who have passed a resolution calling for independent research and the development of authoritative wind turbine guidelines designed to protect human health.***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	This pre-emptive stereotyping dismisses the claim that the panel is independent and unbiased.
ES1	"Following review, analysis, and discussion of current knowledge, the panel reached consensus on the following conclusions: • There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects. • The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans. • The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences." ***The contents of the A/CanWEA Panel Review do not support these statements. See discussion on pages 5-1 and 5-2.***
2-1	Methodology 2.1 Formation of Expert Panel "The American and Canadian wind energy associations, AWEA and CanWEA, assembled a distinguished panel of independent experts to address concerns that the sounds emitted from wind turbines cause adverse health consequences." ***Industry trade associations convening and sponsoring a literature review cannot be considered independent or unbiased.*** ***This approach is reminiscent of the now discredited "Tobacco Industry Research Committee" created in the 1950's and sponsored by the tobacco industry.*** ***http://www.sourcewatch.org/index.php?title=Tobacco_Industry_Research_Committee***
2-1	2.2 Review of Literature Directly Related to Wind Turbines "The panel conducted a search of Pub Med under the heading "Wind Turbines and Health Effects" to research and address peer-reviewed literature. In addition, the panel conducted a search on "vibroacoustic disease." The reference section identifies the peer and non-peer reviewed sources that were consulted by the panel."

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The search criteria used in the report is very limited and limiting. ***For example, additional searches should have included relevant headings such "wind turbines and adverse health effects", "noise", "annoyance", "low frequency noise", "stress", "sleep disturbance" and "flicker" to name a few obvious omissions.*** ***The A/CanWEA Panel Review is not comprehensive as it did not consider other environmental exposures associated with wind turbine operations such as safety, visual acceptability, electromagnetic pollution and visual interference or flicker.*** ***The A/CanWEA Panel Review is an incomplete literature review.***
2-2	"The reference section identifies the peer and non-peer reviewed sources that were consulted by the panel." ***The A/CanWEA Panel Review presents peer and non peer reviewed sources but displays selective bias regarding sources which do not support the conclusions of the report.*** ***Many relevant and authoritative sources have not been cited or discussed in the A/CanWEA Panel Review.*** ***See discussion regarding page 6-1.***
2-1	2.3 Review of Potential Environmental Exposures "The panel conducted a review of potential environmental exposures associated with wind turbine operations, with a focus on low frequency sound, infrasound, and vibration." ***The A/CanWEA Panel Review was not comprehensive as it ignored other environmental exposures associated with wind turbine operations such safety, visual acceptability, electromagnetic pollution and visual interference or flicker.*** ***In summary the A/CanWEA Panel Review is an incomplete literature review.***
3-12 to 3-14	3.3 Potential Adverse Effects of Exposure to Sound ***The A/CanWEA Panel Review displays selective bias in citing noise limits from various references regarding potential adverse effects of exposure to sound (sections 3.3.1-3.3.5)***.

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The A/CanWEA Panel Review cites selective noise limits which are consistently higher than the authoritative health based noise guidelines of the World Health Organization. 3.3.1 Speech Interference "Levels below 45 dBA can be considered irrelevant with respect to speech interference." ***The A/CanWEA Panel Review displays selective bias by citing a level of 45dBA.*** ***World Health Organization guidelines indicates a level of 35 LAeq[dB] to protect speech intelligibility and moderate annoyance, daytime and evening (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note: an increase of 10 dBA is a 10-fold increase in acoustic energy.*** 3.3.2 Noise-Induced Hearing Loss "Regulatory (OSHA, 1983) and advisory (NIOSH, 1998) authorities in the U.S. concur that risk of NIHL begins at about 85 dBA" ***The A/CanWEA Panel Review displays selective bias by citing a level of 85dBA.*** ***World Health Organization guidelines recommend a level of 70 LAeq [dB] to protect against hearing impairment in industrial, commercial, shopping and traffic areas, indoors and outdoors (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note an increase of 10 dBA is a 10-fold increase in acoustic energy.*** 3.3.3 Task Interference "Levels below 70 dBA do not result in task interference."

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The A/CanWEA Panel Review displays selective bias by citing a level of 70dBA. ***World Health Organization guidelines recommend a level of 35 LAeq [dB] to protect disturbance of information extraction (e.g. comprehension and reading acquisition). (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note an increase of 10 dBA is a 10-fold increase in acoustic energy.*** 3.3.4 Annoyance "It is important to note that although annoyance may be a frustrating experience for people, it is not considered an adverse health effect or disease of any kind." ***The A/CanWEA Panel Review displays selective bias by ignoring the adverse health effect of noise induced annoyance.*** ***Health Canada states in their publication "It's Your Health":*** ***"The most common effect of community noise is annoyance, which is considered an adverse health effect by the World Health Organization."*** ***http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/community-urbain-eng.php#he*** ***World Health Organization states:*** ***"The range of health effects of noise is wide. They include pain and hearing fatigue, hearing impairment including tinnitus, annoyance…"*** ***http://www.euro.who.int/Noise/activities/20021203_2*** ***"Sleep disturbance and annoyance are the first effects of night noise and can lead to mental disorders.***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	The effects of noise can even trigger premature illness and death." ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***W. David Colby, M.D., one of the authors or the A/CanWEA Panel Review, described the consequence of wind turbines induced annoyance when he publicly stated:*** ***"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick."*** ***W. David Colby, M.D, Sounding Board, 97.9 FM The Beach December 17, 2009*** ***The A/CanWEA Panel Review ignores the serious risk to human health that annoyance and stress may cause.*** ***According to Health Canada:*** ***"…stress is considered to be a risk factor in a great many diseases, including:*** ***• heart disease*** ***• some types of bowel disease*** ***• herpes*** ***• mental illness*** ***Stress also makes it hard for people with diabetes to control their blood sugar.*** ***Stress is also a risk factor in alcohol and substance abuse, as well as weight loss and gain. Stress has even been identified as a possible risk factor in Alzheimer's Disease. Severe stress can cause biochemical changes in the body, affecting the immune system, leaving your body vulnerable to disease."*** ***http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/stress-eng.php*** "Noise from airports, road traffic, and other sources (including wind turbines) may annoy some people, and, as described in Section 4.1, the louder the noise, the more people may become annoyed." ***The A/CanWEA Panel Review ignores the risk to human health from***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"Noise from airports, road traffic, and other sources (including wind turbines)". ***World Health Organization states:*** ***"The effects of noise can even trigger premature illness and death. Night noise from aircraft can increase blood pressure, even if it does not wake people. Noise is likely to be more harmful when people are trying to fall asleep and awaken. Recent studies show that aircraft noise in the early morning is the most harmful in increasing the heart rate."*** ***"Nuisance at night can lead to an increase in medical visits and spending on sleeping pills, which affects families' budgets and countries' health expenditure."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** 3.3.5 Sleep Disturbance "DNL is a 24-hour average that gives 10 dB extra weight to sounds occurring between 10p.m. and 7 a.m., on the assumption that during these sleep hours, levels above 35 dBA indoors may be disruptive." ***While the A/CanWEA Panel Review acknowledges "… levels above 35 dBA indoors may be disruptive" it cites a 1974 document without citing WHO (1999).*** ***World Health Organization guidelines recommend a level of 30 LAeq [dB] indoors to protect against sleep disturbance and when the noise is composed of a large proportion of low-frequency sounds a still lower guideline value is recommended, because low frequency noise (e.g. from ventilation systems) can disturb rest and sleep even at low sound pressure levels. (Guidelines For Community Noise 1999)*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Note an increase of 10 dBA is a 10-fold increase in acoustic energy.*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states:***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"For the primary prevention of subclinical adverse health effects related to night noise in the population, it is recommended that the population should not be exposed to night noise levels greater than 40 dB of Lnight, outside during the part of the night when most people are in bed. The LOAEL of night noise, 40 dB Lnight, outside, can be considered a health-based limit value of the night noise guidelines (NNG) necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise." ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***The A/CanWEA Panel Review ignores the serious adverse health consequences from noise induced sleep disturbance.*** ***World Health Organization states:*** ***"Recent research clearly links exposure to night noise with harm to health. Noise can aggravate serious health problems, beyond damage to hearing, particularly through its effects on sleep and the relations between sleep and health."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states:*** ***"There is plenty of evidence that sleep is a biological necessity, and disturbed sleep is associated with a number of health problems. Studies of sleep disturbance in children and in shift workers clearly show the adverse effects."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***According to World Health Organization some of the documented health related consequences of sleep debt include poor***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality. ***World Health Organization "Night Noise Guidelines for Europe" 2009*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** 3.3.6 Other Adverse Health Effects of Sound ***The A/CanWEA Panel Review displays selective bias by attempting to understate the risk of noise induced chronic health problems such as hypertension and heart disease. The A/CanWEA Panel Review selectively quotes references, many of which are decades old to understate this risk.*** ***World Health Organization states:*** ***"Recent research clearly links exposure to night noise with harm to health. Noise can aggravate serious health problems, beyond damage to hearing, particularly through its effects on sleep and the relations between sleep and health. When people are asleep, their ears, brains and bodies continue to react to sounds. Sleep disturbance and annoyance are the first effects of night noise and can lead to mental disorders.*** ***The effects of noise can even trigger premature illness and death. Night noise from aircraft can increase blood pressure, even if it does not wake people."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states*** ***"Above 55 dB The situation is considered increasingly dangerous for public health. Adverse health effects occur***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases." ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***The A/CanWEA Panel Review assumes people are inside their homes 24 hours a day with doors and windows shut. This is inaccurate.*** ***Families are entitled to work, play and enjoy all areas of their property. Infants, children, adults and seniors risk being exposed to wind turbine outdoor noise levels much higher than the guidelines allow for noise receptors (homes).*** ***Modern wind turbines emit 100 to 110 dBA Sound Power Level. Unweighted Sound Power Levels which are seldom reported are 120 dB or higher. Additional turbines result in higher combined sound pressure levels. Typically noise guidelines for wind turbines provide no protection for humans outside of their home. In Ontario it is allowable for multiple wind turbines to be sited within 50 meters (blade length plus 10 meters) of a non participant's property line. As an example on a one hundred acre parcel of land it is possible for individuals to be exposed on their property to wind turbine sound pressure levels which may cause speech interference, task interference, annoyance and other adverse health effects of sound. (previously referenced above section 3.3)*** ***The A/CanWEA Panel Review ignores this environmental exposure and the associated risks to human health.*** ***In summary:*** ***Wind turbines emit industrial noise pollution. Wind turbine "noise is a primary siting constraint".*** ***Rogers, A. and J. Manwell . Wright, S. 2002. Wind turbine acoustic noise. Amended January 2006*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	The A/CanWEA Panel Review displays selective bias by understating the risk of adverse health effects from environmental noise. ***The A/CanWEA Panel Review displays selective bias by consistently ignoring the recommendations and guidance of the World Health Organization on the issue of noise and health. (see discussion regarding World Health Organization page 4-13)***
3-14	"On the other hand, many people become accustomed to regular exposure to noise or other potential stressors, and are no longer annoyed." ***This A/CanWEA Panel Review statement is false.*** ***World Health Organization states*** ***"During sleep the auditory system remains fully functional. Incoming sounds are processed and evaluated and although physiological changes continue to take place, sleep itself is protected because awakening is a relatively rare occurrence. Adaptation to a new noise or to a new sleeping environment (for instance in a sleep laboratory) is rapid, demonstrating this active protection. The physiological reactions do not adapt, as is shown by the heart rate reaction and the increase of average motility with sound level."*** ***World Health Organization "Night Noise Guidelines for Europe" 2009*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)***
3-17	3.4.3 Low-Frequency Sound and Infrasound "No scientific studies have specifically evaluated health effects from exposure to low frequency sound from wind turbines." ***The absence of scientific studies does not imply that health effects from exposure to low frequency sound from wind turbines do not occur - it implies scientific uncertainty and the requirement for third party independent health studies.***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This <u>is</u> settled medical science. ***Sound energy in the infra and low frequency range may also be a factor for other adverse health effects. Although these sounds may be sub-audible to all but the most sensitive people, others may perceive it as internal body sensations. This is compounded indoors, because the sound pressure levels inside homes may be augmented by building resonance and harmonics. This can result in a larger percentage of the general population that may perceive the sound or vibration in their body or home, and stronger effects on those who responded without such augmentation. It can also result in perceptible audible noise to people who may not have perceived the sounds outdoors or in another building with different resonance characteristics.*** ***The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects upon the human body remains an open question - there is <u>no</u> settled medical science on this issue as yet.*** "Natural sources of low frequency sound include wind, rivers, and waterfalls in both audible and non-audible frequencies. Other sources include road traffic, aircraft, and industrial machinery. The most common source of infrasound is vehicular (National Toxicology Program, 2001)." ***This statement is misleading. There are references that wind turbine low frequency noise is unique.*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise."*** ***(Note: this reference is listed in Additional References but the citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Soysai, H., and O. Soysai. Wind farm noise and regulations in the***

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	eastern United States. 2007 states: ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic."*** ***(Note: this applies to the lower frequency fluctuation of sound of modern upwind industrial scale wind turbines. This reference is listed in Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** "The U.S. Food and Drug Administration (FDA) has approved the use of infrasound for therapeutic massage at 70 dB in the 8 to 14 Hz range (National Toxicology Program, 2001). In light of the FDA approval for this type of therapeutic use of infrasound, it is reasonable to conclude that exposure to infrasound in the 70 dB range is safe." ***This A/CanWEA Panel Review conclusion has no reference to support it.*** ***A therapeutic device would likely have operating instructions and guidance.*** ***The product website states:*** ***"…it should not be used within six inches of a pacemaker, and should not be used on the calves where blood clots are suspected."*** ***"Therapy on the developing fetus has not been studied, we do not recommend applying it directly over the developing fetus."*** ***http://www.chinahealthways.com***
3-15 3-16	3.4.1 Evaluation of Annoyance and Dose-Response Relationship of Wind Turbine Sound

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"To date, three studies in Europe have specifically evaluated potential health effects of people living in proximity to wind turbines (Pedersen and Persson Waye, 2004; Pedersen and Persson Waye, 2007; Pedersen et al., 2009)." ***This A/CanWEA Panel Review statement is misleading as none of the three studies cited were specifically designed to "specifically" evaluate potential adverse health effects. The studies were very specific in scope as noted below:*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008 states:*** ***"The purpose of this study is to gain insight into the perception of a modern wind farm by residents living nearby such a farm. The objective of the WINDFARMperception project is:*** ***- to provide knowledge on the perception of wind turbines by people living close to windfarms;*** ***- to evaluate human responses to audio and visual exposures from wind turbines and to give insight in possibilities to mitigate the local impact of wind farms."*** ***Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and wellbeing in different living environments states:*** ***"The objectives of this study were to evaluate the prevalence of perception and annoyance due to wind turbine noise among people living in the vicinity of one or more turbines, and to study relationships between noise and perception/annoyance with focus on differences between different living environments."*** ***Perception and annoyance due to wind turbine noise—a dose–response relationship Eja Pedersen and Kerstin Persson Waye 2004 states*** ***"The aims of this study were to evaluate the prevalence of annoyance due to wind turbine noise and to study dose–response relationships. The intention was also to look at interrelationships between noise annoyance and sound characteristics, as well as the influence of subjective***

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	variables such as attitude and noise sensitivity." ***The three studies cited documented high annoyance and sleep disturbance associated with wind turbines.*** ***The A/CanWEA Panel Review fails to note that:*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008 concludes:*** ***"With respect to other health effects associated with wind turbines:*** • ***The risk for sleep interruption by noise was higher at levels of wind turbine sound above 45 dBA than at levels below 30 dBA.*** • ***Annoyance with wind turbine noise was associated with psychological distress, stress difficulties to fall asleep and sleep interruption."*** ***The A/CanWEA Panel Review fails to note that:*** ***Perception and annoyance due to wind turbine noise—a dose–response relationship Eja Pedersen and Kerstin Persson Waye 2004 states:*** ***"At lower sound categories, no respondents were disturbed in their sleep by wind turbine noise, but 16% (n520, 95%CI: 11%–20%! of the 128 respondents living at sound exposure above 35.0 dBA stated that they were disturbed in their sleep by wind turbine noise."*** ***"Some of the respondents also stated that they were disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL. The number of respondents disturbed in their sleep, however, was too small for meaningful statistical analysis, but the probability of sleep disturbances due to wind turbine noise can not be neglected at this stage."*** ***The A/CanWEA Panel Review ignores that:*** ***Regarding:*** ***Pedersen, E. and K. Persson Waye. 2007. Wind turbine***

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	noise, annoyance and self-reported health and wellbeing in different living environments: ***Table 1, contained in the report, indicates the mean SPL for respondents was 33.4 dBA which is far lower than the wind turbine SPL that many families are being subjected to.*** ***In an interview with A/CanWEA Panel Review author Dr. Robert McCunney states:*** ***"... the existing peer-reviewed literature generally examined exposure to sounds from homes or residential areas that are about one kilometre away or further from wind turbines."*** ***Canwest News Service December 16, 2009*** ***In North America many turbines have been sited less than 400 metres from homes. New set back guidelines in Ontario allow for multiple turbines within 550 meters of a home.*** ***The A/CanWEA Panel Review displays selective bias by omitting to discuss the significance of the typical setback distances and sound power levels in the references cited.*** ***The report found that:*** ***"Annoyance was further associated with lowered sleep quality and negative emotions. This, together with reduced restoration possibilities may adversely affect health."*** ***The A/CanWEA Panel Review displays selective bias by omitting sleep disturbance, annoyance, stress, and negative emotions (adverse psychological effects) reported by the references used by the Panel.*** "Although some people may be affected by annoyance, there is no scientific evidence that noise at levels created by wind turbines could cause health problems" ***The A/CanWEA Panel Review displays selective bias by concluding with a citation from a 2003 reference when subsequent references by the same author, Eja Pedersen, state in 2004, 2007 and 2008:*** ***"Some of the respondents also stated that they were***

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	disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL. The number of respondents disturbed in their sleep, however, was too small for meaningful statistical analysis, but the probability of sleep disturbances due to wind turbine noise can not be neglected at this stage." ***Perception and annoyance due to wind turbine noise—a dose–response relationship Eja Pedersen and Kerstin Persson Waye 2004*** ***"Annoyance was further associated with lowered sleep quality and negative emotions. This, together with reduced restoration possibilities may adversely affect health."*** ***Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and wellbeing in different living environments*** ***"With respect to other health effects associated with wind turbines:*** ***• The risk for sleep interruption by noise was higher at levels of wind turbine sound above 45 dBA than at levels below 30 dBA.*** ***• Annoyance with wind turbine noise was associated with psychological distress, stress difficulties to fall asleep and sleep interruption."*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008 concludes:*** ***"Perhaps the main finding is that wind turbine sound is relatively annoying, more so than equally loud sound from aircraft or road traffic. A swishing character is perceived by most respondents, indicating that this is an important characteristic of wind turbine sound. Sound should therefore receive more attention in the planning of wind farms, and (more) sound mitigation measures must be considered."*** ***The A/CanWEA Panel Review displays selective bias by omitting***

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	this citation which recommends "additional sound mitigation measures be considered." The A/CanWEA Panel Review ignores this recommendation in section 4.6.3 Wind Turbine Siting Guidelines (see discussion regarding pages 4-13 to 4-15) ***There are other relevant findings in these three studies cited which the A/CanWEA Panel Review neglected to discuss or reference.***
3-17	"According to a report of the National Research Council (NRC), low frequency sound is a concern for older wind turbines but not the modern type (National Research Council, 2007)." ***This statement contained in the A/CanWEA Panel Review is misquoted.*** ***According to "Public Health Impacts of Wind Turbines" Prepared by: Minnesota Department of Health Environmental Health Division, 2009*** ***"The National Research Council of the National Academies (NRC, 2007) has reviewed impacts of wind energy projects on human health and well-being. The NRC begins by observing that wind projects, just as other projects, create benefits and burdens, and that concern about impacts is natural when the source is near one's home. Further, the NRC notes that different people have different values and levels of sensitivity. Impacts noted by the NRC that may have the most effect on health include noise and low frequency vibration, and shadow flicker."*** ***Based on the draft copy of "National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects NRC, Washington, DC."*** ***This citation states:*** ***"Broadband, tonal, and low-frequency noise have all been addressed to some degree in modern upwind horizontal wind turbines, and turbine technologies continue to improve in this regard."*** ***The qualification that "Broadband, tonal, and low-frequency noise have all been addressed to some degree" suggests than there are still low-frequency noise issues with modern turbines. This***

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	qualification contradicts the A/CanWEA Panel Review statement. "According to a report of the National Research Council (NRC), low frequency sound is a concern for older wind turbines but not the modern type (National Research Council, 2007)." ***This is confirmed on page 4-1 of the A/CanWEA Panel Review where it is acknowledged that:*** "The low frequency sound emitted by spinning wind turbines could possibly be annoying to some…" ***The A/CanWEA Panel Review displays selective bias by omitting the following passages from the National Research Council draft cited:*** ***"Low-frequency vibration and its effects on humans are not well understood. Sensitivity to such vibration resulting from wind-turbine noise is highly variable among humans. Although there are opposing views on the subject, it has recently been stated (Pierpont 2006) that "some people feel disturbing amounts of vibration or pulsation from wind turbines, and can count in their bodies, especially their chests, the beats of the blades passing the towers, even when they can't hear or see them." More needs to be understood regarding the effects of low-frequency noise on humans."*** ***"Guidelines for measuring noise produced by wind turbines are provided in the standard, IEC 61400-11: Acoustic Noise Measurement Techniques for Wind Turbines (IEC 2002), which specifies the instrumentation, methods, and locations for noise measurements. Wind-energy developers are required to meet local standards for acceptable sound levels; for example, in Germany, this level is 35 dB(A) for rural nighttime environments."*** ***"Noise-emission measurements potentially are subject to problems, however. A 1999 study involving noise-measurement laboratories from seven European countries found, in measuring noise emission from the same 500 kW wind turbine on a flat terrain, that while apparent sound power levels and wind speed dependence could be measured reasonably reliably, tonality measurements were***

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	much more variable (Kragh et al. 1999.) In addition, methods for assessing noise levels produced by wind turbines located in various terrains, such as mountainous regions, need further development." ***"Shadow flicker caused by wind turbines can be an annoyance, and its effects need to be considered during the design of a wind-energy project. In the United States, shadow flicker has not been identified as even a mild annoyance. In Northern Europe, because of the higher latitude and the lower angle of the sun, especially in winter, shadow flicker has, in some cases, been noted as a cause for concern."*** ***"Recent research studies regarding noise from wind-energy projects suggest that the industry standards (such as the IEC 61400-11 guidelines) for assessing and documenting noise levels emitted may not be adequate for nighttime conditions and projects in mountainous terrain. This work on understanding the effect of atmospheric stability conditions and on site-specific terrain conditions and their effects on noise needs to be accounted for in noise standards. In addition, studies on human sensitivity to very low frequencies are recommended.*** ***Computational tools have become available that not only compute shadow flicker in real time during turbine operation, but also convey information to the turbine-control system to allow shutdown if the shadow flicker at a particular location becomes particularly problematic. Hence, the development and implementation of a real-time system at a wind-energy project to take such actions when shadow flicker is indicated might be useful."***
4-1	4.1 Infrasound, Low-Frequency Sound, and Annoyance "The infrasound emitted from wind turbines is at a level of 50 to 70 dB, sometimes higher, but well below the audible threshold. There is a consensus among acoustic experts that the infrasound from wind turbines is of no consequence to health." ***The NASA Technical paper "Wind Turbine Acoustics" states:*** ***"People who are exposed to wind turbine noise inside buildings experience a much different acoustic environment***

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	than do those outside….They may actually be more disturbed by the noise inside their homes than the would be outside." ***The paper also states:*** ***"One of the common ways that a person might sense the noise-induced excitation of a house is though structural vibrations. This mode of observation is particularly significant at low frequencies, below the threshold of normal hearing."*** "The low frequency sound emitted by spinning wind turbines could possibly be annoying to some when winds are unusually turbulent, but there is no evidence that this level of sound could be harmful to health." ***Public Health Impacts of Wind Turbines*** ***Prepared by: Minnesota Department of Health*** ***Environmental Health Division states:*** ***"Wind turbines generate a broad spectrum of low-intensity noise. At typical setback distances higher frequencies are attenuated. In addition, walls and windows of homes attenuate high frequencies, but their effect on low frequencies is limited."*** ***"The most common complaint in various studies of wind turbine effects on people is annoyance or an impact on quality of life. Sleeplessness and headache are the most common health complaints and are highly correlated (but not perfectly correlated) with annoyance complaints. Complaints are more likely when turbines are visible or when shadow flicker occurs."*** ***"Most available evidence suggests that reported health effects are related to audible low frequency noise. Complaints appear to rise with increasing outside noise levels above 35 dB(A)."*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"For broadband noise, such as wind turbines produce, the low frequency components may travel further than the higher frequency components. Since low-frequency noise is***

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	particularly annoying to most people, it is important to specify limits for low frequency noise." ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise. Light weight building home structures will not attenuate these frequencies components as well as higher frequency components."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Incorporating Low Frequency Noise Legislation for the Energy Industry in Alberta, Canada*** ***Authors: DeGagne, David C.; Lapka, Stephanie D states:*** ***"Complaints related to LFN are often described by the affected party as a deep, heavy sound, like "humming," sometimes with an accompanying vibration. In some cases, the direction of the source of the LFN will be unknown to the receptor. However, it is the complainant that is most able to detect the presence of the LFN, signifying a particular sensitivity of the individual to the sound while others in the same family may not be able to detect the sound at all. To make a proper determination for the presence of LFN, the data must be collected during a time when environmental conditions are representative of when the sound is annoying. Residents who are impacted by LFN may suffer from sleep disturbances, headaches, and in some cases chronic fatigue."*** ***"Unlike higher frequency noise issues, LFN is very difficult to suppress. Closing doors and windows in an attempt to diminish the effects sometimes makes it worse because of the propagation characteristics and the low-pass filtering effect of structures. Individuals often become irrational and anxious as attempts to control LFN fail, serving only to increase the individual's awareness of the noise, accelerating the above symptoms."*** ***World Health Organization, Guidelines for Community Noise, 1999 states***

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	"Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general" ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** "If so, city dwelling would be impossible due to the similar levels of ambient sound levels normally present in urban environments. Nevertheless, a small number of people find city sound levels stressful." ***This A/CanWEA Panel Review conclusion does not appear to be based on scientific evidence. The conclusion there are no adverse health effects from noise on the basis that people are able live in cities ignores the ample evidence that environmental noise is a risk to human health.*** ***World Health Organization states:*** ***"Just like air pollution and toxic chemicals, noise is an environmental hazard to health. While almost everyone is exposed to too much noise, it has traditionally been dismissed as an inevitable fact of urban life and has not been targeted and controlled as much as other risks," concludes Dr Rokho Kim of the WHO Regional Office for Europe, who managed the project to draw up the guidelines. "We hope that the new guidelines will create a culture of noise awareness, and prompt governments and local authorities to invest effort and money in protecting health from this growing hazard, particularly in cities."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***"Noise seriously harms human health and interferes with people's daily activities at school, at work, at home and during leisure time. Traffic noise alone is harming the health of almost every third European. One in five Europeans is regularly exposed to sound levels at night that could significantly damage health."*** ***http://www.euro.who.int/Noise***
4-3	"The main health effect of noise stress is disturbed sleep, which may

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	lead to other consequences." "There is no evidence that sound at the levels from wind turbines as heard in residences will cause direct physiological effects. A small number of sensitive people, however, may be stressed by the sound and suffer sleep disturbances." ***These A/CanWEA Panel Review statements are paradoxical. The statements acknowledge sleep disturbance(s) and stress may occur from wind turbine exposure. The second statement concludes there is no evidence direct physiological effects occur.*** ***World Health Organization, Guidelines For Community Noise 1999 states:*** ***Uninterrupted sleep is a prerequisite for good physiological and mental functioning, and the primary effects of sleep disturbance are: difficulty in falling asleep; awakenings and alterations of sleep stages or depth; increased blood pressure, heart rate and finger pulse amplitude; vasoconstriction; changes in respiration; cardiac arrhythmia; and increased body movements.*** ***(Note this reference is listed in the References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***World Health Organization "Night Noise Guidelines for Europe" 2009 states:*** ***"There is plenty of evidence that sleep is a biological necessity, and disturbed sleep is associated with a number of health problems."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***According to World Health Organization "Night Noise Guidelines for Europe" 2009:*** ***Sleep documented health related consequences of sleep debt include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders***

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	(depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality among others. ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***The A/CanWEA Panel Review is silent on what scientific basis it came to the conclusion that only "***A small number of sensitive people" ***may be*** "stressed by the sound and suffer sleep disturbances." ***The A/CanWEA Panel Review qualification that only a small number and only sensitive people will be adversely affected is not supported by any credible reference.***
4-3 to 4-5	4.1.3 Other Aspects of Annoyance 4.1.4 Nocebo Effect 4.1.5 Somatoform Disorders ***These sections of the A/CanWEA Panel Review are disturbing.*** ***The A/CanWEA Panel Review acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms.*** ***One of the authors of the report W. David Colby, M.D. has stated:*** ***"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick."*** ***Sounding Board, 97.9 FM The Beach December 17, 2009*** ***Despite these acknowledgements and without having studied victims the authors of the A/CanWEA Panel Review offer the Nocebo Effect and Somatoform Disorders as causal explanations for physiological and psychological symptoms being reported by clinicians such as Dr. Pierpont.*** ***Without having studied victims, the A/CanWEA Panel Review***

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	speculates further that: "Associated stress from annoyance, exacerbated by the rhetoric, fears, and negative publicity generated by the wind turbine controversy, may contribute to the reported symptoms described by some people living near rural wind turbines." ***There are people reporting adverse health effects from exposure to wind turbines. Families including children have abandoned their homes to protect their health. This cannot be denied.*** ***There are European peer review studies that have documented high annoyance and sleep disturbance in populations exposed to industrial wind turbines.*** ***A 2009 court decision requires a France industrial wind turbine facility to shut down at night to protect the local population from sleep disturbance.*** ***http://www.ouest-france.fr/actu/actuLocale_-La-justice-demande-l-arret-nocturne-des-huit-eoliennes-de-Cast_-1183050------29103-abd_actu.Htm*** ***Clinicians and other researchers have documented victim symptoms and sleep disturbance which tends to be reported as the number one health complaint.*** ***The A/CanWEA Panel Review ignores the literature on the effects of annoyance, stress and sleep disturbance and the associated symptoms.***
4-8 4-11	4.3 Wind Turbine Syndrome ***The A/CanWEA Panel Review does not deny there are victims experiencing symptoms from exposure to industrial wind turbines.*** "The symptoms are common in cases of extreme and persistent annoyance, leading to stress responses in the affected individual and may also result from severe tinnitus, when there is no external sound." ***The A/CanWEA Panel Review concludes*** "The symptoms are exhibited by a small proportion of sensitive

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	persons…" ***A/CanWEA Panel Review does not provide a credible reference for this statement.***
4-13	4.6 Standards for Siting Wind Turbines 4.6.1 Introduction "Opponents of wind energy development argue that the height and setback regulations established in some jurisdictions are too lenient and that the noise limits which are applied to other sources of noise (either industrial or transportation) are not sufficient for wind turbines for a variety of reasons." ***The A/CanWEA Panel Review uses biased pre-emptive stereotyping by labelling individuals or groups who have legitimate concerns about the adverse effects from exposure to industrial wind turbines as "opponents". These pre-emptive stereotyping attempts to invalidate legitimate concerns at the onset.*** ***This pre-emptive stereotyping extends to concerned medical professionals such as members of the Maine Medical Association who have passed a resolution calling for independent research and the development of authoritative wind turbine guidelines designed to protect human health.*** ***This pre-emptive stereotyping dismisses the claim that the panel is independent and unbiased.*** ***Preliminary findings of a controlled study (Mars Hill, Maine) being conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomatology, compared to a control group living 5000-6000 meters away.*** ***Significantly, they require increased prescription medications to deal with these symptoms compared to the control group. Most symptomatology appears attributable to the quality and persistence of the noise generated by the turbine installations. Additional investigation of the children living in close proximity to industrial wind turbines is urgently needed. Improvements in pre-***

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	construction sound modeling and siting ordinances are required to prevent the negative health effects observed in our study population. This is a work in progress. http://windvigilance.com/mars_hill.aspx ***The A/CanWEA Panel Review displays selective bias by failing to acknowledge that wind turbine noise is unique in character.*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Soysai, H., and O. Soysai. Wind farm noise and regulations in the eastern United States. 2007 states*** ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Aero acoustics of large wind Turbines Harvey Hubbard Lockheed Engineering and Sciences Company, Kevin P Shepherd NASA*** ***"There is a concern for the possible adverse environmental impact of noise from large horizontal axis wind turbines operated for electric power generation. Widespread deployment of such machines is anticipated in wind power***

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	stations, some of which may be located in proximity to residential areas. Routine operations of such wind power stations may result in some unique community noise exposure situations." "Opponents of wind energy development argue that the height and setback regulations established in some jurisdictions are too lenient and that the noise limits which are applied to other sources of noise (either industrial or transportation) are not sufficient for wind turbines for a variety of reasons." ***The A/CanWEA Panel Review displays selective bias with this statement.*** ***A European study concludes:*** ***"Perhaps the main finding is that wind turbine sound is relatively annoying, more so than equally loud sound from aircraft or road traffic. A swishing character is perceived by most respondents, indicating that this is an important characteristic of wind turbine sound. Sound should therefore receive more attention in the planning of wind farms, and (more) sound mitigation measures must be considered."*** ***Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008*** "Consequently, there are those who advocate for a revision of the existing regulations for noise and setback pertaining to the siting of wind installations (Kamperman and James, 2009). Some have indicated their belief that setbacks of more than 1 mile may be necessary. While the primary purpose of this study was to evaluate the potential for adverse health effects rather than develop public policy, the panel does not find that setbacks of 1 mile are warranted." ***Note: the reference cited by the A/CanWEA Panel Review*** (Kamperman and James, 2009) ***should be dated*** (Kamperman and James, 2008). ***This A/CanWEA Panel Review statement is ambiguous. The impression is the A/CanWEA Panel Review favours set backs based on public policy over those designed to protect humans from adverse health effects.***

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4-13 to 4-15	4.6.3 Wind Turbine Siting Guidelines ***The A/CanWEA Panel Review does not deny there are victims experiencing adverse health effects from industrial wind turbines.*** ***One of the authors of the A/CanWEA Panel Review W. David Colby, M.D. reinforced this position regarding wind turbines by stating*** ***"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick."*** ***Sounding Board, 97.9 FM The Beach December 17, 2009*** ***The A/CanWEA Panel Review acknowledges that wind turbine noise can cause annoyance, stress and sleep disturbance.*** ***The A/CanWEA Panel Review acknowledges that these effects*** "may lead to other consequences". ***The A/CanWEA Panel Review acknowledges wind turbine low frequency noise can cause annoyance.*** ***Geoff Leventhall, one of the authors of the A/CanWEA Panel Review acknowledges the serious nature of low frequency noise induced annoyance by asserting:*** ***"The claim that their "lives have been ruined" by the noise is not an exaggeration…"*** ***Leventhall HG. Low frequency noise and annoyance. Noise Health 2004*** ***A European study concludes:*** ***"Perhaps the main finding is that wind turbine sound is relatively annoying, more so than equally loud sound from aircraft or road traffic. A swishing character is perceived by most respondents, indicating that this is an important characteristic of wind turbine sound. Sound should therefore receive more attention in the planning of wind farms, and (more) sound mitigation measures must be considered."***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	Project WINDFARMperception Visual and acoustic impact of wind turbine farms on residents Pedersen et al., 2008
	Despite these acknowledgements, the A/CanWEA Panel Review neglects to advocate for authoritative regulations to mitigate the risk of adverse health effects.
	The A/CanWEA Panel Review discusses random noise limits based on policy, not health protection.
	The A/CanWEA Panel Review uses a draft report titled "Environmental Noise and Health in the UK." to support that World Health Organization noise guidelines do not need to be followed:
	"Surveys have shown that about half of the UK population lives in areas where daytime sound levels exceed those recommended in the WHO Community Noise Guidelines. About two-thirds of the population live in areas where the night-time guidelines recommended by WHO are exceeded."
	This statement does not stand up to scrutiny under a preventative health care model.
	The A/CanWEA Panel Review ignores the serious nature of noise induced annoyance, stress and sleep disruption.
	The inclusion of this section displays selective bias: it favours noise intensive industries such as industrial wind energy. The A/CanWEA Panel Review does not state reasons for including this section. It is an attempt to encourage authorities to circumvent the World Health Organizations noise guidelines which are designed to protect human health.
	World Health Organization states
	"Just like air pollution and toxic chemicals, noise is an environmental hazard to health. While almost everyone is exposed to too much noise, it has traditionally been dismissed as an inevitable fact of urban life and has not been targeted and controlled as much as other risks," concludes Dr Rokho Kim of the WHO Regional Office for Europe, who managed the project to draw up the guidelines. "We hope that the new guidelines will create a culture of noise awareness, and prompt governments and local

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	authorities to invest effort and money in protecting health from this growing hazard, particularly in cities." ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1*** ***"…one in five Europeans is regularly exposed to sound levels at night that could significantly damage their health."*** ***http://www.euro.who.int/Noise/activities/20040721_1***
5-1 to 5-2	SECTION 5 Conclusions "There is nothing unique about the sounds and vibrations emitted by wind turbines." ***This conclusion contradicts the content of the A/CanWEA Panel Review which acknowledges that wind turbine noise is complex due to infrasound, low frequency noise, broadband noise, and amplitude modulation.*** ***The US Department of Energy states:*** ***"Types of Wind Turbine Sound Wind turbines make different types of sound, including broadband, infrasonic, impulsive, and tonal sound."*** ***Health Council of the Netherlands (HCN). 2004 The Influence of Night-time Noise on Sleep and Health. The Hague: Health Council of the Netherlands, 2004; publication no. 2004/14E."*** ***The HCN (2004) states:*** ***"The Committee has identified a number of forms of noise that may have a particularly pronounced effect on people exposed to them:*** ***• Noise characterised by low-pitch components (buzzing)*** ***• Noise consisting entirely of one or more low buzzing sounds (low-frequency noise)*** ***• Tonal noise*** ***• Noise events characterised by a rapid increase in intensity at the beginning (impulse noise)*** ***• Industrial noise***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	• Noise characterised by sporadic high LAmax or SEL values." ***Wind turbine noise is known to contain most if not all of these forms of noise.*** ***Alberts, D. 2006. Primer for Addressing Wind Turbine Noise states:*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Soysai, H., and O. Soysai. Wind farm noise and regulations in the eastern United States. 2007 states:*** ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic."*** ***(Note this reference is listed in the Additional References but this citation was neglected in the main body of the A/CanWEA Panel Review)*** ***Aero acoustics of large wind Turbines Harvey Hubbard Lockheed Engineering and Sciences Company, Kevin P Shepherd NASA*** ***"There is a concern for the possible adverse environmental impact of noise from large horizontal axis wind turbines operated for electric power generation. Widespread deployment of such machines is anticipated in wind power stations, some of which may be located in proximity to residential areas. Routine operations of such wind power stations may result in some unique community noise***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	exposure situations."
5-2	"In conclusion: 1. Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans. ***Conclusion 1 contradicts the A/CanWEA Panel Review which acknowledges that wind turbine noise may cause annoyance, stress and sleep disturbance and that as a result people may experience adverse physiological and psychological symptoms.*** 2. Subaudible, low frequency sound and infrasound from wind turbines do not present a risk to human health. ***Conclusion 2 contradicts the NASA Technical paper "Wind Turbine Acoustics" which states:*** ***"People who are exposed to wind turbine noise inside buildings experience a much different acoustic environment than do those outside….They may actually be more disturbed by the noise inside their homes than the would be outside."*** ***The NASA Technical paper also states:*** ***"One of the common ways that a person might sense the noise-induced excitation of a house is though structural vibrations. This mode of observation is particularly significant at low frequencies, below the threshold of normal hearing."*** ***Conclusion 2 contradicts the A/CanWEA Panel Review statement from page 4-1 which states:*** "The low frequency sound emitted by spinning wind turbines could possibly be annoying to some…" ***The World Health Organization acknowledges annoyance as an adverse health effect.*** ***World Health Organization Guidelines For Community Noise 1999***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations *The Society for Wind Vigilance analysis in bold italicized* Note any errors or omissions are unintentional.
	Conclusion 2 contradicts the A/CanWEA Panel Review statement from page 4-10 which states that physiological and psychological symptoms caused by annoyance include: "…distraction, dizziness, eye strain, fatigue, feeling vibration, headache, insomnia, muscle spasm, nausea, nose bleeds, palpitations, pressure in the ears or head, skin burns, stress, and tension…" ***There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This is settled medical science.*** ***Sound energy in the infra and low frequency range may also be a factor for other adverse health effects. Although these sounds may be sub-audible to all but the most sensitive people, others may perceive it as internal body sensations. This is compounded indoors, because the sound pressure levels inside homes may be augmented by building resonance and harmonics. This can result in a larger percentage of the general population that may perceive the sound or vibration in their body or home, and stronger effects on those who responded without such augmentation. It can also result in perceptible audible noise to people who may not have perceived the sounds outdoors or in another building with different resonance characteristics.*** ***The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects upon the human body remains an open question - there is <u>no</u> settled medical science on this issue as yet.*** 3. Some people may be annoyed at the presence of sound from wind turbines. Annoyance is not a pathological entity. ***Conclusion 3 contradicts World Health Organization which acknowledges annoyance is an adverse health effect.*** ***World Health Organization Guidelines For Community Noise 1999*** ***Conclusion 3 contradicts the A/CanWEA Panel Review***

A/CanWEA Panel Review Page Reference	Table 1 Analysis A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	statement from page 4-10 which states that physiological and psychological symptoms caused by annoyance include: "…distraction, dizziness, eye strain, fatigue, feeling vibration, headache, insomnia, muscle spasm, nausea, nose bleeds, palpitations, pressure in the ears or head, skin burns, stress, and tension…" 4. A major cause of concern about wind turbine sound is its fluctuating nature. Some may find this sound annoying, a reaction that depends primarily on personal characteristics as opposed to the intensity of the sound level." ***Conclusion 4 contradicts World Health Organization which acknowledges annoyance is an adverse health effect and states:*** ***"The annoyance response to noise is affected by several factors, including the equivalent sound pressure level and the highest sound pressure level of the noise, the number of such events, and the time of day."*** ***World Health Organization Guidelines For Community Noise 1999*** ***Conclusion 4 contradicts The A/CanWEA Panel Review statement from page 3-13 which states that noise levels directly impact annoyance*** "Noise from airports, road traffic, and other sources (including wind turbines) may annoy some people, and, as described in Section 4.1, the louder the noise, the more people may become annoyed." ***Throughout the A/CanWEA Panel Review it is acknowledged that the wind turbine noise may cause annoyance, stress and sleep disturbance.*** ***The A/CanWEA Panel Review does not deny there are victims experiencing adverse health effects from exposure to industrial wind turbines.*** ***One of the authors of the report W. David Colby, M.D. has stated:***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
	"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick." ***Sounding Board, 97.9 FM The Beach December 17, 2009*** ***World Health Organization states:*** ***"Sleep disturbance and annoyance are the first effects of night noise and can lead to mental disorders.*** ***The effects of noise can even trigger premature illness and death."*** ***http://www.euro.who.int/mediacentre/PR/2009/20091008_1***
	The Society for Wind Vigilance Conclusion: ***It is apparent from this analysis that the A/CanWEA Panel Review is neither authoritative nor convincing. The work is characterized by commission of unsupportable statements and the confirmation bias in the use of references. Many important references have been omitted and not considered in the discussion. Furthermore the authors have taken the position that the World Health Organization standards regarding community noise are irrelevant to their deliberation - a remarkable presumption.*** ***There is no medical doubt that audible noise such as emitted by modern upwind industrial wind turbines sited close to human residences causes significant adverse health effects. These effects are mediated through sleep disturbance, physiological stress and psychological distress. This is settled medical science.*** ***There are many peer-reviewed studies showing that infra and low frequency sound can cause adverse health effects, especially when dynamically modulated. Modern upwind industrial scale turbines of the types now being located in rural areas of North America require study. The extent to which infra and low frequency noise from wind turbines inside or outside homes causes direct adverse effects***

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	upon the human body remains an open question - there is no settled medical science on this issue as of yet. ***Perhaps the most egregious conclusion is that no more research is required. That statement implies that the science is settled which quite simply is false. It also demonstrates a disdain for the scientific method itself.*** ***There is but one conclusion: independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur.*** ***In contrast to the statement of the A/CanWEA Panel Review, our view is that a great deal of research is required for the protection of people's health.***
6-1 6-9	SECTION 6 References ***The A/CanWEA Panel Review displays selective bias favouring the positions of CanWEA and AWEA by omitting relevant references.*** ***Examples of obvious omissions of the A/CanWEA Panel Review include the research conducted by Dr Amanda Harry (UK) or Dr Michael A. Nissenbaum (USA). Both are available on the web.*** ***The A/CanWEA Panel Review ignores that members of the Maine Medical Association passed a Resolution RE: Wind Energy and Public Health":*** ***"work with health organizations and regulatory agencies to provide scientific information of known medical consequences of wind development in order to help safeguard human health and the environment; and to 'work with other stakeholders to encourage performance of studies on health effects of wind turbine generation by independent qualified researchers at qualified research institutions;"*** ***and to***

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	"ensure that physicians and patients alike are informed of evidence-based research results." ***Preliminary findings of a controlled study (Mars Hill, Maine) being conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomatology, compared to a control group living 5000-6000 meters away.*** ***Significantly, they require increased prescription medications to deal with these symptoms compared to the control group. Most symptomatology appears attributable to the quality and persistence of the noise generated by the turbine installations. Additional investigation of the children living in close proximity to industrial wind turbines is urgently needed. Improvements in pre-construction sound modeling and siting ordinances are required to prevent the negative health effects observed in our study population. This is a work in progress.*** http://windvigilance.com/mars_hill.aspx ***Other important references ignored by the A/CanWEA Panel Review include but are not limited to:*** • ***"Minnesota Department of Health (MDH) 2009 Public Health Impacts of Wind Turbines"*** • ***"The Noise Association. 2006. Location, location, location. An investigation into wind farms and noise by The Noise Association"*** • ***Noise Radiation From Wind Turbines Installed Near Homes: Effects On Health With an annotated review of the research and related issues by Barbara J Frey, BA, MA and Peter J Hadden, BSc, FRICS*** • ***"Sleep Disturbance And Wind Turbine Noise" Dr Christopher Hanning BSc, MB, BS, MRCS, LRCP, FRCA, MD dated June 2009.***

A/CanWEA Panel Review Page Reference	**Table 1** **Analysis** A/CanWEA Panel Review contents in non bold quotations ***The Society for Wind Vigilance analysis in bold italicized*** Note any errors or omissions are unintentional.
6-8	Alberts, D. 2006. Primer for Addressing Wind Turbine Noise. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***Relevant citations not cited in the A/CanWEA Panel Review include:*** ***The acknowledgment of the risk of sleep disturbance being a health risk.*** ***"a Dutch study that showed noise from a 30 MW wind farm becomes more noticeable and annoying to nearby residents at night. This study noted that although the noise is always present, certain aspects of turbine noise, such as thumping and swishing, were not noticeable during the day, but became very noticeable at night. Residents as far as 1900 meters from the wind farm complained about the night time noise."*** ***"For broadband noise, such as wind turbines produce, the low frequency components may travel further than the higher frequency components. Since low-frequency noise is particularly annoying to most people, it is important to specify limits for low frequency noise."*** ***"Wind direction also has an influence on sound propagation. Within 900 ft of a sound source, the wind direction does not seem to influence the sound. After about 900 ft., the wind direction becomes a major factor in sound propagation. Downwind (meaning the wind is moving from the noise source towards the receiver) of the source, sound volume will increase for a time before decreasing."*** ***"Wind turbine noise, especially at lower wind and blade speeds, will contain more low frequency components than traffic noise. Light weight building home structures will not attenuate these frequencies components as well as higher frequency components."***
6-8	Chatham-Kent Public Health Unit. 2008. The Health Impact of Wind Turbines: a Review of the Current White, Grey and Published Literature 2008. ***Regarding this reference Dr Colby stated:***

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	"The research and writing was done by April Rietdyk but I endorse and take full responsibility for the content." ***An October 2009 letter from The College of Physicians and Surgeons of Ontario, Inquiries, Complaints and Reports Committees Decisions and Reasons states that:*** ***"…the Committee observes, Dr. Colby's expertise is in medical microbiology and infectious diseases, an area quite distinct from audiology or other fields to the physical impact of wind turbines on human health. Thus the committee wishes to remind Dr. Colby, going forward, of the importance of fully disclosing the extent of his qualifications in a field that he has been retained as an "expert" and also to ensure he fully disclose to the public the organization or corporation by whom he has been retained by an expert."*** ***In addition:*** ***SkyPower, a wind energy developer advertised Dr Colby as one of their "representatives". Dr Colby has stated that he received an honorarium for this service.*** ***This document is an inadequate public health document. This statement is based on the following:*** ***The report displays selective bias favouring the wind energy industry in the presentation of the material referenced.*** • ***Heavy reliance on references from the wind energy industry (CanWEA, AWEA, BWEA, Danish Wind Energy Association)*** • ***Heavy reliance on references from listed members of CanWEA (Howe Gastmeier Chapnik Limited. Mississauga HGC Engineering)*** • ***The report displays selective bias favouring the wind energy industry by the omission of relevant references.*** • ***As a result of the above deficiencies the report provides incomplete risk assessments related to health including the failure to adequately consider the health impacts of annoyance, stress or sleep disturbance. (based on a key word searches of "annoyance", "stress" and "sleep disturbance")*** • ***The report uses pre-emptive stereotyping of individuals who***

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	have concerns about associated with wind turbine facilities. (ie "Those Opposed to Wind Power").
6-8	Copes, R. and K. Rideout. Wind Turbines and Health: A Review of Evidence. Ontario Agency for Health Protection and Promotion 2009 ***The power point slides contain few references and much of the material is similar to that used by the wind energy industry.*** ***The conclusion of the power point presentation is inconsistent as it states:*** ***"No evidence of noise-induced health effects at levels emitted by wind turbines"*** ***Then paradoxically concludes:*** ***" Stress and sleep disturbance possible"*** ***"Sound, flicker, aesthetics may affect annoyance + stress"*** ***"Health concerns are valid and must be addressed."*** ***"Any effects on health more likely related to annoyance/sleep disturbance than to direct effect of SPLs at residence."***
6-8	Draft New Zealand standard for wind turbine sound. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***Relevant citations not cited in the A/CanWEA Panel Review include:*** ***"Limits for wind farm noise are required to provide protection against sleep disturbance and maintain reasonable residential amenity."*** ***"In certain situations (see 5.3), consideration of a noise limit more stringent than 40 dB may be appropriate to further protect amenity for particular noise sensitive locations."*** ***As a result the draft standard recommends a secondary noise limit for quiet areas***

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	"Where a secondary noise limit is applicable, wind farm sound levels (LA90(10 min)) should not exceed the background sound level by more than 5 dB, or a level of 35 dB LA90(10 min), whichever is the greater." ***The New Zealand draft standard recommends improvement to sound modelling including testing being conducted at various temperature and atmospheric conditions.***
6-8	2009. Maine Osteopathic Association Resolution: Wind Energy and Public Health. ***The Maine Osteopathic Association Resolution: Wind Energy and Public Health dated September 25, 2009 and is listed under Additional References of the A/CanWEA Panel Review.*** ***The Maine Medical Association Resolution: Wind Energy and Public Health. September 12, 2009 is not listed in the A/CanWEA Panel Review.*** ***The A/CanWEA Panel Review displays selective bias by including the Maine Osteopathic Association Resolution but neglecting to include the Maine Medical Association Resolution: Wind Energy and Public Health***.
6-8	Keith, S. E., D. S. Michaud, and S. H. P. Bly. 2008. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control, 27 (4):253-265. ***This article acknowledges both annoyance and sleep disturbance may occur from wind turbines noise even at levels of 40dBA or 45dBA.***
6-9	Ramakrishnan, R. 2007. Acoustic Consulting Report Prepared for the Ontario Ministry of the Environment: Wind Turbine Facilities Noise Issues. Aiolos Engineering Corporation. ***In an email exchange Dr Ramani Ramakrishnan, the author of this reference states*** ***"I am not a medical doctor or a psychoacoustician or a physiological acoustician. I am an acoustician from the engineering science perspective. So, to comment on health issues is outside my area of expertise."***

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	This reference does however suggest scientific uncertainty by concluding ***"…additional concerns still need to be addressed in the next round of revisions to their assessment process. These revisions may need to be addressed after the results from future research provide scientifically consistent data for effects such as meteorology, human response and turbine noise source character."***
6-9	Rogers, A. and J. Manwell . Wright, S. 2002. Wind turbine acoustic noise. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***From Rogers, A. and J. Manwell . Wright, S. 2002. Wind turbine acoustic noise. Amended January 2006*** ***It concludes:*** ***"…noise is a primary siting constraint."*** ***"Community noise standards are important to ensure liveable communities. Wind turbines must be held to comply with these regulations."***
6-9	Soysai, H., and O. Soysai. Wind farm noise and regulations in the eastern United States. 2007. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***Relevant citations not cited in the A/CanWEA Panel Review include:*** ***"Sound generated by wind turbines has particular characteristics and it creates a different type of nuisance compared to usual urban, industrial, or commercial noise. The interaction of the blades with air turbulences around the towers creates low frequency and infrasound components, which modulate the broadband noise and create fluctuations of sound level. The lower frequency fluctuation of the noise***

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	is described as 'swishing' or 'whooshing' sound, creating an additional disturbance due to the periodic and rhythmic characteristic." ***"Specific noise limits need to be developed by considering the characteristics of wind turbine noise. Especially the low frequency sound components and the modulation of the background noise resulting must be considered to represent the activity interference of the wind turbine sound. Adequate criteria to asses the wind turbine sound will greatly help the development the wind industry by reducing the community reaction based on subjective opinions."***
6-9	World Health Organization (WHO). 2009. Night Noise Guidelines for Europe. The World Health Organization, Geneva, Switzerland. ***The A/CanWEA Panel Review displays selective bias by neglecting to include this reference in the body of the report.*** ***The A/CanWEA Panel Review acknowledges that wind turbines may cause sleep disturbance.*** ***In 2009 World Health Organization released Night Noise Guidelines for Europe which is a 184 page peer reviewed summary of the risks to human health that may result from noise induced sleep disturbance. Some of the adverse health documented include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality.*** ***The A/CanWEA Panel Review's failure to include an analysis of this document in the context of wind turbine noise induced sleep disturbance is a conspicuous omission.***

END OF ANALYSIS

A Primer on Adverse Health Effects and Industrial Wind Turbines

March, 2010

Prepared by the Society for Wind Vigilance

www.windvigilance.com

Signed by (Alphabetical order)
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A Primer on Industrial Wind Turbines
and
Adverse Health Effects
March, 2010

The American Wind Energy Association and Canadian Wind Energy Association sponsored report entitled "Wind Turbine Sound and Health Effects" (A/CanWEA Panel Review) concludes that "sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans." [1] This denial does not withstand scrutiny.

On January 11, 2010 The Society for Wind Vigilance released a critique of the A/CanWEA Panel Review and concluded that it was "…neither authoritative nor convincing.." and "…independent third party studies must be undertaken to establish the incidence and prevalence of adverse health effects relating to wind turbines. Beyond that a deeper understanding of the potential mechanisms for the impacts must be elucidated in order to define the mechanisms by which the sleep disturbance, stress and psychological distress occur."[2]

On January 19, 2010 The UK National Health Service (NHS) released an independent critique of the A/CanWEA Panel Review and concluded "The link between psychological distress and physical symptoms has not been explored by this report. The acknowledgment that some people exposed to wind turbine noise suffer annoyance suggests that monitoring and maximum permitted levels need to be considered carefully in areas where turbines are planned. Overall, this review will probably not resolve this controversy as there was a lack of high-level evidence on which to base any solid conclusions. What is now needed are studies that compare people exposed to turbine noise with well-matched control subjects who have not had that exposure."[3]

The NHS critique is based on "the best scientific knowledge currently available".

To read the NHS editorial policy visit.
http://www.nhs.uk/aboutNHSChoices/aboutnhschoices/Aboutus/Pages/Editorialpolicy.aspx

Two independent critiques of the same industry sponsored report have come to remarkably similar conclusions.

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[1] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association
[2] The Society for Wind Vigilance, Wind Energy Industry Acknowledgement of Adverse Health Effects, An Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects An Expert Panel Review, December 2009", 2010 http://windvigilance.com/awea_media.aspx
[3] UK National Health Service, Wind turbine sound 'needs research', Thursday January 28, 2010, http://www.nhs.uk/news/2010/01January/Pages/Wind-turbine-sound-and-health.aspx

Paradoxically the conclusions of the A/CanWEA Panel Review are not supported by its own contents in that it acknowledges wind turbine noise may cause annoyance, stress and sleep disturbance and as a result people may experience adverse physiological and psychological symptoms. [4]

In a radio interview one of the authors of the A/CanWEA Panel Review W. David Colby, M.D. stated:

"We're not denying that there are people annoyed and that maybe some of them are getting stressed out enough about being annoyed that they're getting sick." [5]

The Ontario Ministry of Health and Long Term Care also acknowledge wind turbines may cause annoyance, stress and sleep disturbance.[6]

The A/CanWEA Panel Review acknowledges wind turbine noise induced symptoms may include palpitations, insomnia, nose bleeds, dizziness, nausea, eye strain, feeling vibration and headache. [7]

In 2010 Geoff Leventhall an author of the A/CanWEA Panel Review is quoted as stating "… there was no doubt people living near the turbines suffered a range of symptoms, including abnormal heart beats, sleep disturbance, headaches, tinnitus, nausea, visual blurring, panic attacks and general irritability.…it's ruining their lives – and it's genuine…".[8]

"Health Canada advises…that there are peer-reviewed scientific articles indicating that wind turbines may have an adverse impact on human health."[9]

Peer reviewed studies of European industrial wind turbine facilities have documented high annoyance and sleep disturbance in respondents.[10],[11],[12]

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[4] W. David Colby, M.D et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009, Prepared for American Wind Energy Association and Canadian Wind Energy Association

[5] W. David Colby, M.D., Sounding Board, 97.9 FM The Beach December 17, 2009

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World Health Organization recognizes annoyance and sleep disturbance as adverse health effects. [13]

In 2009 World Health Organization released a 184 page peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effect documented in the report include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality.[14]

The A/CanWEA Panel Review acknowledges that wind turbine low frequency noise may cause annoyance.[15]

Some of the documented effects of low frequency noise induced annoyance include task performance deterioration, reduced wakefulness, sleep disturbance, headaches, and irritation.[16]

"Unlike higher frequency noise issues, LFN is very difficult to suppress. Closing doors and windows in an attempt to diminish the effects sometimes makes it worse because of the propagation characteristics and the low-pass filtering effect of structures. Individuals often become irrational and anxious as attempts to control LFN fail, serving only to increase the individual's awareness of the noise, accelerating the above symptoms"[17]

The NASA Technical paper "Wind Turbine Acoustics" states "People who are exposed to wind turbine noise inside buildings experience a much different acoustic environment than do those outside….They may actually be more disturbed by the noise inside their homes than they would be outside….One of the common ways that a person might sense the noise-induced excitation of a house is through structural vibrations. This mode of observation is particularly significant at low frequencies, below the threshold of normal hearing."[18]

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Geoff Leventhall one of the authors of the A/CanWEA Panel Review acknowledges the serious nature of low frequency noise induced annoyance by asserting “The claim that their "lives have been ruined" by the noise is not an exaggeration…”[19]

In a 2009 article the UK National Health Service stated “…it is physically and biologically plausible that low frequency noise generated by wind turbines can affect people…” [20]

The Canadian Wind Energy Association claims that wind turbine “installations meet strict government regulations with respect to sound”[21] but at the same time acknowledges that noise modelling typically used does not purport to consider the worst case and that actual noise levels may exceed that predicted.[22]

According to the Ontario Ministry of Environment “There is currently no scientifically accepted field methodology to measure wind turbine noise to determine compliance or non compliance with a Certificate of Approval limits.”[23]

In most jurisdictions there is no requirement for the wind energy industry to monitor or address for wind turbine low frequency noise.

The World Health Organization states:

“The precautionary principle. In all cases noise should be reduced to the lowest level achievable in a particular situation. When there is a reasonable possibility that the public health will be endangered, even though scientific proof may be lacking, action should be take to protect the public health, without awaiting the full scientific proof.”[24]

To learn more visit The Society for Wind Vigilance at www.windvigilance.com

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Brief Overview of References

Noise including Industrial Wind Turbines

and Adverse Health Effects

March, 2011

By Carmen Krogh, BScPharm,
Member of the Society for Wind Vigilance

Excerpted from work compiled by Brett Horner, B.A, CMA,

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NOTICE TO READER

Authoritative references are cited as much as possible to support the assertions contained within this overview.

Every reasonable attempt was made to ensure the accuracy of this overview. Any errors or omissions contained within this overview are unintentional.

No financial compensation has been requested nor received for the compilation of this overview.

FORWARD

This overview may be used by other individuals as required.

Due to time and resource constraints this overview does not detail all the references available.

There is, however, ample evidence indicating a risk to health resulting from noise.

NOISE ANNOYANCE CAN AFFECT HEALTH

World Health Organization recognizes annoyance and sleep disturbance as adverse health effects. [1]

Regarding noise induced annoyance the US Environmental Protection Agency states "…"annoyance" can have major consequences, primarily to one's overall health." [2]

The health impacts of noise induced annoyance must not be underestimated.

The word annoyance may mean different things to different people; however in clinical terms annoyance is acknowledged to be a risk to human health.

A World Health Organization study "…confirmed, on an epidemiological level, an increased health risk from chronic noise annoyance." [3]

Noise induced annoyance contributes to stress, [4] sleep disturbance [5] and an increased risk of regulation diseases. [6]

Annoyance may adversely affect physiological health. Research indicates that for "chronically strong annoyance a causal chain exists between the three steps health – strong annoyance – increased morbidity." [7]

The subjective experience of noise stress can, through central nervous processes, lead to an inadequate neuro-endocrine reaction and finally to regulation diseases. [8]

"Adults who indicated chronically severe annoyance by neighbourhood noise were found to have an increased health risk for the cardiovascular system and

the movement apparatus, as well as an increased risk of depression and migraine…With children the effects of noise-induced annoyance from traffic, as well as neighbourhood noise, are evident in the respiratory system." [9]

To protect against adverse health effects noise level limits "…should be based on annoyance responses to noise." [10]

"Dose-response relations for different types of traffic noise (air, road and railway) clearly demonstrate that these noises can cause different annoyance effects at equal LAeq,24h values." [11]

NOISE AND STRESS

Noise is an environmental stressor [12] which can cause stress related adverse health effects. [13]

"The subjective experience of noise stress can, through central nervous processes, lead to an inadequate neuro-endocrine reaction and finally lead to regulatory diseases." [14]

Peer reviewed scientific research reveals "With children the effects of noise-induced annoyance from traffic, as well as neighbourhood noise, are evident in the respiratory system. The increased risk of illness in the respiratory system in children does not seem to be caused primarily by air pollutants, but rather, as the results for neighbourhood noise demonstrate, by emotional stress." [15]

"Also, recent epidemiological studies have shown a connection between disturbed sleep and later occurrence of stress-related disorders such as cardiovascular diseases…and diabetes type II…" [16]

Regarding stress Health Canada states [17]

> "…stress is considered to be a risk factor in a great many diseases, including: heart disease, some types of bowel disease, herpes, mental illness.
>
> …Stress also makes it hard for people with diabetes to control their blood sugar.
>
> …Stress is also a risk factor in alcohol and substance abuse, as well as weight loss and gain. Stress has even been identified as a possible risk factor in Alzheimer's Disease.
>
> …Severe stress can cause biochemical changes in the body, affecting the immune system, leaving your body vulnerable to disease."

Other health effects associated with stress include becoming increasingly distressed, and irritable, unable to relax or concentrate, have difficulty thinking logically, and making decisions, depression, anxiety, sleep disorders, disorders of the digestive system, increases in blood pressure, headaches and musculo-skeletal disorders. [18], [19]

NOISE AND SLEEP DISTURBANCE

Difficulty falling asleep constitutes sleep disturbance which can have serious consequences. [20]

Sleep disturbance is acknowledged to be an adverse health effect. [21], [22]

The consequences of sleep disturbance can be serious.

In 2009 World Health Organization released a 184 page peer reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effect documented in the report include poor performance at work, fatigue, memory difficulties, concentration problems, motor vehicle accidents, mood disorders (depression, anxiety), alcohol and other substance abuse, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, obesity, impaired immune system function and a reported increased risk of mortality. [23]

LOW FREQUENCY NOISE AND INFRASOUND

It is widely affirmed that exposure to audible low frequency noise can cause adverse health effects in humans. [24], [25], [26], [27]

Low frequency noise can cause "…immense suffering to those who are unfortunate to be sensitive to low frequency noise and who plead for recognition of their circumstances." [28]

Annoyance is an acknowledged adverse health effect. [29], [30]

"Regulatory authorities must accept that annoyance by low frequency noise presents a real problem which is not addressed by the commonly used assessment methods." [31]

Literature reviews and scientific articles confirm the symptoms associated with low frequency noise exposure include annoyance, stress, sleep disturbance, headaches, difficulty concentrating, irritability, fatigue, dizziness or vertigo, tinnitus, heart ailments anxiety, stitch and beating palpitation. [32], [33], [34]

While there is a consensus on the symptoms caused by low frequency noise exposure the mechanism of action is not fully understood.

"Today we know that most illnesses, mental and physical, are influenced by a combination of biological, psychological and social factors." [35]

"In an integrated and evidence-based model of health, mental health (including emotions and thought patterns) emerges as a key determinant of overall health. Anxious and depressed moods, for example, initiate a cascade of adverse changes in endocrine and immune functioning, and create increased susceptibility to a range of physical illnesses." [36]

"Mental health is as important as physical health. In fact, the two are intertwined. Our mental health directly affects our physical health and vice versa…mental health factors can increase the risk of developing physical problems such as, diabetes, heart disease, weight gain or loss, gastrointestinal problems, reductions in immune system, efficiency, and blood biochemical imbalances." [37]

World Health Organization advises that "Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general…The evidence on low-frequency noise is sufficiently strong to warrant

immediate concern." and consequently "Noise with low-frequency components require lower guideline values." [38]

The effects of low frequency noise induced annoyance and stress are acknowledged to be serious as evidenced by "The claim that their "lives have been ruined" by the noise is not an exaggeration…" [39]

"…LFN *(low frequency noise)* does not need to be considered "loud" for it to cause such forms of annoyance and irritation." [40]

"The effects of infrasound or low frequency noise are of particular concern because of its pervasiveness due to numerous sources, efficient propagation, and reduced efficiency of many structures (dwellings, walls, and hearing protection) in attenuating low frequency noise compared with other noise." [41]

"Unlike higher frequency noise issues, LFN is very difficult to suppress. Closing doors and windows in an attempt to diminish the effects sometimes makes it worse because of the propagation characteristics and the low-pass filtering effect of structures. Individuals often become irrational and anxious as attempts to control LFN fail, serving only to increase the individual's awareness of the noise, accelerating the above symptoms" [42]

"Those exposed may adopt protective strategies, such as sleeping in their garage if the noise is less disturbing there. Or they may sleep elsewhere, returning to their own homes only during the day." [43]

"There is no doubt that some humans exposed to infrasound experience abnormal ear, CNS, and resonance induced symptoms that are real and stressful." [44]

There is no scientific consensus that infrasonic noise below the threshold of hearing will have no effect on health. There is scientific uncertainty regarding the understanding of human response to infrasound.

"There is no consensus whether sensitivity below 20 Hz is by a similar or different mechanism than sensitivity and hearing above 20 Hz…" [45]

The National Research Council states "Low-frequency vibration and its effects on humans are not well understood. Sensitivity to such vibration resulting from wind-turbine noise is highly variable among humans…. studies on human sensitivity to very low frequencies are recommended." [46]

The conclusions of a 2010 peer reviewed scientific article states

> "1) Hearing perception, mediated by the inner hair cells of the cochlea, is remarkably insensitive to infrasound.
>
> 2) Other sensory cells or structures in the inner ear, such as the outer hair cells, are more sensitive to infrasound than the inner hair cells and can be stimulated by low frequency sounds at levels below those that are heard. The concept that an infrasonic sound that cannot be heard can have no influence on inner ear physiology is incorrect.
>
> 3) Under some clinical conditions, such as Meniere's disease, superior canal dehiscence, or even asymptomatic cases of endolymphatic hydrops, individuals may be hypersensitive to infrasound.
>
> 4) A-weighting wind turbine sounds underestimates the likely influence of the sound on the ear. A greater effort should be made to document the infrasound component of wind turbine sounds under different conditions.

5) Based on our understanding of how low frequency sound is processed in the ear, and on reports indicating that wind turbine noise causes greater annoyance than other sounds of similar level and affects the quality of life in sensitive individuals, there is an urgent need for more research directly addressing the physiologic consequences of long-term, low level infrasound exposures on humans." [47]

Recent research on the issue of infrasound below the hearing threshold states:

"For years, people have been told that infrasound you cannot hear cannot affect you. This is completely WRONG.

As the inner ear DOES respond to infrasound at levels that are not heard, people living near wind turbines are being put at risk by infrasound effects on the body that no-one presently understands.

Until a scientific understanding of this issue is established we should not be dismissing these effects, but need to be erring on the side of caution." [48]

It is incorrect to assume that inaudible low frequency noise cannot cause adverse health effects as "…non-aural physiological and psychological effects may be caused by levels of low frequency noise below the individual hearing threshold." [49]

"Low-frequency noise may also produce vibrations and rattles as secondary effects." [50]

"Jung and colleagues (2008), in a Korean study, concluded that low-frequency noise in the frequency range above 30 Hz can lead to psychological complaints and that infrasound in the frequency range of 5–8 Hz can cause complaints due to rattling doors and windows in homes." [51]

Living conditions are acknowledged to be a key determinate of health. [52]

A World Health Organization epidemiology study confirms disturbed living conditions caused by noise increases the risk of ill health. [53]

Peer reviewed scientific research confirms "Pollution and degradation of the indoor environment cause illness, increased mortality, loss of productivity, and have major economic and social implications….The health effects of indoor noise include an increase in the rates of diseases and disturbances… these illnesses, and the related reduction in human productivity, can result in substantial economic losses." [54]

"A limitation of much work on assessment of low frequency noise has been that long term averaged measurements were used and, consequently, information on fluctuations was lost. Many complaints of low frequency noise refer to its throbbing or pulsing nature." [55]

Research related to low frequency noise "…confirms the importance of fluctuations as a contributor to annoyance and the limitation of those assessment methods, which do not include fluctuations in the assessment." [56]

Low Frequency Noise is an issue that must be resolved quickly and accurately to improve the sound environment and quality of life for the residents. For this reason, it remains the duty of industry and authorities to implement regulations that will account for low frequency noise. [57]

It is widely affirmed that A-weighting underestimates the sound pressure level of noise with low-frequency components. [58], [59], [60], [61] "A-weighted level is very inadequate…" [62] when assessing low frequency noise and infrasound.

NOISE CHARACTERISTICS

"Noise is multidimensional. A one dimensional view of noise is the A - weighting, which considers only levels and neglects frequencies. Another one-dimensional view is to consider only frequencies and neglect levels. Developing the dimensions further, two dimensions include both frequency and level (the spectrum), three dimensions adds in the time variations of the noise, whilst higher dimensions include subjective response." [63]

Peer reviewed scientific research confirms "The capacity of a noise to induce annoyance depends upon many of its physical characteristics, including its sound pressure level and spectral characteristics, as well as the variations of these properties over time. [64]

"Noise measures based solely on LAeq values do not adequately characterize most noise environments and do not adequately assess the health impacts of noise on human well-being. It is also important to measure the maximum noise level and the number of noise events when deriving guideline values. If the noise includes a large proportion of low-frequency components, values even lower than the guideline values will be needed, because low-frequency components in noise may increase the adverse effects considerably. When prominent low-frequency components are present, measures based on A-weighting are inappropriate. However, the difference between dBC (or dBlin) and dBA will give crude information about the presence of low-frequency components in noise. If the

difference is more than 10 dB, it is recommended that a frequency analysis of the noise be performed." [65]

It is affirmed that modulated broad band noise, low frequency noise, infrasound, tonal noise, and impulse noise have a particularly pronounced effect on people exposed to them. [66], [67], [68], [69]

Peer reviewed scientific research confirms noise limits should be based on annoyance scientific dose responses to individual noise sources. [70]

To protect people from the adverse health effect of noise annoyance World Health Organization states "Noise with low-frequency components require lower guideline values." [71]

Research confirms is inadequate as A-weighting underestimates the sound pressure level of noise with low-frequency components. [72], [73], [74]

"A-weighted levels for assessment of environmental noise are normally taken outside a residential property. The complexities of low frequency noise, including uncertainties in the transmission loss of the structure and resonances within rooms, require low frequency noise to be assessed by internal measurements." [75]

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[75] A Review of Published research on Low Frequency Noise and Its Effects, Dr. Geoff Leventhall et.al., May 2003

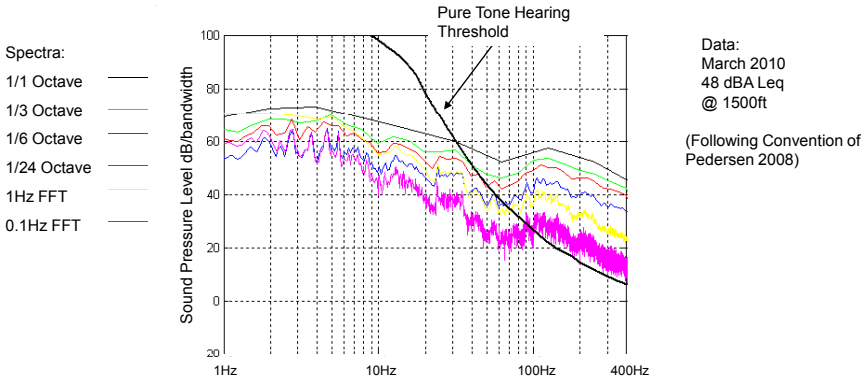
Fourth International Meeting on Wind Turbine Noise

Rome Italy 12-14 April 2011

The Audibility of Low Frequency Wind Turbine Noise

Dr M.A.Swinbanks,
MAS Research Ltd

The Problem: 2008 T.H.Pedersen Emphasized that Different Resolutions of the Same Wind Turbine Spectra lead to Different Conclusions



Data:
March 2010
48 dBA Leq
@ 1500ft

(Following Convention of Pedersen 2008)

"……. it can be seen that a direct comparison of the hearing threshold and the spectrum of the wind turbine is not meaningful……" *

" …….. have been discussed with a number of researchers (Henrik Moller, Aaborg University, Torsten Dau, Danish Technical University, Hugo Fastl and Geoff Leventhall) and solutions have been sought for without result." *

* Reference [1]

Summary & Conclusions

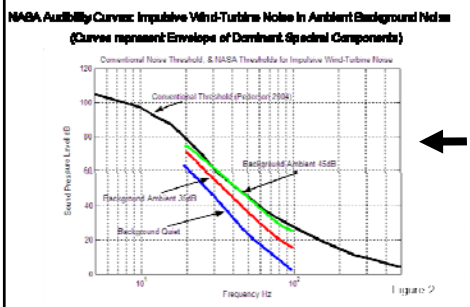
Low Frequency Noise & Infrasound Directly Impacts on Wind Turbine Communities Worldwide:
Accurate Assessment is Essential

- Pedersen (2008): Highlighted Unresolved Ambiguity in Evaluating Wind Turbine LF Noise.
- Present Author: Cumulative HT-Weighted Spectrum eliminates Ambiguity & Enables Unique Initial Comparison Based on RMS Levels
- Audible Energy Band lies to Left of Intersection with Threshold.

  Lower Limit: -6dB to -10dB for 75% to 90% Energy

- RMS Levels Underestimate Crest Factor, which Enhances Perception.
- Time-Domain Simulation Enables more Detailed Assessment of Crest Factor.
- Reveals Further Enhanced Perception (5dB to 11dB) for Random Noise & Infrasonic Impulses.
- Conclusions Consistent with 1980's NASA Studies, and On-Site Experience.

Prior Investigations of Audibility



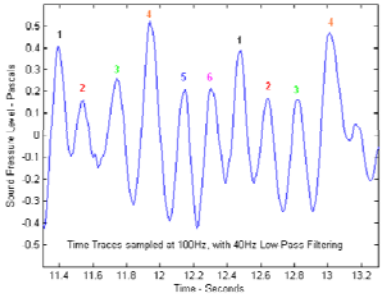
1982: NASA Tested Audibility of Impulsive Downwind Turbines.

Showed Envelope of Dominant Spectral Components Audible -20dB Below Hearing Threshold

1989: NASA showed Upwind Turbines Could Generate Low Frequency Impulsive Noise from Wind Gradients

Modern Windfarms can produce Impulsive Infrasonic Noise

Multiple Low-Frequency Impulses Measured Indoors in March 2010 at a Modern, Upwind-Rotor Windfarm. 6 Separate Turbines can be Identified



Peak Sound Pressure '4': 88dB Farthest Turbine '2': 1.2 miles

Approximately -3dB per Doubling of Distance

Industrial Gas Turbine 3rd Octave Spectra

1981 Author Demonstrated Silencing of Low Frequency Gas-Turbine Compressor Noise using Active Sound Control.

1987 Further Active Silencers Commissioned, at Lower Frequency.

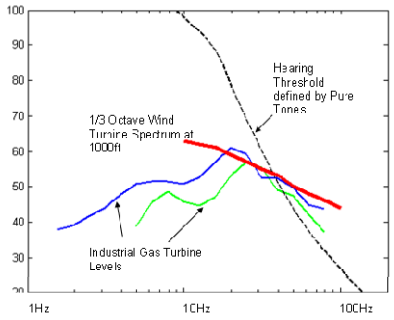


Figure 4

Example of LF Wind Turbine Spectrum, Considered to be not Audible to the Average Person up to about 31.5Hz – 40Hz (from [8]). Compared to Industrial Gas Turbines with Peak Levels at 20Hz & 25Hz, Reported as Audible.

Projected Noise Levels causing Complaints were directly comparable to Wind Turbine LF Noise now considered "below" the Threshold of Hearing

First Steps to Solution

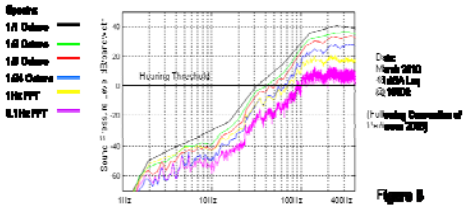


Figure 5

Pedersen: Weight Spectra by Inverse Hearing Threshold, & Integrate over Critical Hearing Bands: 0-100Hz, & 100Hz-200Hz

=> 2 Unique Values re 0dB Threshold

Does not identify frequency where Threshold is crossed.

Present Author: Impose Running, Cumulative Integration e.g. 1-2Hz, 1-3Hz, … 1-50Hz etc.

Condenses Spectra to Single Common Curve.

At 0dB Intersection, LF Energy is equal to "just audible" Sine Wave.

75% Energy between -6dB & 0dB

90% Energy between -10dB & 0dB

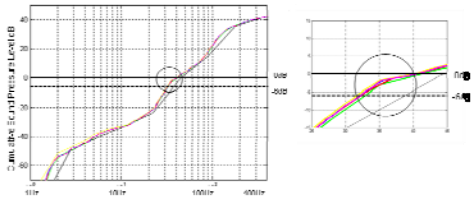
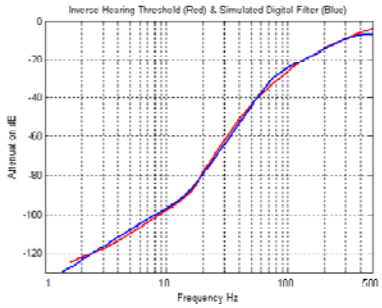


Figure 6

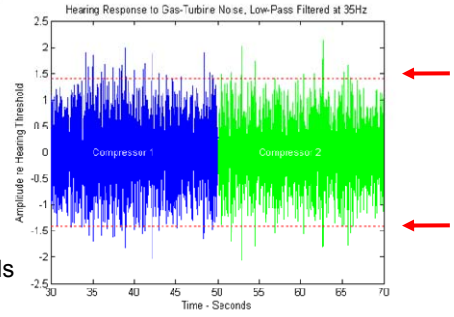
Note: Intersection is close to 1/3rd Octave Result

Importance of Crest Factor (Peak-to-RMS Ratio)

'First Steps' Equated Mean Energy Levels, defined by RMS Values
Typical Real Waveforms have Higher Crest Factor than Pure Sinusoids.
Peak Levels can "Punch Through" Threshold



Simulate Hearing Threshold Response using Digital Filter



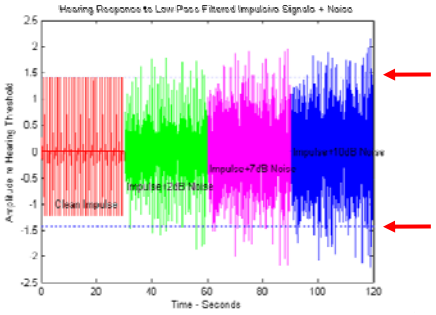
Simulate Random Signals for Gas Turbine, & Filter with Hearing Response

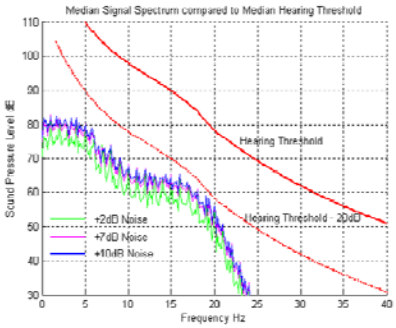
Amplitude at Hearing Threshold corresponds To +/- √2 = 1.4

Impulse at Hearing Threshold: Time History & Power Spectrum

Reproduce Infrasonic Impulse ~ NASA 1989, for Upwind Turbine in Wind Gradient

Filter with Simulated Hearing Response



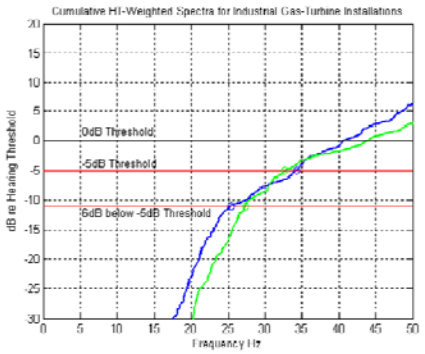


Spectrum for Impulse at Median Level lies -20dB below Median Threshold

Consistent with 1982 NASA Audibility Tests

Cumulative Inverse HT-Weighted Spectra for Simulations

Industrial Gas-Turbine Spectra



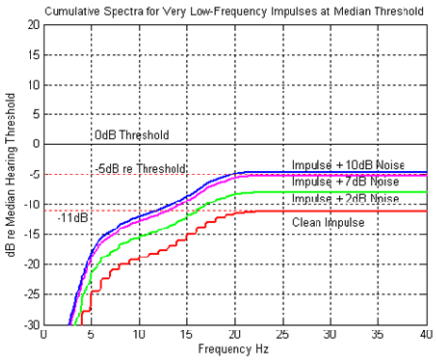
Gas Turbine Noise, Low-Pass Filtered below 35Hz met +/- 1.4 Limits at RMS Level -5dB

75% Lower Limit: -11dB at 25 Hz, 27Hz

90% Lower Limit: - 15dB at 22.5Hz, 25Hz

Consistent with Complaints

Impulsive Infrasonic WT-Spectra



Flattens-Out above 20Hz, since Infrasound Only

Clean Impulse met +/-1.4 Limits at RMS Level -11dB

+2dB Noise: Perception at -8dB

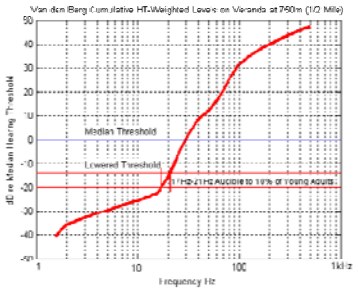
+10dB Noise: Perception at -5dB

(Asymptotes to Random Noise).

Application to Van den Berg 2004 Windfarm Data

1/3rd Octave Data Measured on Terrace of House at 750m from Nearest Turbine. (Data as Reported removed -3dB to yield Free-Field.)

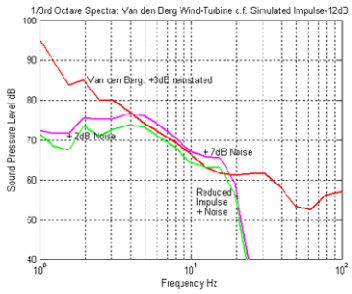
3dB Reinstated to Represent Actual Measured Sound Pressure Levels



Cumulative HT-Weighted Spectrum

Threshold Lowered -8dB for 10% Young Adults, plus -6dB for Impulsive Infrasound + Noise

Conclusion: 17Hz -21Hz Perceptible to 10% Young Adults



Hearing Threshold for 2.5% Adults: -12dB re Median

So Reduce Median Infrasonic Impulse by -12dB

Reduced 1/3 Octave 'Impulse + Noise' correspond to Measured Wind-Turbine Levels

Conclusion: Significant Infrasonic Noise Perceptible to 2.5% Adults

Summary & Conclusions

• Pedersen (2008): Highlighted Unresolved Ambiguity in Evaluating Wind Turbine LF Noise.

• Present Author: Cumulative HT-Weighted Spectrum eliminates Ambiguity & Enables Unique Initial Comparison Based on RMS Levels

• Audible Energy Band lies to Left of Intersection with Threshold.

Lower Limit: -6dB to -10dB for 75% to 90% Energy

• RMS Levels Underestimate Crest Factor, which Enhances Perception.

• Time-Domain Simulation Enables more Detailed Assessment of Crest Factor.

• Reveals Further Enhanced Perception (5dB to 11dB) for Random Noise & Infrasonic Impulses.

• Conclusions Consistent with 1980's NASA Studies, and On-Site Experience.

Consequently, this Analysis shows the Impact of Wind Turbine Low-Frequency Noise & Infrasound has been Significantly Underestimated.

WTN 2011

Fourth International Meeting on Wind Turbine Noise

Rome Italy 12-14 April 2011

Responses of the Inner Ear to Infrasound

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2) Eaton-Peabody Laboratory, Massachusetts Eye & Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114 and Department of Otology & Laryngology, Harvard Medical School, Boston, Massachusetts 02115, USA.
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Abstract

Unweighted sound measurements show that wind turbines generate high levels of infrasound. It has been wrongly assumed that if subjects cannot hear the infrasound component of the noise then they cannot be affected by it. On the contrary, the mammalian ear is highly sensitive to infrasound stimulation at levels below those that are heard. Most aspects of responses to infrasound are far from well established. Measurements made within the endolymphatic system of the cochlea show responses that become larger, relative to measurements made in perilymph, as frequency is lowered. This suggests that endolymphatic responses to infrasound are enhanced in some manner. For high-frequency sounds, acoustic stimuli in the ear are summed. In contrast, the inner ear's responses to infrasound are suppressed by the presence of higher frequency stimuli. The complexity of the ear's response to infrasound leads us to the conclusion that there are many aspects that need to be better understood before the influence of wind turbine noise on the ear can be dismissed as insignificant.

Introduction

The effects of sounds on humans are typically evaluated through measurements made with instrumentation such as microphones and sound level meters. As the vast majority of these measurements relate to sounds that people can hear or which may damage the ear, measurements are routinely weighted according to the hearing sensitivity of humans (i.e. the A-weighting curve which is based on the 40 phon audibility curve in humans). As the ear represents the highly sensitive sound detector of the body, it has been widely assumed that if a sound is not detected (i.e. the sound is not heard by a listening subject) then the sound has no relevance to human physiology. This concept was further developed with respect to whether harm could arise from sounds and has been widely expressed in the form of statements along the lines of "what you can't hear, can't hurt you". The origins of this belief are

difficult to trace but it is believed to originate from the title of a newspaper article by an engineer making measurements of the "Kokomo hum" in 2001 (Alves-Pereiraa M, Castelo Branco, 2007). It is important to realize that the concept was not based on physiologic scientific studies in which "harm" was quantified or measured in some way that correlated with low-frequency sound measurements. Rather, the statement was a speculation without any fundamental consideration of how the ear works. Indeed, it is quite remarkable how such an erroneous concept could have gained such widespread acceptance when there is such a large amount of physiological data showing that the ear's response to low-frequency sounds is far more complex than that of a simple microphone (reviewed by Salt and Hullar, 2010).

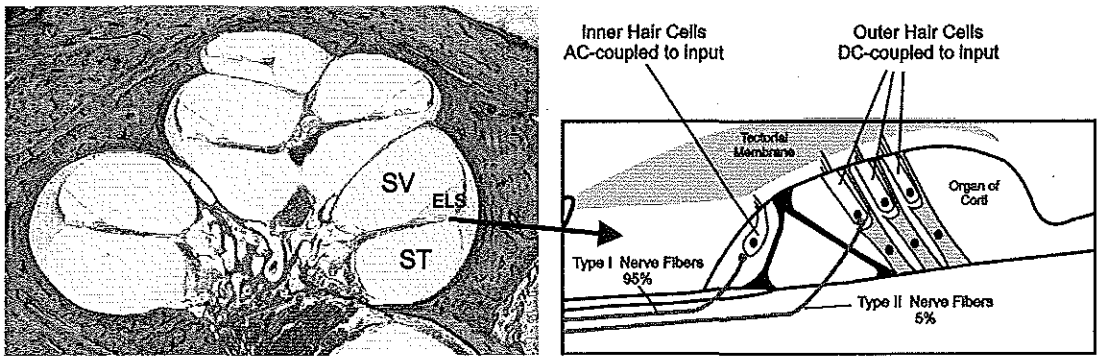

Figure 1: Anatomy of the Inner Ear. ***Left:*** *A mid-modiolar section of the human cochlea spiral with the compartments of one turn labelled. SV:scala vestibuli; ELS: endolymphatic space; ST: scala tympani. The structure containing the sensory cells, called the organ of Corti, is on the lower border of the ELS.* ***Right:*** *Enlarged schematic of the organ of Corti, which contains two types of sensory cells. The sensory hairs of the outer hair cells are embedded in the gelatinous tectorial membrane making them DC-coupled to the input stimulus. The hairs of the inner hair cells are free within the fluid space below the membrane, causing them to be AC-coupled to the input stimulus. Histological image courtesy of Saumil Merchant, MD, Otopathology Laboratory, Massachusetts Eye and Ear Infirmary and Harvard Medical School, Boston.*

The anatomic features of the inner ear that are relevant to its sensitivity to low-frequency stimulation are summarized in Figure 1. The important feature is that the sounds that are heard are mediated through the inner hair cells and transmitted to the brain through the Type I nerve fibers which make up the majority (95%) of the auditory nerve. In simple terms, the inner hair cells are AC-coupled to the mechanical stimulus, meaning that they respond well to high stimulus frequencies but are insensitive to very low-frequency or sustained displacements of the organ. Based on single nerve fiber recordings, Temchin et al., 1997 concluded that a high-pass filter was interposed before the site where auditory nerve excitation thresholds were determined. A consequence of this arrangement is that subjective hearing is insensitive to stimuli of infrasonic frequencies because of the high-pass filter/ AC coupling. However, because the outer hair cells of the ear are DC-coupled to the stimulus (sensitive to high-frequency stimulation, low-frequency stimulation and sustained displacements of the organ), their characteristics can indeed render the ear sensitive to infrasound. It has been shown that prolonged displacements of the

organ of Corti for 20 minutes or longer, by microinjection of gel into the cochlear apex, cause endocochlear potential changes that were sustained throughout the procedure (Salt et al, 2008). This confirms the ability of the outer hair cells to respond to slowly occurring or sustained displacements. The outer hair cells are mechanically coupled to the inner hair cells and are innervated by so called Type II fibers that make up 5% of the auditory nerve.

The fact that hearing is insensitive to infrasonic frequencies therefore does not indicate that the entire ear is insensitive to infrasound. This is analogous to viewing the electrical output of a low-frequency-capable sound level meter on an AC-coupled oscilloscope and concluding that the sound level meter is "insensitive" to low-frequencies. Similarly, because subjective hearing is based on an AC-coupled output from the ear, that does not mean that an unheard infrasound cannot influence the other components of the ear, such as the outer hair cells, and thereby influence heard sounds in a number of complex manners, as discussed below. Here we present a number of different measurements that characterize a number of aspects of the ear's sensitivity to infrasound.

Methods

The electrical measurements from the inner ear we present in this paper include data from guinea pigs and cats. In guinea pig experiments, stimuli were generated and responses were recorded using Tucker-Davis System 3 hardware controlled by custom-written software on a PC. Sound stimuli were generated in a closed system, using a hollow ear bar between the transducers and the external ear canal. Full technical details of stimulus generation are given elsewhere (Brown et al., 2009). Cochlear responses were measured from electrolyte-filled glass pipettes, inserted into the cochlear fluids spaces, via a high input impedance electrometer.

Single nerve fiber recordings in cats followed methods described by Kiang *et al.* (1965). Low-frequency (i.e., 50 Hz) tones were presented to cat ears with a DT48 headphone coupled to the ear through a hollow ear bar.

Guinea pig experiments were approved by the Animal Studies Committee of Washington University. Cat experiment protocols were approved by the Animal Care Committee of the Massachusetts Eye and Ear Infirmary.

Results

1) Endolymphatic enhancement of responses to low-frequency sounds.

In this study, we measured electrical responses from the basal turn of the guinea pig cochlea in response to tones of varying frequency. Sound levels were varied until a specific response amplitude (500 μV) was generated. These sound level thresholds were measured in scala media (endolymph) and scala tympani (perilymph) in the same animals. At 4 kHz, we found larger electrical responses in the endolymphatic system, requiring 10 dB lower sound level to achieve the criterion 500 μV response amplitude. The difference between endolymph and perilymph increased

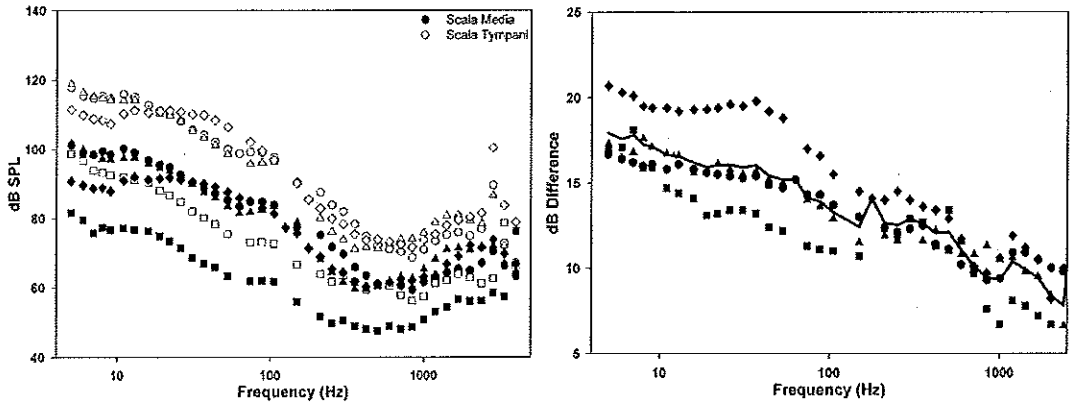

Figure 2: ***Left:*** *Thresholds of stimulation required to generate a cochlear microphonic amplitude of 500 uV in scala media (filled symbols) or scala tympani (open symbols) of the cochlea of 4 animals.* ***Right:*** *The difference between the thresholds measured in perilymph and endolymph. Positive values indicate that larger responses were generated (resulting in lower measured thresholds) in the endolymphatic space (scala media). The cutoff in sensitivity as frequency decreased was lower in the endolymphatic space. This demonstrates that low-frequency sensitivity varies in different parts of the ear, with the endolymphatic space showing relatively higher sensitivity to infrasound. The difference averaged 18 dB at 5 Hz.*

systematically as frequency decreased, with the difference approaching 20 dB at the lower frequencies tested. These measurements show that responses in the endolymphatic system were larger than those measured in perilymph. They vary in a frequency-dependent manner, generating relatively larger responses with infrasound stimulation. Even with the high (500 µV) response criterion, microphonic thresholds measured in the endolymphatic space were in the 80-100 dB SPL range.

2) Inner ear sensitivity to infrasound.

The sensitivity to infrasound was greater when measured in the higher cochlear turns, which predominantly respond to lower frequencies. In Figure 3 we show cochlear microphonic responses evoked from three stimulus frequencies and recorded from the endolymph compartment of the 3rd turn of the guinea pig cochlea. In this experiment, the responses were band pass filtered at the stimulus frequency, and 20 responses were averaged for each measurement to reduce noise levels. Although the ear is less sensitive to 5 Hz compared to 500 Hz (~37 dB higher level required to generate 100 µV at 5 Hz), the maximum voltages generated inside the ear were over 3x greater for 5 Hz (17.3 mV maximum) than for 500 Hz (5.5 mV maximum). This demonstrates that the ear is not only sensitive to infrasonic stimuli, but under some conditions can generate responses to infrasonic stimuli that are larger than those generated for stimuli that are more easily heard by the animal.

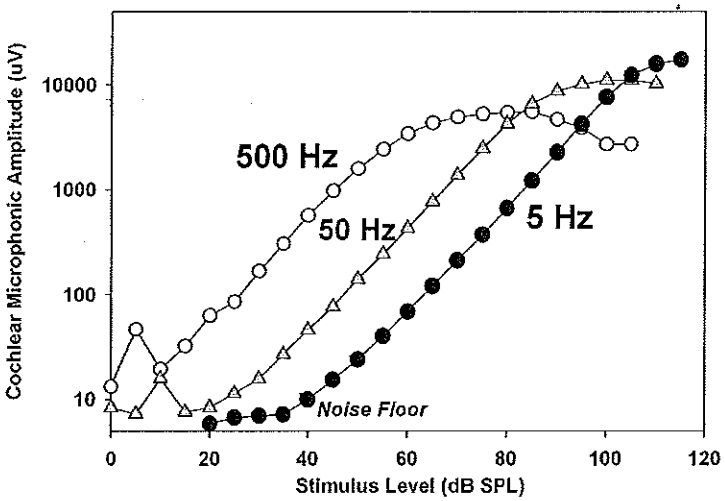

Figure 3: Amplitude of cochlear microphonics recorded from endolymph of the third turn for 3 stimulus frequencies. For each measurement point 20 responses were band-pass filtered and averaged to reduce background noise levels. Although lower sound levels are required to generate responses at 500 Hz, the maximum response amplitude is considerably higher at 5Hz (17.3 mV) than at 500 Hz (5.5 mV).

3) Infrasound responses are inhibited by sounds of higher frequency.

The large potentials generated in the endolymphatic system of the ear in response to infrasound have unique properties that differ from those in response to higher frequency sounds. When two sounds at high-frequency are presented simultaneously to the ear the cochlear microphonic response they generate is typically the sum of the responses to the two signals. This behaviour is analogous to that of a microphone and is the basis of the naming of this response as the cochlear "microphonic". Thus, at the level of the cochlear microphonic, one sound does not generally inhibit the other. The cochlear microphonic responses to infrasonic stimuli behave differently, however, and are sensitive to the presence of other sounds of higher frequency. In Figure 4 we show an experiment in which a 500 Hz probe tone was superimposed on a sustained 5 Hz stimulus. The recording shows that when the 500 Hz tone was present, the response to 5 Hz was markedly reduced. Analysis of these results shows that the low-frequency response amplitude was initially 8.4 mV peak and was reduced to 2.3 mV peak when the 500 Hz stimulus was present.

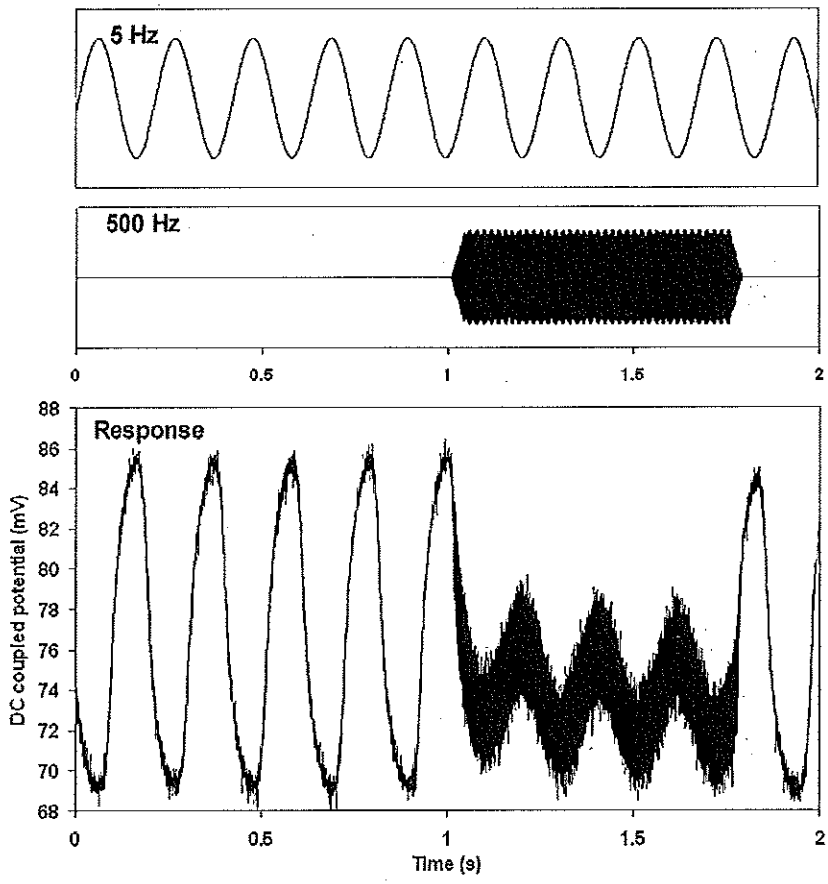

Figure 4: Cochlear microphonic responses from the endolymphatic space of the third turn of the guinea pig cochlea in response to a 5 Hz, 110 dB SPL, 2 s duration stimulus with a superimposed 500 Hz, 80 dB SPL stimulus commencing after 1 s as shown in the upper panels. The cochlear response to the 5 Hz stimulus was dramatically reduced for the duration of the 500 Hz stimulus. Responses were recorded as a single epoch with no averaging.

Although the example demonstrates the phenomenon with a high (110 dB SPL) infrasound level, a similar suppression of the infrasound response occurs with the infrasound at levels as low as 80 dB SPL, as shown in Figure 5. The level of probe tone needed to suppress the infrasound response was approximately 60 dB SPL.

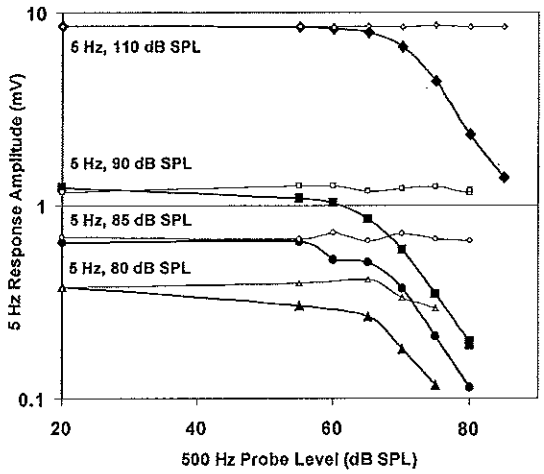

Figure 5: Suppression of cochlear microphonic responses to infrasound (5 Hz) with different levels of the infrasound and of a superimposed 500 Hz probe, as shown in the previous figure. Each curve shows measured responses at the infrasound level indicated. Open symbols show the 5 Hz response amplitude in the region preceding the probe, while solid symbols show the 5 Hz amplitude measured during the probe. Responses to both high (110 dB SPL) and low (80 dB SPL) levels of infrasound stimulation are suppressed by the presence of an audible tone.

4) Responses from the auditory nerve show how a low-frequency sound, that do not by itself excite a single-fiber, can amplitude modulate responses of higher frequency stimuli.

Approximately 30,000 fibers comprise the afferent portion of the cat auditory nerve. We measured single-fiber responses by inserting an electrode made from glass capillary tubing into the region between the ear and the brainstem. When a single-fiber was contacted, we recorded its response with no stimulus (to measure the fiber's "spontaneous rate"), with a high-frequency tone alone, a low-frequency tone alone, and combinations of a probe tone at constant level with a low-frequency tone that was varied in level (Lichtenhan, Guinan, and Shera, 2011). The right panel of Figure 6 shows the firing rate of one fiber under different stimulus conditions. This fiber had a low-spontaneous rate that did not increase (show excitation) when a low-frequency (50 Hz) tone was presented alone. A probe tone of 910 Hz, which was at the "best frequency" for this fiber, caused excitation (firing rate increased to approximately 250 spikes/s). As the level of the low-frequency tone was increased, it suppressed the responses to the higher frequency probe tone, even though the fiber did not respond to the low-frequency tone alone. The left panel of Figure 6 shows single-fiber histograms which demonstrate how the nerve fiber responses synchronize to particular phases of the low-frequency tone when the probe and low-frequency tone were presented together. The 20 ms time interval shown corresponds to one cycle of the low-frequency, 50 Hz tone. At the lowest level of the low-frequency tone (65 dB SPL) the responses are unaffected by the low-frequency and the responses occur uniformly throughout the cycle of the tone. As the level of the low-frequency is increased, it can be seen that not only does the firing rate decrease (as shown in the right panel), but also that the responses predominantly occurred at certain time points in the cycle of the low-frequency tone.

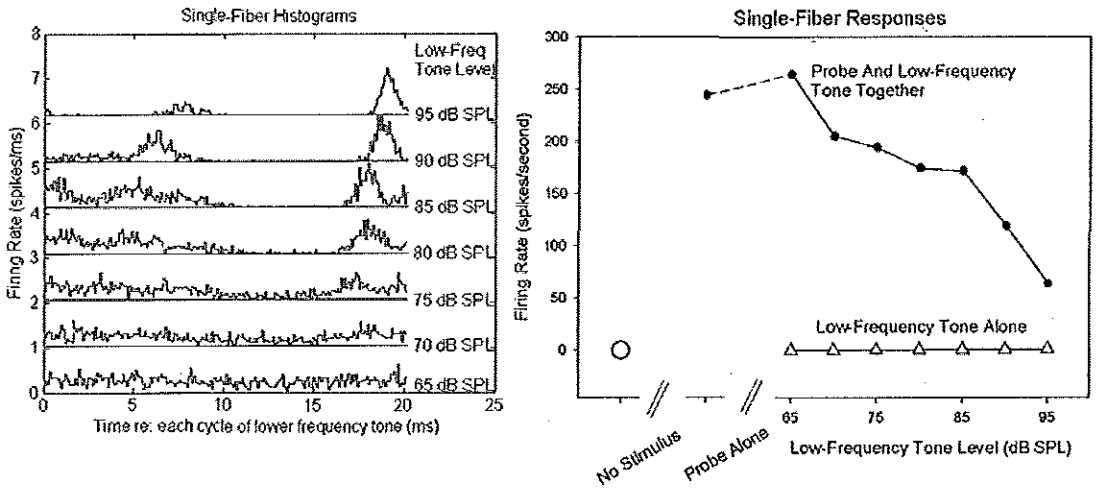

Figure 6: ***Left:*** *A single-fiber's firing rate histogram as a function of one cycle of the low-frequency tone. Here, a higher frequency probe tone (910 Hz – a frequency well above the fundamental frequency of a typical male's voice) and a low-frequency (50 Hz) tone were presented together. As the level of the low-frequency tone is increased, the firing rate is suppressed at particular phases of the low-frequency tone.* ***Right:*** *The low-frequency tone presented alone does not significantly alter the spontaneous-rate (measured by using no stimulus), while the probe alone did excite the fiber. When a 40 dB high-frequency tone and low-frequency are presented simultaneously, the response from the high-frequency tone is decreased as the level of the low-frequency tone is increased.*

The response of this fiber to the higher frequency tone was clearly modulated by the presence of the low-frequency. These data show that although a low-frequency stimulus, when presented alone, does not excite the fiber (and was therefore not necessarily "heard" by the fiber), the low-frequency stimulus had a marked influence on both the audibility and temporal characteristics of responses to higher frequency signals. This is because although the inner hair cells do not respond to very low-frequencies, they are affected by high-frequency responses of the outer hair cells, which are sensitive to and are modulated by the low-frequency tone

Conclusions

We have presented a number of measurements showing how the inner ear is sensitive to low-frequency and infrasonic sound stimuli presented at levels well below those that would be heard. Our results are consistent with the interpretation that hearing occurs through the inner hair cells which are AC-coupled to the stimulus, while the measured cochlear microphonic responses are generated by the outer hair cells that are DC-coupled to the stimulus. On the basis of these findings it seems reasonable to conclude that when a subject cannot hear a low-frequency sound, this cannot be taken as evidence that the sound cannot affect ear or the subject in other ways.

Our measurements from single-fibers of the auditory nerve show how low-frequency tones that do not by themselves stimulate nerve fibers, can modulate responses to higher frequency stimuli that certainly do stimulate the fiber.

Comparable findings from experiments in chinchillas were reported by Temchin et al., 1997. The frequency dependence they found led them to conclude "that a (high-pass) frequency filter is interposed between the site of origin of modulation and suppression and the site where auditory nerve excitation thresholds are determined". The most likely candidate for this high-pass frequency filter is the sub-tectorial fluid movement that couples outer hair cell movements to the inner hair cells, which in turn provide "hearing". Because the outer hair cell's stereocilia are imbedded in the tectorial membrane, their responses (and their ability to amplify high-frequency sounds) are affected by low-frequency or infrasonic tones while the inner hair cell's stereocilia are not. The inner hair cells can thus "see" the outer hair cells' amplitude modulated, high-frequency output and pass that representation to the auditory nerve which forms the basis of hearing.

This raises the possibility that there are multiple mechanisms by which infrasound or low-frequency sounds, at levels too low to be heard, could influence the representation of sounds in the brain. They can suppress and amplitude modulate responses to higher frequency sounds. By slowly displacing the organ of Corti, they can modulate harmonic distortions to higher frequency stimuli or two-tone emissions (Brown et al., 2009). Such modulation of distortion has been observed both in animals and in humans through acoustic emission measurements from the external ear canal (e.g., Marquardt et al., 2007). The outer hair cells could also stimulate their own afferent innervation directly. The stimulus conditions that cause excitation of the outer hair cell afferents remain largely unexplored. Some have suggested that the afferents may be used in a local network to synchronize the responses of outer hair cells (Thiers et al., 2008). Because these afferents have synapses in the cochlear nucleus of the brain (Benson and Brown, 2004), that central projection could provide an input which may be subconscious.

These findings are relevant to the perception of the "amplitude modulation" of sounds, and represent a biological form of modulation by low-frequency sounds that cannot be measured with a sound level meter. Indeed, some have described how low-frequency biasing can suppress the audibility of higher-frequency tones in the range of speech frequencies (e.g., Zwicker, 1976). A resulting consequence of amplitude modulation of speech sounds by wind turbine infrasound may perhaps be a more difficult, or perceptually taxing, listening environment. Such amplitude modulation of speech sounds may contribute to the "noise annoyance" and problems with "noise sensitivity" reported by Pedersen and Waye (2004)

Responses of the ear to infrasound are substantially greater when measured in the endolymphatic system. The greater sensitivity to infrasound probably results from alterations in ion transport during the relatively prolonged displacements of the organ of Corti during individual cycles of very low-frequency sounds. This is analogous to the voltages change in the battery of a device when sustained current is drawn, compared with those when current draw is modulated (both increasing and decreasing) at high-frequency.

The presence of high-frequency sounds suppresses some aspects of the ear's response to infrasound. This means that under conditions where infrasound levels are high, while ambient sounds are low, the ear may be maximally affected by the infrasound. This may be relevant to the exposure of people to wind turbine sounds in a quiet listening environment (such as a bedroom), where response to the infrasound

may be augmented relative to listening conditions where higher levels of other ambient sounds are present.

We conclude that the ear exhibits a number of complex physiological responses to infrasound stimulation at moderate levels that may exist in the vicinity of wind turbines under some operating conditions. Because the ear is undoubtedly responding to these sounds, it cannot be concluded that infrasound effects on the ear are insignificant because the sounds are not heard. It is therefore premature to assert that long term exposure to wind turbine noise can have no physiological effect on humans.

Acknowledgments

We thank Mr. Nikolas A. Francis, Dr. John J. Guinan Jr. and Dr. Christopher A. Shera for helpful discussion on this research. ANS was supported by grant RO1 DC01368 from the NIDCD, National Institutes of Health. JTL was supported by grant F32 DC010112 from the NIDCD, National Institutes of Health. Cat experiments were supported by grants RO1 DC00235, R01 DC03687, and P30 DC05029 from the NIDCD, National Institutes of Health.

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Fourth International Meeting on Wind Turbine Noise

Rome Italy 12-14 April 2011

Wind turbine noise and health-related quality of life of nearby residents: a cross-sectional study in New Zealand.

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Abstract

Hearing allows humans to detect threats in the environment and to communicate with others. However, unwanted sound has the capacity to evoke reflexive and emotional responses, and can act a stressor. The World Health Organisation classifies noise as an environmental pollutant that degrades sleep, quality of life and general health. Previous research provides evidence of a relationship between wind turbine noise and both annoyance and sleep disturbance. However, wind turbines are a relatively new source of community noise, and as such their effects on health have yet to be fully described. We report a study exploring the effect of wind turbine noise on health and well-being in a sample of New Zealand residents living within two kilometres of a wind turbine installation. Our data provide evidence that wind turbine noise can degrade aspects of health-related quality of life and amenity. On this evidence, wind turbine installations should be sited with care and consideration with respect to the communities hosting them.

Introduction

Wind turbines transform wind energy into electricity. Over the last decade, the industrial-scale harvesting of wind energy has increased, driven by a desire to generate sustainable energy. Wind turbines were initially welcomed by communities, but public opposition to wind turbines has since increased,[1] largely because of the noise they produce and also their visual impact.

There has been considerable debate over whether wind turbines pose a significant health threat to those living in their vicinity. It has been suggested that wind turbines can directly impact health via the emission of low-frequency sound energy (i.e. infrasound), though this is currently an area of controversy.[2, 3]Additionally, wind turbines may compromise health by producing sound that is annoying and/or can disturb sleep. In this respect, it can be classified as community noise along with industrial and transportation noise. When built in rural settings, the visual impact of turbines can also degrade amenity and interact with turbine noise to exacerbate annoyance reactions.[4]

Figure 1 represents a simple model informed by the literature [5, 6] demonstrating that, in the rural context, there are feasible mechanisms by which wind turbine exposure can degrade health and well-being. Turbine noise can lead directly to annoyance and sleep disturbance (primary health effects), or can induce annoyance by degrading amenity. Additionally, the trait of noise sensitivity (being likely to attend to sound, evaluate sound negatively, and have stronger emotional reactions to noise) constitutes a risk factor. The secondary heath effects would be immediate reductions in general well-being and stress-related disease emerging from chronic annoyance and sleep disturbance. Chronic noise exposure is a psychosocial stressor that can induce maladaptive psychological responses and negatively impact health via interactions between the autonomic nervous system, the neuroendocrine system, and the immune system.[6] A chronic stress response will, in turn, degrade quality of life (Figure 1).

Quantifying the impact of wind turbines on individual health will inform wind turbine operational guidelines. One approach to health assessment involves a subjective appraisal of Health-Related Quality of Life (HRQOL), a concept that measures general well-being and well-being in the physical, psychological, social, and environmental domains. The WHO recommends the use of HRQOL measures as an outcome variable, arguing that the effects of noise are strongest for those outcomes classified under HRQOL rather than illness.[7] HRQOL is related to health by the WHO (1948) definition of health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”, and can be considered as an operationalisation of the well-being concept.[8]

There is scientific evidence linking community noise to health problems.[6, 7, 8] The WHO reports that chronic noise-induced annoyance and sleep disturbance can compromise health and HRQOL.[7, 9, 10] However, there has been little research examining the relationship between noise and HRQOL. An exception is Dratva et

al.,[11] who, using the Short Form (SF36) health survey, reported an inverse relationship between annoyance from traffic noise and HRQOL. They argued that HRQOL would be expected to co-vary more with annoyance than with noise level as level is a poor predictor of the human response to noise, and its role in health is commonly over-emphasised. As alternatives to noise level, other factors associated with the listener should be considered,[5] including the perceived control a person has over the noise, as well as their attitudes, personality, and age.

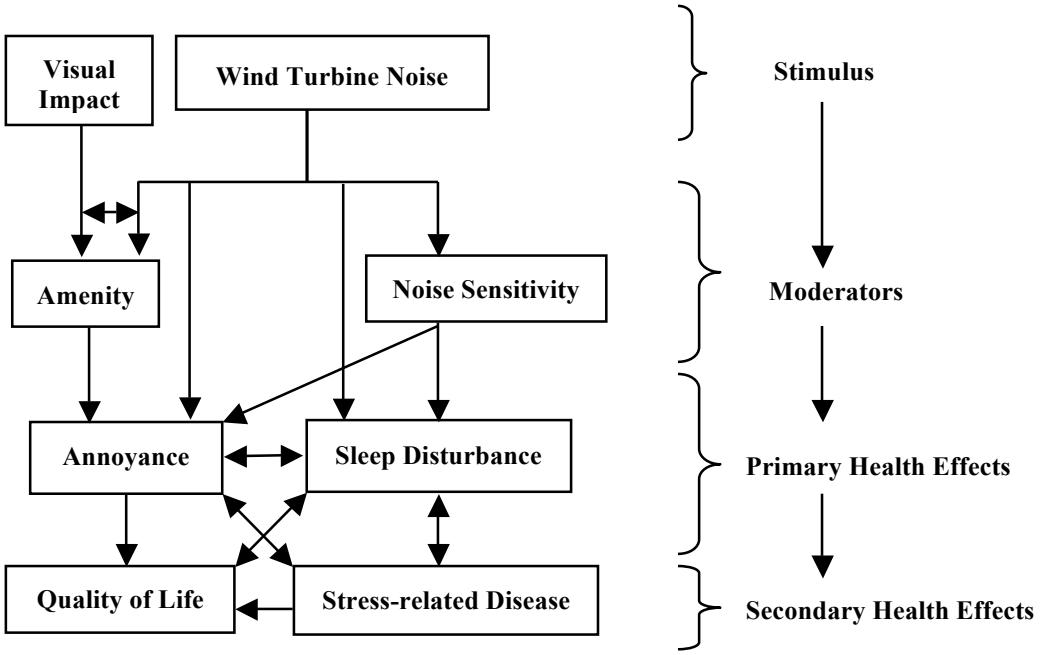

Figure 1 A schematic representation of the relationship between wind-turbines and health in a rural setting. The multiplicity of relationships emerges due to variability in the response of individuals to noise.

Case studies supported by qualitative analyses [2, 12, 13] suggest a negative relationship between wind turbine noise and wellbeing. There have been no previous quantitative investigations of the impact of wind turbines on HRQOL, though correlations have been observed between wind turbine noise, annoyance, and sleep disruption.[14, 15] Our study is the first to examine the association between HRQOL and the proximity to an industrial
wind turbine installation.

Method

A non-equivalent comparison group posttest-only study design was utilised. Strict socioeconomic matching was undertaken using the New Zealand Deprivation Index 2006,[16] as described elsewhere.[17] Both areas are classified as rural,[18] with a population density of less than 15 people per square kilometre.

Samples were drawn from two demographically matched areas differing only in their distances from a wind turbine installation in the Makara Valley, an area 10 kilometres west of New Zealand's capital city, Wellington. The Makara Valley is characterised by hilly terrain, with long ridges running 250 – 450 metres above sea level, on which sixty-six 125-metre-high wind turbines are positioned. The first sample (the Turbine group) was drawn from residents in the South Makara Valley who resided in 56 houses located within two kilometres of a wind turbine. A comprehensive noise survey of the area was undertaken independently, and indicated the intrusive nature of the turbine noise.[19] The Makara turbines, operational since May 2009, have measured levels that are consistent with levels reported in European studies,[15] which showed that typical noise exposures from wind turbines ranged from between 24 and 54 dB(A). The second sample (the Comparison group) was taken from residents in 250 houses in a geographically and socioeconomically matched area, but which were located at least eight kilometres from any wind turbine installation.

Each house received two copies of the questionnaire. The coversheet of the questionnaire bore the title 2010 Wellbeing and Neighbourhood Survey, designed to mask the true intent of the study. Potential participants were invited to participate in the research investigating their place of living and their wellbeing if they resided at the address to which the questionnaire had been delivered and if they were 18 years or older. The order of the questions was a prime consideration: HRQOL (26 items), amenity (2 items), neighbourhood problems (14 items), annoyance (7 items) demographic information (7 items), and a single item probing noise sensitivity. All scale items were presented on a numbered five-point scale with appropriate descriptors anchoring the terminals. Self-reported HRQOL was measured using the abbreviated version of the WHOQOL-BREF which affords composite measures of Physical (7 items), Psychological (6 items), Social (3 items) and Environmental (8 items) HRQOL. Additionally, the WHOQOL-BREF has two generic items asking about general health and overall quality of life. The two amenity items were: "I am satisfied with my neighbourhood / living environment" and "My neighbourhood / living environment makes it difficult for me to relax at home". A modified neighbourhood problem scale [20] consisted of 14 distracter items that were not relevant to the current study and were not included in the analysis. Seven items on annoyance were included, 4 distracter items asking about air quality, and 3 items probing annoyance to traffic, other neighbours, or other noise (please specify). Additionally, participants were asked if they were not noise sensitive, moderately noise sensitive, or very noise sensitive. The questionnaire terminated with an open-ended item asking "If you would like to share any comments relating to your neighbourhood or this survey then

please do so in the box below". Participants were asked to respond to all items and to return surveys by post in the prepaid envelopes provided.

Self-reported age and sex measures were obtained and self-reported level of educational status used as an indicator of socioeconomic status. Additionally, participants were asked what their current employment status was, and whether they were currently ill or had a medical condition. Participants were also asked how long they had lived at their current residence.

Analysis commenced after an evaluation of each scale's psychometric properties, including inspection for floor and ceiling effects and tests of internal consistency (Cronbach's alpha) and to validate dimensionality (corrected item-total correlations). Differences in HRQOL and amenity between the Turbine and Comparison groups were calculated using univariate Analysis of Covariance (ANCOVA), with length of residence selected a priori as a covariate. All testing was undertaken in accordance with Tabachnick and Fidell's [21] guidelines for testing between groups with unequal sample sizes, and Bonferroni corrections were applied where appropriate. Because of the unequal sizes between the two groups the assumptions of normality and homogeneity of variance were assessed carefully. Five cases were excluded from the Comparison group because they were multivariate outliers as defined by extreme Mahalanobis distances, with response set acquiescence clearly evident in all five cases.

Results

The response rates, 34% and 32% from the Turbine and Comparison groups, respectively, were typical for this type of research (e.g., van den Berg and colleagues' (2008) report a 37% response rate). Table 1 presents demographic information for the Comparison and Turbine groups. Prior to analyses the data were screened to identify potential confounds. The proportions of males and females in each area were equivalent (χ^2 (1) = .001, p = .967), while a Mann Whitney U indicated no age difference between the two areas (U(n1= 158 , n2 =39) = 16022.5, p = .802). Education (χ^2 (2) = 2.474, p = .291), noise sensitivity (χ^2 (2) = .553, p = .758), and self-reported illness (χ^2 (1) = .414, p = .562) were not associated with area.

Table 1 Demographic profile of the Turbine and Comparison groups

Variables	**Turbine Group (*n*=39)** *n* (%)	**Comparison Group (*n*=158)** *n** (%)
Sex		
Male	16 (41)	63 (41)
Female	23 (59)	91 (58)
Age group, years		
18 – 20	1 (2.6)	2 (1.2)
21 – 30	1 (2.6)	1 (0.5)
31 – 40	5 (12.8)	22 (13.9)
41 – 50	10 (25.6)	53 (33.5)
51 – 60	11 (28.2)	44 (27.8)
61 – 70	7 (17.9)	27 (17.1)
71+ –	3 (7.7)	9 (5.6)
Education (completed)		
High School	11 (28.2)	55 (34.8)
Polytechnic	11 (28.2)	48 (30.3)
University	17 (43.6)	54 (34.2)
Employment status		
Full time	21 (53.8)	83 (52.5)
Part time	0 (0)	3 (1.8)
Unpaid work	1 (2.6)	3 (1.8)
Unemployed	6 (15.3)	27 (17.1)
Retired	10 (25.6)	40 (25.3)
Noise sensitivity		
None	13 (33.3)	60 (37.9)
Moderate	21 (55.3)	76 (48.1)
Severe	5 (12.8)	20 (12.7)
Current illness		
Yes	10 (27)	50 (31.6)
No	27 (69.2)	104 (65.8)

Table 2 Pearson product-moment correlation coefficients (*r*) for noise-related and HRQOL variables. Statistics to the right of the major diagonal are for the Comparison group, while those to the left are for the Turbine group

					Health-Related Quality of Life				
	Sensitivity	Annoyance	Sleep	Health	Physical	Psychological	Social	Environment	Overall
Sensitivity	1	0.134	-0.017	0.082	-0.017	-0.069	0.006	-0.066	-0.109
Annoyance	0.440**	1	.042	-0.258**	-0.209*	-0.135	-0.155*	-0.319**	-0.097
Sleep	-0.433**	-0.147	1	0.337**	0.378**	0.489**	0.327**	0.279**	0.198*
Health	-0.234	-0.308	0.471**	1	0.706**	0.493**	0.158*	0.284**	0.327**
Physical§	-0.24	-0.212	0.364*	0.524**	1	0.655**	0.29**	0.455**	0.475**
Psychological	-0.404*	-0.113	0.473**	0.329*	0.268	1	0.55**	0.608**	0.589**
Social	-0.359*	-0.236	0.116	-0.021	0.036	0.212	1	0.456**	0.457**
Environment	-0.235	0.028	0.404**	0.2	0.474*	0.468*	-0.17	1	0.546**
Overall	-0.203	0.16	0.471**	0.289	0.282	0.286	-0.162	0.380*	1

$p < .05$

** $p < .001$*

§ Item 16 (satisfaction with sleep) was removed from the Physical HRQOL domain when correlated with sleep satisfaction.

Table 2 displays correlation coefficients (Pearson's *r*) between noise-related and health-related variables for both groups. Of remark is the negative correlation between annoyance and self-rated health for both groups, and a different pattern of correlations between noise sensitivity and annoyance across the two groups. Separate ANCOVA's revealed differences and similarities between the two areas in terms of HRQOL (see Table 3). Firstly, the Turbine group reported a lower ($F(1,194) = 5.816$, $p = .017$) mean physical HRQOL domain score than the Comparison group. Scrutiny of the seven facets of the physical domain showed a difference in perceived sleep quality between the two areas ($t(195) = 3.089$, $p = .006$), and between self-reported energy levels ($t(195) = 2.217$, $p = .028$). Secondly, the Turbine group had lower ($F(1,194) = 5.694$, $p = .018$) environmental HRQOL scores than the Comparison group. This domain is the sum of eight items, and further analysis of these revealed that the turbine group considered their environment to be less healthy ($t(195) = 3.272$, $p < .007$) and were less satisfied with the conditions of their living space ($t(195) = 2.176$, $p = .031$). Thirdly, there were no statistical differences in social ($F(1,194) = 0.002$, $p = .963$) or psychological ($F(1,194) = 3.334$, $p = .069$) HRQOL, although the latter was marginal and the mean for the Turbine group was lower. Of the two generic WHOQOL-BREF items, the mean of the self-rated general health item was equivalent between Turbine and Comparison groups ($t(195) = 0.374$, $p = .709$), while the mean ratings for an overall quality of life item was lower ($t(195) = 2.364$, $p = .019$) in the Turbine group.

Table 3 Mean (M) and Standard Deviation (SD) statistics for the four HRQOL domains of the WHOQOL-BREF and Amenity total scores, presented for both the Comparison group and the Turbine group

	Turbine Group		*Comparison Group*	
Measure	*M*	*SD*	*M*	*SD*
Physical	27.38	3.14	29.14	3.89
Psychological	22.36	2.67	23.29	2.91
Social	12.53	1.83	12.54	2.13
Environmental	29.92	3.76	32.76	4.41
Amenity	7.46	1.42	8.91	2.64

The Turbine group reported lower amenity than the Comparison group ($F(1,194) = 18.88$, $p < .001$). There were no differences between groups for traffic ($t(195) = 0.568$, $p = .154$) or neighbourhood ($t(195) = 1.458$, $p = .144$) noise annoyance. A comparison between ratings of turbine noise was not possible, but the mean annoyance rating for Turbine group individuals who specifically identified wind turbine noise as annoying was 4.59 (SD = 0.65), indicating that the turbine noise was perceived as extremely annoying. For the Comparison group, seven 'other' annoying noises were identified: barking dogs (x2), farm machinery (x2), and racing cars (x3).

Discussion

Those residing in the immediate vicinity of wind turbines scored worse than a matched comparison group in terms of physical and environmental HRQOL, and HRQOL in general. The high incidence of annoyance from turbine noise in the Turbine group is consistent with the theory that exposure to turbine noise is the cause of these differences. Importantly, we also found a reduction in sleep satisfaction ratings, suggesting that both annoyance and sleep disruption may mediate the relationship between noise and HRQOL. These findings are consistent with those reported in relation to aviation noise [22] and traffic noise.[10, 11]

Of further interest are the likely mechanisms involved in the degradation of HRQOL when exposed to turbine noise. Studies show that the level of turbine noise is a poor predictor of human response, and dose-response relationships typically explain little of the association between turbine noise and annoyance.[23] Pedersen et al.[4, 23] and van den Berg et al.[15] show that for equivalent noise levels, people judge wind turbine noise to be of greater annoyance than aircraft, road traffic, or railway noise. This may be due to the unique characteristics of turbine noise, that is, clusters of turbines present a cumulative effect characterized by a dynamic or modulating sound as turbines synchronise. The characteristic swishing or thumping noise associated with larger turbines [19] is audible over long distances, 2 to 3 kilometres and beyond in some reports.[1]

van den Berg [15] showed that sound is the most annoying aspect of wind turbines, and is more of a problem at night. A large proportion (23/39) of respondents from the Turbine group identified turbine noise as a problem and rated it to be extremely annoying. It should be noted that, in contemporary medicine, annoyance exists as a precise technical term describing a mental state characterised by distress and aversion, which if maintained, can lead to a deterioration of health and wellbeing.[24] A Swedish study [23] reported that, for respondents who were annoyed by wind turbine noise, feelings of resignation, violation, strain, and fatigue were statistically greater than for respondents not annoyed by turbine noise. We also observed lower sleep satisfaction in the Turbine group than in the Comparison group, a finding which is consistent with previous research showing more sleep disturbances. [2, 4, 15]

Wind turbines were associated with degraded amenity. This is consistent with previous research showing that wind turbine noise was judged incongruent with the natural soundscape of the area.[23] Amenity values are based upon what people feel about an area, its pleasantness, or some other value that makes it a desirable place to live. There is an expectation of “peace and quiet” when living in a rural area, and most choose to live in rural areas for this reason. [1, 25] Furthermore, those who live in rural areas have different expectations about community noise than those living elsewhere.[4] Other studies [26, 27] report that wind turbines are viewed as eyesores and visual spoilers of the environment, and from an aesthetic perspective, those who

view the wind turbines as ugly are likely to disassociate them from the landscape and react more strongly to turbine noise.

Strengths and limitations

A strength of this study is the masking of the primary intent of the questionnaire by giving the impression that general neighbourhood factors (e.g., street lighting, rubbish collection), and not wind turbine exposure, constituted the study's core aims. Concealing the study's objectives should reduce response bias, and our placing of the HRQOL items at the beginning of the survey, well before the three items probing noise annoyance, would serve to elicit subjective ratings of HRQOL without first being primed with potentially upsetting noise items. The main limitation of the study is the size of the sample. While the response rate compares favourably to other wind turbine research reported in the literature,[15] the sparsely populated locations of wind turbine farms in rural New Zealand presents a recruitment challenge. A larger sample of residents exposed to wind turbines would have afforded more analytical options. However, that the effects were found with such a modest sample size is indicative of genuine differences between the two groups.

Assessing health using HRQOL rather than objective metrics such as blood pressure has it advantages and disadvantages, though the merits of the HRQOL approach have been noted by others researching air pollution.[28] While blood pressure and heart attacks are well defined and easily measured, sleep disturbance, fatigue, annoyance and similar subjective symptoms are less easily measured and distinguished from the background levels present in the population, and furthermore, may change only after decades of exposure .[7]

Conclusions

A thorough investigation of wind turbine noise and its effects on health is important given the prevalence of exposed individuals, a non-trivial number that is increasing with the popularity of wind energy. For example, in the Netherlands it is reported that 440,000 inhabitants (2.5% of the population) are exposed to significant levels of wind turbine noise.[29] Additionally, policy makers are demanding more information on the possible link between wind turbines and health in order to inform setback distances. Our results suggest that utility-scale wind energy generation is not without adverse health impacts on nearby residents. Thus, nations undertaking large-scale deployment of wind turbines need to consider the impact of noise on the HRQOL of exposed individuals. Along with others,[30] we conclude that night-time wind turbine noise limits should be set conservatively to minimise harm, and, on the basis of our data, suggest that setback distances needs to be greater than two kilometres.

Acknowledgements

We wish to thank Dr Robert Thorne for his insightful comments and the provision of information that guided both design and analysis. Chris Hanning reviewed this paper.

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Portland, Oregon
NOISE-CON 2011
2011 July 25-27

Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception

Wade Bray[1)]
HEAD acoustics, Inc.
6964 Kensington Road
Brighton, MI 48116

Richard James[2)]
E-Coustic Solutions
Okemos, MI 48805

A set of binaural time-recordings and analyses of wind turbine noise outside and inside a residence in Huron County, Michigan, made over two days and the intervening night in December 2009, is presented, centering on analysis at the time/frequency resolutions of human hearing according to the well-established practices of sound quality engineering and Soundscaping [1].

The purpose of this paper is to present wind turbine acoustic measurements at these time-frequency scalings and to suggest that such consideration, frequently neglected in favor of frequency resolution and long-term level averages, could augment the perceptually inappropriate averages (often A-weighted) typically taken over much longer intervals. The authors maintain that most measurements of wind turbines up to now have not considered, or not adequately considered, these signals' very complex and varying behaviors at the time/bandwidth scaling of human perception. Although treating wind turbine noise aspects at all relevant frequencies, this paper will concentrate on low-frequency information.

What this paper adds to the discussion of wind turbine noise and potential adverse health effects.

The reason the wind industry experts could claim that wind turbines produced insignificant levels of infra and low frequency sound is not because there isn't any, but instead, because the instruments/methods they used could not detect it. They went hunting for a needle in the haystack using a magnet when the needle was made out of plastic.

When analyzed using a tool that can detect it, we find that it is there and at SPL's much higher than previously considered likely. The infrasound from wind turbines rises and falls in sound pressure level (amplitude modulation) at a very rapid rate (approximately 60 msec peak to peak or so) and with a high dynamic range, phenomena too fast to be 'noticed' when standard acoustical filters are used to isolate this region of acoustic energy (a 1 Hz ANSI S1.11 1/3-octave filter has an impulse response of about 5 seconds). The understatement of the true peaks that occurs during analysis using standard acoustical instruments/methods flattened and stretched out the dynamic modulation (crest factor) leading to a misconception that the levels were insignificant.

This study shows that when analyzed according to the time response of the human transducer, the peaks of the energy waves can be above 90 dB SPL. Combined with the findings of Dr. Salt's research this analysis shows that the dynamically modulated infrasound can be perceived by the auditory system at levels that are below the conventionally-determined threshold of audibility.

It is the short duration and extent of the change in sound pressure that is stimulating the vestibular system, not the overall energy level. This is not about the average energy but instead about the short duration, peak values and extent of change in energy assuming that some lower threshold like Dr. Salt's 60 dBG for OHC activity has been reached."

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[2)] Email address: rickjames@e-coustic.com

From: Mike Kelley <kelley@w205.com>
Date: Mon, Feb 13, 2012 at 11:39 AM
Subject:
To: SherryH@co.wasco.or.us

Sherry

I own property located in Wasco County. I split my time between my acreage outside of Antelope and my home in the Portland metro area. I was shocked to hear of the proposed ordinance which would prohibit construction of a wind turbine within 1.5 miles of an occupied dwelling. I have visited personally with multiple land owners in Sherman County which have turbines very near their homes with no adverse impact. I believe this ill conceived ordinance would deprive property owners of their rights and potential income.

Mike Kelley
5200 SW Meadows Rd. Suite B-100
Lake Oswego, Oregon 97035
(503) 601-8762 Office
(503) 931-3129 Mobile
(503) 601-8761 Fax

From: Jeanne Carver <jeanne@imperialstockranch.com>
Date: Mon, Feb 13, 2012 at 10:58 PM
Subject: Wind Development Setback Standards Comments...
To: johnr@co.wasco.or.us

Dear Mr. Roberts,

Please enter the attached comments into the record with regard to Setback Standards for wind development in Wasco County.

Respectfully,

Jeanne Carver

Wind Development Setback Standards Comments.docx
105K View Download

To: Board of County Commissioners
From: Jeanne Carver, Imperial Stock Ranch
Re: WC Petition for Setback Standards
Date: February 12, 2011

We (my husband and I) ranch in the southern part of Wasco County. We own and steward a 50 square mile operation. Our first and most important consideration, is the health of the land itself. Second, is the viability of the operation, which harvests sunlight in the form of food and fiber, critical to preserving the future for all. Third, we preserve the history of the people and families who have been a part of this 141 year old operation. And fourth, we preserve the buildings and facilities which are Oregon's only ongoing ranching property designated a National Historic District. Agriculture is a critical segment of Wasco County's fabric and its economic health and vitality. Our family businesses are responsible for the employment of approximately 60 people in south Wasco County.

To survey a small segment of residents residing in a town in the far north end of the county, and then project that to be what the "majority" of county residents think, is inaccurate. Additionally, what should not be dismissed, is that less than 20% of the county population manages a vast majority of the natural resource base in this county, which enhances the livability and quality of life for all residents.

We object to any proposed change in County ordinances that changes the current State approved setbacks of wind turbines. The State of Oregon has rules and regulations in effect that adequately address the setback issues. Under those rules, variance can only be approved by the home/land owner.

We feel honored and convicted to preserve our natural resources in every way possible. We don't take any decision on the ground lightly. When wind development companies first started contacting us, we flat out said no. We reacted from our hearts. We were driven by the aesthetics of open space, and a historical ethic of maintaining things close to the way they'd always been. We were resistant to change.

I want to stress, that any decision we've made with regard to renewable wind energy, was not arrived at quickly. Several years went by. Continuing contacts from development companies, changes in political and environmental factors, other people in our area moving forward with renewable energy projects, all kept the pressure on us. We are located in an area targetec with high potential for wind energy development. We had to continue to ask questions of ourselves and to seek out and ask questions of others, in order to come to a decision about what is the right and best thing to do. It required us to step back and recognize that maybe it isn't about us. It's about all of us collectively.

This is about a much larger community that is continuing to put increasing pressure on our limited natural resources. Do we continue to take from the earth to support our energy needs, and in so doing, continue exporting our dollars at the current rate? Or do we utilize what the earth gives us, moving us more toward energy independence, and keeping more of those dollars at home? What will our future be?

We've watched businesses come and go in the small communities throughout this county. They try to make it..but don't. There's no money for infrastructure improvements to entice tourists or provide services to tourists if they come. We were recently featured in Oregon Business Magazine: The New Ranch Economy. It tells the story of how things change over time and how we've adapted to remain viable. It gets harder and harder to do that. Family farms and ranches are decreasing in number every year in this state and across the country. It's no different in Wasco County. It's important that we continue to adapt, embrace change and find a way forward.

Evolution is necessary. What we need to pursue in this case, is the best possible path forward based on the considered expertise as set forth by the state; not on how many signatures we get, or how many letters we write, or who shouts the loudest. Who is the authority? Who knows what's best for the safety and health of our citizens, communities and the greater community? Lay people??? Or those we've charged with planning and determining exactly that. Those who have the professional expertise, and what's more..the burden of liability and responsibility for exactly those issues and concerns, and therefore take a professionally conservative position. We should all be proud of Oregon's leading position in this country, with regard to policies and practices relative to the environment and the common good.

Let's not make the mistake of saying what "can't be done" here. Instead say "what can be done" and find a way to do it well. In this case...abide by the carefully considered regulations set forth by the state agencies and committees who worked so hard to put forth a plan for the future benefit of every citizen and resource of this state.

I think it's important to note, that PGE has made recommendations that Wasco County comply with a consistent set of standards in order to facilitate development and delivery of energies across this state and beyond. They state that it is very challenging to implement services when local standards are inconsistent with mandatory state standards and regulations. We are risking the smart investment and development of our own future. Moving forward with renewable wind development in Wasco County will provide economic benefit to every citizen of the county.

I would like to respectfully submit the following specific comments:

1. For those who would argue increased setbacks for noise, Wasco County's Comprehensive Land Use Plan says:

Noise levels should be maintained in compliance with state and federal standards. (Goal 6 AIR, WATER AND LAND RESOURCES QUALITY – Policy 3)

This is consistent with Oregon law which states that it is legislative policy …to centralize in the Environmental Quality Commission the authority to adopt reasonable statewide standards for noise emissions permitted within this state and to implement and enforce compliance with such standards. (Oregon Revised Statutes 467.010)

Based on that law, the Oregon Department of Energy says the following regarding noise regulation for wind energy facilities, ..local jurisdictions may adopt the DEQ noise control regulations in their local land use ordinances and apply the state noise standards at the local level.. (http://www.oregon.gov/ENERGY/RENEW/Wind/noise.shtml) .

How can we honor state law and adopt setbacks as de factor noise standards. It makes more sense to rely on the Environmental Quality Commission in which the State of Oregon has vested the authority and responsibility to set statewide standards. For those who would argue other standards, the EQC would be the forum to make those arguments. Let's keep the setbacks we have in place.

2. The approach of working with the appropriate state agency to develop renewable energy resources also fits with Wasco County's comprehensive land use plan Goal 13 policy:

The County will work with appropriate State and Federal agencies to identify and protect, and if feasible, develop potential energy resources, especially renewable energy resources. (Goal 13 Energy Conservation Policy 1)

Oregon law sets forth the goal of developing permanently sustainable energy resources and that it is the policy of Oregon to encourage the development and use of sustainable energy resources that future generations not be left a legacy of vanished or depleted resources (ORS 469.010).

The Wasco County comprehensive land use plan Goal 13 policy states that use of renewable energy shall be encouraged. The proposed changes in setbacks would severely threaten the viability of continuing forward with wind development projects in this county. The land use plan recognizes that wind is a renewable resource. The proposed amendments acknowledge that there are promising wind resources in …the southeastern half of the county generally surrounding the cities of Shaniko and Antelope.

This is the area where we are located. On the Imperial Stock Ranch – near Shaniko – we are harvesting sunlight in sun-grown grasses by grazing livestock which convert that sunlight energy to the food and fiber that gives life to all of us. That sunlight is a sustainable resource, like the wind that blows across the land. The legacy we must leave future generations is one of working in harmony with our natural resources, using energy given to us rather than energy torn from the earth. We do not create solar energy. We use it to sustain us. We do not create wind energy, but we can use it to sustain us as well. We believe that the sun, the wind and the land are a legacy worth leaving. Let's adopt standards that will make it possible to build that legacy – not standards that will foreclose it.

Respectfully submitted,
Jeanne Carver

From: Dan Carver <dan@imperialstockranch.com>
Date: Mon, Feb 13, 2012 at 10:34 PM
Subject: Comments on Wind Development Setbacks...
To: johnr@co.wasco.or.us

Dear Mr. Roberts,

Please enter my attached comments with regard to Wind Development setbacks and standards for Wasco County, into the record.

Thank you.

Respectfully,
Dan Carver

Wind Development Setback Comments.docx
117K View Download

To: Board of County Commissioners, Wasco County
From: Dan Carver
Date: February 12, 2012

I am Dan Carver. My family ranches on 32,000 acres in south Wasco County. We have been honored many times for our environmental ethic including a feature in the current issue of Oregon Business Magazine. We are very proud of helping to restore steelhead to Buckhollow Creek, a major tributary of the lower Deschutes River. In 1990, two fish returned. Through proper land management we have seen as many as 800 return to spawn in recent years.

In other words, we and our neighbors don't take land management lightly. As to energy generated by the wind, as recent as 6 years ago, my stance was "not in my back yard." Then as time went on and I started seeing some of the positive things about wind energy, my mind became more open. It was two of my close friends that came to the ranch and tipped me over to be a strong wind proponent. Ken Williamson, Dean of Engineering at OSU, said, "You got used to seeing utility lines and fences didn't you?" He strongly encouraged us to get involved. The second was Yvon Chouinard, founder and owner of Patagonia, and the founder of "1% For the Planet." When we asked for his opinion as to what to do, he emphatically said, "Times have changed, you must get involved."

So with the momentum shifting and all of the outside encouragement, we signed a wind lease 3 years ago. We now have peace knowing the ranch can pass to the next generation intact; we can continue improving the landscape; and our over 60 plus employees can have confidence in their job stability and opportunities.

We already harvest the sun's energy and market it in our meats, grains and woolen products. We have trademarked "The American Wool Tradition." We are bringing it home to America. Our Wasco County wool is sold in yarn shops across America and into Europe. Consumers love the story of sustainability, so why not harvest the wind. Sun and wind are all part of the same story.

As to how and where to site a wind facility, I believe the state has done a very good job in enacting their minimum siting standards. They had the Department of Energy, Department of Environmental Quality, Fish and Game, Department of Agriculture, and many other state, environmental and private concerns give input. Their standards are very conservative and I highly recommend you, the BOCC, adopt them as stated. Any dilution could possibly jeopardize this whole opportunity that would benefit every person in Wasco County.

Respectfully Submitted,

Dan Carver

From: Rick Till <Rick@gorgefriends.org>
Date: Mon, Feb 13, 2012 at 8:56 PM
Subject: Friends Comments - Wasco County Energy Ordinance
To: Scott Hege <scotth@co.wasco.or.us>, SherryH@co.wasco.or.us,RodR@co.wasco.or.us
Cc: John Roberts <johnr@co.wasco.or.us>

Commissioners,

Please find the attached advance copy of the written comments that Friends of the Columbia Gorge will be submitting at the upcoming public hearing.

Thank you for your time and consideration,

Richard Till, Conservation Legal Advocate
Friends of the Columbia Gorge
rick@gorgefriends.org
522 SW 5th Ave., Suite 720
Portland, Oregon 97204-2100
(503) 241-3762 x 107
Fax: (503) 241-3873

FRIENDS OF THE COLUMBIA GORGE

SUBMITTED VIA E-MAIL AND HAND DELIVERY

February 13, 2011

Wasco County Board of County Commissioners
c/o Wasco County Department of Planning and Economic Development
2705 East Second Street
The Dalles, Oregon 97058

Re: Wasco County's proposed Energy Ordinance Updates (PLALEG-09-06-0003).

Dear Commissioners:

Friends of the Columbia Gorge (Friends) previously submitted comments on the proposed revisions to Wasco County energy ordinance. Since that time Friends has been notified of a recent Land Use Board of Appeals decision related to Umatilla County's land use standards for wind energy facilities. *Cosner v. Umatilla County*, 63 Or LUBA ___ (Jan. 12, 2012)(LUBA Nos. 2011-070, 2011-071, and 2011-072). Friends submits these comments to address legal findings in that case that should be addressed in Wasco County's proposed ordinance. Friends also provides additional comments in response to comments submitted on behalf of Iberdrola Renewables, Inc.

A. Cosner *establishes that two-mile setbacks are permissible and that if waivers from setbacks are allowed, there must be standards for granting such waivers.*

Cosner establishes several important precedents relevant to the County's proposed energy ordinance. A critical finding of *Cosner* is that Umatilla County had a sufficient factual basis for imposing a two-mile setback for wind energy facilities from urban growth boundaries and residences. Based on this precedent and the facts currently in the record before Wasco County, there is clear authority and factual basis for adopting a two-mile setback from non-resource zoned lands and all residences in resource lands.

Friends previously recommended a 1.5 mile setback. Based on *Cosner*, Friends encourages Wasco County to adopt a two-mile setback.

The *Cosner* decision also addresses the legal requirements for authorizing waivers from setbacks. LUBA determined that Umatilla County improperly delegated legislative authority by authorizing waivers "determined solely at the discretion of . . . the landowner, based on no standards at all." *Cosner* at 5–6. LUBA did not explain what type of standards would be adequate to comply with state law and focused on the fact that there were absolutely *no* standards to be applied by the county.

Based on this ruling Wasco County has two options when considering whether to allow waivers. First, Wasco County could choose to not allow waivers. Second, Wasco County could authorize discretionary waivers only if specified conditions are met. If the County prefers to include a waiver provision for residences in resource zone lands, Friends recommends requiring that any waiver be subject to the variance requirements in LUDO Chapters 6 and 7. Wasco County could include additional standards to tailor variance standards to apply to the unique circumstances of wind facilities. For non-project boundaries variances should not be allowed to reduce setbacks below the general property line setbacks for the applicable zone. For non-resource zone dwellings, setbacks should not be reduced below 1,320 feet, which EFSC has previously found is necessary to protect against turbine failure and blade throw.

Friends recommends the following language to implement this recommendation:

> Draft LUDO § 19.030(D)(1)(c)(2), (3), Att. A at 19-36:[1]
>
> (2) Non Project Boundaries - Wind turbines and their above ground parts shall be set back from the property line of any abutting property not part of the project, the right of way of any dedicated road, and any above ground major utility facility line a minimum of 1.5 times the height of the wind turbine tower. Wind turbines and their above ground parts shall be set back from any above ground minor utility facility line a minimum of 1.1 times the height of the wind turbine tower.
>
> Wind turbines and their above ground parts ~~shall~~ may be allowed closer to a property line of any abutting property not part of the project, the right of way of any dedicated road, or any above ground utility facility line than the distances cited above ~~without~~ subject to obtaining a variance pursuant to either Chapter 6 or 7 ~~if~~ and obtaining ~~granted~~ written permission from the abutting property owner, road authority, or utility. ~~Said w~~Written permission shall be made part of permit and the deed records to any private property. Variances shall not reduce the setback to less than the property line setback of the zone in which the turbine is located.

[1] Citations refer to the specific Draft LUDO section and the page number in Staff Report Attachment A ("Att. A"). Recommendations for new language are **underlined.** Recommended deletions are identified by **~~strikethrough~~.**

~~Notwithstanding receiving permission from the abutting property owner, road authority or utility, wind turbines and their above ground parts shall still be required to meet the property line setback of the zone in which they are located unless a variance is granted pursuant to either Chapter 6 or 7.~~

(3) Resource Zone Dwellings - Wind turbines shall be setback from all approved resource zone dwellings a minimum of 2 ~~2/3~~ miles ~~(3,520 feet),~~ measured from the center line of the turbine tower to the edge of the dwelling or the distance required to comply with the DEQ noise standard (OAR 340-035-0035) in Subsection D(3) above, whichever is greater. ~~*(Following this same noise standard EFSC has typically required a setback of approximately ¼ mile (1,320 feet) for turbines. This was put forth on a vote of 5 – 2 by the planning commission. The 2 dissenting planning commissioner votes were in favor of a ¼ mile buffer.)*~~

Wind turbines shall be allowed closer to an approved resource zone dwelling subject to obtaining a variance pursuant to either Chapter 6 or 7 and obtaining ~~granted~~ written permission from the owner of the property where the approved resource zone dwelling is located. Said written permission shall be made part of the permit and deed records to any private property. A variance may exceed 50% of the requirement in Chapter 7 (LUDO § 7.010(A)), but not less than 1,320 feet or the "maximum allowable/Table 8" noise test in OAR 340-035-0035(1)(b)(B), whichever is greater.

If the location of the wind turbine(s) would not comply with the DEQ "ambient degradation" noise standard in OAR 340-035-0035(1)(b)(B) ~~(OAR 340-035-0035)~~ as required in Subsection D(3) above, a waiver would only be allowed pursuant to the same standard.

B. Editorial remarks in the Draft Ordinance misstate EFSC's typical setbacks for noise impacts.

Under the section for setbacks from resource zone dwellings the propose ordinance includes the following editorial remarks regarding EFSC's typical setback for wind turbines:

> Following this same noise standard EFSC has typically required a setback of approximately ¼ mile (1,320 feet) for turbines. This was put forth on a vote of 5 – 2 by the planning commission. The 2 dissenting planning commissioner votes were in favor of a ¼ mile buffer.

Draft LUDO § 19.030(D)(1)(c)(2), Att. A at 19-3. Friends emphasizes that this description of ESFC setbacks is demonstrably false. As such, the assumptions underlying the Planning Commission's recommendation were incorrect. EFSC's prior use of a 1,320-foot-setback was actually based on the risk associated with turbine failure and blade throw. EFSC's Final Order for the Shepards Flats Wind Farm is very clear on this point:

A quarter-mile safety setback (1,320 feet) provides a margin of safety beyond the maximum reported throw distance of 984 feet for a blade fragment.

Shepherds Flat Wind Farm Final Order at 24. An excerpt of the relevant portion of the Shepherds Flat Wind Farm Final Order is attached for the County Commission's reference. The Shepherds Flats Final Order clearly ties a minimum 1,320-foot minimum setback to the risk of turbine failure, blade fragmentations, and blade throw. Notably, the Shepherds Flat Final Order does not allow for a waiver from the 1,320-foot minimum setback. The Shepherds Flat decision also requires an additional buffer from residences to address noise impacts, but deferred identification of the specific setback.

Contrary to the false statement in the draft ordinance, EFSC's implementation of the DEQ noise standards has actually resulted in a range of setbacks based on complex noise modeling performed by project applicants. Identifying the exact setback for the DEQ noise standards is exceedingly complex. To demonstrate the rigors of that process, Friends has will submit the noise impact analysis for the Shepherds Flat Wind Project. The analysis is 63 pages long and packed with an enormous amount of technical analysis. Based on this complex modeling, the project applicant estimated the noise contours for the "ambient degradation" test and the "maximum allowable" test required by the DEQ noise regulations. This modeling was used to determine the actual setbacks from residences.

Friends previously submitted noise contour maps for the Shepherds Flat Wind Project, the Leaning Juniper II Wind Project, and the Summit Ridge Wind Project. As stated before, these maps depict the effective noise setbacks. Rather than a distance of 1,320 feet as the Planning Commission was led to believe, the distance is actually up to two miles from wind facilities.

If the Planning Commission had had complete and accurate information it may have recommended a substantially larger setback from resource zone residences and non-resource zones. The County Commission should base its decision on the correct factual assumptions.

C. Response to Iberdrola Renewables Inc.'s recommended revisions.

Iberdrola Renewables Inc. submitted comments through its attorney. These comments include recommended revisions to the draft ordinance. Friends provides the following response to Iberdrola's comments.

1. Onsite Access Roads and Staging Areas LUDO § 19.030(C)(11).

Iberdrola recommends revising the regulations for access roads and dust control to only address "private" roads within the "Energy Facility Project Area." Iberdrola Comment at 2, addressing LUDO § 19.030(C)(11) and (12). The recommended revision would undermine the County's efforts to ensure accountability for all impacts associated with wind facility development. Wind energy facilities often require the use public roads as haul-routes and access roads. Preventing and fixing impacts from using public roads should be the responsibility of the developer. As such, the County should not adopt the proposed revision.

2. FAA Lighting LUDO § 19.030(D)(1)(a)(3).

Iberdrola recommends that the County not expressly require the use of radar triggered lighting even if the FAA approves the use of the technology for wind energy facilities. Iberdrola Comment at 3. The comment also states that the FAA may approve the technology on a case-by-case basis. *Id*. The red-lined version of the ordinance includes a note stating that radar triggered lighting could still be considered even though it is not explicitly referenced. The comment does not provide any facts or rationale for not requiring that developers apply for approval to use radar triggered lighting.

Nighttime lighting on wind facilities dramatically transforms rural landscapes and is one of the most significant concerns of rural landowners. If the technology is available and approved by the FAA, the County should require that developers apply to the FAA for approval to use radar triggered lighting.

3. Wind Specific Setbacks LUDO § 19.030(D)(1)(c).

Iberdrola recommends adopting 1,320-foot setbacks for residences in resource zone lands and a 3,520-foot setback for non-resource zone lands. Iberdrola Comment at 3. Iberdrola also recommends creating an "adjustment" process for allowing a reduction of both setbacks. Iberdrola's recommended revisions would be a substantial deviation from the Planning Commission's recommendation. Moreover, the recommendations are contrary to the preferences of the overwhelming majority of public comments and the facts in the record.

Iberdrola recommends allowing waivers from the setback for non-resource zoned land. Friends encourages the BOCC to follow the Planning Commission's recommendation to not allow a waiver or adjustment from the setback for non-resource zone lands. Adopting substantial setbacks from non-resource zone lands will protect residentially zoned areas and urban areas from large-scale industrial development. There is no need to invite controversy by allowing waivers.

Iberdrola recommends a 1,320-foot setback from dwellings in resource zones as well as a waiver to reduce that setback even more. Iberdrola states that its "recommended setbacks are based on distances EFSC has found to be sufficiently protective of public health and safety." Iberdrola Comment at 4. As explained above, EFSC's use of a 1,320-foot setback was based solely on the risk of turbine failure and blade throw. In addition, EFSC does not allow waivers below the 1,320-foot safety setback. In practice, EFSC has implemented larger setbacks to protect the public from excessive noise. A larger setback is also justified to reduce the adverse scenic impacts and ensure compatibility with surrounding land uses. In addition, in *Cosner* LUBA held that the 2-mile setback adopted by Umatilla County was permissible.

Based on the facts and the law, Wasco County should adopt substantially larger setbacks than those recommended by Iberdrola. Moreover, based on the risk of flying blade fragments, the County should not allow setbacks to be reduced below 1,320 feet.

C. Conclusion

Thank you for the opportunity to comment.

/s/ *R. F. Till*
Richard Till
Conservation Legal Advocate

Attachments

BEFORE THE
ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

In the Matter of the Application for a Site Certificate for the Shepherds Flat Wind Farm	))))	FINAL ORDER

The Oregon Energy Facility Siting Council

July 25, 2008

An attachment to the CWEC report discusses actual turbine failure reports from Denmark and Germany. The data show that blade fragments are likely to be thrown farther from the turbine tower than whole blades.[56] For turbines larger than 1 MW, the maximum reported throw distance for a blade fragment is 300 meters (984 feet). The maximum throw distance for an entire blade is 150 meters (492 feet), but there is no data for turbines larger than 600 kW. The zone of risk for a turbine collapse is a distance equal to the maximum blade tip height.[57]

A recently-completed report commissioned by the Union of Nova Scotia Municipalities reviewed peer-reviewed journal articles and other sources regarding the impacts of wind energy generation and approaches to regulation.[58] The report noted that "there is no scientific or societal consensus on many aspects of wind development." Nevertheless, with regard to blade failure risk, the report suggested a safety setback distance of 2 to 3 times maximum blade tip height. This recommendation appeared to be based on consideration of the range setback regulations adopted by various Canadian municipalities.

Until more definitive turbine-failure data become available, the Council adopts safety setbacks based on the Council's own precedents, on ordinances from other jurisdictions that have addressed the issue and on the available turbine failure data discussed above. For public roads, the Council adopts a safety setback of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest edge of the public road right-of-way, assuming a minimum right-of-way width of 60 feet. For residences, the Council adopts a safety setback of one-quarter mile (1,320 feet or 402 meters).[59] The distance would be measured from the centerline of the turbine tower to the center of the house and would apply to residences existing at the time of facility construction. In addition, the Council adopts a setback requirement of 110-percent of maximum blade tip height from the centerline of the turbine to the nearest boundary of the certificate holder's lease area.[60] These safety setback distances would apply unless a greater setback distance is required under the County ordinances discussed below or is necessary for compliance with noise control regulations (discussed at page 130).

GCZO Section 7.020(T)(4)(d)(1), discussed below at page 34, requires that "no portion of the facility" be located within 3,520 feet of properties zoned for residential use. The application states that no portion of the proposed facility would be located within 3,520 feet of property zoned for residential use or designated in the Gilliam County Comprehensive Plan as a residential zone.[61] Based on the applicant's representation, the Council includes this restriction in the site certificate.

---

[56] The throw distance for ice shedding from a turbine blade is assumed to be similar to the range of a blade fragment (CWEC report, Attachment 1, p. 2).

[57] CWEC report, Attachment 1, p. 19.

[58] Jaques Whitford Consultants, *Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities*, January 2008.

[59] A quarter-mile safety setback (1,320 feet) provides a margin of safety beyond the maximum reported throw distance of 984 feet for a blade fragment, as discussed above. For comparison, the ordinances of Alameda County, Riverside County and Solano County (California) require a setback of 3 times maximum blade tip height, which would result in a setback distance of 1,476 feet, assuming a blade-tip height of 150 meters (the maximum that would be allowed under Condition 26).

[60] The lease-boundary setback requirement is based on the applicant's representation in the application and supporting record, in accordance with OAR 345-027-0020(10).

[61] App Supp, Exhibit K, response to RAI K1, p. 5.

control regulations adopted by the Environmental Quality Commission, the Division of State Lands' regulations for removal or fill of material affecting waters of the state, the Water Resources Department's (WRD) regulations for appropriating ground water and the Council's statutory authority to consider protection of public health and safety.

(a) Noise Control Regulations

The applicable noise control regulations are as follows:

OAR 340-035-0035

Noise Control Regulations for Industry and Commerce

(1) Standards and Regulations:

* * *

(b) New Noise Sources:

* * *

(B) New Sources Located on Previously Unused Site:

(i) No person owning or controlling a new industrial or commercial noise source located on a previously unused industrial or commercial site shall cause or permit the operation of that noise source if the noise levels generated or indirectly caused by that noise source increase the ambient statistical noise levels, L10 or L50, by more than 10 dBA in any one hour, or exceed the levels specified in Table 8, as measured at an appropriate measurement point, as specified in subsection (3)(b) of this rule, except as specified in subparagraph (1)(b)(B)(iii).

(ii) The ambient statistical noise level of a new industrial or commercial noise source on a previously unused industrial or commercial site shall include all noises generated or indirectly caused by or attributable to that source including all of its related activities. Sources exempted from the requirements of section (1) of this rule, which are identified in subsections (5)(b) - (f), (j), and (k) of this rule, shall not be excluded from this ambient measurement.

(iii) For noise levels generated or caused by a wind energy facility:

(I) The increase in ambient statistical noise levels is based on an assumed background L50 ambient noise level of 26 dBA or the actual ambient background level. The person owning the wind energy facility may conduct measurements to determine the actual ambient L10 and L50 background level.

(II) The "actual ambient background level" is the measured noise level at the appropriate measurement point as specified in subsection (3)(b) of this rule using generally accepted noise engineering measurement practices. Background noise measurements shall be obtained at the appropriate measurement point, synchronized with windspeed measurements of hub height conditions at the nearest wind turbine location. "Actual ambient background level" does not include noise generated or caused by the wind energy facility.

(III) The noise levels from a wind energy facility may increase the ambient statistical noise levels L10 and L50 by more than 10 dBA (but not above the limits

specified in Table 8), if the person who owns the noise sensitive property executes a legally effective easement or real covenant that benefits the property on which the wind energy facility is located. The easement or covenant must authorize the wind energy facility to increase the ambient statistical noise levels, L10 or L50 on the sensitive property by more than 10 dBA at the appropriate measurement point.

(IV) For purposes of determining whether a proposed wind energy facility would satisfy the ambient noise standard where a landowner has not waived the standard, noise levels at the appropriate measurement point are predicted assuming that all of the proposed wind facility's turbines are operating between cut-in speed and the wind speed corresponding to the maximum sound power level established by IEC 61400-11 (version 2002-12). These predictions must be compared to the highest of either the assumed ambient noise level of 26 dBA or to the actual ambient background L10 and L50 noise level, if measured. The facility complies with the noise ambient background standard if this comparison shows that the increase in noise is not more than 10 dBA over this entire range of wind speeds.

(V) For purposes of determining whether an operating wind energy facility complies with the ambient noise standard where a landowner has not waived the standard, noise levels at the appropriate measurement point are measured when the facility's nearest wind turbine is operating over the entire range of wind speeds between cut-in speed and the windspeed corresponding to the maximum sound power level and no turbine that could contribute to the noise level is disabled. The facility complies with the noise ambient background standard if the increase in noise over either the assumed ambient noise level of 26 dBA or to the actual ambient background L10 and L50 noise level, if measured, is not more than 10 dBA over this entire range of wind speeds.

(VI) For purposes of determining whether a proposed wind energy facility would satisfy the Table 8 standards, noise levels at the appropriate measurement point are predicted by using the turbine's maximum sound power level following procedures established by IEC 61400-11 (version 2002-12), and assuming that all of the proposed wind facility's turbines are operating at the maximum sound power level.

(VII) For purposes of determining whether an operating wind energy facility satisfies the Table 8 standards, noise generated by the energy facility is measured at the appropriate measurement point when the facility's nearest wind turbine is operating at the windspeed corresponding to the maximum sound power level and no turbine that could contribute to the noise level is disabled.

* * *

Findings of Fact

A. Applicable Regulations

The applicant addressed compliance with the noise regulations adopted by the Oregon Department of Environmental Quality (DEQ) in Exhibit X of the application. The proposed facility would be a "new industrial or commercial noise source" under OAR 340-035-0035

because construction of the facility would begin after January 1, 1975.[338] The noise control regulations impose different limits on new noise sources constructed on a "previously used industrial or commercial site" compared to the limits imposed on new sources constructed on a "previously unused industrial or commercial site." A site is considered a "previously unused industrial or commercial site" if the site has not been in an industrial or commercial use at any time during the 20 years preceding the construction of a new noise source on the site.[339] According to the applicant, all the equipment associated with the proposed SFWF would be located on property that has not been used for industrial or commercial operations during the past 20 years. The SFWF should be considered a "new industrial noise source" located on a "previously unused industrial or commercial site." Therefore, the noise generated by the proposed project must comply with OAR 340-035-0035 (1)(b)(B).

OAR 340-035-0035 (1)(b)(B) requires that the noise generated by a new wind energy facility located on a previously unused site must comply with two tests. Facility-generated noise must not increase the ambient hourly L_{10} or L_{50} noise levels at any noise sensitive receiver by more than 10 decibels (dBA) when turbines are operating "between cut-in speed and the wind speed corresponding to the maximum sound power level."[340] This requirement is known as the "ambient degradation" test. To show that a proposed facility complies with this test, the applicant may use an assumed ambient hourly L_{50} noise level of 26 dBA; otherwise, the applicant must measure the actual ambient hourly noise levels at the receiver in accordance with the procedures specified in the regulation. OAR 340-035-0035 (1)(b)(B)(iii)(III) relieves the applicant from having to show compliance with the ambient degradation test "if the person who owns the noise sensitive property executes a legally effective easement or real covenant that benefits the property on which the wind energy facility is located" (a "noise waiver").

The potential "waiver" of the ambient degradation test does not relieve the wind facility from compliance with the second test imposed under OAR 340-035-0035 (1)(b)(B). A new wind energy facility located on a previously unused site must not radiate sound levels to any noise sensitive receiver exceeding the noise limits specified in Table 8 of the regulation. This is known as the "Table 8" or "maximum allowable" test. Table 8 provides the following limits:

[338] OAR 340-035-0015(33) defines "new industrial or commercial noise source."
[339] OAR 340-035-0015(47) defines "previously unused industrial or commercial site."
[340] In this discussion, "dBA" refers to sound levels in decibels as measured on a sound level meter using the A-weighted filter network, which corresponds closely to the frequency response of the human ear. The regulation applies the test "as measured at an appropriate measurement point." The "appropriate measurement point," as defined by OAR 340-035-0015 (3), is "25 feet (7.6 meters) toward the noise source from that point on the noise sensitive building nearest the noise source" or "that point on the noise sensitive property line nearest the noise source," whichever is farther from the source. OAR 340-035-0015 (38) defines "noise sensitive property" as "real property normally used for sleeping, or normally used as schools, churches, hospitals, or public libraries." Private residences are the only "noise sensitive properties" potentially affected by the proposed SFWF. We refer to these as the "noise sensitive receivers."

Statistical Noise Limits for Industrial and Commercial Sources		
Statistical Descriptor	**Maximum Permissible Statistical Noise Levels (dBA)**	
	Daytime (7:00 AM - 10:00 PM)	**Nighttime (10:00 PM - 7:00 AM)**
L_{50}	55	50
L_{10}	60	55
L_1	75	60
The hourly L_{50}, L_{10} and L_1 noise levels are defined as the noise levels equaled or exceeded 50 percent, 10 percent and 1 percent of the hour, respectively.		

Because the proposed energy facility would operate on a 24-hour basis, the noise radiating from the facility must not exceed the maximum allowable nighttime noise limits (10:00 PM to 7:00 AM). To comply with the "maximum allowable" test, the noise radiating from the SFWF must not exceed an hourly L_{50} noise level of 50 dBA at any noise sensitive receiver. For the purpose of assessing whether the proposed wind facility would comply with this test, noise levels must be predicted "assuming that all of the proposed wind facility's turbines are operating at the maximum sound power level."

B. Construction Noise

OAR 340-035-0035(5)(g) specifically exempts noise caused by construction activities. Construction of the proposed SFWF would produce localized, short duration noise levels similar to those produced by any large construction project with heavy construction equipment. Much of the project work would be far removed from any noise sensitive receivers. Nevertheless, to mitigate noise impacts at local residences, the Council adopts Condition 96, which would require the certificate holder to confine the noisiest construction activities to daylight hours.

C. Compliance with the Regulations

The applicant has elected to use the assumed ambient hourly L_{50} noise level of 26 dBA for the background ambient noise level rather than to conduct noise measurements at the noise sensitive receivers in the vicinity of the project. Accordingly, to show compliance with the ambient degradation test, the noise generated by the operation of the proposed SFWF wind turbines between cut-in wind speed and maximum sound power level wind speed must not cause the hourly L_{50} noise level at any noise sensitive receiver to exceed 36 dBA.

The applicant is proposing a wind energy facility that will contain up to 303 wind turbines. The applicant provided sound power level and octave band data for four turbine types that might be selected for use in the proposed SFWF: the GE Energy 1.5-MW, the Siemens SWT-93 2.3-MW, the Clipper Liberty 2.5-MW and the Vestas V90 3.0-MW.[341] The applicant requests flexibility to use any combination of turbine types, subject to the restrictions described in Condition 26. The final selection of turbine types used in the project would be based on the availability and cost of the turbines and on the constraints placed on the project by the site certificate. In addition, the applicant requests the design flexibility to locate the turbines anywhere within the proposed site boundary, subject to the conditions of the site certificate. For the purpose of showing that the proposed facility can comply with the noise regulations, the

[341] App Supp, Amended Exhibit B, pp. 4-5.

Department asked the applicant to submit data that demonstrates that there is at least one layout of wind turbines on the site that would comply with the regulations (a "default layout").

The applicant submitted a default layout of turbines within the site boundary that includes 280 Siemens SWT-93 turbines in the northern project area and 23 Vestas V90 turbines in the southern project area.[342] To support the conclusion that the default layout would be in compliance with the noise regulations, the applicant retained an acoustical consultant, Mr. Bruce Walker, Ph.D. of Channel Island Acoustics, to calculate the predicted sound pressure level at each noise sensitive receiver.[343] The Department consulted with Mr. Kerrie Standlee of Daly Standlee and Associates to review and confirm Walker's findings.

The equations used in Walker's program were classical sound propagation equations that account for distance attenuation, atmospheric attenuation, ground attenuation and terrain attenuation. In predicting the maximum noise levels at the 31 noise sensitive receivers, Walker included distance attenuation and atmospheric attenuation associated with conditions of 50 degrees F (10 degrees C) and 70 percent relative humidity. The final calculations did not include factors for ground attenuation or terrain attenuation. The predicted noise levels would likely have been lower if factors for ground attenuation and terrain attenuation had been included. The predicted noise levels, therefore, are conservative predictions of what the actual noise effects would be.

Octave band sound power level reference data supplied by the turbine manufacturer (data for wind blowing at 8 meters per second, 10 meters off the ground) were used in predicting the maximum noise levels at the 31 noise sensitive receivers. The octave band data were increased so that the resulting overall A-weighted sound power level reference data was 2 dB higher than the overall maximum sound power level warranted by the manufacturer. This adjustment was applied to account for the amount of uncertainty associated with the manufacturer's warranted data. Accordingly, the applicant assumed that the Siemens turbines had a maximum A-weighted sound power level output of 109.0 dBA and the Vestas turbines had a maximum A-weighted sound power level output of 111.3 dBA.

In addition to calculating the noise generated by the wind turbines, the applicant calculated and included the noise that would radiate to each receiver from the power transformers located at the two proposed substations. The applicant used a maximum A-weighted sound power level of 105 dBA for each of four transformers expected at the north substation and 101 dBA for the single transformer expected at the south substation.

In presenting the results of the analysis, the applicant provided three tables showing the noise level contributed by 303 turbines and five transformers. One table presented the predicted turbine-generated sound pressure levels reaching 10 receivers (Receivers 1 through 10) located near the northern project area.[344] Another table presented predicted turbine-generated sound

[342] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, Figure RAI#3 X1a revision 3 and Figure RAI#3 X1b revision 3.

[343] Walker used an in-house, Matlab-based, computer program to predict the noise levels at 31 noise sensitive receivers located around the project site. He located the turbines and the noise sensitive receivers on a 501 by 501 grid and then used tied the grid to his computer program to calculate the total sound pressure level at each receiver contributed by all turbines (email from Kerrie Standlee, January 9, 2008).

[344] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, table entitled "North turbine noise analysis using A-weighted octave band data."

pressure levels reaching 21 residences (Receivers 11 through 31) near the southern project area.[345] The third table presented the predicted transformer-generated sound pressure levels reaching each of the 31 receivers investigated around the site.[346] Each table included the total sound pressure level expected at the receiver and the sound pressure level contributed by each source included in the calculation. In addition, as a visual aid, the applicant presented Figure RAI#3 X1c to show the 5-dB interval noise contours between 30 dBA and 55 dBA around the northern project area.[347] Based on data from the applicant's tables, the maximum predicted noise levels generated by the SFWF are as shown in Table 15 below. Data shown in boldface exceed the 36-dBA ambient degradation limit.

Table 15: Predicted Noise Levels

Receiver	Predicted Maximum Hourly L_{50} Noise Level (dBA)	Receiver	Predicted Maximum Hourly L_{50} Noise Level (dBA)
R1	32	R17	32
R2	29	R18	34
R3	34	R19	**40**
R4	30	R20	34
R5	33	R21	29
R6	35	R22	29
R7	35	R23	26
R8	36	R24	23
R9	36	R25	22
R10	35	R26	30
R11	**39**	R27	32
R12	**39**	R28	29
R13	35	R29	31
R14	**39**	R30	21
R15	36	R31	19
R16	**39**		

As seen from the data in Table 15, the noise levels at all receivers are predicted to comply with the 50-dBA maximum allowable test. At five receivers (R11, R12, R14, R16 and R19), operation of the proposed facility could increase the ambient statistical noise level by more than 10 dBA above the assumed background L_{50} ambient noise level of 26 dBA. At these properties, the ambient degradation limit would be exceeded. The proposed facility would comply with the applicable noise regulations if it were constructed according to the default layout (using the turbine types analyzed above) and if the certificate holder had acquired noise waivers from the owners of properties R11, R12, R14, R16 and R19. The applicant has discussed the potential noise impacts with the owners of these properties but prefers to negotiate any necessary waivers after the final facility layout has been determined. The Department asked the applicant to

[345] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, table entitled "South turbine noise analysis using A-weighted octave band data."
[346] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, table entitled "Transformer sound levels using 105 dB(A) for each north transformer and 101 dB(A) for the south transformer."
[347] App Supp, Exhibit X, email from Patricia Pilz, November 12, 2007, Figure RAI#3 X1c. The applicant did not provide a similar contour map for the southern project area.

identify which turbines would be eliminated from the default layout to ensure compliance with the ambient degradation limit. The applicant identified twelve turbines within the southern project area that would need to be eliminated.[348] The Department's consultant, Kerrie Standlee, reviewed the data and confirmed that removal of the twelve identified turbines would bring the facility-generated noise levels into compliance with the ambient noise degradation limit of 36 dBA at Receivers R11, R12, R14, R16 and R19.[349] The Council finds that the proposed SFWF would comply with the applicable noise regulations in OAR 340-035-0035 if the facility were built according to the default layout described herein and if the twelve identified turbines were eliminated from that layout.

To ensure that the facility as built would comply with the noise control regulations, the Council adopts Condition 97. This condition would require the certificate holder to provide information about the turbines selected and about the final design layout to the Department before beginning construction. The condition requires the certificate holder to demonstrate to the satisfaction of the Department that the facility as built according to the final design layout would comply with the applicable noise control regulations.

Under OAR 340-035-0035 (4)(a), DEQ has authority to require the owner of an operating noise source to monitor and record the statistical noise levels upon written notification. In the event of a complaint regarding noise levels during operation of the SFWF, the Council has the authority to act in the place of DEQ to enforce this provision to verify that the certificate holder is operating the facility in compliance with the noise control regulations. Under Condition 3, the certificate holder would be required to operate the facility in accordance with all applicable state laws and administrative rules. The Council adopts Condition 98, which would require the certificate holder to notify the Department of any complaints received about noise from the facility as well as the actions taken to address them.

Conclusions of Law

Based on the findings and site certificate conditions discussed above, the Council finds that the proposed facility would comply with the applicable State noise control regulations.

(b) Removal-Fill Law

The Oregon Removal-Fill Law (ORS 196.800 through 990) and regulations (OAR 141-085-0005 through 141-085-0090) adopted by the Department of State Lands (DSL) require a permit if 50 cubic yards or more of material is removed, filled or altered within any "waters of the state" at the proposed site.[350] The Council must determine whether a permit is needed. The U.S. Army Corps of Engineers administers Section 404 of the Clean Water Act, which regulates the discharge of fill into waters of the United States (including wetlands). A Nationwide or Individual fill permit may be required.

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[348] Email from Patricia Pilz, January 28, 2008. The twelve turbines are numbered 283, 284, 291 through 294, 296 through 299, 301 and 302 in the application (App Supp, Exhibit X, Correspondence, email from Patricia Pilz, November 12, 2007).

[349] Email from Kerrie Standlee, January 31, 2008.

[350] OAR 141-085-0010(225) defines "Waters of this State." The term includes wetlands and certain other water bodies.

38 During construction and operation of the facility, the certificate holder shall implement a plan to control the introduction and spread of noxious weeds. The certificate shall develop the weed control plan consistent with the Gilliam County and Morrow County Weed Control Programs.

39 Before beginning construction of the facility, the certificate holder shall record in the real property records of Gilliam County a Covenant Not to Sue with regard to generally accepted farming practices on adjacent farmland consistent with Gilliam County Zoning Ordinance 7.020(T)(4)(a)(5).

40 The certificate holder shall construct all facility components in compliance with the following setback requirements:

(a) All facility components must be at least 3,520 feet from the property line of properties zoned residential use or designated in the Gilliam County Comprehensive Plan as residential.

(b) Where (a) does not apply, the certificate holder shall maintain a minimum distance of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest edge of any public road right-of-way. The certificate holder shall assume a minimum right-of-way width of 60 feet.

(c) Where (a) does not apply, the certificate holder shall maintain a minimum distance of 1,320 feet, measured from the centerline of the turbine tower to the center of the nearest residence existing at the time of tower construction.

(d) Where (a) does not apply, the certificate holder shall maintain a minimum distance of 110-percent of maximum blade tip height, measured from the centerline of the turbine tower to the nearest boundary of the certificate holder's lease area.

41 Within 90 days after beginning operation, the certificate holder shall provide to the Department and to the Planning Directors of Gilliam County and Morrow County the actual latitude and longitude location or Stateplane NAD 83(91) coordinates of each turbine tower, connecting lines and transmission lines. In addition, the certificate holder shall provide to the Department and to the Planning Directors of Gilliam County and Morrow County, a summary of as-built changes in the facility compared to the original plan, if any.

42 The certificate holder shall install gates on all private facility access roads in Gilliam County, in accordance with Gilliam County Zoning Ordinance Section 7.020(T)(4)(d)(6).

3. Cultural Resource Conditions

43 Before beginning construction, the certificate holder shall provide to the Department a map showing the final design locations of all components of the facility and areas that would be temporarily disturbed during construction. In addition, the certificate holder shall comply with the following requirements:

(a) The certificate holder shall avoid disturbance within a 30-meter buffer around the two prehistoric archaeological sites and five historic-period archaeological sites identified by AINW as "possibly eligible" for listing in the National Register of Historic Places (NRHP) as described in the Final Order on the Application.

(b) The certificate holder shall avoid disturbance of the 36 stacked rock features identified by AINW as "possibly eligible" for listing in the NRHP as described in the Final Order on the Application and shall, to the extent practicable, maintain a 30-meter no-

9. Visual Effects Conditions

93 To reduce the visual impact of the facility, the certificate holder shall:
(a) Mount nacelles on smooth, steel structures, painted uniformly in a matte-finish, neutral white color.
(b) Paint substation structures in a neutral color to blend with the surrounding landscape.
(c) Not allow any advertising to be used on any part of the facility.
(d) Use only those signs required for facility safety, required by law or otherwise required by this site certificate, except that the certificate holder may erect a sign to identify the facility near each field workshop, may paint turbine numbers on each tower and may allow unobtrusive manufacturers' logos on turbine nacelles.
(e) Not locate any facility signs along Highway 74.
(f) Design signs in accordance with Gilliam County Zoning Ordinance Section 8.030 and Morrow County Zoning Ordinance Section 4.070, as applicable.
(g) Maintain any signs allowed under this condition in good repair.

94 The certificate holder shall design and construct the field workshops to be generally consistent with the character of similar buildings used by commercial farmers or ranchers in the area and shall paint the buildings in a neutral color to blend with the surrounding landscape.

95 The certificate holder shall not use exterior nighttime lighting except:
(a) The minimum turbine tower lighting required or recommended by the Federal Aviation Administration.
(b) Security lighting at the field workshops and substations, provided that such lighting is shielded or downward-directed to reduce glare.
(c) Minimum lighting necessary for repairs or emergencies.

10. Noise Control Conditions

96 To reduce noise impacts at nearby residences, the certificate holder shall:
(a) Confine the noisiest operation of heavy construction equipment to the daylight hours.
(b) Require contractors to install and maintain exhaust mufflers on all combustion engine-powered equipment; and
(c) Establish a complaint response system at the construction manager's office to address noise complaints.

97 Before beginning construction, the certificate holder shall provide to the Department:
(a) Information that identifies the final design locations of all turbines to be built at the facility.
(b) The maximum sound power level for the substation transformers and the maximum sound power level and octave band data for the turbines selected for the facility based on manufacturers' warranties or confirmed by other means acceptable to the Department.
(c) The results of noise analysis of the facility to be built according to the final design performed in a manner consistent with the requirements of OAR 340-035-0035 (1)(b)(B)(iii)(IV) and (VI) demonstrating to the satisfaction of the Department that the total noise generated by the facility (including the noise from turbines and substation transformers) would meet the ambient degradation test and maximum allowable test at the appropriate measurement point for all potentially-affected noise sensitive properties.

(d) For each noise-sensitive property where the certificate holder relies on a noise waiver to demonstrate compliance in accordance with OAR 340-035-0035 (1)(b)(B)(iii)(III), a copy of the a legally effective easement or real covenant pursuant to which the owner of the property authorizes the certificate holder's operation of the facility to increase ambient statistical noise levels L_{10} and L_{50} by more than 10 dBA at the appropriate measurement point. The legally-effective easement or real covenant must: include a legal description of the burdened property (the noise sensitive property); be recorded in the real property records of the county; expressly benefit the certificate holder; expressly run with the land and bind all future owners, lessees or holders of any interest in the burdened property; and not be subject to revocation without the certificate holder's written approval.

98 During operation, the certificate holder shall maintain a complaint response system to address noise complaints. The certificate holder shall promptly notify the Department of any complaints received regarding facility noise and of any actions taken by the certificate holder to address those complaints. In response to a complaint from the owner of a noise sensitive property regarding noise levels during operation of the SFWF, the Council may require the certificate holder to monitor and record the statistical noise levels to verify that the certificate holder is operating the facility in compliance with the noise control regulations.

11. Waste Management Conditions

99 The certificate holder shall provide portable toilets for on-site sewage handling during construction and shall ensure that they are pumped and cleaned regularly by a licensed contractor who is qualified to pump and clean portable toilet facilities.

100 During operation, the certificate holder shall discharge sanitary wastewater generated at the field workshops to licensed on-site septic systems in compliance with county permit requirements. The certificate holder shall design each septic system for a discharge capacity of less than 2,500 gallons per day.

101 The certificate holder shall implement a waste management plan during construction that includes but is not limited to the following measures:

(a) Recycling steel and other metal scrap.

(b) Recycling wood waste.

(c) Recycling packaging wastes such as paper and cardboard.

(d) Collecting non-recyclable waste for transport to a local landfill by a licensed waste hauler or by using facility equipment and personnel to haul the waste.

(e) Segregating all hazardous wastes such as used oil, oily rags and oil-absorbent materials, mercury-containing lights and lead-acid and nickel-cadmium batteries for disposal by a licensed firm specializing in the proper recycling or disposal of hazardous wastes.

(f) Discharging all concrete truck rinse water into foundation holes and completing truck wash-down off-site.

102 The certificate holder shall implement a waste management plan during operation that includes but is not limited to the following measures:

(a) Training employees to minimize and recycle solid waste.

(b) Recycling paper products, metals, glass and plastics.

From: Shirley Decker <sldjadecker@yahoo.com>
Date: Tue, Feb 14, 2012 at 2:17 PM
Subject: Public Hearing on E.on Climate & Renewables
To: "RodR@co.wasco.or.us" <RodR@co.wasco.or.us>

Mr Commissioner Rod,

I am a land owner in south Sherman County and also one of the owners of Black Rock Grazing Co-0p east of Antelope in Wasco
County.

I am opposed to a 1.5 mile set back for wind turbines from residences.

This take away my right for the property I own and enjoy and is not in the best interest of Wasco County.

I would appreciate a no vote on this petition.

Art Decker

WASCO COUNTY

wcplanning wcplanning <wcplanning@co.wasco.or.us>

Testimony about Revisions to Chapter 19 of the LUDO, and Petition for setback standards

1 message

Maureen Mack Kullman <mcmack2@mindspring.com> Wed, Feb 15, 2012 at 1:55 PM
To: wcplanning@co.wasco.or.us

Here is a copy of testimony that we would like to present at the meeting this afternoon . We will bring a signed copy to submit at the hearing.

Thank you.

Maureen Mack,
Connolly Land and Livestock, Inc.

Board of County Commissioners Wasco County.doc
28K

Board of County Commissioners, Wasco County

February 15, 2012

Re: Revisions to Chapter 19 of the Land Use Development Ordinance
Petition for Setback Standards

Connolly Land and Livestock, Inc, is a 42,000 acre ranch located in Southern Wasco County, extending from the Deschutes River south to the Criterion area, and includes property on both sides of Bakeoven Road, and Highway 197. The ranch has been in the Connolly family since Tom Connolly came to Wasco County in l899 from Galway, Ireland. He homesteaded, with sheep, and as he acquired any money, he would send it back to Ireland so another brother could come. Five brothers and two sisters came at different times. Now the ranch produces commercial cattle.

In the recent past, we have been approached by Iberdrola Renewables, about participation in a proposed Wind Energy project in the region.

The Wasco County Planning commission did a good job working on the Amendments to the Comprehensive Plan, and the Amendments to the Wasco County Land Use and Development Ordinance, both of which were recommended for adoption to the Board of County Commissioners on June 7, 2011. However, we believe the setbacks need to be adjusted to allow for greater flexibility in South County and rural areas that are less populated. We believe the Wasco County setbacks do not need to exceed those established by the State of Oregon Energy Facility siting Council,

There is a movement by residents of North Wasco County, to influence the BOCC to change the wind turbine set-backs for the entire county, without regard to population density, topography, and private property owner rights .These setbacks exceed the Oregon State DEQ Noise setback ruling and do not allow for a variance by the individual property owner.. This overly restrictive set back restriction may very well threaten the ability of Wind Energy projects to be viable in South Wasco County.

In much of the testimony, there has been little mention of the economic benefit derived from Wind Energy installations. In Sherman County, for the 2011-2012 tax year, six different Wind Energy companies paid a total property tax of $2,730,543.19. (Dick Stradly, assessor, Sherman County) Each city in Sherman County receives $100,000 per year to share in the bounty, and in addition, each household in Sherman County receives $590 per year. Think what the communities in Wasco County could do with similar income!!

We are concerned that if the excessively restrictive wind turbine restrictions are put in place in Wasco County, and therefore makes Wind Energy installation non-viable, our ability to use our property will be compromised. Furthermore, the citizens of Wasco County will be denied the benefits of increased tax revenues.

We urge the BOCC to adopt the current State recommendations for wind turbine setbacks, specifically the OR DEQ Noise setbacks and distances to urban growth boundaries of incorporated cities.

Frances Connolly, President, Connolly Land and Livestock, Inc.

Kathleen C. Tovey, Shareholder, Connolly Land and Livestock, Inc.

Maureen C. Mack M.D. Shareholder, Connolly Land and Livestock, Inc.