March 10, 2009

Burl W. Haar
Executive Secretary
Minnesota public utilities commission
121 7th Place East, Suite 350
St Paul, MN 55101

RE: In the Matter of the Application of Pleasant Valley Wind LLC For Certificate of Need, Docket Number CN-09-937

Dear Dr. Haar:

On October 26, 2009, Pleasant Valley Wind LLC ("Applicant") filed an application for a Certificate of Need for a Large Energy Facility with the Minnesota Public Utilities Commission. In this application, the Applicant failed to demonstrate need for this proposed facilities in accordance with Minnesota Rules 7849.0120 and therefore should not be granted a Certificate of Need by the Commission.

I. Minnesota Rule 7849.0120-A

1. Sale of Project Output and/or REC outside Minnesota

Minnesota Rule 7849.0120 subpart (A), states that in order for a certificate of need to be granted, the Applicant be able to demonstrate that the "the probable result of denial would be an adverse effect upon the future adequacy, reliability, or efficiency of energy supply to the applicant, to the applicant's customers, or to the people of Minnesota and neighboring states".

Since the Applicant is an Independent Power Producer (IPP), it does not have customers similar to a public utility. Consequently, the Applicant has requested, and has been granted by the Commission, an exemption from having to provide information such as customer load forecasts, conservation programs, and other information typically required by MN Rule 7849. Therefore, since the applicant can not demonstrate an adverse impact to its customers, it must be able to demonstrate that the denial of this certificate of need would have adverse impact to the "people of Minnesota and neighboring states" according to MN Rule 7849.0120 subp.(A).

Instead, the Applicant attempts to use State renewable energy standards (RES) as a basis for compliance to 7849.0120, however no evidence is provided to demonstrate that denial of this CN will have an adverse impact on the people of Minnesota and neighboring states.

On page 8, section 2, subpart 1 of the application, the Applicant attempts to argue that the Project complies with 7849.0120-A because "The Project will be an adequate, reliable, and efficient energy supply to GRE's (or other Minnesota utilities') customers;" however, the Applicant gives no guarantee that the output of this Project will be sold to GRE or a Minnesota utility. It is therefore impossible for the applicant to demonstrate that denial of this CN would have an adverse impact to the people of Minnesota since there is no guarantee that the output of this project will serve the people of Minnesota.

Even if the actual energy from the output stays in Minnesota, the Applicant has stated that it may separate the renewable energy credit (REC) from the actual energy and sell the REC to someone else. The Applicant gives no guarantee that the REC will be sold to a Minnesota utility. It is therefore impossible for the Applicant, or anyone else to conclude that the probable result of denial (of this CN) would be an adverse effect upon the future adequacy, reliability, or efficiency of energy supply to the people of Minnesota.

Since the Applicant has given no guarantees that the output associated with this project will sold to serve the people of Minnesota or a neighboring state, the Applicant can't prove that denial of this CN will adversely impact the people of Minnesota and neighboring states.

2. Sale of Project Output and/or REC to a Minnesota Utility

If the output and REC from this Project were sold to GRE or another Minnesota utility, the Applicant still fails to demonstrate that denial of the CN would result in any adverse impacts to the people of MN in accordance with MN Rule 7849.0120-A.

The Applicant instead uses the argument on page 8, section 2.1, that "The competitive (bidding) process employed by GRE to select Pleasant Valley as a potential source of clean renewable energy ensures the cost-competitiveness, adequacy and efficiency of the Pleasant Valley Project." however, the Applicant provides no evidence that denial of this CN would have an adverse impact on GRE.

If the Applicant were to sell the output of this Project to another Minnesota utility other than GRE, it has stilled failed to satisfy the requirements of 7849.0120-A. Once again, the only argument which the Applicant uses to justify the Project is the current Minnesota RES. The

Applicant provides no evidence that any Minnesota utility is currently unable to meet their RES requirement or that the denial of this Project CN would adversely impact any Minnesota utilities ability to meet there RES requirements.

The fact that all Minnesota utilities have an RES requirement is not in itself evidence for the need of this Project nor does it prove that failure to build this Project would have any adverse impact at all on the people of Minnesota. Both the Applicant and the OES conclude that Minnesota needs an additional 801 to 1493 megawatts of new wind energy to meet the RES compliance for 2012. There is currently 147 Minnesota based wind farm projects listed in the MISO queue for completion by 2012 with a total capacity of 18,000 megawatts. If the CN for the Applicant's Project were denied, it would not adversely impact the ability for the State to meets its RES goals since there is 18,000 additional MW already in the MISO queue and therefore the Project can not meet the requirements of 7849.0120-A.

3. Sale of Project Output to MISO

The Applicant also states that, rather than selling this energy to a Minnesota utility, the Applicant may chose to sell the output to the Midwest Independent System Operator (MISO), located in Carmel Indiana. If the energy were to be sold to MISO, the Applicant could not demonstrate need since MISO itself is not a utility and does not have a need to serve. MISO is simply an independent clearinghouse for the sale and transfer of energy. Each individual Load Serving Entity (LSE) within the MISO footprint must own sufficient resources to meet its own needs plus reserves. MISO is not responsible for meeting the needs of any customer or LSE.

Likewise, if the Applicant were to sell the output of this Project to MISO, the Applicant can not demonstrate that denial of this CN would have and adverse impact on the people of Minnesota since there is no guarantee that the energy will be used to serve the people of Minnesota. MISO has a multi-state jurisdiction and also has links to other many other ISO's. Once the energy is sold to MISO, it can be moved to anywhere in the Eastern Interconnection including parts of Canada. Since sale of this energy to MISO can not guarantee it will be used in Minnesota or neighboring States, the Applicant can not prove that denial would adversely impact the people of Minnesota.

The Applicant also maintains that several other States in the region also have renewable energy requirements similar to Minnesota. The OES quotes the MISO ISO Transmission Plan for 2009 which states a requirement of roughly 12,000 MW above and beyond the current 10,861 MW installed. MISO currently has over 65,000 MW of planned wind projects in their queue or 5 times more than needed. If the CN for the Applicant's Project were denied, it would not

adversely impact the ability for the other States within the MISO region to meets their RES goals and therefore can not meet the requirements of 7849.0120-A.

II. Minnesota Rule 7849.0120-B

Minnesota Rule 7849.0120-B states that "A certificate of need must be granted to the applicant on determine that a more reasonable and prudent alternative to the proposed facility has not been demonstrated by a preponderance of the evidence on record" The criteria used to determine the prudency of the Project as compared to the alternatives are:

1. The size, type and timing of the Project and alternatives
2. The cost of the proposed Project versus the alternatives
3. The effects on natural and socioeconomic environments
4. The Project reliability compared to its alternatives

Since the Applicant has not yet identified a buyer for this Project, it is impossible for the Applicant, or anyone else for that matter, to argue that the size, type, or timing of this proposed Project is any better or any worse than any other possible alternatives. The best size and timing for one potential buyer is most likely not the same for every potential buyer. For that reason, the criteria of size, type, and timing is not applicable to any comparison of possible alternatives.

In fact, the reasoning used by the OES in reviewing the Applicant's compliance to 7849.0120-B(1) states that, "these factors (size, type and timing) are relevant to the wind generation industry as well as the proposed Project" Therefore, the Applicant can not argue that the size, type, and timing of their Project has any advantage over any other wind based alternatives.

Also, the Applicant has requested, and has been granted, an exception from any comparison against non-renewable energy based alternatives. Since all alternatives used in this comparison are renewable energy alternatives, the effects on the natural and socioeconomic environments for all alternatives will generally be the same as that of the proposed Project. In the OES review of the Applicant's compliance to Minnesota Rule 7849.0120-B(3), they stated that "comparing the (natural and socioeconomic environmental) effects of this Project with another wind project of this size is not likely to result in significant differences." As a result, the criteria of natural and socioeconomic environmental impact also become non-applicable in the comparison of other renewable alternatives for the Project.

Since subpart B(1) and B(3) are indistinguishable between the Project and other renewable alternatives, the only criteria in MN Rule 7849-0120-B that is applicable to this Project when comparing it to possible alternatives is subpart (2) cost, and subpart (4) reliability.

1. Alternatives outside Minnesota

In the Applicant's review of alternatives, they limited the scope to only those alternatives that were available to a Minnesota utility however, the Applicant gives no guarantee that the output of this Project will go to serve a Minnesota utility. Since the Applicant has the freedom to sell the output of this facility to any utility in the United States, they must also assess alternatives outside Minnesota.

<u>Alternative #1:</u>
If this Project were to be sold to a utility in North or South Dakota, there would be several possible alternatives that would be much more prudent than this proposed Project. Since the wind potential is much greater in the Dakota's than it is in Minnesota, a 300 MW wind farm located in the Dakotas of identical size and design as the proposed Project would produce approximately 5% more energy that the Project. Moreover, a wind alternative built closer to the buyer's loads will be significantly more efficient than having to transmit the energy from Dodge County Minnesota to the Dakotas.

There are currently 65 new wind project scheduled in the MISO queue for North and South Dakota with a total generating capacity of over 18,000 MW. All 65 of these projects are schedule for completion before 2012. A copy of all renewable projects currently in the MISO queue is included in Attachment A of this document. Each of these 65 alternative wind projects are a much more reasonable and prudent alternative to the proposed facility for all potential buyers located in the Dakotas.

<u>Alternative #2 through #8:</u>
The table below shows a list of the total MW capacity of new wind energy projects currently in the MISO queue by State, in addition to those in the Dakota's and Minnesota.

Iowa	12,895
Illinois	4,585
Indiana	3179
Michigan	3022
Missouri	4450

Ohio 248
Wisconsin 578

A wind energy farm is most efficient when it is located as close to the end customer as possible. If the Applicant were to sell the output of their Project to an end user in one of the above States, there would be significant inefficiencies involved with having to transmit the energy over long distances from their Project in Dodge County Minnesota.. As a result, the 28,598 MW of alternative projects listed above are a much more reasonable and prudent alternative to the Applicants' proposed Project for all potential buyers located in these States.

Alternative #9:

The Applicant argues in their application that no prudent hydro-electric alternatives exist in Minnesota; however, the Applicant has not limited the sale of their Project to a Minnesota utility. There are several prudent hydro-electric based alternatives to this Project located outside Minnesota.

Numerous utilities in MISO are located near vast hydro-electric reserves in Canada. The cost data provided by the Applicant in table 6 of their application shows the cost of a conventional hydro plant to be $2,038/kW compared to $1,797/kW for a wind farm. A wind farm of 300 MW, similar to the Applicant's will produce approximately 1 million MWh of renewable energy each year. The installed cost of this facility would be $1,797/Kw times 300,000 kW, or $539 Million dollars.

The generating capacity of a hydro electric facility is in excess of 90% compared to the Applicants' Project at 38%. As a result, this same amount of renewable energy can be produced at a hydro electric plant rated at only 125 MW in size. The cost to build a 125 MW hydro plant, using the Applicants' values is only $255 Million dollars or less than half the cost of the Applicant's Project.

Manitoba Hydro currently has a new 200 MW hydroelectric plant scheduled for completion in 2011. The Manitoba Hydro website publication included in Attachment B of this documents states that "Current projections show that Manitoba's domestic demand for new power is not required until 2020. But by advancing the in-service date of Wuskwatim to 2011 means additional export revenues and profits will be possible." As a result, this new hydroelectric facility is a more prudent alternative to the Applicant's Proejct.

Alternative #10:

The Applicant argues in their application that no prudent landfill gas alternatives exist in Minnesota; however, once again, the Applicant has not limited the sale of their Project to a Minnesota utility. In addition, since the Applicant has not yet identified a specific buyer for their Project, so there is no evidence that a 300 MW project is the proper size for all potential buyers. A small municipal utility may only need a small percentage of the total output of this Project.

Since a landfill gas facility can generate at a 95% capacity factor compared to the proposed Project at 38%, a landfill gas facility of only 8 MW in size would produce the same amount of renewable energy as 20 MW of the Applicant's Project. Once again, using the same data provide by the Applicant in table 6, the cost to the potential buyer of a landfill gas alternative would be only $19 million dollars compared to the Applicant's Project cost of $36 million dollars. There are numerous landfills throughout the MISO footprint and beyond that can provide this level of needed output. Attachment C contains a list of possible landfill gas sites in Minnesota.

2. Alternatives inside Minnesota

The Applicant's review of alternatives for Minnesota based utilities was limited to hydro, biomass, landfill gas, and photovoltaic. However, the Applicant failed to compare itself against other wind energy alternatives available in Minnesota. There are several reasonable and prudent alternatives to the Applicant's Project currently available in Minnesota from other wind projects.

On page 8, section 2.1, of the CN application, the Applicant states that "The competitive (bidding) process employed by GRE to select Pleasant Valley as a potential source of clean renewable energy ensures the cost-competitiveness, adequacy and efficiency of the Pleasant Valley Project". If the Commission agrees with this argument, then the Commission must also conclude that the exact opposite is also true. If GRE chooses another one of the many IPP project currently in the MISO queue in Minnesota instead of the Applicant's Project, this must demonstrate that the Applicant's Project is not the most cost effective alternative for GRE and other Minnesota utilities.

Alternative #11:

One such alternative to the Applicant's Project would be a "self build" wind option. Many Minnesota utilities have moved away from PPA's to meet their RES and migrated instead to

a “self build” option. This is because the utility generally has access to much less expensive financing that an IPP and the utilities rate of return on their investment is also much lower.

An IPP such as the Applicant generally has a return on investment requirement of 16% to 18% or higher. The return on investment requirement for a rate regulated utility is closer to 8% to 12%. The return on investment for a non-regulated municipal or cooperative utility is zero since they are both non-profit organizations. Whats more, most municipal and cooperative electric utilities have access to tax exempt bonds which further reduce to cost of a large project such as a wind farm.

The actual financial data for the Applicant’s Project has been kept confidential; however, the Commission does have access to this data. The following cost comparison uses an estimate of the Applicants cost. The Commission can use the same methodology to compare these alternatives to the actual cost of the Applicant’s Project.

Assuming that the Applicant can borrow money at 8% interest and their return on investment is 18%, and also assuming a 20/80 split in ownership equity versus financing, the annualized cost of the Applicants Project would be $63 million for a 20 year PPA. Given the fact that a municipal or cooperative utility has no return on investment requirements and has access to tax exempt bonds currently in the range of 5%, the cost to “self build” this same project would be only $42 million. For an investor owned utility in Minnesota with a regulated rate of return of 10% and access to the same financing as the IPP, the “self build” cost of this same project would be only $56 million.

Minnesota utilities currently have several self build projects among the 147 projects in the MISO queue. Each of these self build wind farm alternative is a viable and more prudent alternative to the Applicants’ proposed Project.

<u>Alternative #12:</u>
As stated in the alternative above, many Minnesota utilities have moved away from using PPA’s to meet their RES requirements in favor of the self build option due to the considerable cost savings. As a result, this has created a surplus of IPP based wind projects in Minnesota.

There are currently 147 wind farm projects listed in the MISO queue for Minnesota totaling over 18,000 MW of capability, schedule for completion by 2012. A complete list of these projects is given in Attachment A. Each of these wind projects are competing for a very

limited number of Minnesota buyers. The OES states that there is a need for 801 to 1493 MW of renewable energy in Minnesota by 2012. Therefore, the existing MISO queue currently contains more than 10 times the amount of wind energy as needed to meet Minnesota's' 2012 RES requirements.

If GRE decides not to purchase the output from the Applicant, it is most likely due to the fact that one of these many alternatives were more cost effective. Likewise, if the Applicant finds no Minnesota buyer and must sell their Project outside Minnesota, this would provide even more evidence that these Minnesota utilities had access to less expensive projects. Therefore, if the Applicant cannot sell this Project to GRE or another Minnesota utility, it must be concluded that this proposed Project was not as cost effective as the Applicant claims.

There is no way to determine for certain if any of these 147 alternative wind projects are any more or less expensive than the Applicant's Project. However, common sense would dictate that half of the 147 projects are probably cheaper and half are probably more expensive. This means there is most likely more than 70 projects currently in Minnesota that are less expensive that the Applicants. Even if only 10% of the queued projects are less expensive, this means that there is still 1800 MW available as a lower cost alternative, more than enough to satisfy the Minnesota RES requirement.

As a result, the existence of 147 alternative wind projects currently in the State of Minnesota serves as ample evidence that more prudent alternatives most likely exist.

<u>Alternative #13:</u>

Another viable alternative to the Applicant's Project would be for a Minnesota utility to purchase the entire project from a wind developer rather than purchasing the project output. Many wind developer, as part of their overall business plan, strive to develop a diverse portfolio of products and service. Since many utilities prefer to own their own assets, several IPPs offer to develop and build a wind project and turn final ownership over to the utility rather than selling the output of the project under a PPA. This allows the utility to take advantage of their lower cost of financing since they can capitalize the purchase of the facility.

The Grand Meadows wind development in Dexter, adjacent to the Applicant's Project is one such project. The entire wind farm was developed, designed, and built by enXco and then sold to Xcel energy, transferring total project ownership over to Xcel. There are several

other proposed wind projects amount the 147 scheduled for Minnesota that offer this same opportunity. As a result, there are several alternatives that would be more cost effective than the Applicant's Project

Alternative #14:

As stated earlier, there are currently 147 new proposed wind facilities scheduled in the MISO queue for completion by 2012. Sixty five of these projects are located in the same Minnesota Counties as the Applicants' Project. All 65 of these projects offer the same level of benefits to the environment and to the people of Dodge and Mower Counties as does the Applicants' Project if not more. One of these projects is the High County Energy project currently under development by National Wind in Dodge, Olmsted, and Mower counties.

The High Country Energy project is also scheduled for completion at the same time as the Applicant's Project, however, this project is being developed as a CBED project. CBED projects provide significantly more socioeconomic benefits to the local community and the people of Minnesota than the Applicant's project. As a result, the High Country Energy project in Dodge County is a much more reasonable and prudent alternative to the Applicant's Project.

Alternative #15:

In the Applicant's review of prudent alternatives, they stated that there were insufficient hydro resources to make this a viable alternative in Minnesota. Nothing can be further from the Truth. Minnesota utilities currently purchase over 1000 MW of hydro electric energy and capacity from Manitoba. Manitoba is currently building more hydro generation facilities to sell to Minnesota and neighboring utilities. Attachment C contains a printout of Manitoba Hydro's new hydro plant currently under construction. Manitoba plans to build over 1600 MW of new hydro generation by 2020. As demonstrated in one of the previous alternatives, hydro electric generation can be built for less than half the cost of Wind farms.

As a result, there is ample new hydro electric generation available to Minnesota utilities well into the future. Also, hydro electric plants also offer significant more reliability to the grid than wind farms. This lower cost and increased reliability makes hydro electric generation a more reasonable and prudent alternative to the Applicants' proposed Project for most all Minnesota utilities.

3. Combination of alternatives

The Applicant states in their application that there is no combination of alternative that would be more reasonable and prudent than the Applicant's Project. This is not true. There are several alternatives both inside and outside Minnesota that when combine provide for a much more reasonable and prudent alternative.

Alternative #16:

One such combination of alternatives is for a utility to meet their RES compliance requirements by purchase Renewable Energy Credits (REC) from the MRETS system. The actual energy can then be met through more conventional means such as purchasing the power from MISO.

There is currently a surplus of REC available through the MRETS trading system. As a result, the cost of a wind REC is only about $1 each. A utility would have to purchase one million RECS annually at a cost of 1 million dollars in order to have the same amount of RECs generate by the Applicant's Project.

MISO records show that the average Locational Marginal Pricing (LMP) for purchased power at the existing GRE Pleasant Valley generating plant for the period of 2007 through 2009 was $41.09 $/MWH. Therefore it would cost a utility $41 million dollars to purchase an equivalent amount of energy. The total cost to the utility for the purchase of the energy and the REC would be $42 million dollars per year. The estimated cost of the Applicants Project (as demonstrated earlier) is $63 million dollars.

As a result, the combine strategy of purchasing REC and MISO market energy is a more reasonable and prudent alternative to the Applicant's Project.

Alternative #17:

Another very attractive combination of alternatives would be for a utility to purchase the output of several different wind projects located over a large geographical area rather than the output from a single project such as the Applicants.

Diversifying the location of a utilities wind assets accomplishes several objectives. First, by spreading the assets over a larger geographical area, it is less likely that the wind would not be blowing in all locations at the same time thus increasing the probability of a more steady

production of electricity. Second, by diversifying the number and locations of PPA with multiple IPP's, the risk of reliability or other problems is reduced. Finally, since the MISO LMP changes based on the location of the generating facility, having multiple locations reduces the risk of being adversely impacted by low LMPs in any one area. Since LMP's tend to decrease in areas with surplus wind generation, it is even more important for a utility to spread its wind generation assets over a larger geographical area.

As a result, purchasing the output of several smaller wind projects rather than buying all 300 MW from the Applicant would be a more reliable and prudent alternatives for most Minnesota utilities.

III. Conclusion

Since the Applicant has not committed to a specific buyer for this Project, granting this Certificate of Need would allow the Applicant to sell the output of this Project to almost any utility, organization, or other IPP in the Eastern Interconnect. As a result it is impossible for the Applicant to demonstrate that denial of this Project would have "an adverse effect upon the future adequacy, reliability, or efficiency of energy supply to the people of Minnesota and neighboring states".

Even if the Applicant did choose to sell the output of this Project to a Minnesota utility, the Applicant still failed to provide any evidence that denial of this certificate of need would inhibited the ability of any Minnesota utility to meet their ongoing RES requirements and thus adversely impact the people of Minnesota.

In addition, this document has provided ample evidence that there are several more reasonable and prudent alternative to this Project for potential buyers both inside and outside Minnesota.

Moreover, if the Applicant is granted a certificate of need without first having a buyer for their project then all wind development projects without designated buyers should also be granted certificates of need. This would open the flood gates for new applications and would result in a massive overbuilding of wind generation facilities.

In view of the evidence provided, it is abundantly clear that the Applicant failed to satisfy the requirements of Minnesota Rule 7849.0120 subpart A and B. As a result, this application for certificate of need should be denied.

Sincerely

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Attachment A

MISO Queue for Wind Generation as of March 6, 2010

MISO #	County	State	Size	In Service Date		Study Status
J092	Green	IA	20	7/31/2010		DPP - M2 & D3 Required
J097	Des Moines	IA	200	9/1/2012		DPP - M2 & D3 Required
G643	Mitchell	IA	20	3/1/2008		DPP - Parked
G790	Franklin	IA	150	9/1/2009		DPP - Parked
G972	Fayette	IA	500	12/1/2009		DPP - Parked
G973	Washington	IA	501	10/1/2010		DPP - Parked
G985	Fayette	IA	200	12/1/2009		DPP - Parked
H085	Marshall	IA	200	12/1/2012		DPP - Parked
H097	Boone	IA	121	12/31/2013		DPP - Parked
R67	Hancock and Kossuth	IA	250	12/31/2010		DPP - Parked
G695	Winnebago	IA	200	12/31/2010		DPP - System Impact Study
G735	Hancock	IA	200	9/1/2008		DPP - System Impact Study
G798	Story	IA	150	12/31/2008		DPP - System Impact Study
G813	Boone	IA	100	6/1/2009		DPP - System Impact Study
G947	Franklin	IA	99	9/1/2011		DPP - System Impact Study
G962	Mitchell	IA	100	12/31/2010		DPP - System Impact Study
H007	Delaware	IA	41	12/31/2010		DPP - System Impact Study
H008	Fayette	IA	36	12/31/2010		DPP - System Impact Study
H009	Tama	IA	150	12/31/2011		DPP - System Impact Study
H020	Webster	IA	200	12/1/2012		DPP - System Impact Study
H021	Grundy	IA	138.6	12/31/2012		DPP - System Impact Study
H078	Marshall	IA	121	12/31/2012		DPP - System Impact Study
H096	Greene	IA	50	12/31/2012		DPP - System Impact Study
J029	Howard and Mitchell	IA	102			DPP - System Impact Study
J030	Howard and Mitchell	IA	198			DPP - System Impact Study
J068	Dickson	IA	100	9/1/2009		DPP - System Impact Study
R57	Carroll	IA	100	12/31/2011		DPP - System Impact Study
R59	Wright	IA	28	6/30/2010		DPP - System Impact Study
R60	Sac	IA	54	6/30/2010		DPP - System Impact Study
R62	Green	IA	300	12/31/2010		DPP - System Impact Study

R65	Cass	IA	92	12/31/2010		DPP - System Impact Study
G530	Greene	IA	14	9/1/2006		Facilities Study
G552	Emmet	IA	50	8/1/2006		Facilities Study
G614	Emmet/Dickinson	IA	200	12/31/2008		Facilities Study
J114	Tama	IA	150	8/1/2013		Feasibility Study
J116	Hancock	IA	999	9/30/2010		Feasibility Study
J118	Greene	IA	50	7/31/2010		Feasibility Study
G976	Johnson	IA	18	8/31/2010		Parked (1 Year Rule)
R15	Pocahontas	IA	80	12/1/2007		SIS - Complete
R42	Webster	IA	250	9/1/2009		SIS - MEC
R47	Cherokee	IA	100	12/1/2010		SIS - MEC
R48	Cherokee	IA	100	12/1/2010		SIS - MEC
R49	Pomeroy	IA	12	8/15/2009		SIS - MEC
R50	Washington	IA	501	10/1/2010		SIS - MEC
R51	Poweshiek	IA	250.5	10/1/2010		SIS - MEC
R52	Adair	IA	500	1/1/2010		SIS - MEC
R53	Adair	IA	200	1/1/2010		SIS - MEC
R56	Audubon & Guthrie	IA	150	12/31/2010		SIS - MEC
R58	Pottowattamie	IA	3	12/31/2008		SIS - MEC
R64	Carroll	IA	70	12/31/2010		SIS - MEC
R68	Hancock & Kossuth	IA	250	12/31/2010		SIS - MEC
R61	Green	IA	200	12/31/2010		SPA - M1 & D2 Required (MEC trans.)
R63	Calhoun	IA	300	12/31/2009		SPA - M1 & D2 Required (MEC trans.)
R66	Adams	IA	150	12/31/2012		SPA - M1 & D2 Required (MEC trans.)
G740	Howard	IA	300	6/15/2009		SPA - System Impact Study
G771	Howard	IA	200	1/1/2010		SPA - System Impact Study
G948	Clay	IA	250	12/31/2009		SPA - System Impact Study
G957	Emmet	IA	300	7/1/2010		SPA - System Impact Study
G963	Mitchell	IA	200	12/31/2010		SPA - System Impact Study
G964	Mitchell	IA	300	12/31/2010		SPA - System Impact Study
G965	Mitchell	IA	300	12/31/2010		SPA - System Impact Study
G970	Howard	IA	100	1/1/2011		SPA - System Impact Study
H077	Kossuth	IA	250	12/31/2010		SPA - System Impact Study
J007	Osceola	IA	250	12/31/2010		SPA - System Impact Study
J009	Clinton	IA	250	12/31/2010		SPA - System Impact Study
J041	Grundy	IA	90	9/1/2010		SPA - System Impact Study
J072	O'Brien	IA	200.1	10/1/2012		SPA - System Impact Study

J091	Hancock	IA	66	11/1/2009		SPA - System Impact Study
J093	Green	IA	50	7/31/2010		SPA - System Impact Study
J095	Cerro Gordo & Hancock	IA	300	10/31/2012		SPA - System Impact Study
J096	Tama	IA	150	5/1/2012		SPA - System Impact Study
J103	Story	IA	20	8/1/2011		SPA - System Impact Study
G599	Adams	IL	144	12/1/2009		DPP - M3 Required
G775	Hancock	IL	200	8/1/2009		DPP - Parked
G925	DeWitt	IL	300	10/1/2010		DPP - Parked
G978	Douglas	IL	100	12/31/2011		DPP - Parked
H003	McDonough	IL	200	10/1/2010		DPP - Parked
J008	Knox	IL	150	12/31/2010		DPP - Parked
J044	Edgar	IL	100.5	9/30/2011		DPP - Parked
G979	Edgar	IL	100	12/31/2011		DPP - System Impact Study
H006	Douglas	IL	100	12/31/2011		DPP - System Impact Study
J034	Logan	IL	405	8/1/2010		DPP - System Impact Study
J038	Sangamon	IL	498			DPP - System Impact Study
J105	Ford	IL	80	8/1/2011		DPP - System Impact Study
G598	Adams	IL	144	12/1/2010		Facilities Study
G654	Pike	IL	250	9/1/2007		Facilities Study
H094	Vermilion	IL	99	3/31/2011		Facilities Study
J002	Ford	IL	100	12/31/2010		Facilities Study
G908	Morgan	IL	150	10/15/2010		SPA - System Impact Study
G909	Cass	IL	150	10/1/2010		SPA - System Impact Study
G966	Ford	IL	100	11/20/2010		SPA - System Impact Study
J100	Henry	IL	300	9/30/2013		SPA - System Impact Study
J101	Henry	IL	300	9/30/2014		SPA - System Impact Study
J107	Logan	IL	450	8/30/2013		SPA - System Impact Study
J108	Ford	IL	165	8/15/2011		SPA - System Impact Study
G864	White	IN	201	12/1/2009		DPP - Parked
G865	Benton	IN	201	12/1/2009		DPP - Parked
G888	Benton	IN	50	5/15/2008		DPP - Parked
G935	Clinton	IN	201	10/1/2010		DPP - Parked
G952	Tipton	IN	100	10/1/2010		DPP - Parked
H026	Tippecanoe	IN	150	12/1/2013		DPP - Parked
H027	Boone	IN	200	12/1/2013		DPP - Parked
J054	Tipton	IN	197.8	7/1/2012		DPP - Parked
J076	Howard	IN	151.2			DPP - Parked
G887	Benton	IN	20	2/28/2008		DPP - System Impact Study
G906	Montgomery	IN	200	11/1/2009		DPP - System Impact Study
G949	Montgomery	IN	200	10/15/2010		DPP - System Impact Study
H001	Clinton	IN	200	12/31/2009		DPP - System Impact Study

H002	Clinton	IN	200	12/31/2009		DPP - System Impact Study
J053	Boone	IN	200	12/1/2011		DPP - System Impact Study
J083	Warren	IN	200	12/31/2012		DPP - System Impact Study
G967	Newton	IN	101	7/1/2010		Facilities Study
J028	Tippecanoe	IN	200	10/31/2011		Facilities Study
J011	LaPorte	IN	150	12/31/2012		Parked (1 Year Rule)
J065	Scottsburg	IN	28	9/1/2011		DPP - System Impact Study
J012	Crawford	IN	28	7/1/2010		Parked (1 Year Rule)
J099	Hillsdale	MI	48.6	8/31/2011		DPP - M2 & D3 Required
G934	Gratiot	MI	300	10/1/2010		DPP - Parked
G997	Huron	MI	200	12/31/2012		DPP - Parked
H030	Tuscola	MI	200	12/1/2012		DPP - Parked
J056	Hillsdale	MI	101.2	1/1/2012		DPP - Parked
J059	Monterey	MI	99	12/31/2010		DPP - Parked
J061	Delta	MI	170	12/31/2013		DPP - Parked
J066	Chippewa	MI	120	8/1/2011		DPP - Parked
J070	Clinton	MI	49.2			DPP - Parked
J085	Hillsdale	MI	150	12/31/2012		DPP - Parked
J088	Lenawee	MI	100.5	8/31/2012		DPP - Parked
G905	Gratiot & Saginaw	MI	200	6/30/2010		DPP - System Impact Study
J052	Bay	MI	100	9/1/2011		DPP - System Impact Study
J060	Delta	MI	29	12/31/2009		DPP - System Impact Study
G774	Mason	MI	70	6/1/2010		Facilities Study
G889	Huron	MI	59	12/31/2008		Facilities Study
H075	Oceana	MI	60	12/31/2010		Facilities Study
G742	Missaukee	MI	120	12/31/2010		Parked (1 Year Rule)
G958	Kent & Ottawa	MI	120	12/31/2010		Parked (1 Year Rule)
J074	Huron	MI	350	5/15/2012		SPA - System Impact Study
J075	Huron	MI	350	5/15/2012		SPA - System Impact Study
J078	Marquette	MI	26	7/31/2011		DPP - Parked
G006	Clay	MN	2			
G081	Pipestone	MN	1			
G663	Lincoln	MN	20	11/1/2007		DPP - M2 & D3 Required
G680	Yellow Medicine	MN	20	7/1/2008		DPP - M2 & D3 Required
G721	Otter Tail	MN	160	8/15/2008		DPP - M2 & D3 Required
G737	Stevens	MN	100	1/1/2010		DPP - M2 & D3 Required
G777	Stevens	MN	20	1/1/2009		DPP - M2 & D3 Required
G778	Grant	MN	20	1/1/2009		DPP - M2 & D3 Required
G792	Big Stone	MN	400	7/1/2011		DPP - M2 & D3 Required
G805	Stevens	MN	300	11/1/2010		DPP - M2 & D3 Required
G817	Grant	MN	20	12/1/2009		DPP - M2 & D3 Required

G818	Grant	MN	20	12/1/2009		DPP - M2 & D3 Required
G823	Yellow Medicine	MN	300	10/15/2013		DPP - M2 & D3 Required
G831	Murray	MN	50	10/1/2011		DPP - M2 & D3 Required
G894	Big Stone	MN	50	12/1/2010		DPP - M2 & D3 Required
H065	Renville	MN	40	9/1/2010		DPP - M2 & D3 Required
J051	Jackson	MN	200	9/15/2010		DPP - M2 & D3 Required
G670	Faribault	MN	200	4/1/2008		DPP - Parked
G759	Cottonwood	MN	101	11/30/2008		DPP - Parked
G797	Martin	MN	30	9/1/2009		DPP - Parked
G801	Mower	MN	50	12/31/2009		DPP - Parked
G871	Freeborn	MN	201	9/1/2009		DPP - Parked
G893	Rock	MN	80	9/1/2010		DPP - Parked
H043	Martin	MN	50	12/31/2011		DPP - Parked
H051	Redwood	MN	40	12/31/2011		DPP - Parked
H053	Waseca	MN	50	12/31/2011		DPP - Parked
H054	Redwood	MN	40	12/31/2011		DPP - Parked
G636	Swift	MN	18.9	8/31/2007		DPP - System Impact Study
G637	Traverse	MN	20	10/1/2007		DPP - System Impact Study
G644	Stevens	MN	20	1/1/2008		DPP - System Impact Study
G668	Big Stone	MN	100	10/1/2011		DPP - System Impact Study
G681	Freeborn	MN	44	4/1/2008		DPP - System Impact Study
G697	Otter Tail	MN	20	12/1/2007		DPP - System Impact Study
G762	Dodge	MN	401	11/30/2008		DPP - System Impact Study
G768	Watonwan	MN	50	11/30/2008		DPP - System Impact Study
G769	Cottonwood	MN	50	11/30/2008		DPP - System Impact Study
G812	Pope	MN	20	12/1/2009		DPP - System Impact Study
G826	Jackson	MN	200	8/15/2010		DPP - System Impact Study
G852	Dodge, Olmstead	MN	300	8/1/2010		DPP - System Impact Study
G870	Freeborn	MN	201	9/1/2009		DPP - System Impact Study
G968	Marshall	MN	100	12/31/2010		DPP - System Impact Study
H042	Waseca	MN	50	12/31/2011		DPP - System Impact Study
H045	Cottonwood	MN	50	12/31/2011		DPP - System Impact Study
H047	Steele	MN	35	12/31/2011		DPP - System Impact Study
H049	Stearns	MN	45	1/1/2011		DPP - System Impact Study
H050	Meeker	MN	200	12/31/2011		DPP - System Impact Study
H052	Brown	MN	50	12/31/2011		DPP - System Impact Study
H055	Redwood	MN	40	12/31/2011		DPP - System Impact Study
H056	Rice	MN	40	12/31/2011		DPP - System Impact Study
H057	Jackson	MN	40	12/31/2011		DPP - System Impact Study
H058	Stearns	MN	45	12/31/2011		DPP - System Impact Study
H059	Nobles	MN	40	12/31/2011		DPP - System Impact Study

H069	Waseca	MN	55	12/31/2011		DPP - System Impact Study
H071	Stearns	MN	40	12/31/2011		DPP - System Impact Study
H073	Douglas	MN	100	12/31/2011		DPP - System Impact Study
H074	Goodhue	MN	50	12/31/2011		DPP - System Impact Study
J005	Todd	MN	17.5	2/28/2012		DPP - System Impact Study
J024	Freeborn	MN	201			DPP - System Impact Study
J032	Watonwan	MN	4.95	11/30/2010		DPP - System Impact Study
J033	Cottonwood	MN	4.95	11/30/2010		DPP - System Impact Study
J035	Wilkin	MN	4.95	11/30/2010		DPP - System Impact Study
J036	Jackson	MN	4.95	11/30/2010		DPP - System Impact Study
J058	Cottonwood	MN	4.95	9/1/2011		DPP - System Impact Study
G442	Cottonwood	MN	50	9/30/2005		Facilities Study
G549	Pope	MN	20	12/15/2006		Facilities Study
G555	Stevens	MN	100	11/1/2007		Facilities Study
G576	Rock	MN	40	9/1/2007		Facilities Study
G593	Jackson	MN	100	10/1/2007		Facilities Study
G594	Jackson	MN	50	10/1/2007		Facilities Study
G602	Nobles	MN	32	11/1/2007		Facilities Study
G608	Pope	MN	6	10/1/2006		Facilities Study
G617	Blue Earth	MN	50	12/1/2008		Facilities Study
G618	Yellow Medicine	MN	138	12/1/2009		Facilities Study
G621	Pipestone	MN	20	9/1/2007		Facilities Study
G628	Brown	MN	32	12/1/2007		Facilities Study
G631	Nobles	MN	19	7/1/2007		Facilities Study
G632	Nobles	MN	19	7/30/2007		Facilities Study
G633	Nobles	MN	19	7/30/2007		Facilities Study
G638	Stevens	MN	20	10/1/2007		Facilities Study
G640	Todd	MN	30	12/31/2007		Facilities Study
G657	Pope	MN	20	1/1/2008		Facilities Study
G658	Pope	MN	20	1/1/2008		Facilities Study
G667	Jackson	MN	20	12/15/2008		Facilities Study
G685	Meeker	MN	20	10/1/2007		Facilities Study
G789	Pope	MN	20	6/1/2009		Facilities Study
G843	Otter Tail	MN	100	12/31/2011		Facilities Study
G846	Clay	MN	4	7/1/2009		Facilities Study
G858	Stearns	MN	38	11/1/2010		Facilities Study
G873	Kittson	MN	20	12/31/2009		Facilities Study
G875	Kittson/Marshall	MN	80	12/31/2010		Facilities Study
G971	Meeker	MN	20	10/1/2011		Facilities Study
H048	Stearns	MN	50	12/31/2011		Facilities Study
H061	Goodhue	MN	39	12/31/2009		Facilities Study

H062	Goodhue	MN	39	12/31/2009		Facilities Study
H067	Kandiyohi	MN	40	12/31/2009		Facilities Study
J111	Olmsted	MN	150	6/15/2012		Feasibility Study
J112	Winona	MN	4.95	6/15/2011		Feasibility Study
G746	Fillmore	MN	200	6/15/2009		SPA - System Impact Study
G770	Martin	MN	100	1/1/2010		SPA - System Impact Study
G772	Nobles	MN	200	1/1/2010		SPA - System Impact Study
G779	Dodge	MN	260	11/30/2008		SPA - System Impact Study
G796	Dodge & Olmstead	MN	300	12/1/2008		SPA - System Impact Study
G821	Clay	MN	201	6/30/2010		SPA - System Impact Study
G824	Mower	MN	200	8/15/2010		SPA - System Impact Study
G828	Blue Earth	MN	76	8/15/2010		SPA - System Impact Study
G841	Lyon	MN	250	11/1/2010		SPA - System Impact Study
G842	Lyon	MN	250	11/1/2011		SPA - System Impact Study
G855	Freeborn	MN	200	12/1/2009		SPA - System Impact Study
G857	Mower	MN	400	12/1/2009		SPA - System Impact Study
G859	Clay	MN	600	9/1/2014		SPA - System Impact Study
G879	Murray	MN	150	10/1/2011		SPA - System Impact Study
G890	Fillmore	MN	200	6/15/2010		SPA - System Impact Study
G903	Wright	MN	2000	12/31/2011		SPA - System Impact Study
G907	Mower	MN	450	10/15/2011		SPA - System Impact Study
G910	Mower	MN	99	11/30/2010		SPA - System Impact Study
G911	Mower	MN	99	11/30/2011		SPA - System Impact Study
G912	Mower	MN	99	11/30/2012		SPA - System Impact Study
G913	Wilkin	MN	201	10/15/2011		SPA - System Impact Study
G959	Goodhue	MN	200	12/31/2012		SPA - System Impact Study
G960	Goodhue	MN	200	12/31/2012		SPA - System Impact Study
G961	Goodhue	MN	200	12/31/2012		SPA - System Impact Study
G991	Fillmore	MN	200	12/1/2016		SPA - System Impact Study
H011	Mower	MN	250	7/1/2011		SPA - System Impact Study
H017	Cottonwood	MN	100	12/31/2010		SPA - System Impact Study
H018	Cottonwood	MN	150	12/31/2010		SPA - System Impact Study
H019	Watonwan	MN	150	12/31/2010		SPA - System Impact Study
H028	Olmsted	MN	299	10/1/2014		SPA - System Impact Study
H031	Wilkin	MN	160	12/1/2011		SPA - System Impact Study
H033	Kandiyohi	MN	300	7/1/2011		SPA - System Impact Study
H041	Lincoln	MN	400	6/1/2012		SPA - System Impact Study
H044	Watonwan	MN	75	12/31/2011		SPA - System Impact Study
H046	Jackson	MN	100	12/31/2011		SPA - System Impact Study
H070	Renville	MN	85	12/31/2011		SPA - System Impact Study
H081	Lyon	MN	201	12/1/2013		SPA - System Impact Study

H083	Lyon	MN	201	12/1/2013		SPA - System Impact Study
H099	Clay	MN	150	12/1/2012		SPA - System Impact Study
J001	Clay	MN	150	6/1/2011		SPA - System Impact Study
J006	Nicollet	MN	25	6/1/2010		SPA - System Impact Study
J014	Stearns	MN	100	12/31/2012		SPA - System Impact Study
J026	Mower	MN	50	9/15/2012		SPA - System Impact Study
J027	Kandiyohi	MN	48.3	10/1/2010		SPA - System Impact Study
J042	Morrison	MN	249.15	1/18/2012		SPA - System Impact Study
J045	Pipestone	MN	23.1	9/1/2012		SPA - System Impact Study
J062	Polk, Norman & Mahnomen	MN	250	9/1/2011		SPA - System Impact Study
J067	Olmsted	MN	300	9/30/2011		SPA - System Impact Study
J077	Polk	MN	50	10/15/2012		SPA - System Impact Study
J086	Kandiyohi	MN	100	6/1/2012		SPA - System Impact Study
J087	Kandiyohi	MN	30	6/1/2012		SPA - System Impact Study
H086	Monroe	MO	300	12/31/2010		DPP - Parked
G698	Putnam	MO	150	9/1/2008		Facilities Study
J113	Atchison	MO	100.5	10/15/2012		Feasibility Study
J115	St. Francois	MO	3500	3/1/2015		Feasibility Study
R26	Atchison	MO	400	12/31/2008		SIS - Complete
G994	Wibaux	MT	20	6/30/2009		DPP - Parked
G767	Fallon	MT	30	12/21/2007		DPP - System Impact Study
G753	Fallon	MT	300	10/15/2009		SPA - System Impact Study
G981	Grant	ND	20	11/1/2008		DPP - Parked
G904	Rolette	ND	150	1/7/2009		DPP - System Impact Study
J003	Bowman	ND	20	12/31/2009		DPP - System Impact Study
G359	Dickey	ND	150	12/1/2005		Facilities Study
G622	Dickey	ND	150	9/1/2007		SPA - System Impact Study
G624	McIntosh	ND	150	6/1/2008		SPA - System Impact Study
G650	Mountrail	ND	99	4/1/2008		SPA - System Impact Study
G690	Dickey	ND	200	12/1/2008		SPA - System Impact Study
G696	Cass	ND	280	5/1/2008		SPA - System Impact Study
G713	Dickey	ND	200	12/1/2008		SPA - System Impact Study
G751	Adams	ND	200	10/1/2010		SPA - System Impact Study
G752	Adams	ND	150	11/1/2008		SPA - System Impact Study
G757	Adams/Bowman	ND	200	2/20/2009		SPA - System Impact Study
G781	Adams	ND	150	12/31/2009		SPA - System Impact Study
G783	Ward and McLean	ND	122	8/1/2011		SPA - System Impact Study
G784	Ward and McLean	ND	122	9/1/2010		SPA - System Impact Study
G810	Bowman	ND	101	9/30/2009		SPA - System Impact Study

G830	McHenry	ND	99	11/1/2010		SPA - System Impact Study
G853	Dickey	ND	600	10/15/2012		SPA - System Impact Study
G860	Burleigh	ND	900	10/1/2013		SPA - System Impact Study
G861	Burleigh	ND	960	10/1/2012		SPA - System Impact Study
G885	Barnes	ND	200	12/1/2010		SPA - System Impact Study
G916	Sheridan	ND	53	12/31/2011		SPA - System Impact Study
G951	Sheridan	ND	99	12/31/2011		SPA - System Impact Study
G980	Hettinger	ND	60	6/30/2009		SPA - System Impact Study
G988	McIntosh	ND	200	6/1/2011		SPA - System Impact Study
H022	Barnes	ND	33	12/31/2011		SPA - System Impact Study
H082	Oliver	ND	500	12/31/2010		SPA - System Impact Study
H084	McLean	ND	200	12/1/2012		SPA - System Impact Study
H088	Sargent	ND	150	12/31/2010		SPA - System Impact Study
J013	Stutsman	ND	200	12/31/2012		SPA - System Impact Study
J031	Stutsman and Barnes	ND	250	9/1/2010		SPA - System Impact Study
J048	Nelson	ND	140	6/1/2012		SPA - System Impact Study
J081	Mercer	ND	200	12/1/2012		SPA - System Impact Study
J082	Mercer	ND	100	12/1/2012		SPA - System Impact Study
J090	Mercer	ND	200	9/30/2012		SPA - System Impact Study
J098	Dickey	ND	150	9/1/2012		SPA - System Impact Study
J057	Morrow	OH	200	12/31/2012		DPP - Parked
G652	Erie	OH	48	10/15/2008		Facilities Study
G722	Grant	SD	250	12/31/2008		DPP - M2 & D3 Required
G736	Grant	SD	400	9/1/2008		DPP - M2 & D3 Required
G802	Grant	SD	125	7/15/2009		DPP - M2 & D3 Required
G804	Deuel	SD	250	9/1/2016		DPP - M2 & D3 Required
G939	Grant	SD	250	12/1/2011		DPP - M2 & D3 Required
G982	Roberts	SD	300	6/1/2011		DPP - M2 & D3 Required
H095	Roberts	SD	550	12/1/2011		DPP - M2 & D3 Required
G699	Roberts	SD	250	6/1/2008		DPP - System Impact Study
G763	Minnehaha	SD	50	7/1/2010		DPP - System Impact Study
G634	Brookings	SD	96	10/1/2008		Facilities Study
G635	Deuel	SD	101	10/1/2008		Facilities Study
G662	Corson	SD	100	12/31/2008		SPA - System Impact Study
G703	Hand/Hyde	SD	1500	10/1/2009		SPA - System Impact Study
G704	Hand/Hyde	SD	1500	10/1/2010		SPA - System Impact Study
G705	Hand/Jerauld	SD	2000	10/1/2012		SPA - System Impact Study
G727	Turner	SD	100	10/1/2009		SPA - System Impact Study
G731	Jerauld	SD	750	7/1/2009		SPA - System Impact Study
G734	Brookings	SD	101	10/1/2009		SPA - System Impact Study
G764	Minnehaha	SD	242	2/1/2011		SPA - System Impact Study

G776	Brookings	SD	200	1/1/2009		SPA - System Impact Study
G803	Deuel	SD	150	9/1/2012		SPA - System Impact Study
G825	Brookings	SD	100	8/15/2010		SPA - System Impact Study
G827	Minnehaha	SD	100	8/15/2010		SPA - System Impact Study
G829	Minnehaha	SD	100	8/15/2010		SPA - System Impact Study
G878	Turner	SD	150	10/1/2010		SPA - System Impact Study
H016	Minnehaha	SD	200	12/31/2010		SPA - System Impact Study
H025	Minnehaha	SD	200	12/1/2012		SPA - System Impact Study
J080	Brookings	SD	200	6/1/2013		SPA - System Impact Study
J109	Lafayette	WI	99	12/1/2012		DPP - M2 & D3 Required
J079	Columbia	WI	29	3/1/2011		DPP - Parked
J084	Grant	WI	100	12/31/2012		DPP - System Impact Study
H012	Columbia	WI	150	3/11/2011		Facilities Study
J094	Manitowoc and Kewaunee	WI	200	9/30/2012		SPA - System Impact Study

Attachment B

Manitoba Hydro Wuskwatim Generation Project

Overview

- Involves the development of a 200-megawatt generating station at Taskinigup Falls on the Burntwood River.
- Involves less than half a square kilometre of flooding.
- Includes an associated access road, construction camp, and other infrastructure.
- Located in the Nelson House Resource Management Area, approximately 45 km southwest of Thompson, 35 km southeast of Nelson House.
- Being developed by an equity partnership between Nisichawayasihk Cree Nation (NCN) and Manitoba Hydro, the Wuskwatim Power Limited Partnership (open new window).
- Unique, as it represents the first time we have entered into an equity partnership with a First Nations community on a generating station project.
- Scheduled for completion in 2011 at a cost of $1.3 billion.

Current projections show that Manitoba's domestic demand for new power is not required until 2020. But by advancing the in-service date of Wuskwatim to 2011 means additional export revenues and profits will be possible.

The estimated capital cost for Wuskwatim, including all generation and transmission components, is approximately $1.6 billion.

The information above was take from the Manatoba Hydro web site at:
http://www.hydro.mb.ca/projects/wuskwatim/overview.shtml?WT.mc_id=2625

Attachment C

List of Landfill Gas Opportunities in Minnesota

Project ID #	Landfill ID #	Expansion ID #	LMOP Territory	Landfill Name	Landfill City	Landfill County	State	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status
879	809	0	4	Anoka/Ramsey Sanitary LF	Anoka	Anoka	MN	3,419,316	1972	1993	State of Minnesota	Operational
882	812	0	4	Burnsville SLF	Burnsville	Dakota	MN	1,000,000		2001	Waste Management, Inc.	Operational
180852	816	0	4	Elk River SLF	Elk River	Sherburne	MN	1,464,188	1975	2042	Waste Management, Inc.	Operational
180852	816	1	4	Elk River SLF	Elk River	Sherburne	MN	1,464,188	1975	2042	Waste Management, Inc.	Operational
890	820	0	4	Pine Bend Landfill	Inver Grove Heights	Dakota	MN	18,362,736	1971	2027	Republic Services, Inc.	Operational
167078	1993	0	4	Spruce Ridge Landfill	Glencoe	McLeod	MN	2,920,000	1970	2040	Waste Management, Inc.	Operational
180311	2227	0	4	Waste Disposal Engineering (WDE) SLF	Andover	Anoka	MN	2,400,000	1971	1983	State of Minnesota	Operational
886	816	0	4	Elk River SLF	Elk River	Sherburne	MN	1,464,188	1975	2042	Waste Management, Inc.	Shutdown
896	826	0	4	Flying Cloud Landfill	Eden Prairie	Hennepin	MN	4,799,040	1970	1985	Republic Services, Inc.	Shutdown
878	808	0	4	Albert Lea Landfill	Albert Lea	Freeborn	MN	1,060,161	1965	1993	Minnesota Pollution Control Agency	Candidate
880	810	0	4	Blue Earth County, MN	Mankato	Blue Earth	MN	1,165,580	1973	2066	Ponderosa of Blue Earth County, Inc.	Candidate
884	814	0	4	Crow Wing County SLF (new)	Brainerd	Crow Wing	MN	360,000	1992	2023	Crow Wing County, MN	Candidate
885	815	0	4	East Central SLF	Mora	Kanabec	MN	1,232,500	1970	2098	East Central Solid Waste Comm.	Candidate
888	818	0	4	Kandiyohi County SLF	New London	Kandiyohi	MN	1,300,000	1970	2020	Kandiyohi County, MN	Candidate
875	805	0	4	Louisville Landfill	Shakopee	Scott	MN	2,200,000	1968	1990	Minnesota Pollution Control Agency	Candidate
892	822	0	4	Rice County SLF	Dundas	Rice	MN	1,555,267	1973	2025	Rice County Waste Management, MN	Candidate
877	807	0	4	Woodlake SLF	Hamel	Hennepin	MN	2,100,000	1971	1993	Minnesota Pollution Control Agency	Candidate

180217	2147	0	4	Becker County SLF	Detroit Lakes	Becker	MN	420,000	1972	1998		Potential
881	811	0	4	Brown County SLF	Sleepy Eye	Brown	MN	480,000	1980	2036	Landfill Owner	Potential
883	813	0	4	Clay County SLF	Moorhead	Clay	MN		1972	2006	Landfill Owner	Potential
895	825	0	4	Crow Wing County SLF(old)	Brainerd	Crow Wing	MN	224,332	1974	1991	Landfill Owner	Potential
874	804	0	4	Freeway	Burnsville	Dakota	MN	3,000,000	1969	1990	Landfill Owner	Potential
180312	2228	0	4	Hopkins SLF	Hopkins	Hennepin	MN	1,500,000	1971	1980		Potential
167032	1950	0	4	Lake Elmo-Washington County Landfill	Lake Elmo	Washington	MN	1,540,000	1969	1975	Landfill Owner	Potential
889	819	0	4	Lyon County SLF	Lynd	Lyon	MN	800,000	1970	2020	Landfill Owner	Potential
180219	2149	0	4	Olmsted County/Kalmar LF	Rochester	Olmsted	MN	310,640	1990	2011	Olmsted County	Potential
891	821	0	4	Polk County SLF	Crookston	Polk	MN	600,000			Landfill Owner	Potential
876	806	0	4	Roseau County LF	Salol	Roseau	MN	1,439,112	1973	1994	Roseau County, MN	Potential
180218	2148	0	4	St. Augusta SLF	St. Cloud	Stearns	MN		1966	1980		Potential
893	823	0	4	Steele County SLF	Blooming Prairie	Steele	MN	621,000	1973		Steele County, MN	Potential
887	817	0	4	Veolia ES Rolling Hills Landfill, Inc.	Buffalo	Wright	MN		1993	2015	Veolia ES Solid Waste, Inc.	Potential
894	824	0	4	WLSSD SLF	Duluth	St. Louis	MN	2,400,000	1971	1993	Landfill Owner	Potential

Public Health Impacts of Wind Turbines

Prepared by:
Minnesota Department of Health
Environmental Health Division

In response to a request from:
Minnesota Department of Commerce
Office of Energy Security

May 22, 2009

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I. Introduction

In late February 2009 the Minnesota Department of Health (MDH) received a request from the Office of Energy Security (OES) in the Minnesota Department of Commerce, for a "white paper" evaluating possible health effects associated with low frequency vibrations and sound arising from large wind energy conversion systems (LWECS). The OES noted that there was a request for a Contested Case Hearing before the Minnesota Public Utilities Commission (PUC) on the proposed Bent Tree Wind Project in Freeborn County Minnesota; further, the OES had received a long comment letter from a citizen regarding a second project proposal, the Lakeswind Wind Power Plant in Clay, Becker and Ottertail Counties, Minnesota. This same commenter also wrote to the Commissioner of MDH to ask for an evaluation of health issues related to exposure to low frequency sound energy generated by wind turbines. The OES informed MDH that a white paper would have more general application and usefulness in guiding decision-making for future wind projects than a Contested Case Hearing on a particular project. (Note: A Contested Case Hearing is an evidentiary hearing before an Administrative Law Judge, and may be ordered by regulatory authorities, in this case the PUC, in order to make a determination on disputed issues of material fact. The OES advises the PUC on need and permitting issues related to large energy facilities.)

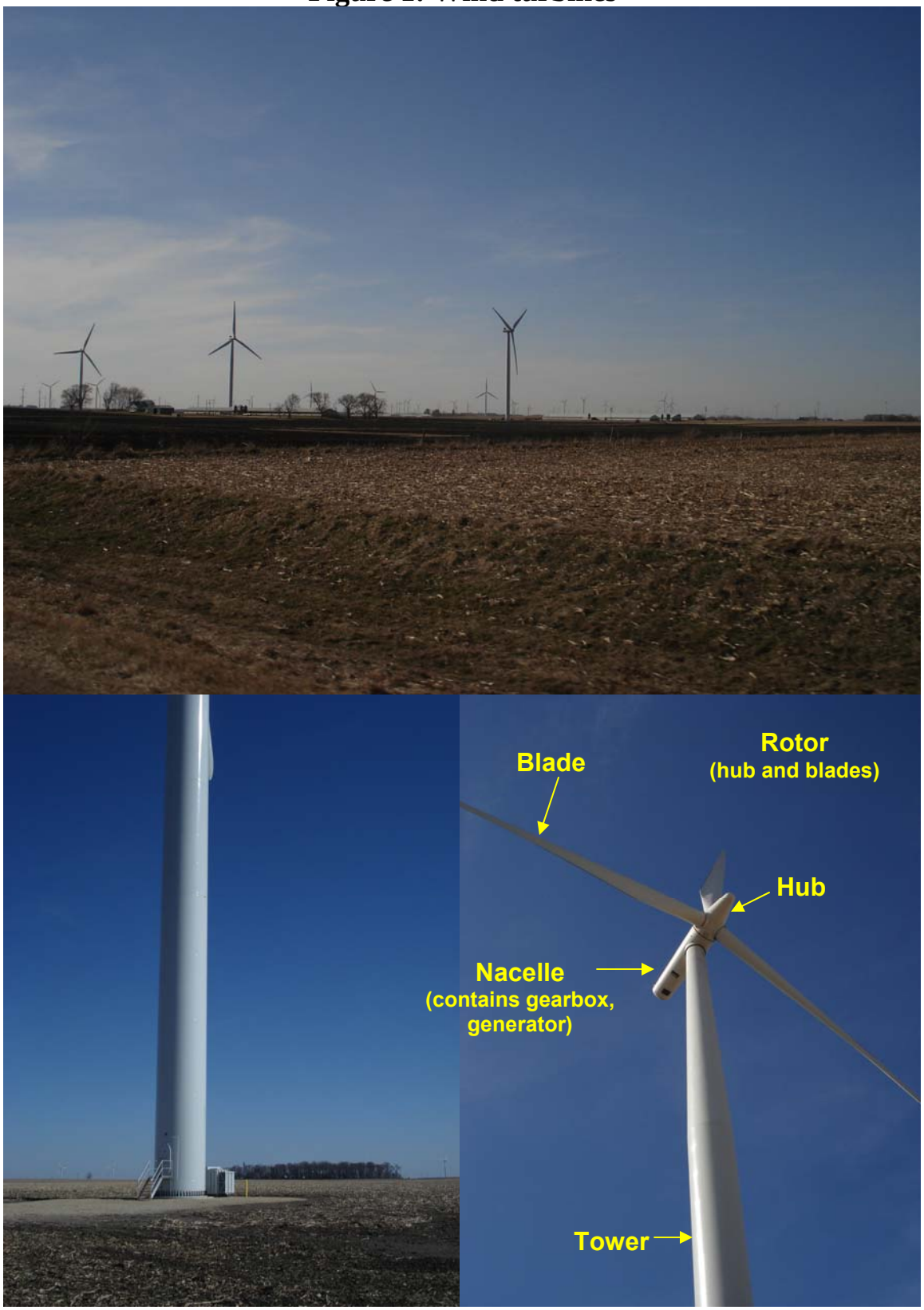
In early March 2009, MDH agreed to evaluate health impacts from wind turbine noise and low frequency vibrations. In discussion with OES, MDH also proposed to examine experiences and policies of other states and countries. MDH staff appeared at a hearing before the PUC on March 19, 2009, and explained the purpose and use of the health evaluation. The Commissioner replied to the citizen letter, affirming that MDH would perform the requested review.

A brief description of the two proposed wind power projects, and a brief discussion of health issues to be addressed in this report appear below.

A. Site Proposals

Wind turbines are huge and expensive machines requiring large capitol investment. Figure 1 shows some existing wind turbines in Minnesota. Large projects require control of extensive land area in order to optimize spacing of turbines to minimize turbulence at downwind turbines. Towers range up to 80 to 100 meters (260 to 325 feet), and blades can be up to 50 meters long (160 feet) (see Tetra Tech, 2008; WPL, 2008). Turbines are expected to be in place for 25-30 years.

Figure 1: Wind turbines



1. Bent Tree Wind Project in Freeborn County

This is a proposal by the Wisconsin Power and Light Company (WPL) for a 400 megawatt (MW) project in two phases of 200 MW each (requiring between 80 and 130 wind turbines). The cost of the first phase is estimated at $497 million. The project site area would occupy approximately 40 square miles located 4 miles north and west of the city of Albert Lea, approximately 95 miles south of Minneapolis (Figure 2) (WPL, 2008). The Project is a LWECS and a Certificate of Need (CON) from the PUC is required (*Minnesota Statutes 216B.243)*. The PUC uses the CON process to determine the basic type of facility (if any) to be constructed, the size of the facility, and when the project will be in service. The CON process involves a public hearing and preparation of an Environmental Report by the OES. The CON process generally takes a year, and is required before a facility can be permitted.

WPL is required to develop a site layout that optimizes wind resources. Accordingly, project developers are required to control areas at least 5 rotor diameters in the prevailing (north-south) wind directions (between about 1300 and 1700 feet for the 1.5 to 2.5 MW turbines under consideration for the project) and 3 rotor diameters in the crosswind (east-west) directions (between about 800 and 1000 feet). Thus, these are minimum setback distances from properties in the area for which easements have not been obtained. Further, noise rules promulgated by the Minnesota Pollution Control Agency (MPCA; *Minnesota Rules* Section 7030), specify a maximum nighttime noise in residential areas of 50 A-weighted decibels (dB(A). WPL has proposed a minimum setback of 1,000 feet from occupied structures in order to comply with the noise rule.

2. Noble Flat Hill Wind Park in Clay, Becker and Ottertail Counties

This is a LWECS proposed by Noble Flat Hill Windpark I (Noble), a subsidiary of Noble Environmental Power, based in Connecticut. The proposal is for a 201 MW project located 12 miles east of the City of Moorhead, about 230 miles northwest of Minneapolis (Figure 3) (Tetra Tech, 2008). The cost of the project is estimated to be between $382 million and $442 million. One hundred thirty-four GE 1.5 MW wind turbines are planned for an area of 11,000 acres (about 17 square miles); the site boundary encompasses approximately 20,000 acres. Setback distances of a minimum of 700 feet are planned to comply with the 50 dB(A) noise limit. However, rotor diameters will be 77 meters (250 feet). Therefore, setback distances in the prevailing wind direction of 1,300 feet are planned for properties where owners have not granted easements. Setbacks of 800 feet are planned in the crosswind direction.

Figure 2: Bent Tree Wind Project, Freeborn County

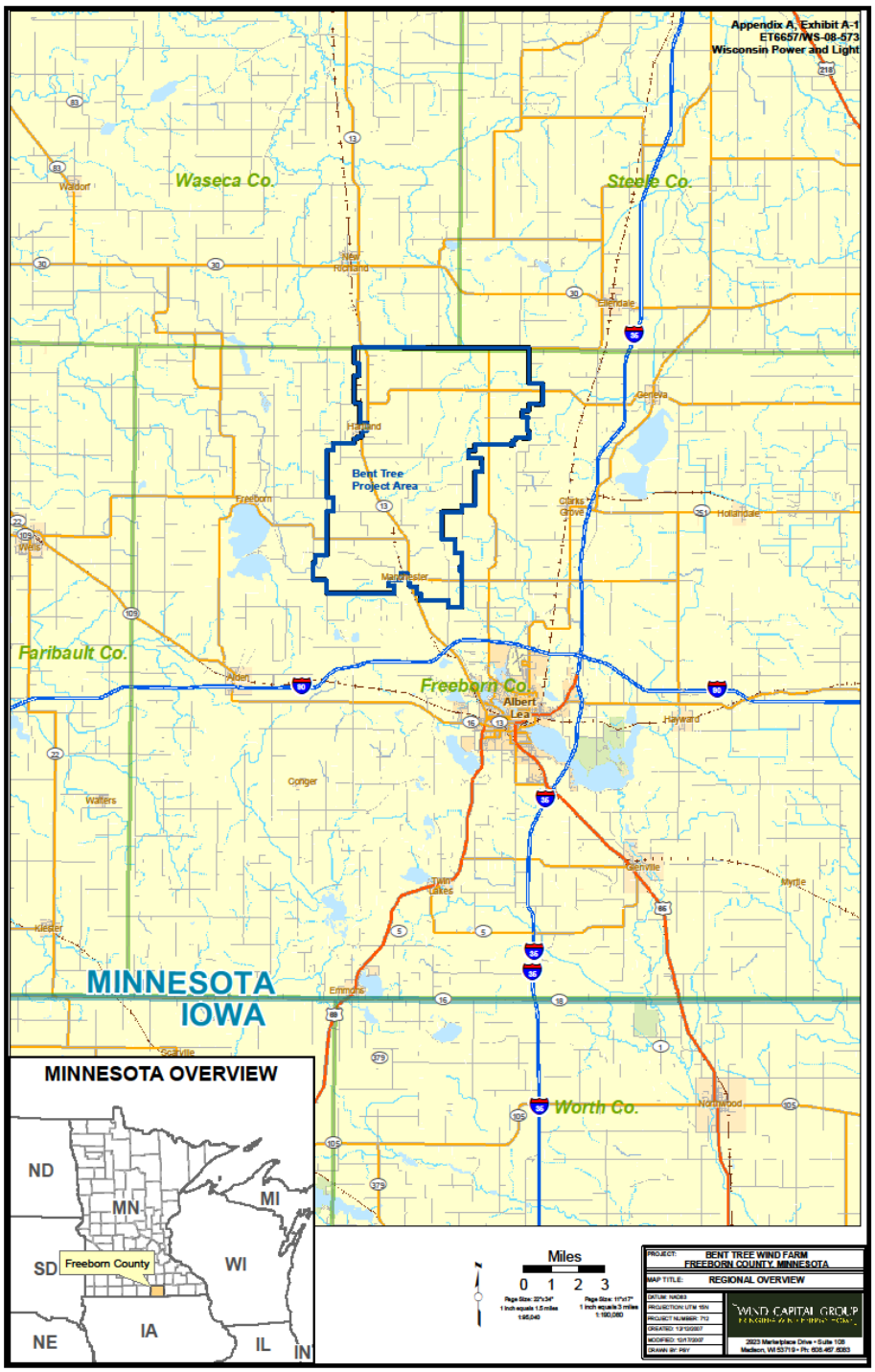
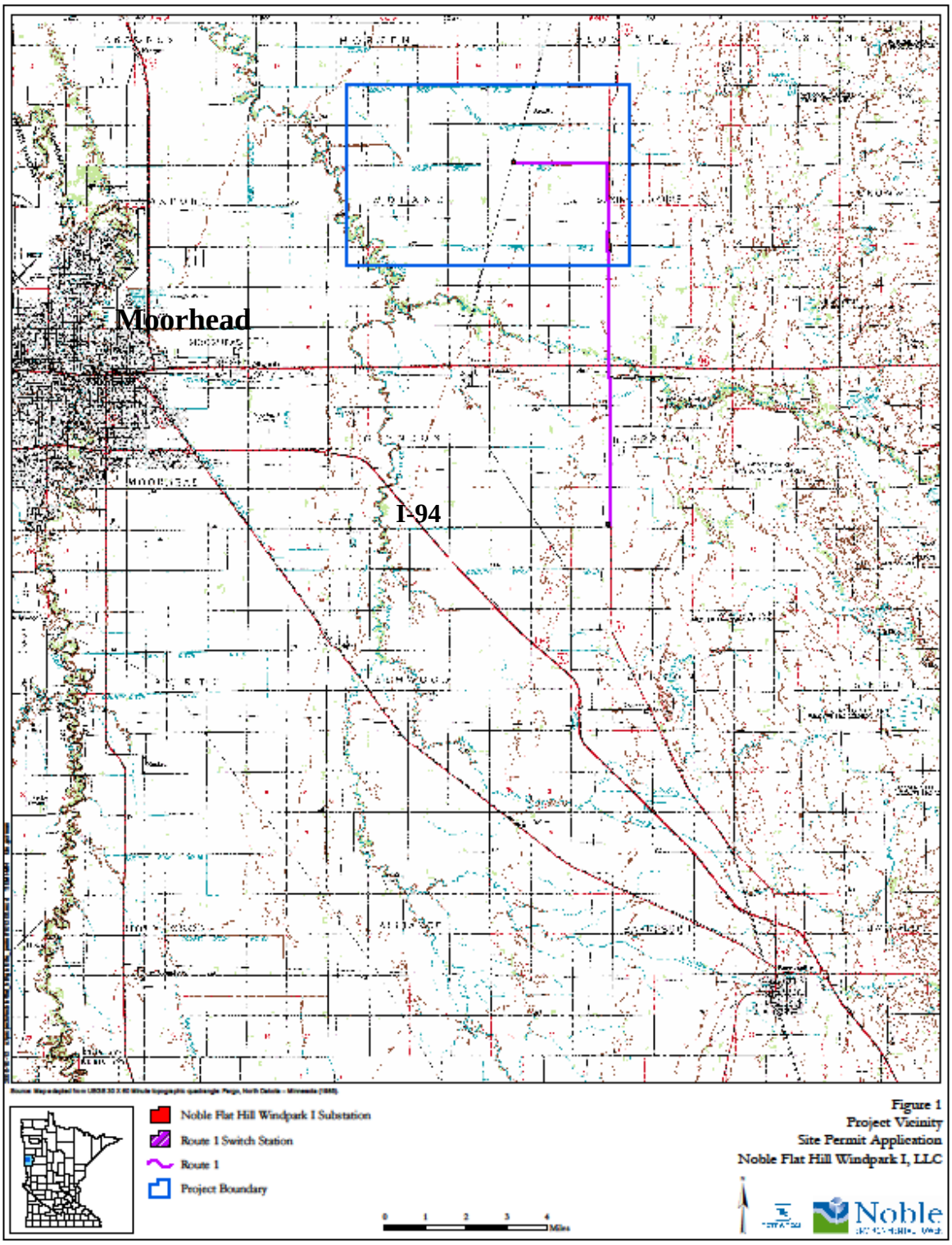


Figure 3: Noble Flat Hill Wind Park, Clay, Becker, Ottertail Counties



B. Health Issues

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. While noise and vibration are the main focus of this paper, shadow flicker (casting of moving shadows on the ground as wind turbine blades rotate) will also be briefly discussed.

Noise originates from mechanical equipment inside the nacelles of the turbines (gears, generators, etc.) and from interaction of turbine blades with wind. Newer wind turbines generate minimal noise from mechanical equipment. The most problematic wind turbine noise is a broadband "whooshing" sound produced by interaction of turbine blades with the wind. Newer turbines have upwind rotor blades, minimizing low frequency "infrasound" (i.e., air pressure changes at frequencies below 20-100 Hz that are inaudible). However, the NRC notes that during quiet conditions at night, low frequency modulation of higher frequency sounds, such as are produced by turbine blades, is possible. The NRC also notes that effects of low frequency (infrasound) vibration (less than 20 Hz) on humans are not well understood, but have been asserted to disturb some people.

Finally, the NRC concludes that noise produced by wind turbines is generally not a major concern beyond a half mile. Issues raised by the NRC report and factors that may affect distances within which wind turbine noise may be problematic are discussed more extensively below.

II. Elementary Characteristics of Sensory Systems and Sound

A. Sensory Systems

1. Hearing

Sensory systems respond to a huge dynamic range of physical stimuli within a relatively narrow dynamic range of mechanical, chemical and/or neuronal (electrophysiological) output. Compression of the dynamic range is accomplished by systems that respond to logarithmic increases in intensity of physical stimuli with arithmetically increasing sensory responses. This general property is true for hearing, and has been recognized since at least the mid-19th century (see e.g., Woodworth and Schlosberg, 1964). "Loudness" is the sensory/perceptual correlate of the physical intensity of air pressure changes to which the electro-mechanical transducers in the ear and associated neuronal pathways are sensitive. Loudness increases as the logarithm of air pressure, and it is convenient to relate loudness to a reference air pressure (in dyne/cm^2 or pascals) in tenths of logarithmic units (decibels; dB). Further, the ear is sensitive to only a relatively narrow frequency range of air pressure changes: those between approximately 20 and 20,000 cycles per second or Herz (Hz). In fact, sensitivity varies within this range, so that the sound pressure level relative to a reference value that is audible in the middle of the range

(near 1,000 Hz) is about 4 orders of magnitude smaller than it is at 20 Hz and about 2 orders of magnitude smaller than at 20,000 Hz (Fig. 3). Accordingly, measurements of loudness in dB generally employ filters to equalize the loudness of sounds at different frequencies or "pitch." To approximate the sensitivity of the ear, A-weighted filters weigh sound pressure changes at frequencies in the mid-range more than those at higher or lower frequencies. When an A-weighted filter is used, loudness is measured in dB(A). This is explained in greater detail in Section B below.

The ear accomplishes transduction of sound through a series of complex mechanisms (Guyton, 1991). Briefly, sound waves move the eardrum (tympanic membrane), which is in turn connected to 2 small bones (ossicles) in the middle ear (the malleus and incus). A muscle connected to the malleus keeps the tympanic membrane tensed, allowing efficient transmission to the malleus of vibrations on the membrane. Ossicle muscles can also relax tension and attenuate transmission. Relaxation of muscle tension on the tympanic membrane protects the ear from very loud sounds and also masks low frequency sounds, or much background noise. The malleus and incus move a third bone (stapes). The stapes in turn applies pressure to the fluid of the cochlea, a snail-shaped structure imbedded in temporal bone. The cochlea is a complex structure, but for present purposes it is sufficient to note that pressure changes or waves of different frequencies in cochlear fluid result in bending of specialized hair cells in regions of the cochlea most sensitive to different frequencies or pitch. Hair cells are directly connected to nerve fibers in the vestibulocochlear nerve (VIII cranial nerve).

Transmission of sound can also occur directly through bone to the cochlea. This is a very inefficient means of sound transmission, unless a device (e.g. a tuning fork or hearing aid) is directly applied to bone (Guyton, 1991).

2. Vestibular System

The vestibular system reacts to changes in head and body orientation in space, and is necessary for maintenance of equilibrium and postural reflexes, for performance of rapid and intricate body movements, and for stabilizing visual images (via the vestibulo-ocular reflex) as the direction of movement changes (Guyton, 1991).

The vestibular apparatus, like the cochlea, is imbedded in temporal bone, and also like the cochlea, hair cells, bathed in vestibular gels, react to pressure changes and transmit signals to nerve fibers in the vestibulocochlear nerve. Two organs, the utricle and saccule, called otolith organs, integrate information about the orientation of the head with respect to gravity. Otoliths are tiny stone-like crystals, embedded in the gels of the utricle and saccule, that float as the head changes position within the gravitational field. This movement is translated to hair cells. Three semi-circular canals, oriented at right angles to each other, detect head rotation. Stimulation of the vestibular apparatus is not directly detected, but results in activation of motor reflexes as noted above (Guyton, 1991).

Like the cochlea, the vestibular apparatus reacts to pressure changes at a range of frequencies; optimal frequencies are lower than for hearing. These pressure changes can be caused by body movements, or by direct bone conduction (as for hearing, above) when vibration is applied directly to the temporal bone (Todd et al., 2008). These investigators

found maximal sensitivity at 100 Hz, with some sensitivity down to 12.5 Hz. The saccule, located in temporal bone just under the footplate of the stapes, is the most sound-sensitive of the vestibular organs (Halmagyi et al., 2004). It is known that brief loud clicks (90-95 dB) are detected by the vestibular system, even in deaf people. However, we do not know what the sensitivity of this system is through the entire range of sound stimuli.

While vestibular system activation is not directly felt, activation may give rise to a variety of sensations: vertigo, as the eye muscles make compensatory adjustments to rapid angular motion, and a variety of unpleasant sensations related to internal organs. In fact, the vestibular system interacts extensively with the "autonomic" nervous system, which regulates internal body organs (Balaban and Yates, 2004). Sensations and effects correlated with intense vestibular activation include nausea and vomiting and cardiac arrhythmia, blood pressure changes and breathing changes.

While these effects are induced by relatively intense stimulation, it is also true that A-weighted sound measurements attuned to auditory sensitivity, will underweight low frequencies for which the vestibular system is much more sensitive (Todd et al., 2008). Nevertheless, activation of the vestibular system *per se* obviously need not give rise to unpleasant sensations. It is not known what stimulus intensities are generally required for for autonomic activation at relatively low frequencies, and it is likely that there is considerable human variability and capacity to adapt to vestibular challenges.

B. Sound

1. Introduction

Sound is carried through air in compression waves of measurable frequency and amplitude. Sound can be tonal, predominating at a few frequencies, or it can contain a random mix of a broad range of frequencies and lack any tonal quality (white noise). Sound that is unwanted is called noise.

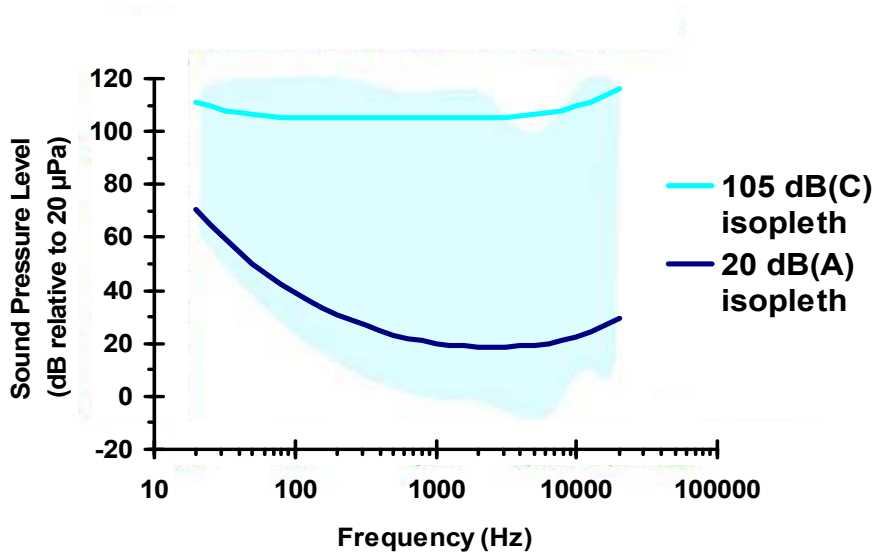
Audible Frequency Sound

Besides frequency sensitivity (between 20 and 20,000 Hz), humans are also sensitive to changes in the amplitude of the signal (compression waves) within this audible range of frequencies. Increasing amplitude, or increasing sound pressure, is perceived as increasing volume or loudness. The sound pressure level in air (SPL) is measured in micro Pascals (μPa). SPLs are typically converted in measuring instruments and reported as decibels (dB) which is a log scale, relative unit (see above). When used as the unit for sound, dBs are reported relative to a SPL of 20 μPa. Twenty μPa is used because it is the approximate threshold of human hearing sensitivity at about 1000 Hz. Decibels relative to 20 μPa are calculated from the following equation:

$$\text{Loudness (dB)} = \text{Log}\left(\left(\text{SPL} / 20\ \mu\text{Pa}\right)^2\right) * 10$$

Figure 4 shows the audible range of normal human hearing. Note that while the threshold sensitivity varies over the frequency range, at high SPLs sensitivity is relatively consistent over audible frequencies.

Figure 4: Audible Range of Human Hearing



Equivalence curves for different frequencies, when sound meter readings in dB are taken with A or C-weighting filters. (Adapted from EPD Hong Kong SAR, 2009)

Sub-Audible Frequency Sound

Sub-audible frequency sound is often called infrasound. It may be sensed by people, similar to audible sound, in the cochlear apparatus in the ear; it may be sensed by the vestibular system which is responsible for balance and physical equilibrium; or it may be sensed as vibration.

Resonance and modulation

Sound can be attenuated as it passes through a physical structure. However, because the wavelength of low frequency sound is very long (the wavelength of 40 Hz in air at sea level and room temperature is 8.6 meters or 28 ft), low frequencies are not effectively attenuated by walls and windows of most homes or vehicles. (For example, one can typically hear the bass, low frequency music from a neighboring car at a stoplight, but not the higher frequencies.) In fact, it is possible that there are rooms within buildings exposed to low frequency sound or noise where some frequencies may be amplified by resonance (e.g. ½ wavelength, ¼ wavelength) within the structure. In addition, low frequency sound can cause vibrations within a building at higher, more audible frequencies as well as throbbing or rumbling.

Sounds that we hear generally are a mixture of different frequencies. In most instances these frequencies are added together. However, if the source of the sound is not constant, but changes over time, the effect can be re-occurring pulses of sound or low frequency modulation of sound. This is the type of sound that occurs from a steam engine, a jack hammer, music and motor vehicle traffic. Rhythmic, low frequency pulsing of higher frequency noise (like the sound of an amplified heart beat) is one type of sound that can be caused by wind turbine blades under some conditions.

2. Human Response to Low Frequency Stimulation

There is no consensus whether sensitivity below 20 Hz is by a similar or different mechanism than sensitivity and hearing above 20 Hz (Reviewed by Møller and Pedersen, 2004). Possible mechanisms of sensation caused by low frequencies include bone conduction at the applied frequencies, as well as amplification of the base frequency and/or harmonics by the auditory apparatus (eardrum and ossicles) in the ear. Sensory thresholds are relatively continuous, suggesting (but not proving) a similar mechanism above and below 20 Hz. However, it is clear that cochlear sensitivity to infrasound (< 20 Hz) is considerably less than cochlear sensitivity to audible frequencies.

Møller and Pedersen (2004) reviewed human sensitivity at low and infrasonic frequencies. The following findings are of interest:

- When whole-body pressure-field sensitivity is compared with ear-only (earphone) sensitivity, the results are very similar. These data suggest that the threshold sensitivity for low frequency is through the ear and not vestibular.
- Some individuals have extraordinary sensitivity at low frequencies, up to 25 dB more sensitive than the presumed thresholds at some low frequencies.
- While population average sensitivity over the low frequency range is smooth, sound pressure thresholds of response for individuals do not vary smoothly but are inconsistent, with peaks and valleys or "microstructures". Therefore the sensitivity response of individuals to different low frequency stimulation may be difficult to predict.
- Studies of equal-loudness-levels demonstrate that as stimulus frequency decreases through the low frequencies, equal-loudness lines compress in the dB scale. (See Figure 4 as an example of the relatively small difference in auditory SPL range between soft and loud sound at low frequencies).
- The hearing threshold for pure tones is different than the hearing threshold for white noise at the same total sound pressure.

3. Sound Measurements

Sound measurements are taken by instruments that record sound pressure or the pressure of the compression wave in the air. Because the loudness of a sound to people is usually the primary interest in measuring sound, normalization schemes or filters have been applied to absolute measurements. dB(A) scaling of sound pressure measurements was intended to normalize readings to equal loudness over the audible range of frequencies at low loudness. For example, a 5,000 Hz (5 kHz) and 20 dB(A) tone is expected to have the same intensity or loudness as a 100 Hz, 20 dB(A) tone. However, note that the absolute sound pressures would be about 200 μPa and 2000 μPa, respectively, or about a difference of 20 dB (relative to 20 μPa), or as it is sometimes written 20 dB(linear).

Most sound is not a single tone, but is a mixture of frequencies within the audible range. A sound meter can add the total SPLs for all frequencies; in other words, the dB readings over the entire spectrum of audible sound can be added to give a single loudness metric. If sound is reported as A-weighted, or dB(A), it is a summation of the dB(A) scaled sound pressure from 20 Hz to 20 kHz.

In conjunction with the dB(A) scale, the dB(B) scale was developed to approximate equal loudness to people across audible frequencies at medium loudness, and dB(C) was developed to approximate equal-loudness for loud environments. Figure 4 shows isopleths for 20 dB(A) and 105 dB(C). While dB(A), dB(B), dB(C) were developed from empirical data at the middle frequencies, at the ends of the curves these scales were extrapolated, or sketched in, and are not based on experimental or observational data (Berglund et al., 1996). As a result, data in the low frequency range (and probably the highest audible frequencies as well) cannot be reliably interpreted using these scales. The World Health Organization (WHO, 1999) suggests that A-weighting noise that has a large low frequency component is not reliable assessment of loudness.

The source of the noise, or the noise signature, may be important in developing equal-loudness schemes at low frequencies. C-weighting has been recommended for artillery noise, but a linear, unweighted scale may be even better at predicting a reaction (Berglund et al., 1996). A linear or equal energy rating also appears to be the most effective predictor of reaction to low frequency noise in other situations, including blast noise from mining. The implication of the analysis presented by Berglund et al. (1996) is that annoyance from non-tonal noise should not be estimated from a dB(A) scale, but may be better evaluated using dB(C), or a linear non-transformed scale.

However, as will be discussed below, a number of schemes use a modified dB(A) scale to evaluate low frequency noise. These schemes differ from a typical use of the dB(A) scale by addressing a limited frequency range below 250 Hz, where auditory sensitivity is rapidly changing as a function of frequency (see Figure 4).

III. Exposures of Interest

A. Noise From Wind Turbines

1. Mechanical noise

Mechanical noise from a wind turbine is sound that originates in the generator, gearbox, yaw motors (that intermittently turn the nacelle and blades to face the wind), tower ventilation system and transformer. Generally, these sounds are controlled in newer wind turbines so that they are a fraction of the aerodynamic noise. Mechanical noise from the turbine or gearbox should only be heard above aerodynamic noise when they are not functioning properly.

2. Aerodynamic noise

Aerodynamic noise is caused by wind passing over the blade of the wind turbine. The tip of a 40-50 meter blade travels at speeds of over 140 miles per hour under normal operating conditions. As the wind passes over the moving blade, the blade interrupts the laminar flow of air, causing turbulence and noise. Current blade designs minimize the amount of turbulence and noise caused by wind, but it is not possible to eliminate turbulence or noise.

Aerodynamic noise from a wind turbine may be underestimated during planning. One source of error is that most meteorological wind speed measurements noted in wind farm literature are taken at 10 meters above the ground. Wind speed above this elevation, in

the area of the wind turbine rotor, is then calculated using established modeling relationships. In one study (van den Berg, 2004) it was determined that the wind speeds at the hub at night were up to 2.6 times higher than modeled. Subsequently, it was found that noise levels were 15 dB higher than anticipated.

Unexpectedly high aerodynamic noise can also be caused by improper blade angle or improper alignment of the rotor to the wind. These are correctable and are usually adjusted during the turbine break-in period.

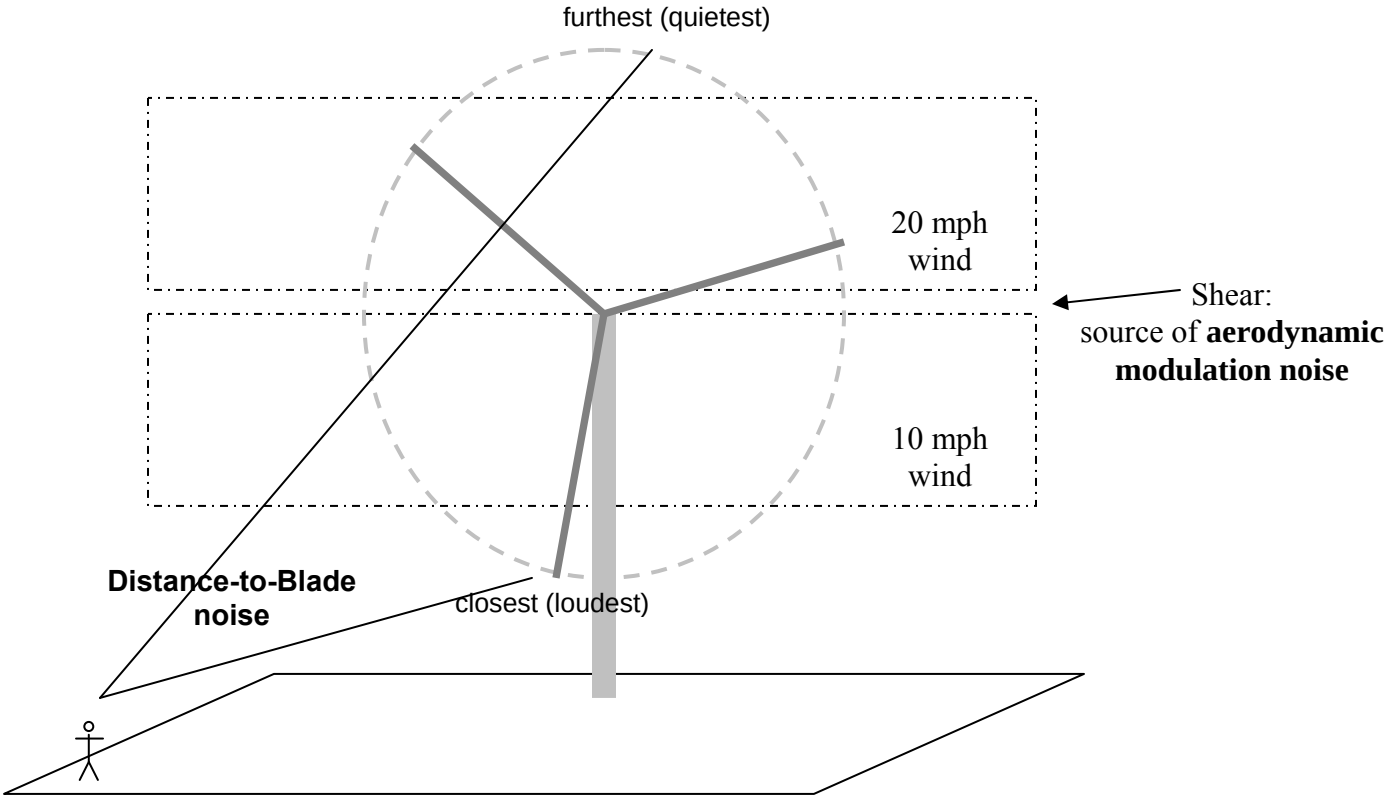
3. Modulation of aerodynamic noise

Rhythmic modulation of noise, especially low frequency noise, has been found to be more annoying than steady noise (Bradley, 1994; Holmberg et al., 1997). One form of rhythmic modulation of aerodynamic noise that can be noticeable very near to a wind turbine is a distance-to-blade effect. To a receptor on the ground in front of the wind turbine, the detected blade noise is loudest as the blade passes, and quietest when the blade is at the top of its rotation. For a modern 3-blade turbine, this distance-to-blade effect can cause a pulsing of the blade noise at about once per second (1 Hz). On the ground, about 500 feet directly downwind from the turbine, the distance-to-blade can cause a difference in sound pressure of about 2 dB between the *tip* of the blade at its farthest point and the *tip* of the blade at its nearest point (48 meter blades, 70 meter tower). Figure 5 demonstrates why the loudness of blade noise (aerodynamic noise) pulses as the distance-to-blade varies for individuals close to a turbine.

If the receptor is 500 feet from the turbine base, in line with the blade rotation or up to 60° off line, the difference in sound pressure from the *tip* of the blade at its farthest and nearest point can be about 4-5 dB, an audible difference. The tip travels faster than the rest of the blade and is closer to (and then farther away from) the receptor than other parts of the blade. As a result, noise from other parts of the blade will be modulated less than noise from the tip. Further, blade design can also affect the noise signature of a blade. The distance-to-blade effect diminishes as receptor distance increases because the relative difference in distance from the receptor to the top or to the bottom of the blade becomes smaller. Thus, moving away from the tower, distance-to-blade noise gradually appears to be more steady.

Another source of rhythmic modulation may occur if the wind through the rotor is not uniform. Blade angle, or pitch, is adjusted for different wind speeds to maximize power and to minimize noise. A blade angle that is not properly tuned to the wind speed (or wind direction) will make more noise than a properly tuned blade. Horizontal layers with different wind speeds or directions can form in the atmosphere. This wind condition is called shear. If the winds at the top and bottom of the blade rotation are different, blade noise will vary between the top and bottom of blade rotation, causing modulation of aerodynamic noise. This noise, associated with the blades passing through areas of different air-wind speeds, has been called aerodynamic modulation and is demonstrated in Figure 5.

Figure 5: Sources of noise modulation or pulsing



In some terrains and under some atmospheric conditions wind aloft, near the top of the wind turbine, can be moving faster than wind near the ground. Wind turbulence or even wakes from adjacent turbines can create non-uniform wind conditions as well. As a result of aerodynamic modulation a rhythmic noise pattern or pulsing will occur as each blade passes through areas with different wind speed. Furthermore, additional noise, or thumping, may occur as each blade passes through the transition between different wind speed (or wind direction) areas.

Wind shear caused by terrain or structures on the ground (e.g. trees, buildings) can be modeled relatively easily. Wind shear in areas of flat terrain is not as easily understood. During the daytime wind in the lower atmosphere is strongly affected by thermal convection which causes mixing of layers. Distinct layers do not easily form. However, in the nighttime the atmosphere can stabilize (vertically), and layers form. A paper by G.P. van den Berg (2008) included data from a study on wind shear at Cabauw, The Netherlands (flat terrain). Annual average wind speeds at different elevations above ground was reported. The annual average wind speed at noon was about 5.75 meters per second (m/s; approximately 12.9 miles per hour(mph)) at 20 m above ground, and about 7.6 m/s (17 mph) at 140 m. At midnight, the annual averages were about 4.3 m/s (9.6 mph) and 8.8 m/s (19.7 mph) for 20m and 140 m, respectively, above ground. The data show that while the average windspeed (between 20m and 140m) is very similar at noon and midnight at Cabauw, the windspeed difference between elevations during the day is

much less than the difference at night (1.85 m/s (4.1 mph) and 4.5 m/s (10 mph), respectively). As a result one would expect that the blade angle can be better tuned to the wind speed during the daytime. Consequently, blade noise would be greater at night.

A number of reports have included discussion of aerodynamic modulation (van den Berg, 2005; UK Department of Transport and Industry, 2006; UK Department for Business Enterprise and Regulatory Reform, 2007; van den Berg, 2008). They suggest that aerodynamic modulation is typically underestimated when noise estimates are calculated. In addition, they suggest that detailed modeling of wind, terrain, land use and structures may be used to predict whether modulation of aerodynamic noise will be a problem at a proposed wind turbine site.

4. Wind farm noise

The noise from multiple turbines similarly distant from a residence can be noticeably louder than a lone turbine simply through the addition of multiple noise sources. Under steady wind conditions noise from a wind turbine farm may be greater than noise from the nearest turbine due to synchrony between noise from more than one turbine (van den Berg, 2005). Furthermore, if the dominant frequencies (including aerodynamic modulation) of different turbines vary by small amounts, an audible beat or dissonance may be heard when wind conditions are stable.

B. Shadow Flicker

Rhythmic light flicker from the blades of a wind turbine casting intermittent shadows has been reported to be annoying in many locations (NRC, 2007; Large Wind Turbine Citizens Committee, 2008). (Note: Flashing light at frequencies around 1 Hz is too slow to trigger an epileptic response.)

Modeling conducted by the Minnesota Department of Health suggests that a receptor 300 meters perpendicular to, and in the shadow of the blades of a wind turbine, can be in the flicker shadow of the rotating blade for almost 1½ hour a day. At this distance a blade may completely obscure the sun each time it passes between the receptor and the sun. With current wind turbine designs, flicker should not be an issue at distances over 10 rotational diameters (~1000 meters or 1 km (0.6 mi) for most current wind turbines). This distance has been recommended by the Wind Energy Handbook (Burton et al., 2001) as a minimum setback distance in directions that flicker may occur, and has been noted in the Bent Tree Permit Application (WPL, 2008).

Shadow flicker is a potential issue in the mornings and evenings, when turbine noise may be masked by ambient sounds. While low frequency noise is typically an issue indoors, shadow flicker can be an issue both indoors and outdoors when the sun is low in the sky. Therefore, shadow flicker may be an issue in locations other than the home.

Ireland recommends wind turbines setbacks of at least 300 meters from a road to decrease driver distraction (Michigan State University, 2004). The NRC (2007) recommends that shadow flicker is addressed during the preliminary planning stages of a wind turbine project.

IV. Impacts of Wind Turbine Noise

A. Potential Adverse Reaction to Sound

Human sensitivity to sound, especially to low frequency sound, is variable. Individuals have different ranges of frequency sensitivity to audible sound; different thresholds for each frequency of audible sound; different vestibular sensitivities and reactions to vestibular activation; and different sensitivity to vibration.

Further, sounds, such as repetitive but low intensity noise, can evoke different responses from individuals. People will exhibit variable levels of annoyance and tolerance for different frequencies. Some people can dismiss and ignore the signal, while for others, the signal will grow and become more apparent and unpleasant over time (Moreira and Bryan, 1972; Bryan and Tempest, 1973). These reactions may have little relationship to will or intent, and more to do with previous exposure history and personality.

Stress and annoyance from noise often do not correlate with loudness. This may suggest, in some circumstances, other factors impact an individual's reaction to noise. A number of reports, cited in Staples (1997), suggest that individuals with an interest in a project and individuals who have some control over an environmental noise are less likely to find a noise annoying or stressful.

Berglund et al. (1996) reviewed reported health effects from low frequency noise. Loud noise from any source can interfere with verbal communication and possibly with the development of language skills. Noise may also impact mental health. However, there are no studies that have looked specifically at the impact of low frequency noise on communication, development of language skills and mental health. Cardiovascular and endocrine effects have been demonstrated in studies that have looked at exposures to airplane and highway noise. In addition, possible effects of noise on performance and cognition have also been investigated, but these health studies have not generally looked at impacts specifically from low frequency noise. Noise has also been shown to impact sleep and sleep patterns, and one study demonstrated impacts from low frequency noise in the range of 72 to 85 dB(A) on chronic insomnia (Nagai et al., 1989 as reported in Berglund et al., 1996).

Case studies have suggested that health can be impacted by relatively low levels of low frequency noise. But it is difficult to draw general conclusions from case studies. Feldmann and Pitten (2004)) describe a family exposed during the winter to low frequency noise from a nearby heating plant. Reported health impacts were: "indisposition, decrease in performance, sleep disturbance, headache, ear pressure, crawl parästhesy [crawling, tingling or numbness sensation on the skin] or shortness of breath."

Annoyance, unpleasant sounds, and complaints

Reported health effects from low frequency stimulation are closely associated with annoyance from audible noise. "There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects" (WHO, 1999). It has not been shown whether annoyance is a symptom or an accessory in the causation of

health impacts from low frequency noise. Studies have been conducted on some aspects of low frequency noise that can cause annoyance.

Noise complaints are usually a reasonable measure of annoyance with low frequency environmental noise. Leventhall (2004) has reviewed noise complaints and offers the following conclusions:

> " The problems arose in quiet rural or suburban environments
> The noise was often close to inaudibility and heard by a minority of people
> The noise was typically audible indoors and not outdoors
> The noise was more audible at night than day
> The noise had a throb or rumble characteristic
> The main complaints came from the 55-70 years age group
> The complainants had normal hearing.
> Medical examination excluded tinnitus.
>
> " These are now recognised as classic descriptors of low frequency noise problems."

These observations are consistent with what we know about the propagation of low intensity, low frequency noise. Some people are more sensitive to low frequency noise. The difference, in dB, between soft (acceptable) and loud (annoying) noise is much less at low frequency (see Figure 4 audible range compression). Furthermore, during the daytime, and especially outdoors, annoying low frequency noise can be masked by high frequency noise.

The observation that "the noise was typically audible indoors and not outdoors" is not particularly intuitive. However, as noted in a previous section, low frequencies are not well attenuated when they pass through walls and windows. Higher frequencies (especially above 1000 Hz) can be efficiently attenuated by walls and windows. In addition, low frequency sounds may be amplified by resonance within rooms and halls of a building. Resonance is often characterized by a throbbing or a rumbling, which has also been associated with many low frequency noise complaints.

Low frequency noise, unlike higher frequency noise, can also be accompanied by shaking, vibration and rattling. In addition, throbbing and rumbling may be apparent in some low frequency noise. While these noise features may not be easily characterized, numerous studies have shown that their presence dramatically lowers tolerance for low frequency noise (Berglund et al., 1996).

As reviewed in Leventhall (2003), a study of industrial exposure to low frequency noise found that fluctuations in total noise averaged over 0.5, 1.0 and 2.0 seconds correlated with annoyance (Holmberg et al., 1997). This association was noted elsewhere and led (Broner and Leventhall, 1983) to propose a 3dB "penalty" be added to evaluations of annoyance in cases where low frequency noise fluctuated.

In another laboratory study with test subjects controlling loudness, 0.5 – 4 Hz modulation of low frequency noise was found to be more annoying than non-modulated low

frequency noise. On average test subjects found modulated noise to be similarly annoying as a constant tone 12.9 dB louder (Bradley, 1994).

B. Studies of Wind Turbine Noise Impacts on People

1. Swedish Studies

Two studies in Sweden collected information by questionnaires from 341 and 754 individuals (representing response rates of 68% and 58%, respectively), and correlated responses to calculated exposure to noise from wind farms (Pedersen and Waye, 2004; Pedersen, 2007; Pedersen and Persson, 2007). Both studies showed that the number of respondents perceiving the noise from the wind turbines increased as the calculated noise levels at their homes increased from less than 32.5 dB(A) to greater than 40 dB(A). Annoyance appeared to correlate or trend with calculated noise levels. Combining the data from the two studies, when noise measurements were greater than 40 dB(A), about 50% of the people surveyed (22 of 45 people) reported annoyance. When noise measurements were between 35 and 40 dB(A) about 24% reported annoyance (67 of 276 people). Noise annoyance was more likely in areas that were rated as quiet and in areas where turbines were visible. In one of the studies, 64% respondents who reported noise annoyance also reported sleep disturbance; 15% of respondents reported sleep disturbance without annoyance.

2. United Kingdom Study

Moorhouse et al. (UK Department for Business Enterprise and Regulatory Reform, 2007) evaluated complaints about wind farms. They found that 27 of 133 operating wind farms in the UK received formal complaints between 1991 and 2007. There were a total of 53 complainants for 16 of the sites for which good records were available. The authors of the report considered that many complaints in the early years were for generator and gearbox noise. However, subjective analyses of reports about noise ("like a train that never gets there", "distant helicopter", "thumping", "thudding", "pulsating", "thumping", "rhythmical beating", and "beating") suggested that aerodynamic modulation was the likely cause of complaints at 4 wind farms. The complaints from 8 other wind farms may have had "marginal" association with aerodynamic modulation noise.

Four wind farms that generated complaints possibly associated with aerodynamic modulation were evaluated further. These wind farms were commissioned between 1999 and 2002. Wind direction, speed and times of complaints were associated for 2 of the sites and suggested that aerodynamic modulation noise may be a problem between 7% and 25% of the time. Complaints at 2 of the farms have stopped and at one farm steps to mitigate aerodynamic modulation (operational shutdown under certain meteorological conditions) have been instituted.

3. Netherlands Study

F. van den Berg et al. (2008) conducted a postal survey of a group selected from all residents in the Netherlands within 2.5 kilometers (km) of a wind turbine. In all, 725 residents responded (37%). Respondents were exposed to sound between 24 and 54 dB(A). The percentage of respondents annoyed by sound increased from 2% at levels of 30 dB(A) or less, up to 25% at between 40 and 45 dB. Annoyance decreased above 45 dB. Most residents exposed above 45 dB(A) reported economic benefits from the

turbines. However, at greater than 45 dB(A) more respondents reported sleep interruption. Respondents tended to report more annoyance when they also noted a negative effect on landscape, and ability to see the turbines was strongly related to the probability of annoyance.

4. Case Reports

A number of un-reviewed reports have catalogued complaints of annoyance and some more severe health impacts associated with wind farms. These reports do not contain measurements of noise levels, and do not represent random samples of people living near wind turbines, so they cannot assess prevalence of complaints. They do generally show that in the people surveyed, complaints are more likely the closer people are to the turbines. The most common complaint is decreased quality of life, followed by sleep loss and headache. Complaints seem to be either from individuals with homes quite close to turbines, or individuals who live in areas subject to aerodynamic modulation and, possibly, enhanced sound propagation which can occur in hilly or mountainous terrain. In some of the cases described, people with noise complaints also mention aesthetic issues, concern for ecological effects, and shadow flicker concerns. Not all complaints are primarily about health.

Harry (2007) describes a meeting with a couple in Cornwall, U.K. who live 400 meters from a wind turbine, and complained of poor sleep, headaches, stress and anxiety. Harry subsequently investigated 42 people in various locations in the U.K. living between 300 meters and 2 kilometers (1000 feet to 1.2 miles) from the nearest wind turbine. The most frequent complaint (39 of 42 people) was that their quality of life was affected. Headaches were reported by 27 people and sleep disturbance by 28 people. Some people complained of palpitations, migraines, tinnitus, anxiety and depression. She also mentions correspondence and complaints from people in New Zealand, Australia, France, Germany, Netherlands and the U.S.

Phipps (2007) discusses a survey of 619 households living up to 10 kilometers (km; 6 miles) from wind farms in mountainous areas of New Zealand. Most respondents lived between 2 and 2.5 km from the turbines (over 350 households). Most respondents (519) said they could see the turbines from their homes, and 80% of these considered the turbines intrusive, and 73% considered them unattractive. Nine percent said they were affected by flicker. Over 50% of households located between 2 and 2.5 km and between 5 and 9.5 km reported being able to hear the turbines. In contrast, fewer people living between 3 and 4.5 km away could hear the turbines. Ninety-two households said that their quality of life was affected by turbine noise. Sixty-eight households reported sleep disturbances: 42 of the households reported occasional sleep disturbances, 21 reported frequent sleep disturbances and 5 reported sleep disturbances most of the time.

The Large Wind Turbine Citizens Committee for the Town of Union (2008) documents complaints from people living near wind turbines in Wisconsin communities and other places in the U.S. and U.K. Contained in this report is an older report prepared by the Wisconsin Public Service Corporation in 2001 in response to complaints in Lincoln County, Wisconsin. The report found essentially no exceedances of the 50 dB(A) requirement in the conditional use permit. The report did measure spectral data

accumulated over very short intervals (1 minute) in 1/3 octave bands at several sites while the wind turbines were functioning, and it is of interest that at these sites the sound pressure level at the lower frequencies (below 125 Hz) were at or near 50 dB(A).

Pierpont (2009) postulates wind turbine syndrome, consisting of a constellation of symptoms including headache, tinnitus, ear pressure, vertigo, nausea, visual blurring, tachycardia, irritability, cognitive problems and panic episodes associated with sensations of internal pulsation. She studied 38 people in 10 families living between 1000 feet and slightly under 1 mile from newer wind turbines. She proposes that the mechanism for these effects is disturbance of balance due to "discordant" stimulation of the vestibular system, along with visceral sensations, sensations of vibration in the chest and other locations in the body, and stimulation of the visual system by moving shadows. Pierpont does report that her study subjects maintain that their problems are caused by noise and vibration, and the most common symptoms reported are sleep disturbances and headache. However, 16 of the people she studied report symptoms consistent with (but not necessarily caused by) disturbance of equilibrium.

V. Noise Assessment and Regulation

1. Minnesota noise regulation

The Minnesota Noise Pollution Control Rule is accessible online at: https://www.revisor.leg.state.mn.us/rules/?id=7030 . A summary of the Minnesota Pollution Control Agency (MPCA) noise guidance can be found online at: http://www.pca.state.mn.us/programs/noise.html . The MPCA standards require A-weighting measurements of noise; background noise must be at least 10 dB lower than the noise source being measured. Different standards are specified for day and night, as well as standards that may not be exceeded for more than 10 percent of the time during any hour (L10) and 50 percent of the time during any hour (L50). Household units, including farm houses, are Classification 1 land use. The following are the Class 1 noise limits:

Table 1: Minnesota Class 1 Land Use Noise Limits

Daytime		Nighttime	
L50	L10	L50	L10
60 dB(A)	65 dB(A)	50 dB(A)	55 dB(A)

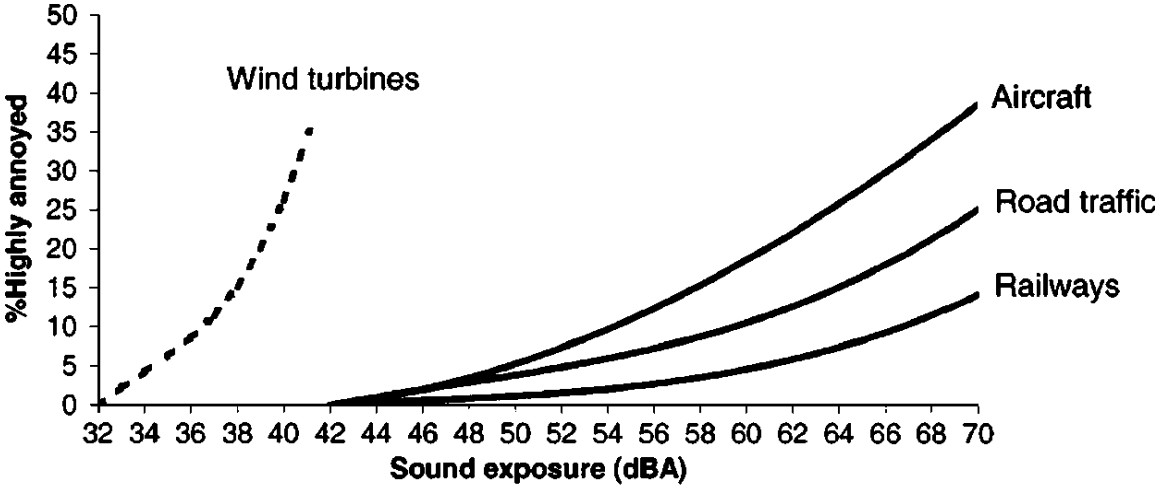
These noise limits are single number limits that rely on the measuring instrument to apply an A-weighting filter over the entire presumed audible spectrum of frequencies (20 Hz to 20 KHz) and then integrating that signal. The result is a single number that characterizes the audible spectrum noise intensity.

2. Low frequency noise assessment and regulation

Pedersen and Waye (2004) looked at the relationship between total dB(A) sound pressure and the annoyance of those who are environmentally exposed to noise from different sources. Figure 6 demonstrates the difficulty in using total dB(A) to evaluate annoyance. Note how lower noise levels (dB(A)) from wind turbines engenders annoyance similar to

much higher levels of noise exposure from aircraft, road traffic and railroads. Sound impulsiveness, low frequency noise and persistence of the noise, as well as demographic characteristics may explain some of the difference.

Figure 6: Annoyance associated with exposure to different environmental noises



Reprinted with permission from Pedersen, E. and K.P. Waye (2004). Perception and annoyance due to wind turbine noise—a dose–response relationship. The Journal of the Acoustical Society of America 116: 3460. Copyright 2004, Acoustical Society of America.

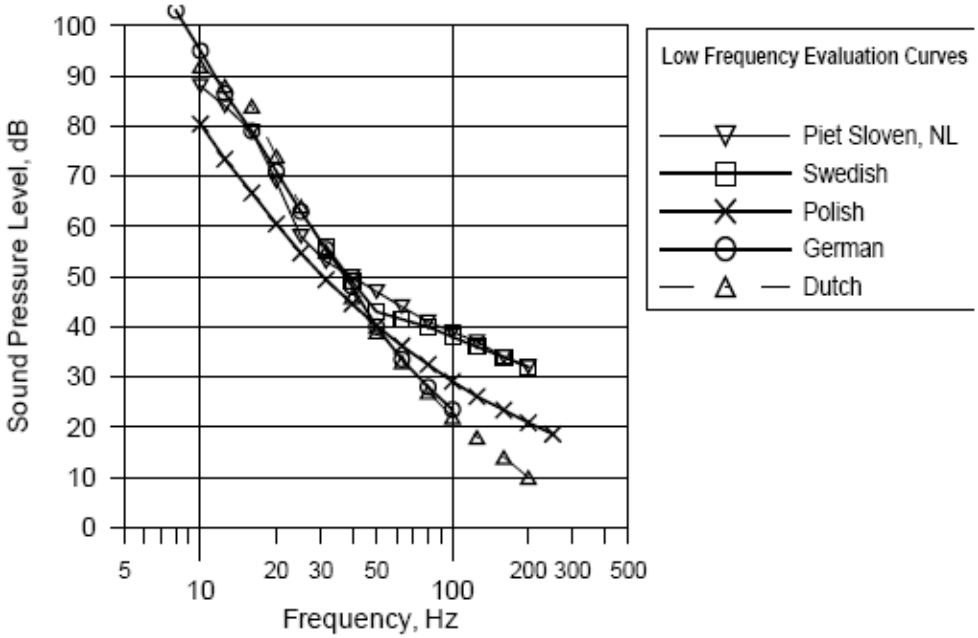
Kjellberg et al. (1997) looked at the ability of different full spectrum weighting schemes to predict annoyance caused by low frequency audio noise. They found that dB(A) is the worst predictor of annoyance of available scales. However, if 6 dB ("penalty") is added to dB(A) when dB(C) – dB(A) is greater than 15 dB, about 71% of the predictions of annoyance are correct. It is important to remember that integrated, transformed measurements of SPL (e.g. dB(A), dB(C)) do not measure frequencies below 20 Hz. While people detect stimuli below 20 Hz, as discussed in above sections, these frequencies are not measured using an A-weighted or C-weighted meter.

The World Health Organization (WHO) recommends that if dB(C) is greater than 10 dB more than dB(A), the low frequency components of the noise may be important and should be evaluated separately. In addition, WHO says "[i]t should be noted that a large proportion of low-frequency components in noise may increase considerably the adverse effects on health." (WHO, 1999)

Many governments that regulate low frequency noise look at noise within bands of frequencies instead of summing the entire spectrum. A study by Poulsen and Mortensen (Danish Environmental Protection Agency, 2002) included a summary of low frequency noise guidelines. German, Swedish, Polish, and Dutch low frequency evaluation curves were compared (see Figure 7). While there are distinctions in how the evaluation curves are described, generally, these curves are sound pressure criterion levels for 1/3 octaves from about 8 Hz to 250 Hz. Exceedance in any 1/3 octave measurement suggests that the noise may be annoying. However, note that regulations associated with low frequency

noise can be quite complex and the regulatory evaluations associated with individual curves can be somewhat different.

Figure 7: 1/3 Octave Sound Pressure Level Low frequency Noise Evaluation Curves



(Danish Environmental Protection Agency, 2002)

The Danish low frequency evaluation requires measuring noise indoors with windows closed; SPL measurements are obtained in 1/3 octave bands and transformed using the A-weighting algorithm for all frequencies between 10 and 160 Hz. These values are then summed into a single metric called $L_{pA,LF}$. A 5 dB "penalty" is added to any noise that is "impulsive". Danish regulations require that 20 dB $L_{pA,LF}$ is not exceeded during the evening and night, and that 25 dB $L_{pA,LF}$ is not exceeded during the day.

Swedish guidance recommends analyzing 1/3 octave bands between 31.5 and 200 Hz inside a home, and comparing the values to a Swedish assessment curve. The Swedish curve is equal to the United Kingdom (UK) Department of Environment, Food and Rural Affairs (DEFRA) low frequency noise criterion curve for overlapping frequencies (31.5 – 160 Hz).

The German "A-level" method sums the A-weighted equivalent levels of 1/3 octave bands that exceed the hearing threshold from 10 – 80 Hz. If the noise is not tonal, the measurements are added. The total cannot exceed 25 dB at night and 35 dB during the day. A frequency-dependent adjustment is applied if the noise is tonal.

In the Poulsen and Mortensen, Danish EPA study (2002), 18 individuals reported annoyance levels when they were exposed through earphones in a controlled environment to a wide range of low frequency environmental noises, all attenuated down to 35 dB, as depicted in Table 2. Noise was simulated as if being heard indoors, filtering out noise at

higher frequencies and effectively eliminating all frequencies above 1600 Hz. Noise levels in 1/3 octave SPLs from 8 Hz to 1600 Hz were measured and low frequencies (below 250 Hz) were used to predict annoyance using 7 different methods (Danish, German A-level, German tonal, Swedish, Polish, Sloven, and C-level). Predictions of annoyance were compared with the subjective annoyance evaluations. Correlation coefficients for these analyses ranged from 0.64 to 0.94, with the best correlation in comparison with the Danish low frequency noise evaluation methods.

As would be expected, at 35 dB nominal (full spectrum) loudness, every low frequency noise source tested exceeded all of the regulatory standards noted in the Danish EPA report. Table 2 shows the Danish and Swedish regulatory exceedances of the different 35 dB nominal (full spectrum) noise.

Table 2: 35 dB(A) (nominal, 8 Hz-20KHz) Indoor Noise from Various Outdoor Environmental Sources

	Traffic Noise	Drop Forge	Gas Turbine	Fast Ferry	Steel Factory	Generator	Cooling Compressor	Discotheque
Noise	67.6 dB(lin)	71.1 dB(lin)	78.4 dB(lin)	64.5 dB(lin)	72.7 dB(lin)	60.2 dB(lin)	60.3 dB(lin)	67.0 dB(lin)
Noise ≥ 20 Hz	35.2 dB(A)	36.6 dB(A)	35.0 dB(A)	35.1 dB(A)	33.6 dB(A)	36.2 dB(A)	36.6 dB(A)	33.6 dB(A)
	62.9 dB(C)	67.3 dB(C)	73.7 dB(C)	61.7 dB(C)	66.0 dB(C)	58.6 dB(C)	59.0 dB(C)	57.8 dB(C)
Danish Environmental Protection Agency	14.5 dB	21.5 dB *	14.8 dB	15.0 dB	13.1 dB	16.1 dB	14.0 dB	18.0 dB *
Swedish National Board of Health and Welfare	14.1 dB	19.7 dB	15.9 dB	16.8 dB	15.5 dB	18.3 dB	16.0 dB	10.0 dB
* includes 5 dB "penalty"								

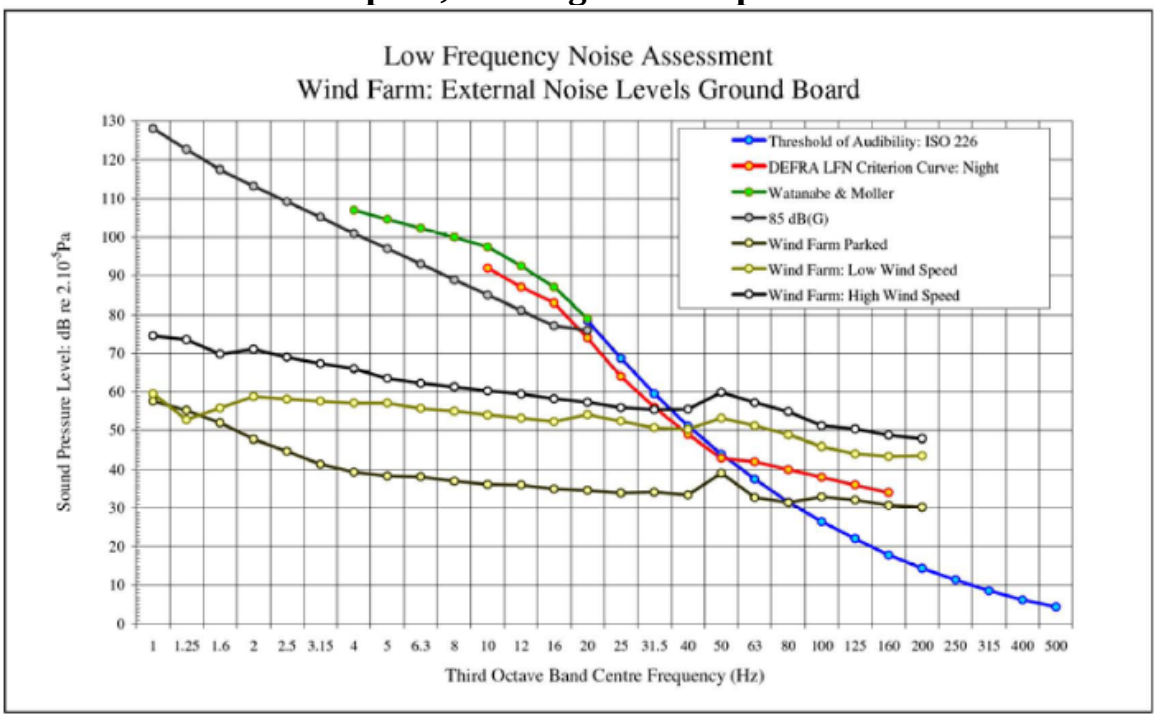
Noise adjusted to dB(lin), dB(A), dB(C) scales. Calculated exceedances of Danish and Swedish indoor criteria. (data from Danish Environmental Protection Agency, 2002)

In their noise guidance, the WHO (1999) recommends 30 dB(A) as a limit for "a good night's sleep". However, they also suggest that guidance for noise with predominating low frequencies be less than 30 dB(A).

3. Wind turbine sound measurements

Figure 8 shows examples of the SPLs at different frequencies from a representative wind turbine in the United Kingdom. Sound pressure level measurements are reported for a Nordex N-80 turbine at 200 meters (UK Department of Transport and Industry, 2006) when parked, at low wind speeds, and at high wind speeds. Figure 8 also includes, for reference, 3 sound threshold curves (ISO 226, Watanabe & Moller, 85 dB(G)) and the DEFRA Low Frequency Noise Criterion Curve (nighttime).

Figure 8: Low Frequency Noise from Wind Farm: Parked, Low Wind Speed, and High Wind Speed

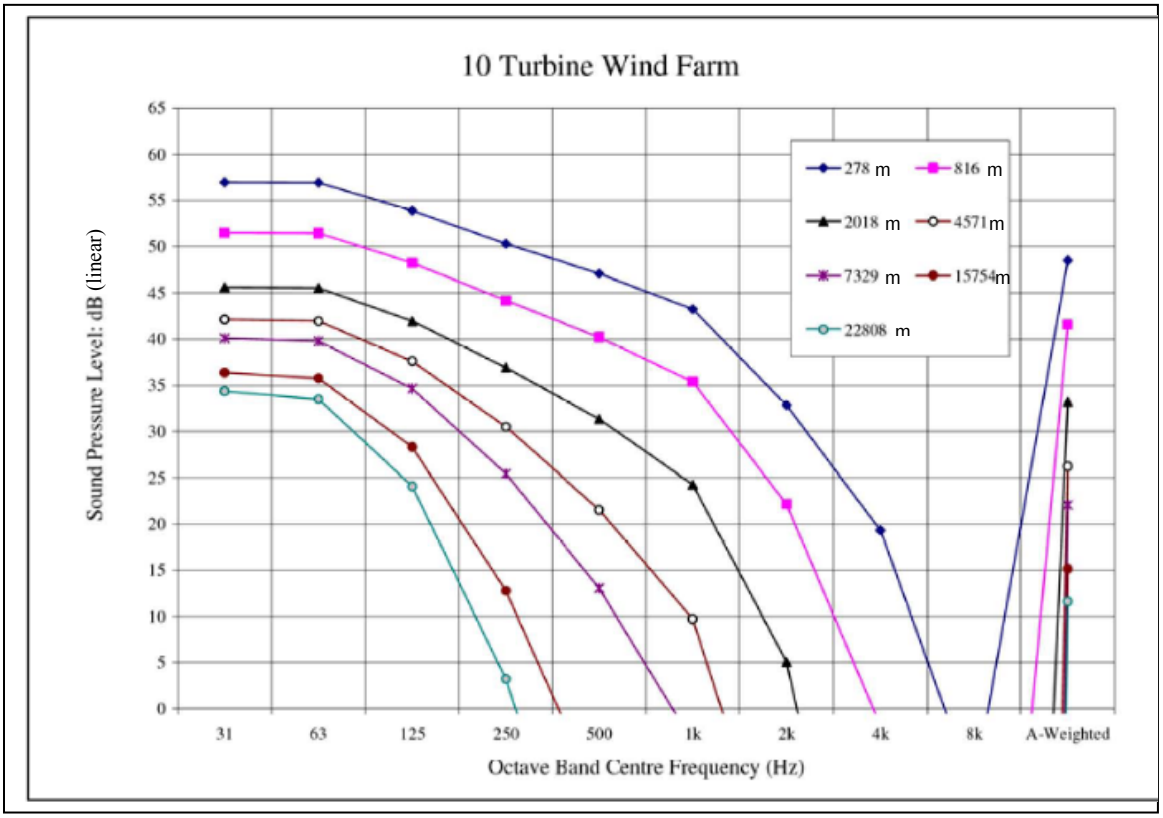


(UK Department of Transport and Industry, 2006)

In general, sound tends to propagate as if by spherical dispersion. This creates amplitude decay at a rate of about -6 dB per doubling of distance. However, low frequency noise from a wind turbine has been shown to follow more of a cylindrical decay at long distances, about -3 dB per doubling of distance in the downwind direction (Shepherd and Hubbard, 1991). This is thought to be the result of the lack of attenuation of low frequency sound waves by air and the atmospheric refraction of the low frequency sound waves over medium to long distances (Hawkins, 1987).

Figure 9 shows the calculated change in spectrum for a wind farm from 278 meters to 22,808 meters distant. As one moves away from the noise source, loudness at higher frequencies decreases more rapidly (and extinguishes faster) than at lower frequencies. Measurement of A-weighted decibels, shown at the right of the figure, obscures this finding.

Figure 9: Change in Noise Spectrum as Distance from Wind Farm Changes



(UK Department of Transport and Industry, 2006)

Thus, although noise from an upwind blade wind turbine is generally broad spectrum, without a tonal quality, high frequencies are efficiently attenuated by both the atmosphere, and by walls and windows of structures, as noted above. As a result, as one moves away from a wind turbine, the low frequency component of the noise becomes more pronounced.

Kamperman and James (2008) modeled indoor noise from outdoor wind turbine noise measurements, assuming a typical vinyl siding covered 2X4 wood frame construction. The wind turbine noise inside was calculated to be 5 dB less than the noise outside. Model data suggested that the sound of a single 2.5 MW wind turbine at 1000 feet will likely be heard in a house with the windows sealed. They note that models used for siting turbines often incorporate structure attenuation of 15dB. In addition, Kamperman and James demonstrate that sound from 10 2.5 MW turbines (acoustically) centered 2 km (1¼ mile) away and with the nearest turbine 1 mile away will only be 6.3 dB below the sound of a single turbine at 1000 feet (0.19 mile).

4. Wind turbine regulatory noise limits

Ramakrishnan (2007) has reported different noise criteria developed for wind farm planning. These criteria include common practices (if available) within each jurisdiction for estimating background SPLs, turbine SPLs, minimum setbacks and methods used to

assess impacts. Reported US wind turbine noise criteria range from: ambient + 10 dB(A) where ambient is assumed to be 26 dB(A) (Oregon); to 55 dB(A) or "background" + 5 dB(A) (Michigan). European criteria range from 35 dB(A) to 45 dB(A), at the property. US setbacks range from 1.1 times the full height of the turbine (consenting) and 5 times the hub height (non-consenting; Pennsylvania); to 350 m (consenting) and 1000 m (non-consenting; Oregon). European minimum setbacks are not noted.

VI. Conclusions

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. Low frequency noise is primarily a problem that may affect some people in their homes, especially at night. It is not generally a problem for businesses, public buildings, or for people outdoors.

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). It has been hypothesized that direct activation of the vestibular and autonomic nervous system may be responsible for less common complaints, but evidence is scant.

The Minnesota nighttime standard of 50 dB(A) not to be exceeded more than 50% of the time in a given hour, appears to underweight penetration of low frequency noise into dwellings. Different schemes for evaluating low frequency noise, and/or lower noise standards, have been developed in a number of countries.

For some projects, wind velocity for a wind turbine project is measured at 10 m and then modeled to the height of the rotor. These models may under-predict wind speed that will be encountered when the turbine is erected. Higher wind speed will result in noise exceeding model predictions.

Low frequency noise from a wind turbine is generally not easily perceived beyond ½ mile. However, if a turbine is subject to aerodynamic modulation because of shear caused by terrain (mountains, trees, buildings) or different wind conditions through the rotor plane, turbine noise may be heard at greater distances.

Unlike low frequency noise, shadow flicker can affect individuals outdoors as well as indoors, and may be noticeable inside any building. Flicker can be eliminated by placement of wind turbines outside of the path of the sun as viewed from areas of concern, or by appropriate setbacks.

Prediction of complaint likelihood during project planning depends on: 1) good noise modeling including characterization of potential sources of aerodynamic modulation noise and characterization of nighttime wind conditions and noise; 2) shadow flicker modeling; 3) visibility of the wind turbines; and 4) interests of nearby residents and community.

VII. Recommendations

To assure informed decisions:

- Wind turbine noise estimates should include cumulative impacts (40-50 dB(A) isopleths) of all wind turbines.
- Isopleths for dB(C) - dB(A) greater than 10 dB should also be determined to evaluate the low frequency noise component.
- Potential impacts from shadow flicker and turbine visibility should be evaluated.

Any noise criteria beyond current state standards used for placement of wind turbines should reflect priorities and attitudes of the community.

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STATE OF MINNESOTA
BEFORE THE PUBLIC UTILITIES COMMISSION

David C. Boyd	Chair
J. Dennis O'Brien	Commissioner
Thomas Pugh	Commissioner
Phyllis A. Reha	Commissioner
Betsy Wergin	Commissioner

In the Matter of the Site Permit and Certificate of Need for Pleasant Valley Wind LLC , Docket Number IP-6828/WS-09-1197 and IP-6828/CN-09-937

OLMSTED WIND TRUTH PETITION FOR A CONTESTED CASE

SITE PERMIT AND CERTIFICATE OF NEED FOR PLEASANT VALLEY WIND PROJECT

Members of Olmsted Wind Truth hereby petition for a Contest Case in the Siting Permit (WS-09-1197) and Certificate of Need (CN-09-937). Olstead Wind Truth requests that these two dockets be forwarded to the Office of Administrative Hearings as a contested case.

The Siting and Routing rules have clear guidelines for contested case; Subp 5:

> A. Any person may request in writing that a contested case hearing be held on an application for a site permit for a proposed LWECS project. The contested case hearing request must be filed within the time period established for submitting comments on the draft site permit. The person requesting the public hearing shall include, as part of the request, the issues to be addressed in the hearing and the reasons a hearing is required to resolve those issues.
>
> B. The commission shall order a contested case hearing if the commission finds that the person requesting the contested case hearing has raised a material issue of fact and that holding a hearing would aid the PUC in making a final determination on the permit application.
>
> C. The hearing must be conducted according to the rules of the Office of Administrative Hearings.
>
> D For a contested case hearing, the commission shall identify the issues to be resolved and limit the scope and conduct of the hearing according to applicable

law, due process, and fundamental fairness. Alternatively, the commission may request the administrative law judge to identify the issues and determine the appropriate scope and conduct of the hearing according to applicable law, due process, and fundamental fairness.

ISSUES AND REASON FOR CONTESTED CASE

Olmsted Wind Truth calls attention to what it knows about the Pleasant Valley Wind Project from the record thus far and other information. The reason for the hearing and issues to be addressed is as follows:

A. The Applicant bases a majority of their case on the claim that they are in negotiations with GRE for the sale of this Project. This is no longer true. As a result, much of the information provide in their Application is no longer factual. Since this contested fact serves as the underlying premise of the entire application, it is of material importance to the evaluation of this CN.

B. A Utility Information Request was sent to the Applicant on January 26, 2010 asking them to provide the Commission with an update on the status of their negotiations with GRE. Rather than informing the Commission that the negotiations with GRE have been terminated, the Applicant stated that they were unable to comply with this request due to confidentiality agreements with GRE. Therefore, a Contested Case will be needed in order to resolve this dispute of the facts. The Contested Case hearing would allow either party, GRE or the Applicant, to provide the evidence needed to resolve this contested fact without violating their confidentiality agreement.

C. Section 2, paragraph 1 of the Applicant's application states that the primary purpose of this facility is to "be an adequate, reliable, and efficient energy supply to GRE's (or other Minnesota utilities') customer." This is not a factual statement since the Applicant has requested the ability to sell the output of this Project to non-Minnesota utilities. The Applicant bases the majority of their evidence on their assertion that this Project will provide significant benefits to Minnesota customers. Olmsted Wind Truth has provided substantial evidence in an earlier filing that the Applicant's claim is false. Once again, since this unsubstantiated fact serves as the underlying premise of the Applicants entire proposed purpose for the CN, it is of material importance to the evaluation of this CN.

D. Section 2.2 of the application states that "The Project is the best alternative given technology, size, location, timing, cost, effects on natural and socioeconomic

environments, and the expected reliability". This is a false statement of fact. Olmsted Wind Truth has submitted extensive evidence into the record which shows numerous alternatives that are better than this Project.

E. In Section 2.2.3 of the application, the Applicant states that the Dodge and Mower counties site has a robust interconnection and "the Project will not be subject to the transmission constraints and congestion issues that occur in southwest Minnesota". This is also a false statement of fact. The area of Dodge and Mower Counties is subject to transmission and congestion issues. Existing wind generation projects in this area are currently curtailed, on average, three times per month, due to congestion. As more and more generation is added to this area, congestion and curtailments will continue to increase. There is currently 18,000 MW of new wind generation scheduled for installation by 2012 in the same area of this Project. There is absolutely no doubt that Applicants Project will be subject to congestion curtailment similar to southwest Minnesota. Since curtailments will result in

F. In this same section, the Applicant also states that "the community is eager for the Pleasant Valley Project to be built." This is also an incorrect statement. Many landowners who have sign leasing agreements with the Applicant for this Project now express remorse for doing so. The Applicant failed to inform the local land owners of all the adverse impacts that this Project will have on their land and the rights. Evidence was provided for this fact by several landowners who voice these concerns at the public meeting held by the OES in Dexter.

G. In several locations within the application, the Applicant suggests that wind generation facility such as the Project are very reliable forms of generation and help to support a robust electrical grid. This is a false statement. Wind generation facilities create significant problems for the electric grid and jeopardize the reliability of the grid. Attachment A provides evidence from several authorities that dispute these presumed facts provide by the Applicant.

H. In Section 2.3 the Applicant states that "The project will produce energy without causing any major environmental damages such as the emission impacts from fossil fuel generation." This is not true. Because of the intermittent natural of wind generation, the MISO grid must carry additional operating reserves. Carrying more operating reserves causes additional consumption of fossil fuels and additional emissions. In addition, MISO must use conventional fossil fuel generating plants to "chase" to wind turbine production throughout the day. As wind resources decrease, the fossil plants

must ramp up to cover the shortfall. As wind resources decrease, these fossil plants must ramp down to prevent over frequencies. This continual ramping up and down forces these fossil units to operate inefficiently and waste a tremendous amount of fuel. Consequently, the installation of this Project into the MISO grid will cause environmental damage from fossil fuel emissions.

I. In Section 2.4 the Applicant also states that "The project will not likely have a significant impact on the future development in the Project region". This is an incorrect claim. This Project creates several adverse restrictions to future development in the region. The Applicant's wind right lease agreements places restrictions on the landowner if they wish to put up a new barn, a new grain storage silo, and many other activities. It prevents neighboring landowners from future development of their property due to the existence of wind towers next door. For example, since the ER process only addresses noise limits at existing home sites, a neighbor could be restricted from building a new home on their property due to the existence on wind turbines on the neighboring property. Also, this Project is located very near the rapidly growing town of Rochester Minnesota. Construction of this Project will prevent any future residential and commercial developments in this region which will have a significant adverse economic impact to the region.

J. In the "Trade Secret" documents of this application, the Applicant claims that this facility will have a capacity factor in excess of 40%. This is a false statement. Evidence from existing wind farms in these same Counties, such as the Wapsipinicon Wind Project located adjacent to the proposed Project, show significantly lower capacity factors.

K. In section 3.2.4 and again in Section 8 of the application, the Applicant states that "Hydropower is not an alternative to the Project." This is a false statement. Olmsted Wind Truth has provided earlier evidence in these proceeding to prove otherwise.

L. In section 3.2.4 and again in Section 8 of the application, the Applicant states that "A landfill gas plant is not an alternative to the Project." This is a false statement. Olmsted Wind Truth has provided earlier evidence in these proceeding to prove otherwise.

M. In section 3.2.5 of the application, the Applicant states that no combination of alternatives exist for this Project. This is a also a false statement. Olmsted Wind Truth has provided earlier evidence in these proceeding to prove otherwise.

N. In section 3.3 of the application, the Applicant states that "This Table 6 shows that wind energy resources are competitive with (and superior) to other forms of renewable resources from a cost perspective." This is a false statement. Table 6 only provides some of the cost data required to demonstrate cost effectiveness. The data in Table 6 by itself does nothing to show competitiveness or superiority of the Project. Olmsted Wind Truth has provided a significant amount of evidence in these proceeding to prove that this Project is not superior to other renewable alternatives.

O. In section 3.3.7, the Applicant states that "the price of the output (of this Project) will have negligible effects on rates." This is a false statement. Wind energy in general and this project specifically are significantly more expensive than conventional means of power generation. The Commission is already well aware of this fact. If wind resources were less expensive, there would be no need for a State wide RES. Utilities would voluntarily build wind generation facilities. The RES in general, and this Project specifically will continue to significantly increase electricity rates in the State.

P. In section 4.1, the Applicant states that "As discussed in Section 2.1, there is a critical need for additional electricity production capacity in Minnesota and the entire region." This is a false statement. The Applicant bases their claim from evidence provided in Section 2.1 that is several years old, prior to the current economic turndown. The data used by the Applicant is no longer applicable. All utilities through the country have experienced a significant decrease in energy demand in 2009. There no longer exists any critical need for additional electric resources in the State.

Sincerely

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Attachment A

Wind Generation Impact on Reliability

The adverse impact to grid reliability caused by intermittent generation facilities such as wind farms is well documented. On January 21, 2010, The Federal Energy Regulatory Commission (FERC) issued a Notice of Inquiry (NOI). The purpose of this NOI is to request comments from interested parties on "the extent to which barriers may exist that impede the reliable and efficient integration of variable energy resources (VERs) into the electric grid" in order to meet the many challenges posed by the increasing addition of wind generation to the grid.

The Midwest Independent System Operator, (MISO) also has several different committees looking into this problem. On September 9, 2009, MISO released its initial report for wind integration into the local grid. In this study, MISO concluded that:

a. "Wind ramping is often directly opposite to load patterns." As a result, MISO must carry additional reserves in order to manage load increases and decreases while at the same time having to compensate for the opposing effect of the wind generation. MISO goes on to say that:
b. "Currently operational requirements are sufficient in meeting the impacts from wind volatility." However the rapid growth of wind development in the area may change these dynamics in the future such that:
c. "Current level of ancillary services and headroom may not fully cover future wind generation volatility impacts." and that
d. "Increased wind generation penetration may not provide additional diversity benefits."

In January of 2010, the MISO Reliability Subcommittee reported that such:

a. "Intermittent (generation) such as wind can not be dispatched as part of our real-time dispatch", and that:
b. "This inability to dispatch necessitates manual curtailment on a regular basis to relieve transmission constraints", and finally that
c. "On average, more than 3 manual curtailments per day" are required to protect the grid from wind volatility.

As a result of these many problems caused by wind generation on the grid, the MISO Planning Advisory Committee conducted a Loss of Load Expectation (LOLE) analysis from wind generation resources using very detailed probabilistic modeling techniques.

On February 24th, 2010, this Committee reported that, for the operating year of 2009, less than 1.5% of the total wind generation in MISO was operational during the system peak. In 2008, only 12% of all wind generation in MISO was operational during the peak. In 2007, once again, less than 1.5% of all wind generation in MISO was operational during the peak.

Due to this poor wind performance, the MISO Planning Advisory Committee was forced to downgrade the value for wind capacity credit from 20% to only 8%. For comparison sake, the typical capacity credit for a conventional generation facility is between 90% to 99%.

There is ample evidence that wind generation has an adverse impact on the electric grid. As a result, the addition of new wind generation must be planned in a systematic approach and in conjunction with the necessary conventional generation resource to mitigate and offset the adverse effects of wind on the grid.

March 10, 2009

Burl W. Haar
Executive Secretary
Minnesota public utilities commission
121 7th Place East, Suite 350
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RE: In the Matter of the Site Permit and Certificate of Need for Pleasant Valley Wind LLC , Docket Number IP-6828/WS-09-1197 and IP-6828/CN-09-937

Dear Dr. Haar:

On October 26, 2009, Pleasant Valley Wind LLC ("Applicant") filed an Application for a Certificate of Need for a Large Energy Facility with the Minnesota Public Utilities Commission. On February 3, 2010, the OES released a Notice of Application Acceptance, Public Information and Scoping Meeting. The purpose of this document is to provide the OES with recommendations on the scope of the Environmental Review (ER) and items to be included in the Draft Site Permit for the Project.

1. Introduction:

Large scale wind energy projects in the upper Midwest have been experiencing bad publicity and increased opposition in recent years. These complaints, in most cases, are a direct result of poor site planning. As a result, the Commission has opened Docket # E-999/CI-09-845 "In the Matter of the Commission Investigation into Large Wind Energy Conversion Systems Permit Conditions on Setbacks and the Minnesota Department of Health Environmental Health Division's White Paper on Public Health Impacts of Wind Turbines."

The Minnesota Department of Health (MDH) report, filed in the above docket, entitled "Public Health Impacts of Wind Turbines" did an excellent job of explaining general issues related to this subject matter. We agree with the MDH conclusion that many of these health complaints are an indirect result of inadequacies in the current Minnesota noise standards when it comes to wind turbine siting.

The current Minnesota rules for noise control are covered under Chapter 7030, Noise Pollution Control. There are 4 specific areas in which these current noise standards are insufficient when applied to wind turbine development sites. First, the existing noise standards do not address sound vibrations which occur at frequencies below the auditable range of the human ear. Second, the existing sound standards are inadequate for rural areas since the limits are set based on the maximum allowable sound levels not

the relative increase in noise over normal background levels. Third, the current practice by wind developers is to use the home or farmhouse as the nearest noise receptor when performing their studies, not the nearest point of human activity as specified by the law. And finally, the existing Minnesota standards do not address noise limits for "impulsive" noise.

1. Inadequate Noise Standards Below The Auditable Range:

The MPCA defines "sound" as an alternation of pressure or vibration that propagates through an elastic medium and produces an auditory sensation. The current MPCA sound standards are only designed to address vibrations that occur in this auditable range. In fact, these standards were specifically designed to ignore any impact of vibration which occur below the hearing range of the human ear.

Wind turbines are known to produce such low frequency pressure waves or vibrations. This pressure wave occurs each time one of the three blades of the wind turbine moves past the fixed vertical tower. Turbine advocates will argue that they can limit this phenomena by designing the turbines to face out of the wind rather than into the wind, In reality, all this accomplishes is changing the pressure wave from one caused by expansion of air between the blades and the tower to one cause by the compression of air between the two.

Even though this low frequency vibration occurs below the hearing range of the average person, it can still cause problems. One of the more common complaints is noise within a home or other building such as a steel pole barn. Since this low frequency vibration is an actual wave of air pressure, it will cause items to vibrate such as the walls and windows of the home or items within the home such as dishware, light fixtures, or picture frames. This vibration of the building components and fixtures then creates a noise of sound vibration which is in the auditable range of the human ear. Therefore, even though most people can not actually hear the low frequency pressure waves created by the wind turbines, they can hear the impact of these pressure waves when they strike other objects. The MDH report confirms that "The existing Minnesota nighttime standard of 50 dB(A) not to exceeded more than 50% of the time in a given hour, appears to underweight the penetration of low frequency noise into dwellings."

In order to address this problem, the MDH recommends that "Isopleths for dB(C) - dB(A) greater that 10 db should also be determined to evaluate low frequency noise component." We recommend that the OES include this evaluation as part of the ER process and incorporate appropriate limits in the Draft Site Permit.

2. Inadequate Noise Standards for Rural Areas

The existing Minnesota Polution Control Agency's rules for noise contains standards for 3 different types of "Noise Area Classifcations". Area 1 is residential areas which include homes, schools, churches, and other types of activities that you would generally find in a city or suburban area. Area 2 contains commercial type activities such as retail trade, business services, airports and bus terminals. Area 3

contains industrial type activities such as textile mills, paper mills, petroleum refineries, and metal fabrication industries. The current MPCA noise standards set a maximum noise limits for each Noise Area Classification. Area 1 allows for noise limits of 60dB to 65dB during the day and 50-55 dB at night. Area 2 allows noise levels of 65-70 dB day or night. Area 3 allows noise levels up to 75-80 dB day or night.

The problems with these existing noise standards are twofold when it comes to rural areas. First, there is no separate Noise Area Classification for homes in rural areas so farmhouses are currently placed in Noise area Classification #1 which means they allow the same sound levels as found in an average city or suburb. By allowing a daytime limit of 60dB for a typical rural area where the normal background noise is only 35-45, it is no surprise that farmers are complaining. This 20dB increase in noise has the same effect as quadrupling the background noise since the dB rating are based on a logarithmic scale.

Second, since the existing standards are based on maximum allowable noise levels not the relative increase from normal background noise, the impacts of noise in a rural area are magnified several fold. The MPCA states that an increase in background noise of 3dB is "relatively imperceptible" to the average person. An increase of 5 dB is "clearly noticeable". An increase in 10dB has the same effect as doubling the background noise and an increase of 20dB has the same effect as quadrupling the background noise.

Given that the normal background noise in a residential suburb or small town is 45dB, a 50dB limit would be relatively imperceptible to the average human ear. Since the typical nigh time background noise in a rural area is closer to 30-35dB, an increase to 50dB would result in a doubling or quadrupling of the normal background noise.

The MDH recommends in their report a broad range of 40-50dB. This is completely inadequate and will only result in more and more noise complaints. The only way to adequately address this issue is to set the standard based on increases in background noise not absolute limits.

We recommend that the OES evaluate the impact from the relative increase in noise levels caused by the Project as compared to the background noise levels at both nighttime and daytime as part of the ER process. We also recommend that the OES then incorporate limit on the increase from background noise of no more than 5dB in the Draft Site Permit.

3. Location Of the Nearest Receptor.

Currently, Minnesota limits for noise are measured at the location of the "nearest receptor". Most people think of the nearest receptor as the house closest to the noise sources. This is not true. The MPCA defines a "receptor" as a "place of human activity". In the case of a residential area, the nearest "place of human activity" could be a patio, porch, or garden area outside the home.

The reason that many people mistakenly consider the "home" as the nearest noise receptor is because residential lots are relatively small. The difference in noise at any given point on a residential

homeowner's property as compared to the house is virtually zero. Therefore the noise level near the home is most likely the same as the noise level everywhere else on the property. However, in a rural area where home sites can be several acres in size, the noise from sources such as a wind turbine, can be significantly different at various locations on the farmer's property.

The problem with previous wind turbine project sites is that they errantly considered the farmhouse to be the "nearest receptor" not the "place of human activity". This is a critical error on the part of the wind developer. Human activities can take place at several locations on a farm site, the barn, the henhouse, the machine shed, or the farm field itself. When a wind developer sites a wind turbine using the state standard of 50dB at the farm house, the actual noise level could be significantly higher in the other areas of the farm where human activities take place.

The existing Minnesota standards clearly state that the nearest receptor should be the "place of human activity" which is not the same as the "farmhouse" for rural environmental. Therefore, we recommend the OES evaluate the noise impacts of this Project at the property line, not the farmhouse during the ER process. We also recommend that all applicable noise standards used in the Draft Site Permit also be based on limits at the property line, not the farmhouse.

4. Impulsive Noise

Minnesota Rule 7020-0020 defines an impulsive noise as "either a single sound pressure peak (with either a rise time less than 200 milliseconds or total duration less than 200 milliseconds) or multiple sound pressure peaks (with either rise times less than 200 milliseconds or total duration less than 200 milliseconds) spaced at least by 200 millisecond pauses. Minnesota Rule 7030-0040 then goes on to say that, "these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare."

The low pressure sound wave created by wind turbines when the individual blades pass by the fixed tower structure meets the definition of impulsive noise. The MDH, in their report states that this "Low frequency noise from a wind turbine is generally not easily perceived beyond ½ mile. However, if a turbine is subject to aerodynamic modulation because of shear caused by terrain (mountains, trees, buildings) or different wind conditions through the rotor plane, turbine noise may be heard at greater distances." The current Minnesota Rule 7030-0040 provides no standards or guidelines for limiting impulsive noise. As a result, the OES must find other ways to accomplish this task in order to protect the public health and welfare from impulsive noise,.

We recommend that the OES evaluate the effects of impulsive noise as part of the ER process. We also ask that the OES set limits on impulsive noise as part of the Draft Site Permit.

Conclusion:

Wind development has been experiencing increased opposition in recent years. The MDH study on the adverse health effects is only one example of the numerous complaints being made by the opposition. The Minnesota Public Utilities Commission needs to address these problem and adopt adequate noise standards in order for future wind development to succeed in Minnesota.

The existing Minnesota noise standards are clearly inadequate for controlling noise pollution from wind farms. Nevertheless, these standards as defined in Minnesota Rule 7030-0040, are only meant to be considered as upper limits not absolute limits. For that reason, the Commission can require noise pollution from wind farms to meet levels that are lower than these recommended upper limits.

In addition, Minnesota Rule 7303-0040 clearly states that "These standards describe the limiting levels of sound established on a basis of present knowledge for the preservation of public health and welfare." The MDH, as well as many other organizations, have provided the Commission with ample evidence that the "present knowledge" used to develop the current Minnesota noise standards is outdated. Therefore, the Commission needs to rethink these standards when applying them to noise problems, such as wind turbines, that were never contemplated when the standards were developed.

Finally, the primary purpose of Minnesota Rule 7030.0010 through 7030-0080 is "the preservation of public health and welfare" not to set arbitrary noise limits. There is ample evidence of file with the Commission under Docket # E-999/CI-09-845 that address the adverse impacts on public health and welfare for poorly planned wind energy sites. We strongly recommend that the OES suspend the ER process for this Project until the Commission identifies a fix to this issue under Docket # E-999/CI-09-845 in order to adequately protect the health and welfare of the residents of Dodge, Mower, and Olmsted Counties.

Sincerely

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STATE OF MINNESOTA
BEFORE THE PUBLIC UTILITIES COMMISSION

David C. Boyd	Chair
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In the Matter of the Site Permit and Certificate of Need for Pleasant Valley Wind LLC , Docket Number IP-6828/WS-09-1197 and IP-6828/CN-09-937

OLMSTED WIND TRUTH PETITION FOR INTERVENTION

Olmsted Wind Truth hereby makes this Petition for Intervention as a full party, with all rights of a party. Olmsted Wind Truth is an organization of affected landowners within the immediate vicinity of the proposed Pleasant Valley Wind Project.

Members of Olmsted Wind Truth will be directly affected by the outcome of this proceeding if a Site Permit and Certificate of Need were to be granted. Participation in these dockets is necessary because Olmsted Wind Truth wishes to protect our interests and develop a record through discovery, testimony, cross examination, motions, and briefing.

Olmsted Wind Truth has been an active and credible participant in the dockets stated above. Olmsted Wind Truth is also participating in the Commission's Docket # E-999/CI-09-845 regarding Public Health Impacts of Wind Turbines and also actively participated in the Bent Tree Wind Project docket.

Olmsted Wind Truth meets the criteria for intervention and respectfully requests that it be granted intervention as a full party, with all rights of a party, in the above Site Permit and Certificate of Need proceedings.

Sincerely,

Peter J. Reinarts, PE
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