COUNTY BOARD FACTSHEET

TO: County Clerk: Attn: Kelly Lundgren
FROM: David R. Cary, Acting Director of Planning
RE: **County Text Amendment No. 15009**
County Wind Energy Conversion Systems Rules and Regulations
DATE: September 4, 2015

1. Attached are the Planning staff report (p.2-49) and the minutes of the Planning Commission (p.50-75) on **Text Amendment No. 15009,** requested by the City of Lincoln/Lancaster County Planning Department, to amend the Lancaster County zoning regulations regarding Section 13.018 "Commercial Wind Energy Conversion Systems" to revise the special permit conditions for wind turbine projects regarding decommissioning, shadow flicker, impact on environmental resources and view corridors, setbacks, noise, noise studies and other conditions.

2. This text amendment was heard before the Planning Commission on August 19, 2015.

3. The staff recommendation to approve the revised wind energy regulations is based upon the "Analysis" as set forth on p.4-18, concluding that the goal of the changes is to allow alternative energy development in the County but also stress providing for the protection of nearby property owners. Large commercial wind turbine projects have successfully located in other counties in Nebraska. However, the land use characteristics in Lancaster County are not like most other counties in Nebraska. There is significant residential development on smaller lots scattered throughout Lancaster County. In addition, wind turbines which are generally around 400 feet in height in other counties, now could range up to 500 feet or more in height. So while wind energy is a worthy goal, the impact on adjacent properties could be substantial. The requested amendments permit commercial wind turbines in Lancaster County while addressing the potential negative impacts on adjacent properties. The staff presentation is found on p.50-51. Staff also presented two memos revising the staff recommendation with minor corrections to Sections (h) and (j), which are found on p.76-78, and a memo on regulations in other states p. 79-83.

4. Twenty-four (24) individuals testified expressing concern and support for various aspects of the text amendment. Specifically the emphasis was on noise and setback provisions (See Minutes, p.51-58). After the public testimony, the Planning Commission then had extensive questions for staff which is found on p.58-70.

5. On August 19, 2015, the Planning Commission voted 8-1 (Weber dissenting) to eliminate the provision in Section (d) that shadow flicker shall not exceed "30 minutes in any one day", but leaving the provision that it shall not exceed 30 hours per any calendar year. The Commission then voted 5-4 (Hove, Sunderman, Scheer and Weber dissenting) to change the noise standard in Section (i) from 40 to 50 dBA in the daytime and from 37 to 42 dBA at night. The Commission voted 5-4 (Hove, Sunderman, Scheer and Weber dissenting) to approve the amended proposal as a whole. See Minutes on p. 70-75.

The Planning staff is scheduled to provide a technical briefing for the County Board on this item at their regular staff meeting on Thursday, September 10, 2015, at10:45 a.m., in the City Council - County Board Chambers of the County-City Building, 555 South 10th Street, Lincoln, Nebraska. The County Board public hearing is scheduled for Tuesday, October 20, 2015, at 4:30 p.m.

If you need any further information, please let me know (402-441-6365).

cc: County Board
Kristy Bauer, Deputy County Attorney
Kerry Eagan, County Commissioners
David Cary, Planning
Judy Halstead, Lincoln/Lancaster C. Health Dept.
Gwen Thorpe, County Commissioners
Pamela Dingman, County Engineer
Steve Henrichsen, Planning
Scott Holmes, Lincoln/Lancaster Co. Health Dept.

LINCOLN/LANCASTER COUNTY PLANNING STAFF REPORT

for August 19, 2015, PLANNING COMMISSION MEETING
**** Per Planning Commission August 19, 2015****

PROJECT #: Text Amendment No. 15009

PROPOSAL: Amend the County zoning regulations, Section 13.018, Commercial Wind Energy Conversion Systems, to revise the special permit conditions for wind turbine projects regarding decommissioning, shadow flicker, impact on environmental resources and view corridors, setbacks, noise, noise studies and other conditions.

CONCLUSION: The goal of the changes is to allow alternative energy development in the County but also stress providing for the protection of nearby property owners. Large commercial wind turbine projects have successfully located in other counties in Nebraska. However, the land use characteristics in Lancaster County are not like most other counties in Nebraska. There is significant residential development on smaller lots scattered throughout Lancaster County. In addition, wind turbines which are generally around 400 in height in other counties, now could range up to 500 feet or more in height. So while wind energy is a worthy goal, the impact on adjacent properties could be substantial. The requested amendments permit commercial wind turbines in Lancaster County while addressing the potential negative impacts on adjacent properties.

RECOMMENDATION:	Approval

GENERAL INFORMATION:

HISTORY:

Mar 2011 Commercial Wind Energy Conversion Systems are included as a specially permitted use in the AG Agricultural District by the County Board through TX11003.

Jan 2015 TX14014 submitted by Volkswind USA was withdrawn prior to Planning Commission public hearing.

Spring 2015 The Lincoln/ Lancaster County Planning Department & Lincoln/ Lancaster County Health Department hosted a series of meetings with a Working Group to help staff revise the current regulations regarding Commercial Wind Energy projects. The Working Group of 12 people included persons with various viewpoints and interests, including industry representatives, environmental interests along with landowners and residents of various viewpoints about wind turbines. The Working Group was joined by 8 members from Gage County who are working on the same topic.

COMPREHENSIVE PLAN SPECIFICATIONS:

Lincoln and Lancaster County: One Community

Lincoln and Lancaster County contain a rich mosaic of households, living in a variety of urban and rural settings. But we share a common bond and work cooperatively to promote future growth that offers new opportunities for living and working while conserving our local environmental and cultural resources for future generations. (Page 1.2)

The importance of building sustainable communities — communities that conserve and efficiently utilize our economic, social, and environmental resources so that the welfare of future generations is not compromised – has long been recognized. This concept has grown in importance with increased understanding of the limits to energy supplies and community resources, the likelihood that energy costs will continue to increase in the future, the climatic impacts of energy consumption, and the impacts on the physical and economic health of the community. LPlan 2040 describes a community that values natural and human resources, supports advances in technology, and encourages development that improves the health and quality of life of all citizens. (Page 1.4)

Vision and Plan: Environmental Stewardship and Sustainability

Efforts are made to attract new and expanding industries that serve the emerging market for more sustainable products and services. (page 1.5)

Guiding Principles:

The 400-foot State Capitol is the key historic, architectural, and geographic landmark of the city and surrounding countryside. Views to the Capitol are highly valued by the people of Lancaster County and the State of Nebraska and should be protected and enjoyed for generations.

Major entryways to Lincoln including Interstate 80 and its exits (especially I-180), Highways 77 and 34 from the north, Cornhusker Highway from the east and from the Airport on the west, O Street from the east and west, Homestead Expressway/Highway 77/Rosa Parks Way from the southwest and west, and Highway 2 from the southeast, should be studied, protected, and enhanced to create and express community pride. (Page 4.6)

Energy and Utilities: Energy Guiding Principles

Promote renewable energy sources.

Energy and Utilities: Strategies for Renewable Energy:

- *Continue to encourage and expand wind and solar access to buildings and other land uses.*
- *Incorporate the use of alternative fuels into local government and institutional operations.*
- *Incorporate the use of alternative fuels when feasible.* (Page 11.6)

ANALYSIS:

History

1. The original text of the Special Permit conditions of approval for Commercial Wind Energy Conversion Systems (CWECS) was developed by County staff in 2011. At that time a wind developer was interested in siting these structures in Lancaster County, although no applicant stepped forward with proposed text for the Special Permit. County staff developed conditions that addressed issues regarding operations and potential impact on adjacent properties. These conditions were developed by reviewing the regulations in other counties and municipalities around the country, as well as the scientific information available at the time. As understanding of these machines has progressed over the past four years, and after an wind developer requested an additional review of the information available, it became apparent that these conditions are in need of review and updating.

2. In summary, the requested changes would:

   a. alter the way the setback to dwellings is measured,
   b. change the noise requirement thresholds and outline noise monitoring requirements,
   c. provide for protection for properties which do not yet have a dwelling on them but may be substantially impacted by wind turbines, and
   d. allow for CWECS that are being developed as part of a larger plan for a wind farm to be included in a single special permit area provided they are separated only by public right-of-way.

3. The goal of the Working Group process was to develop a text amendment that permits commercial wind energy projects provided there is adequate protection of adjacent property owners and residents. Six meetings were held between March 12th and May 21st, 2015 at the Roca Community Center or the Cortland Community Center in Gage County. The communities of Cortland and Roca graciously donated the use of their space for the meetings. The meetings were open to the public and typically 30 to 40 people attended. At the end of each meeting there was an open comment period for the general public. All of the information and presentations from the Working Group process is available on the Planning website at:
   http://www.lincoln.ne.gov/city/plan/dev/wind/index.htm

4. The first five meetings focused on sharing information about wind energy. Topics ranged from the economic benefits of wind energy to health and noise impacts. Staff prepared a discussion draft which was released in early May and was reviewed page by page with Working Group members at the final meeting.

5. The next draft of the text was released on June 8th, 2015. The public was encouraged to provide comments on this draft. Over 40 unique comments were received from the public which are included at the end of this report. The Audubon Society also submitted one comment from over 70 of it's members which is included as well.

6. After reviewing all the comments, the draft was revised for the Planning Commission public hearing and was released on July 9th, 2015. Comments received as of August 4, 2015, are included at the end of the report as well.

Proposed Text

7. The proposed changes have different standards in some cases between participating and non-participating properties. A "participating" property has "entered into a contractual agreement with the CWECS owner/operator." A contractual agreement may be in the form of a lease, easement, or letter of agreement signed by the legal owners of the property. This does not necessarily mean the property must be within the area of the special permit, but may have a separate agreement with the property owner.

8. There currently are no noise regulations in the County jurisdiction, although noise is mentioned in the conditions for Airfield, dwellings within 1320' of a public lake, race track and drag strip, and CWECS. Airfields and dwellings near a lake do not mention specific noise standards, only that noise should be considered. Race tracks and drag strip have specific requirements based upon the pre-construction Noise Pollution Levels and allowing noise levels to exceed this baseline by 10 dB between 10 am and 6 pm, and 6 dB between 6 pm and 10 am, but in no case to exceed 81 dBA. (Note: dB or decibels is a measure of loudness of sound. dBA, decibels measured on the "A" scale, is often used because it approximates how the human ear responds to noise at moderate levels.)

9. Current standards in the County Zoning Resolution require the wind turbine to be rated at 35 dBA. There are currently no commercial wind turbines that are rated at 35 dBA. The majority are rated between 95 and 110 dBA. This means that currently a wind turbine could not be located in Lancaster County. Additionally, the value of the noise rating at the turbine is not as important as the experience of noise by residents in the area. This reference to the rating of the machine is recommended to be removed.

10. Typical noise emitted by common sources is reported differently by different sources of the information. The following is a sampling of typical noise levels as compiled from those reported by Temple University Department of Civil/Environmental Engineering, the Noise Pollution Clearing House, Center for Human Performance & Health, Ontario, Canada, the US Environmental Protection Agency, and the 3M Occupational Health and Environmental Safety Division.

Just audible to most people	10 dBA
Quiet Rural Area	30 dBA
Quiet whisper at 3 ft	30 dBA
Ambient noise in a wilderness area	35 dBA
Rural Residential	39 dBA

Agricultural Crop Land	44 dBA
Typical living room in a quiet house	35 - 45 dBA.
Quiet neighborhood in an urban setting	40 - 45 dBA
Refrigerator	40 to 45 dBA
Wooded residential area	50 dBA
Window air conditioner	50 dBA
A quiet conversation	55 - 65 dBA
An air conditioning unit at 100'	60 dBA
Vacuum cleaner	80 dBA
Blender	90 dBA
Motorized lawn mower	105 dBA

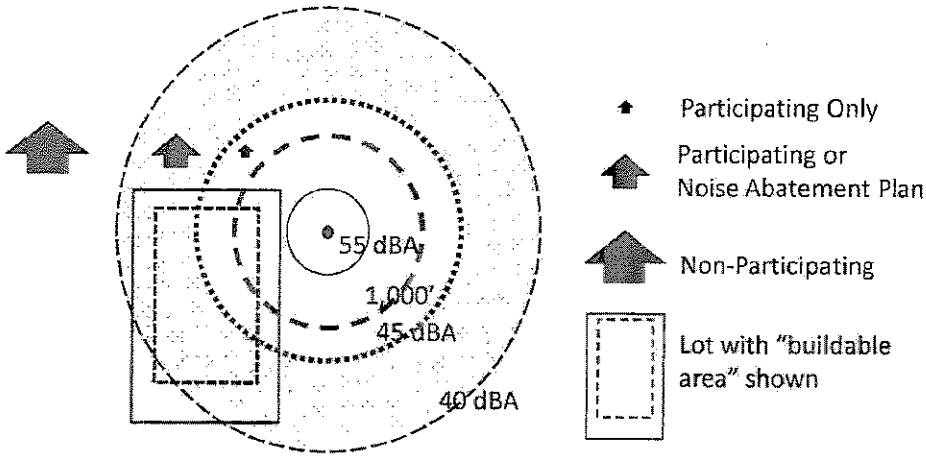
In addition to the perceived "loudness" of noise, it is important to understand that sound also has qualitative aspects and can be more disruptive to people when it is irregular, has higher or lower pitch, or has an impulsive character.

11. The turbine height is defined as the hub height plus the rotor radius.

Hub height

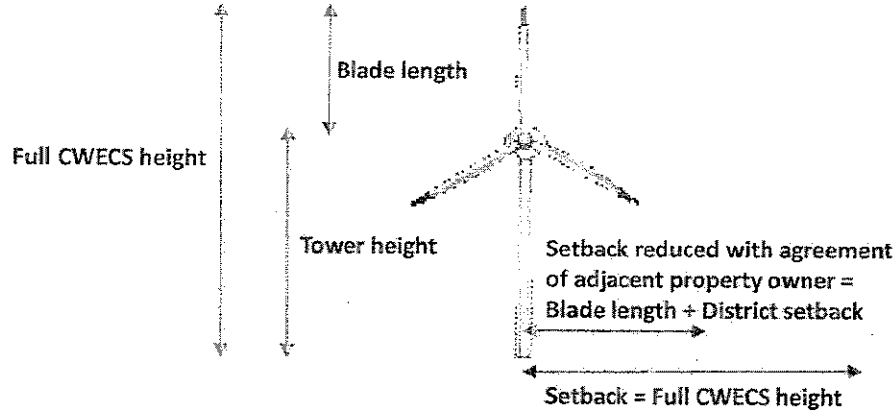
12. The following exhibit is for the review of setbacks and noise on non-participating lots.

Exhibit 2: Noise Contours and 1,000 foot Setback Affect on Unbuilt Lot.



Wind Turbine (center) with noise contours and1,000 foot setback from dwellings shown. Lot with "buildable area" (area within the required district setbacks) demonstrates there is only a small area in the lower left corner that would remain outside the noise and 1,000 foot setback.

Exhibit 1: Tower Height and Setbacks



13. The Lincoln/ Lancaster County Health Department basis for recommendations regarding noise and noise monitoring are found in the attached document. The Health Department notes that these "recommendations are based on the most recent research and review reports cited on the next pages. Of particular importance to the updated recommendations were findings in studies published in late 2014 and early 2015. These studies expanded and improved the knowledge on the potential health risk posed by wind turbine noise, the percentage of people exposed to wind turbine noise that will be annoyed or extremely annoyed, and found that self-reported annoyance was statistically significantly associated with sleep disturbance, and human physiological responses of stress levels (as measured by cortisol) and increased blood pressure (directly measured in exposed individuals)."

14. The following pages review the various aspects of CWECS and the recommendations regarding the County zoning:

Review Topic	Action Recommended for Text Amendment
Economic Implications for land owners & County	
There are many positive economic benefits of wind turbines. Leaseholder receive substantial monthly income over a long period of time. Construction brings work and spending within the County as well as long term employment for a few employees to monitor the turbines. The owner of a wind energy generation facility must pay a nameplate capacity tax equal to the total nameplate capacity of the commissioned wind energy generation facility multiplied by a tax rate of $3,518 per megawatt. In Custer County, a facility with 50 turbines, this amounted to $280,000 per year divided among the various tax jurisdictions in the county. The state does not retain any of the proceeds for administration.	No specific text. (Lancaster County and its residents will benefit by permitting commercial wind energy projects if there is adequate protection of adjacent property owners and residents.)
Processing of Multiple Turbines over a Large Area	
Currently, for a large project with 40 or 50 or more turbines, the special permit rules could require 20 or more separate special permit applications. This would make processing difficult. The proposed text allows turbines in one project, but which are separated from one another only by the presence of public right-of-way may be combined into one special permit application. When a CWECS special permit covers multiple premises, the lease or easement holder may sign the application rather than the lot owner.	New proposed text: (a) In cases where CWECS wind turbines are part of a unified plan, parcels which are separated from one another only by the presence of public right-of-way may be combined into one special permit application. When a special permit covers multiple premises, the lease or easement holder may sign the application rather than the lot owner.
Applicable codes	
CWECS must meet all applicable electrical, building utility tie in codes and other local, State and Federal rules and regulations.	Delete previous text (e). It is not necessary to note that CWECS must all applicable electrical, building codes and other local, State and Federal rules and regulations.

Review Topic	Action Recommended for Text Amendment
Color, Finish and Lighting	
Most ordinances have some standard prohibition against turbines being used for advertising or bright colors to attract attention. Additional text is proposed to state that there shall be no advertising, logo, and that each turbine shall have onsite a name plate which contains contact information of the operator. Concern was expressed about flashing lights on top of a turbine. Any structure above 200 feet tall must be reviewed by the Federal Aviation Administration for obstruction analysis. The FAA, and other relevant Federal agencies, make a determination if the structure impacts private or commercial airspace. If it is determined the project constitutes no-hazard to air navigation, it will also analyze the project as a whole and provide its recommended lighting requirements. Prescribed lighting is typically a slow blinking red light. In addition, newer technology is in development with radar-activated lighting, which detect aircraft presence and thus vary the lighting according to the need.	Proposed revised text: (b) Turbines shall meet all FAA requirements, including but not limited to lighting and radar interference issues. Strobe lighting shall be avoided if alternative lighting is allowed. Color and finish shall be white, gray or another non-obtrusive, non-reflective finish. There shall be no advertising, logo, or other symbols painted on the turbine other than those required by the FAA or other governing body. Each turbine shall have onsite a name plate which is clearly legible from the public right-of-way and contains contact information of the operator of the wind facility
Decommissioning of wind towers	
A decommissioning plan already requires removal of structures and restoration of land, as well as a requirement to post bonds that will assure the restoration work is accomplished. In a review of other jurisdictions, the requirements varies widely. Decommissioning plans are also often a part of the private lease agreements entered into with land owners. The revisions continue to require decommissioning plans for the removal of the tower itself but adding that four feet of soil is required between the ground level and cement base. Also add allowing up to one year before requiring removal to allow time for consideration of options after turbines cease operation. Removal of the access roads on private property would be left to the developer and property owners. Some property owners may wish to retain the access roads on private property.	Proposed revised text: © Each application shall have a decommissioning plan outlining the means, procedures and cost of removing the turbine(s) and all related supporting infrastructure and a bond or equivalent enforceable resource to guarantee removal and restoration upon discontinuance, decommissioning or abandonment. Each tower shall be removed within one year of decommissioning or revocation of the special permit. Upon removal of the tower, there shall be four feet of soil between the ground level and former tower's cement base.

Review Topic	Action Recommended for Text Amendment
Shadow Flicker	
Shadow flicker is the phenomenon caused by the moving shadow of the wind turbine blades moving over a point. The area where flicker is experienced moves as the sun's position relative to the ground changes throughout the day and season to season. It would be at the peak in winter months. One change to the July 9th draft is to address what happens if a turbine violates this standard on a dwelling unit constructed after the turbine is approved. In this case, the turbine becomes a non-conforming, but can remain subject to the zoning regulations for non-conforming uses.	New text proposed: (d) Any proposed turbine which is within half mile of any non-participating dwelling shall provide shadow flicker modeling data showing the expected effect of shadow flicker on non-participating properties. Shadow flicker shall not fall upon any non-participating dwelling, or other building which is occupied by humans, for more than 30 minutes in any one day, nor a total of 30 hours per any calendar year. If shadow flicker exceeds these limits, measures shall be taken to reduce the effects of shadow flicker on buildings, which may include shutting the turbine down during periods of shadow flicker. If a turbine violates this standard on a non-participating dwelling unit, constructed after the turbine is approved, then the turbine becomes a non-conforming use.
Environmental implications	
There is no significant impact on air or water resources. Footprint of any one turbine on land is relatively small. The University of Nebraska and the Nebraska Game and Parks Commission have developed a Nebraska Wind and Wildlife map which identifies the relative sensitivity of biological populations in Nebraska. Lancaster County is shown as an area of low sensitivity, however there are biologically unique areas within Lancaster associated with the Eastern Saline Wetlands which should be protected. Wind turbines do result in bird deaths, but it is relatively less nationally compared to cars, buildings, power lines, communication towers, agricultural chemicals and cats.	New text proposed: (e) Construction and operation shall not adversely impact identified State or Federal threatened or endangered species such as saline wetlands, or rare natural resources such as native prairie and grasslands.

Review Topic	Action Recommended for Text Amendment
Ice Throw	
Ice throw is the phenomenon of ice, which builds up on turbine blades during particular meteorological conditions, being "thrown" from the blades as they turn or being blown from the blades as they are stationary. Most modern turbines are able to detect vibration of turbine blades that can be caused by a build-up of ice and are programmed to shut down in such conditions in order to address safety issues and to protect equipment from damage. Turbine condition monitoring (for example, torque and vibration sensing) will detect changes to the performance of the blades by damage or by ice accumulation and shut them down. In addition, the change to the shape of blade from ice changes the lift and thus the performance of the machine, in relation to its "ice-free" state, and this would also be detected. While safety is the top priority, such measures are also in the interest of machine longevity as operating with ice loads would add to torque loads, mechanical wear, reduced performance, etc." The minimum setback of 1,000 feet provides sufficient space from all dwellings to protect from many of the impacts of the turbines.	No specific text. (New turbines are better designed to minimize and monitor ice on the blades. In addition, setbacks to the property line and right-of-way are substantial so no separate setback for ice throw is proposed.)
Important view corridors	
Concern was expressed about wind turbines blocking the view to the State Capitol. Also concern about views from the Homestead National Monument (in Gage Co.), Nine Mile Prairie or Spring Creek prairie. There were opinions for and against having wind turbines along entryways into Lincoln. Some stated that they didn't want their personal view from their house diminished by views of turbines. However, views from personal property can be altered by an adjoining property owner erecting accessory buildings or antennas or planting trees on their own property, though these would not be near the size of a wind turbine.	New text proposed: (f) No turbine shall obstruct or impair an identified view corridor or scenic vista of public value, as mapped on the Capitol View Corridors map in the Lincoln/ Lancaster County Comprehensive Plan. The views from prominent environmental areas, such as Nine Mile Prairie and Spring Creek Prairie, shall also be protected from adverse visual or noise impacts. Any application which, upon initial review, poses a possible impact to these views will be required to be relocated or provide view shed mapping, and visual simulations from key observation points for review.

Review Topic	Action Recommended for Text Amendment
Setback to Dwelling	
Current language requires a 1,000 foot setback to the property line of existing dwellings not associated with the project. The large variation in lot sizes in the AG district means some dwellings may sit on a large parcel with the dwelling at the far end while others are on a smaller parcel with the dwelling close to the property line. Measuring to the dwelling is a more consistent method. A setback of specific distance does not take into account differences in height of the turbines. For example, the visual impact of a 260 foot turbine is different than a 475 foot turbine. So many communities have include both a minimum setback and a setback based on height and used the greater distance. The increased distance reduces the visual impact, shadow flicker impact and the risk of ice throw. While distance does reduce noise, the primary measure for noise should be a noise standard which is addressed separately. The setback assists in noise reduction, but it will only be pertinent for noise reduction where the ambient background noise might be higher already, such as along a highway. The noise standard will be the primary measure for addressing any noise impacts. This setback is necessary for circumstances where there is not an existing dwelling on the adjacent non-participating property. If the adjacent lot is primarily for residential use (less than 10 acres) then the setback to the vacant lot should be larger. Ten acres was chosen as the dividing line between residential and farm lots. Lots of 10 acres or more can be created without a final plat because they are considered agricultural in use.	New text proposed: (g) Setbacks to the turbine base: 1) For a non-participating lot of less than 10 acres, the setback shall be 1,000 feet or 3 times the turbine height (hub height plus the rotor radius), whichever is greater, measured to the property line. 2) For a non-participating lot of 10 acres or greater, when there is a dwelling unit on the lot, the setback shall be 1,000 feet or 3 times the turbine height, whichever is greater, measured to the closest exterior wall of the dwelling unit. 3) For participating dwelling units, the setback shall be 1,000 feet to the closest exterior wall of the dwelling.

Review Topic	Action Recommended for Text Amendment
Setback to Right of Way	
The purpose of this requirement is to provide for a "worst case scenario" of a tower falling over as a tree does when felled. In general towers are highly unlikely to fall over in this manner, and when failures have occurred they rather occur as a collapse of the tower. There are over 45,000 turbines in the U. S. and there are less than a dozen incidents of a complete collapse event, according to industry experts. The setback of the full turbine height is recommended by the County Engineer to be maintained when adjacent to public right-of-way in order to assure public safety and clear passage of traffic.	New text proposed: (g) Setbacks to the turbine base: 4) The setback to any public right-of-way or private roadway shall be no less than the turbine height.
Setback to Special Permit Boundary	
In addition to the setbacks for streets or to lots with adjacent dwellings, the proposed text includes a standard setback along the perimeter of the special permit. This setback would apply to properties without a dwelling unit.	(g) Setbacks to the turbine base: 5) Setbacks to the external boundary of the special permit area shall be no less than the turbine height, except that the owner of the adjacent property may sign an agreement allowing that setback to be reduced to the rotor radius plus the setback of the zoning district.
Impact on property value of adjacent land	
There is considerable debate about the impact of wind turbine projects on adjacent land values. There are so many factors that go into the value of a house and land that it is difficult to isolate individual elements. Certainly not everyone wants to live near to a wind turbine, so the number of potential buyers would be significantly reduced for small acreage lots. Particularly in an area with many available lots or homes, some buyers will not want a lot nearer to a wind turbine. Many acreage owners specifically moved onto an acreage to be further from the urban environment. However, even in a rural area, adjacent owners have the right to run machinery, build large accessory buildings that obstruct views and conduct farm operations late at night. So an acreage lot doesn't guarantee a quiet setting and unobstructed views.	Wind turbines can have more of an impact on the enjoyment and market for small acreage lots when compared to large farm parcels. Thus, the setback to a nonparticipating residential acreage lot under 10 acres should be larger than the setback to a farm property of more than 10 acres.

Review Topic	Action Recommended for Text Amendment
Impact on development and subdivisions	
It is possible that a non-participating vacant parcel could be significantly impacted by the noise of the turbines and fall within the turbine setbacks. The owner of the vacant parcel could still legally build on their lot, but the enjoyment of the parcel, particularly a smaller parcel could be reduced. The proposed text would require that lots, which because of the location of a CWECS are left with little land outside of the CWECS setbacks or the noise impact area, must be part of a contractual agreement with the CWECS owner/operator. There should be a standard that for vacant farm lots over 10 acres so that the area of the lot outside of the noise contours and setbacks is substantial. This will allow the owner of vacant land to have some choices in location on which to build a house outside of the setbacks and noise contours if they wish.	New text proposed: (h) ~~Any single~~ The turbine(s) shall not impact a non-participating lot, (vacant or occupied; of any size), to the extent that, because of the location of turbine(s), the lot owner is left with less than 3 acres of land outside of the CWECS setbacks and ~~or~~ the noise impact area in Section (i) below, unless they are part of an agreement with the CWECS owner/operator.
Emergency Response to turbine fire	
Some have suggested banning crops under turbines due to potential for lightning strikes and fires. This would significantly reduce the cropland area around a turbine. The risk of lightning strike and crop fire is not significantly more than other lightning strikes to warrant the significant increase in cost of wind turbines and resulting loss of crop land.	No specific text necessary (Local volunteer fire departments and wind turbine operators should meet to discuss plan for if a turbine caught fire.)

Review Topic	Action Recommended for Text Amendment
Noise	
Noise from wind turbines has been shown to be a significant concern and source of investigation. Recent research papers and studies on wind turbine noise and potential health impacts indicate that noise from wind turbines causes annoyance which can lead to sleep disturbance. In considering how to establish wind turbine noise level limits for dwellings, the Lincoln/ Lancaster County Health Department (LLCHD) only considered potential negative public health impacts. In addition, the LLCHD believes that all persons should be afforded, regardless of lease agreements, the same level of public health protection. See attached report from Health Department on noise studies and noise recommendations. One change to the July 9th draft is to address what happens if a turbine violates this standard on a dwelling unit constructed after the turbine is approved. In this case, the turbine becomes a non-conforming, but can remain subject to the zoning regulations for non-conforming uses.	New text proposed: (i) Noise: No CWECS or combination of CWECS turbine(s) shall be located as to cause an exceedance of the following as measured at the closest exterior wall of any dwelling located on the property. If a turbine violates a noise standard on a dwelling unit, constructed after the turbine is approved, then the turbine becomes a non-conforming use. For both participating and nonparticipating properties: (1) From the hours of 7 am to 10 pm: * Forty (40) dBA maximum 10 minute Leq or; * Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 15 hour period. (2) From the hours of 10 pm to 7 am: * Thirty-seven (37) dBA maximum 10 minute Leq or * Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 9 hour period.

Review Topic	Action Recommended for Text Amendment
Noise Studies & Monitoring	
The purpose of noise studies is to provide data that will be used to assess potential public health impacts and compliance with the noise limits established in the county resolution.	New text proposed: (j) A professional pre-construction noise study shall be conducted which includes all property ~~with a dwelling~~ within one mile of a tower support base. The protocol and methodology for such studies shall be submitted to the Lincoln-Lancaster County Health Department for review and approval. Such studies shall include noise modeling for all four seasons and include typical and worst case scenarios for noise propagation. The complete results and full study report shall be submitted to the Lincoln-Lancaster County Health Department for review. (k) Prior to the commencement of construction of any turbine, pre-construction noise monitoring may be conducted to determine ambient sound levels in accordance with procedures acceptable to the Lincoln-Lancaster County Health Department.
Public road improvements needed for construction	
In some jurisdictions, wind developers have rebuilt bridges, roads and intersections, under government supervision, in order to carrying the required loads during CWECS construction. This was the experience in Gage County where the developer worked in advance with government officials on the routing of construction equipment and necessary improvements. After the towers are built, the impact on the roads is minimal.	New text proposed: (l) Prior to the commencement of construction of any turbine, the applicant shall enter into an agreement with the County Engineer regarding use of County roads during construction.

Review Topic	Action Recommended for Text Amendment
Noise Complaints	
The Building and Safety Department is the primary zoning enforcement agency. The County Board can revoke any special permit if the conditions of approval are not being met. Building and Safety often relies upon complaints received from the public to determine when investigative action needs to take place and possible enforcement action taken. In some cases, permit holders must make annual reports to Building and Safety providing specific information on the operation and activities of the permit site. The proposed process for handling noise complaints is to forward them to the Board for their consideration. The Board would then decide if noise monitoring is necessary.	New text proposed: (m) At the discretion of the County Board, post-construction noise level measurements may be required to be performed in accordance with procedures acceptable to the Lincoln-Lancaster County Health Department. (n) All noise complaints regarding the operation of any CWECS shall be referred to the County Board. The County Board shall determine if noise monitoring shall be required to determine whether a violation has occurred.
Interference	
A CWECS must not interfere with established radio or microwave signals. Most wind projects hire a company which maintains a database to report on potential impact of the project on any non-federal government microwave systems. In addition, projects provide their layout to the United States Department of Commerce – National Telecommunications and Information Administration, for review by appropriate federal agencies to identify any concerns regarding blockage of radio transmissions.	No specific text. (No need for local regulations since this concern is handled at federal level.)
County Liability for approval of wind turbines	
The County Attorney's Office determined that was no case law that would indicate a cause of action would exist against a County for issuance of a special permit for a wind turbine site that has a later accident. Additionally, the Political Subdivision Tort Claims Act enumerates an exemption to political subdivision liability if the claim is based on "the issuance, denial, suspension, or revocation of or failure or refusal to issue, deny, suspend, or revoke any permit, license, certificate, or order." In the event the County was ever named in the type of law suit mentioned, this would undoubtedly be raised as a defense.	No specific text necessary.

15. Volkswind USA, was the applicant of the first proposed amendment in September 2014 to the Commercial Wind Energy regulations. Their application, Text Amendment #14014, was withdrawn in February 2015 prior to the Planning Commission public hearing. Volkswind has submitted alternative language to the proposal in this Text Amendment #15009. The alternative is attached.

Conclusion:
Given the amount of acreage development within Lancaster County, it will be difficult to meet the proposed regulations and still have a large scale wind operation. While wind energy is a goal of the Comprehensive Plan, it does not mean that should come at the cost to adjacent non-participating property owners. Lancaster County has numerous residents on smaller lots enjoying a quality of life in a rural setting. The "rural lifestyle" does come with noise and odors from agricultural operations. It also comes with large outbuildings and farm machinery. But none of these aspects of rural life compare to the potential impacts of a 250 to 500 foot wind turbine.

The changes to Section 13.018 provide for protection of the health, safety and welfare of the community while providing for the opportunity for the development of alternative energy in Lancaster County.

Prepared by

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DATE: July 30, 2015

13.018 Commercial Wind Energy Conversion System (CWECS).

A Commercial Wind Energy Conversion System (CWECS) may be allowed in the AG District by special permit under the conditions listed below:

(a) In cases where CWECS wind turbines are part of a unified plan, parcels which are separated from one another only by the presence of public right-of-way may be combined into one special permit application. When a special permit covers multiple premises, the lease or easement holder may sign the application rather than the lot owner.

~~(a) Each CWECS machine shall be no less than 1,000 feet from any property line of a dwelling unit not associated with the project.~~

~~(b) The distance from all external boundary lot lines and/or right-of-way lines of the special permit to any tower support base of the CWECS shall be equal to the height of the tower plus the rotor radius.~~

~~(c) Each CWECS machine, including all equipment, shall have a sound emission rating of no more than 35 dBA. Noise levels caused from the CWECS turbine(s) shall not exceed 35 dBA at the property line of any dwellings within a one mile radius of a CWECS turbine. A noise study, incorporating both A and C weighted noise impacts on property within one mile may be required. Noise rating shall conform to International Electrotechnical Commission (IEC) standards unless otherwise directed by a government agency.~~

~~(d)~~ (b) Turbines shall meet all FAA requirements, including but not limited to lighting and radar interference issues. Strobe lighting shall be avoided if alternative lighting is allowed. Color and finish shall be white, gray or another non-obtrusive, non-reflective finish. There shall be no advertising, logo, or other symbols painted on the turbine other than those required by the FAA or other governing body. Each turbine shall have onsite a name plate which is clearly legible from the public right-of-way and contains contact information of the operator of the wind facility.

~~(e) All applicable electrical, building, utility tie-in codes and other government regulations shall apply.~~

~~(f) The distance from any tower base of a CWECS to any tower support base of another CWECS under other ownership shall be spaced a minimum of five (5) rotor diameters distance figured by the size of the largest rotor.~~

~~(g)~~ (c) Each application shall have a decommissioning plan outlining the means, procedures and cost of removing the turbine(s) and all related supporting infrastructure and a bond or equivalent enforceable resource to guarantee removal and restoration upon discontinuance, decommissioning or abandonment. Each tower shall be removed within one year of decommissioning or revocation of the special permit. Upon removal of the tower, there shall be four feet of soil between the ground level and former tower's cement base.

~~(h) Said CWECS shall meet all Federal, State and local rules and regulations.~~

(d) Any proposed turbine which is within half mile of any non-participating dwelling shall provide shadow flicker modeling data showing the expected effect of shadow flicker on non-participating properties. Shadow flicker shall not fall upon any non-participating dwelling, or other building which is occupied by humans, for more than ~~30 minutes in any one day, nor~~ a total of 30 hours per any calendar

year. If shadow flicker exceeds these limits, measures shall be taken to reduce the effects of shadow flicker on buildings, which may include shutting the turbine down during periods of shadow flicker. If a turbine violates this standard on a non-participating dwelling unit, constructed after the turbine is approved, then the turbine becomes a non-conforming use.

(e) Construction and operation shall not adversely impact identified State or Federal threatened or endangered species such as saline wetlands, or rare natural resources such as native prairie and grasslands.

(f) No turbine shall obstruct or impair an identified view corridor or scenic vista of public value, as mapped on the Capitol View Corridors map in the Lincoln/ Lancaster County Comprehensive Plan. The views from prominent environmental areas, such as Nine Mile Prairie and Spring Creek Prairie, shall also be protected from adverse visual or noise impacts. Any application which, upon initial review, poses a possible impact to these views will be required to be relocated or provide view shed mapping, and visual simulations from key observation points for review.

(g) Setbacks to the turbine base:

1) For a non-participating lot of less than 10 acres, the setback shall be 1,000 feet or 3 times the turbine height (hub height plus the rotor radius), whichever is greater, measured to the property line.

2) For a non-participating lot of 10 acres or greater, when there is a dwelling unit on the lot, the setback shall be 1,000 feet or 3 times the turbine height, whichever is greater, measured to the closest exterior wall of the dwelling unit.

3) For participating dwelling units, the setback shall be 1,000 feet to the closest exterior wall of the dwelling.

4) The setback to any public right-of-way or private roadway shall be no less than the turbine height.

5) Setbacks to the external boundary of the special permit area shall be no less than the turbine height, except that the owner of the adjacent property may sign an agreement allowing that setback to be reduced to the rotor radius plus the setback of the zoning district.

(h) ~~Any single~~ The turbine(s) shall not impact a non-participating lot, (vacant or occupied; of any size), to the extent that, because of the location of turbine(s), the lot owner is left with less than 3 acres of land outside of the CWECS setbacks and ~~or~~ the noise impact area in Section (i) below, unless they are part of an agreement with the CWECS owner/operator.

(i) Noise: No CWECS or combination of CWECS turbine(s) shall be located as to cause an exceedance of the following as measured at the closest exterior wall of any dwelling located on the property. If a turbine violates a noise standard on a dwelling unit, constructed after the turbine is approved, then the turbine becomes a non-conforming use. For both participating and nonparticipating properties:

(1) From the hours of 7 am to 10 pm:
- ~~Forty (40)~~ Fifty (50) dBA maximum 10 minute Leq or;
- Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 15 hour period.

(2) From the hours of 10 pm to 7 am:

- ~~Thirty-seven (37)~~ Forty-two (42) dBA maximum 10 minute Leq or;
- Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be a Leq measured over a representative 9 hour period.

(j) A professional pre-construction noise study shall be conducted which includes all property ~~with a dwelling~~ within one mile of a tower support base. The protocol and methodology for such studies shall be submitted to the Lincoln-Lancaster County Health Department for review and approval. Such studies shall include noise modeling for all four seasons and include typical and worst case scenarios for noise propagation. The complete results and full study report shall be submitted to the Lincoln-Lancaster County Health Department for review.

(k) Prior to the commencement of construction of any turbine, pre-construction noise monitoring may be conducted to determine ambient sound levels in accordance with procedures acceptable to the Lincoln-Lancaster County Health Department.

(l) Prior to the commencement of construction of any turbine, the applicant shall enter into an agreement with the County Engineer regarding use of County roads during construction.

(m) At the discretion of the County Board, post-construction noise level measurements may be required to be performed in accordance with procedures acceptable to the Lincoln-Lancaster County Health Department.

(n) All noise complaints regarding the operation of any CWECS shall be referred to the County Board. The County Board shall determine if noise monitoring shall be required to determine whether a violation has occurred.

Lincoln-Lancaster County Health Department
Recommendations for Noise Levels from
Commercial Wind Energy Conversion Systems

June 2015

The Lincoln-Lancaster County Health Department (LLCHD) recommends the following language for an updated text amendment to the County Resolution addressing noise levels from Commercial Wind Energy Conversion Systems:

No CWECS or combination of CWECS machine(s) shall be located as to cause an exceedance of the following as measured at the closest exterior wall of any participating or non-participating dwelling:

- **From the hours of 7 am to 10 pm:**
  - **Forty (40) dBA maximum 10 minute Leq or;**
  - **Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be an Leq measured over a representative 15 hour period.**
- **From the hours of 10 pm to 7 am:**
  - **Thirty-seven (37) dBA maximum 10 minute Leq or;**
  - **Three (3) dBA maximum 10 minute Leq above background level as determined by a pre-construction noise study. The background level shall be an Leq measured over a representative 9 hour period.**

LLCHD has modified the recommended allowable levels previously suggested for the Lancaster County Resolution text amendment in January 2015. The main changes to our recommendation are:

- changing the L10 noise metric to the more common Leq,
- changing the daytime limit of 45 dBA L10 to 40 dBA Leq,
- changing the nighttime limit of 40 dBA L10 to 37 dBA Leq,
- reducing the measuring period from 1 hour to 10 minutes,
- reducing the level of noise allowed above existing background noise from 5 dBA to 3 dBA, and
- establishing the same noise levels for both participating and non-participating households, assuring equal public health protection for all persons.

These recommendations are based on the most recent research and review reports cited on the next pages. Of particular importance to the updated recommendations were findings in studies published in late 2014 and early 2015. These studies expanded and improved the knowledge on the potential health risk posed by wind turbine noise, the percentage of people exposed to wind turbine noise that will be annoyed or extremely annoyed, and found that self-reported annoyance was statistically

significantly associated with sleep disturbance, and human physiological responses of stress levels (as measured by cortisol) and increased blood pressure (directly measured in exposed individuals).

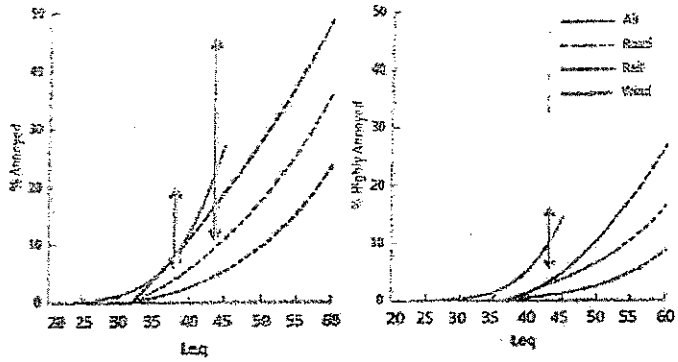
Other factors that influenced LLCHD's recommendation included:

1) Wind turbine noise is more annoying to people than other comparable noise, such as noise from traffic or airports. The primary reason appears to be that wind turbine noise has unique characteristics (significant and frequent amplitude modulation). No matter what the source of noise, if it includes amplitude modulation persons exposed to it will respond as if it were a higher level of noise and indicate that it is more annoying than a noise of the same sound pressure level which does not have amplitude modulation.

2) The 2015 Canadian Academies Expert Panel included this statement in their report: "The Panel stresses that, given the nature of the sound produced by wind turbines and the limited quality of available evidence (small sample sizes, small number of studies available, lack of comprehensive exposure measurement), the health impacts of wind turbine noise cannot be comprehensively assessed at this time."

   This means that there is still considerable uncertainty in potential health impacts with the research that has been conducted to date. In addition, the data on chronic disease health outcomes is significantly limited by the short period of time (last 7 to 10 years) that wind energy systems have grown substantially in number, size, and power output . Chronic disease health outcomes may take 20 to 30 years to develop.

3) Data on annoyance from multiple studies, including the 2015 Health Canada study, indicated that the percentage of people that will be "very" or "extremely" annoyed increases considerably when they are exposed to noise levels above 40 dBA. In late 2014, Schmidt and Klokker indicated that 35 dBA appears to be a "tolerable level". The somewhat older Massachusetts expert panel review (2012) recommended Denmark's nighttime noise limit for residential areas of 37 dBA when wind speeds were 6 m/sec (about 13 mph) and 39 dBA when wind speeds are 8 m/sec (about 18 mph) as a "Promising Practice".



LLCHD estimates of Annoyance with leq in dB(A) based on Canadian Academies study Figure 6.1 using a 5dB conversion factor for Lden to leq
- Range estimates from Pedersen (2011)
- Range estimates from Health Canada (2015) of very or extremely annoyed

4) There appears to be evidence that a small percentage of the population is more senstive to wind turbine noise than the population as a whole.

Staff reviewed many studies, papers, news reports, websites, etc. on wind turbines and potential health impacts. Staff considered the following to be the most valuable and scientifically sound.

1) ***Wind Turbine Health Impact Study: Report of Independent Expert Panel***, January 2012; Prepared for: Massachusetts Department of Environmental Protection & Massachusetts Department of Public Health

2) ***Health Effects Related to Wind Turbine Noise Exposure: A Systematic Review.*** This article was written by Jesper Hvass Schmidt and Mads Klokker. (Reference: Schmidt JH, Klokker M (2014) Health Effects Related to Wind Turbine Noise Exposure: A Systematic Review. PLoS ONE 9(12): e114183.)

3) ***World Health Organization, Nighttime Noise in Europe***, 2009. ISBN 978 92 890 41737

4) ***Understanding the Evidence: Wind Turbine Noise; The Expert Panel on Wind Turbine Noise and Human Health*** by the Council of Canadian Academies (2015), http://www.scienceadvice.ca/en/assessments/completed/wind-turbine-noise.aspx

5) **Health Canada Wind Turbine Noise and Health Study (2015)**, http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php
This was a very well designed epidemiological study of people residing in 1,238 dwelling units exposed to wind turbine noise.

LLCHD also recommends the following with regard to noise modeling, monitoring and complaints.

1) Pre-construction Noise Modeling. A pre-construction noise study on property with a dwelling within one mile of a tower support base shall be required. The protocol and methodology for such studies shall be submitted to the Lincoln-Lancaster County Health Department for review and approval. The results of such studies shall be submitted to the Lincoln-Lancaster County Health Department for review.

2) Pre-Construction Noise Level Monitoring. Prior to the commencement of construction of any CWECS machine, pre-construction noise monitoring may be conducted to determine ambient sound levels in accordance with procedures acceptable to the Lincoln-Lancaster County Health Department.

3) Post-construction Noise Monitoring. At the discretion of the County Board, post-construction noise level measurements may be required to be performed in accordance with procedures acceptable to the Lincoln-Lancaster County Health Department.

4) CWECS Noise Complaints. All noise complaints regarding the operation of any CWECS shall be referred to the County Board. The County Board shall determine if noise monitoring shall be required to determine whether a violation has occurred.

Wind Turbine Health Impact Study: Report of Independent Expert Panel; January 2012; Prepared for: Massachusetts Department of Environmental Protection & Massachusetts Department of Public Health

The Massachusetts Department of Environmental Protection (MassDEP) in collaboration with the Massachusetts Department of Public Health (MDPH) convened a panel of independent experts to identify any documented or potential health impacts of risks that may be associated with exposure to wind turbines, and, specifically, to facilitate discussion of wind turbines and public health based on scientific findings.

Expert Independent Panel Members:

Jeffrey M. Ellenbogen, MD; MMSc; Assistant Professor of Neurology, Harvard Medical School; Division Chief, Sleep Medicine, Massachusetts General Hospital

Sheryl Grace, PhD; MS Aerospace & Mechanical Engineering; Associate Professor of Mechanical Engineering, Boston University

Wendy J Heiger-Bernays, PhD; Associate Professor of Environmental Health, Department of Environmental Health; Boston University School of Public Health; Chair, Lexington Board of Health

James F. Manwell, PhD Mechanical Engineering; MS Electrical & Computer Engineering; BA Biophysics; Professor and Director of the Wind Energy Center, Department of Mechanical & Industrial Engineering University of Massachusetts, Amherst

Dora Anne Mills, MD, MPH, FAAP; State Health Officer, Maine 1996–2011; Vice President for Clinical Affairs, University of New England

Kimberly A. Sullivan, PhD; Research Assistant Professor of Environmental Health, Department of Environmental Health; Boston University School of Public Health

Marc G. Weisskopf, ScD Epidemiology; PhD Neuroscience; Associate Professor of Environmental Health and Epidemiology; Department of Environmental Health & Epidemiology, Harvard School of Public Health; Facilitative Support provided by Susan L. Santos, PhD, FOCUS GROUP Risk Communication and Environmental Management Consultants

Extensive literature searches and reviews were conducted to identify studies that specifically evaluate human population responses to turbines, as well as population and individual responses to the three primary characteristics or attributes of wind turbine operation: noise, vibration, and flicker. Beyond traditional forms of scientific publications, the Panel also took great care to review other non-peer reviewed materials regarding the potential for health effects including information related to "Wind Turbine Syndrome" and provided a rigorous analysis as to whether there is scientific basis for it. Since the most commonly reported complaint by people living near turbines is sleep disruption, the Panel provided a robust review of the relationship between noise, vibration, and annoyance as well as sleep disturbance from noises and the potential impacts of the resulting sleep deprivation.

In assessing the state of the evidence for health effects of wind turbines, the Panel followed accepted scientific principles and relied on several different types of studies. The non-peer reviewed material was considered part of the weight of evidence. In all cases, data quality was considered; at times, some studies were rejected because of lack of rigor or the interpretations were inconsistent with the

scientific evidence. The report cited about 100 specific references and provided a Bibliography containing about 115 reports, papers, regulations, etc. that were considered by the panel.

The Panel came to the following conclusions on health impacts of noise and vibration:

1. Most epidemiologic literature on human response to wind turbines relates to self-reported "annoyance," and this response appears to be a function of some combination of the sound itself, the sight of the turbine, and attitude towards the wind turbine project.
   a. There is limited epidemiologic evidence suggesting an association between exposure to wind turbines and annoyance.
   b. There is insufficient epidemiologic evidence to determine whether there is an association between noise from wind turbines and annoyance independent from the effects of seeing a wind turbine and vice versa.
2. There is limited evidence from epidemiologic studies suggesting an association between noise from wind turbines and sleep disruption. In other words, it is possible that noise from some wind turbines can cause sleep disruption.
3. A very loud wind turbine could cause disrupted sleep, particularly in vulnerable populations, at a certain distance, while a very quiet wind turbine would not likely disrupt even the lightest of sleepers at that same distance. But there is not enough evidence to provide particular sound-pressure thresholds at which wind turbines cause sleep disruption. Further study would provide these levels.
4. Whether annoyance from wind turbines leads to sleep issues or stress has not been sufficiently quantified. While not based on evidence of wind turbines, there is evidence that sleep disruption can adversely affect mood, cognitive functioning, and overall sense of health and well-being.
5. There is insufficient evidence that the noise from wind turbines is *directly (i.e., independent from an effect on annoyance or sleep)* causing health problems or disease.
6. Claims that infrasound from wind turbines directly impacts the vestibular system have not been demonstrated scientifically. Available evidence shows that the infrasound levels near wind turbines cannot impact the vestibular system.
7. There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome."
8. The strongest epidemiological study suggests that there is not an association between noise from wind turbines and measures of psychological distress or mental health problems. There were two smaller, weaker, studies: one did note an association, one did not. Therefore, we conclude the weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems.
9. None of the limited epidemiological evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine.

Health Impacts of Shadow Flicker

1. Scientific evidence suggests that shadow flicker does not pose a risk for eliciting seizures as a result of photic stimulation.
2. There is limited scientific evidence of an association between annoyance from prolonged shadow flicker (exceeding 30 minutes per day) and potential transitory cognitive and physical health effects.

Ice Throw

Production of Ice Throw

Ice can fall or be thrown from a wind turbine during or after an event when ice forms or accumulates on the blades.

1. The distance that a piece of ice may travel from the turbine is a function of the wind speed, the operating conditions, and the shape of the ice.
2. In most cases, ice falls within a distance from the turbine equal to the tower height, and in any case, very seldom does the distance exceed twice the total height of the turbine (tower height plus blade length).

Health Impacts of Ice Throw

1. There is sufficient evidence that falling ice is physically harmful and measures should be taken to ensure that the public is not likely to encounter such ice.

Other Considerations

In addition to the specific findings stated above for noise and vibration, shadow flicker and ice throw, the Panel concludes the following:

1. Effective public participation in and direct benefits from wind energy projects (such as receiving electricity from the neighboring wind turbines) have been shown to result in less annoyance in general and better public acceptance overall.

The Panel developed "Best Practices" Recommendations Regarding Human Health Effects of Wind Turbines

Noise

Evidence regarding wind turbine noise and human health is limited. There is limited evidence of an association between wind turbine noise and both annoyance and sleep disruption, depending on the sound pressure level at the location of concern. However, there are no research-based sound pressure levels that correspond to human responses to noise. A number of countries that have more experience with wind energy and are protective of public health have developed guidelines to minimize the possible adverse effects of noise. These guidelines consider time of day, land use, and ambient wind speed. The table below summarizes the guidelines of Germany (in the categories of industrial, commercial and villages) and Denmark (in the categories of sparsely populated and residential). The sound levels shown in the table are for nighttime and are assumed to be taken immediately outside of the residence or building of concern. In addition, the World Health Organization recommends a maximum nighttime sound pressure level of 40 dB(A) in residential areas. Recommended setbacks corresponding to these values may be calculated by software such as WindPro or similar software. Such calculations are normally to be done as part of feasibility studies. The Panel considered the guidelines shown below to be Promising Practices (Category 3) but to embody some aspects of Field Tested Best Practices (Category 2) as well.

Promising Practices for Nighttime Sound Pressure Levels by Land Use Type

Land Use	**Sound Pressure Level dB(A) Nighttime Limits**
Industrial	70
Commercial	50
Villages, mixed usage	45
Sparsely populated areas, 8 m/s wind*	44
Sparsely populated areas, 6 m/s wind*	42
Residential areas, 8 m/s wind*	39
Residential areas, 6 m/s wind*	37

**measured at 10 m above ground, outside of residence or location of concern*

The time period over which these noise limits are measured or calculated also makes a difference. For instance, the often-cited World Health Organization recommended nighttime noise cap of 40 dB(A) is averaged over one year (and does not refer specifically to wind turbine noise). Denmark's noise limits in the table above are calculated over a 10-minute period. These limits are in line with the noise levels that the epidemiological studies connect with insignificant reports of annoyance.

The Panel recommends that noise limits such as those presented in the table above be included as part of a statewide policy *(in Massachusetts)* regarding new wind turbine installations. In addition, suitable ranges and procedures for cases when the noise levels may be greater than those values should also be considered. The considerations should take into account trade-offs between environmental and health impacts of different energy sources, national and state goals for energy independence, potential extent of impacts, etc.

Shadow Flicker

Based on the scientific evidence and field experience related to shadow flicker, Germany has adopted guidelines that specify the following:

1. Shadow flicker should be calculated based on the astronomical maximum values (i.e., not considering the effect of cloud cover, etc.).
2. Commercial software such as WindPro or similar software may be used for these calculations. Such calculations should be done as part of feasibility studies for new wind turbines.
3. Shadow flicker should not occur more than 30 minutes per day and not more than 30 hours per year at the point of concern (e.g., residences).
4. Shadow flicker can be kept to acceptable levels either by setback or by control of the wind turbine. In the latter case, the wind turbine manufacturer must be able to demonstrate that such control is possible.

Ice Throw

Ice falling from a wind turbine could pose a danger to human health. It is also clear that the danger is limited to those times when icing occurs and is limited to relatively close proximity to the wind turbine. Accordingly, the following should be considered Category 1 Best Practices.

1. In areas where icing events are possible, warnings should be posted so that no one passes underneath a wind turbine during an icing event and until the ice has been shed.
2. Activities in the vicinity of a wind turbine should be restricted during and immediately after icing events in consideration of the following two limits (in meters).

For a turbine that may not have ice control measures, it may be assumed that ice could fall within the following limit:

$x\left(R H\right)_{throw} = 1.5\ 2 + \max,$

Where: R = rotor radius (m), H = hub height (m)

For ice falling from a stationary turbine, the following limit should be used:

$\left(\ \right)/15_{\max,} x\ U\ R\ H_{fall} = +$

Where: U = maximum likely wind speed (m/s)

The choice of maximum likely wind speed should be the expected one-year return maximum, found in accordance to the International Electrotechnical Commission's design standard for wind turbines, IEC 61400-1. Danger from falling ice may also be limited by ice control measures. If ice control

measures are to be considered, the wind turbine manufacturer must be able to demonstrate that such control is possible.

Public Participation/Annoyance

There is some evidence of an association between participation, economic or otherwise, in a wind turbine project and the annoyance (or lack thereof) that affected individuals may express. Accordingly, measures taken to directly involve residents who live in close proximity to a wind turbine project may also serve to reduce the level of annoyance. Such measures may be considered to be a Promising Practice (Category 3).

The following is the Abstract for the December of 2014 PLOS One published an article titled Health Effects Related to Wind Turbine Noise Exposure: A Systematic Review. This article was written by Jesper Hvass Schmidt1,2,3*, Mads Klokker4,5 1. Institute of Clinical Research, University of Southern Denmark, Odense, Denmark, 2. Department of Audiology, Odense University Hospital, Odense, Denmark, 3. Department of ENT Head and Neck Surgery, Odense University Hospital, Odense, Denmark, 4. Department of ENT Head and Neck Surgery & Audiology, Copenhagen University Hospital, Copenhagen, Denmark, 5. Faculty of Health and Medical Sciences, Copenhagen University, Copenhagen, Denmark (Refernce: Schmidt JH, Klokker M (2014) Health Effects Related to Wind Turbine Noise Exposure: A Systematic Review. PLoS ONE 9(12): e114183.

Background: Wind turbine noise exposure and suspected health-related effects thereof have attracted substantial attention. Various symptoms such as sleep related problems, headache, tinnitus and vertigo have been described by subjects suspected of having been exposed to wind turbine noise.

Objective: This review was conducted systematically with the purpose of identifying any reported associations between wind turbine noise exposure and suspected health-related effects.

Data Sources: A search of the scientific literature concerning the health-related effects of wind turbine noise was conducted on PubMed, Web of Science, Google Scholar and various other Internet sources. Study Eligibility Criteria: All studies investigating suspected health-related outcomes associated with wind turbine noise exposure were included.

Results: Wind turbines emit noise, including low-frequency noise, which decreases incrementally with increases in distance from the wind turbines. Likewise, evidence of a dose-response relationship between wind turbine noise linked to noise annoyance, sleep disturbance and possibly even psychological distress was present in the literature. Currently, there is no further existing statistically-significant evidence indicating any association between wind turbine noise exposure and tinnitus, hearing loss, vertigo or headache.

Limitations: Selection bias and information bias of differing magnitudes were found to be present in all current studies investigating wind turbine noise exposure and adverse health effects. Only articles published in English, German or Scandinavian languages were reviewed.

Conclusions: Exposure to wind turbines does seem to increase the risk of annoyance and self-reported sleep disturbance in a dose-response relationship. There appears, though, to be a tolerable level of around LAeq of 35 dB. Of the many other claimed health effects of wind turbine noise exposure reported in the literature, however, no conclusive evidence could be found. Future studies should focus on investigations aimed at objectively demonstrating whether or not measureable health-related outcomes can be proven to fluctuate depending on exposure to wind turbines.

In 2009, the World Health Organization – Europe published a report titled: Night Noise Guidelines for Europe. The following is an abstract from that report:

The WHO Regional Office for Europe set up a working group of experts to provide scientific advice to the Member States for the development of future legislation and policy action in the area of assessment and control of night noise exposure. The working group reviewed available scientific evidence on the health effects of night noise, and derived health-based guideline values. In December 2006, the working group and stakeholders from industry, government and nongovernmental organizations reviewed and reached general agreement on the guideline values and key texts for the final document of the *Night noise guidelines for Europe.*

Considering the scientific evidence on the thresholds of night noise exposure indicated by Lnight,outside as defined in the Environmental Noise Directive (2002/49/EC), an Lnight,outside of 40 dB should be the target of the night noise guideline (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly. Lnight,outside value of 55 dB is recommended as an interim target for the countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers choose to adopt a stepwise approach. These guidelines are applicable to the Member States of the European Region, and may be considered as an extension to, as well as an update of, the previous WHO *Guidelines for community noise* (1999).

Below is a chart from the Executive Summary. This study was NOT specific to wind turbine noise, but did consider noise from all sources, such as traffic, industry, and airplanes.

Average night noise level over a year $L_{night,outside}$	Health effects observed in the population
Up to 30 dB	Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed. $L_{night,outside}$ of 30 dB is equivalent to the no observed effect level (NOEL) for night noise.
30 to 40 dB	A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. $L_{night,outside}$ of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise.
40 to 55 dB	Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.
Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.

Table 3
Effects of different levels of night noise on the population's health

Council of Canadian Academies, 2015. *Understanding the Evidence: Wind Turbine Noise*. Ottawa (ON): The Expert Panel on Wind Turbine Noise and Human Health, Council of Canadian Academies.

Executive Summary

Demand for renewable energy, including wind power, is expected to continue to grow both in Canada and globally for the foreseeable future. The wind energy sector in Canada has grown at an ever-increasing pace since the 1990s, and Canada is now the fifth-largest market in the world for the installation of new wind turbines. As the sector grows, the wind turbines being installed are getting more powerful. The first megawatt-scale turbines were installed in Canada in 2004, with 3 megawatt models arriving in 2008; larger models up to 7.5 megawatt are currently being tested internationally. To produce this power, turbines have also increased in size. As wind turbines become a more common feature of the Canadian landscape, this new source of environmental sound has raised concerns about potential health effects on nearby residents.

Determining whether wind power causes adverse health effects in people is therefore important so that all Canadians can equitably share in the benefits of this technology.

THE CHARGE TO THE PANEL

In response to growing public concern about the potential health effects of wind turbine noise, the Government of Canada, through the Minister of Health (the Sponsor), asked the Council of Canadian Academies (the Council) to conduct an assessment of the question:

Is there evidence to support a causal association between exposure to wind turbine noise and the development of adverse health effects?

The Charge also includes the following sub-questions:

Are there knowledge gaps in the scientific and technological areas that need to be addressed in order to fully assess possible health impacts from wind turbine noise?

Is the potential risk to human health sufficiently plausible to justify further research into the association between wind turbine noise exposure and the development of adverse health effects?

How does Canada compare internationally with respect to prevalence and nature of reported adverse health effects among populations living in the vicinity of commercial wind turbine establishments?

Are there engineering technologies and/or other best practices in other jurisdictions that might be contemplated in Canada as measures that may minimize adverse community response towards wind turbine noise?

The Panel defined *health* in a way that is consistent with the World Health Organization's concept of health: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). The Panel interpreted *noise* to include both objective measures of acoustic signals in the environment (*sound*), as well as subjective perceptions of sound sensations that are unwanted by the listener (*noise*). As there are a variety of wind turbines available worldwide, with differing sound characteristics, the Panel focused

specifically on the type that constitutes almost all of the installed turbines in Canada: modern, three-bladed, tower-mounted, utility-scale (500 kilowatt capacity or more), upwind, horizontal-axis wind turbines that were land-based.

THE PANEL'S APPROACH

To respond to the Charge, the Panel used an evidence-based approach to identify and review relevant research. First, the Panel identified more than 30 symptoms and health outcomes that have been attributed to exposure to wind turbine noise, based on a broad survey of peer-reviewed and grey literature, web pages, and legal decisions.

Empirical evidence related to any associations between these health outcomes and exposure to wind turbine noise was then collected from several sources, including peer-reviewed journal articles, conference papers, and grey literature. More than 300 publications were found through a comprehensive search, and these were narrowed down to 38 relevant studies related to the health effects of wind turbine noise. The body of evidence concerning each health outcome was appraised and assessed according to Bradford Hill's guidelines for causation, and summarized using standard terms adopted from the International Agency for Research on Cancer (IARC). The major steps of the Panel's approach are illustrated in Figure 1.

KEY FINDINGS

Based on its expertise and review of empirical research, the Panel made findings in the following areas:

Acoustic characteristics of wind turbine noise;

Evidence of causal relationships between exposure to wind turbine noise and adverse health effects;

Knowledge gaps and further research; and

Promising practices to reduce adverse community response.

Other aspects of the Charge, such as the prevalence of adverse health outcomes in Canada, could not be answered because of a lack of data.

ACOUSTIC CHARACTERISTICS OF WIND TURBINE NOISE

1. Sound from wind turbines is complex and variable

Like sound from any source, wind turbine noise can be described by frequency components (which determine pitch), sound pressure levels (which determine *loudness*), and the way both of these change over time. Sound from wind turbines is highly complex and variable, but has some characteristics that are similar to other sources of community noise, such as road and airport traffic noise:

Sound from wind turbines is *broadband*, composed of sound over a broad range of frequencies.

The overall sound pressure levels outdoors vary greatly depending on distance, wind speed, and transmission from the source to the receiver.

However, higher frequencies tend to be reduced indoors and with increasing distance, leading to an emphasis on lower frequencies.

It is amplitude modulated, with sound levels changing over time.

Wind turbines also emit sound with the following characteristics, which are less common than other sources of community noise:

Sounds from wind turbines may extend down to the infrasonic range and, in some cases, may include peaks or tonal components at low frequencies.

Sound emissions from a wind turbine increase with greater wind speed at the height of the blades, up to the turbine's *rated wind speed* (speed at which it generates maximum power), above which sound does not increase.

Sound from wind turbines can exhibit periodic *amplitude modulation*, often described as a "swishing" or "thumping" sound. The causes and consequences of this periodic amplitude modulation are areas of ongoing research, as wind turbine designers and manufacturers seek ways to reduce or mitigate it.

Most sound from wind turbines is produced by interactions between the surface of the blade and the air flowing over it (aerodynamic processes), which is strongest near — but not at — the blade tips. Mechanical noise from the physical movements of the gearbox, generator, and other components produces low-frequency tones in some cases.

2. Standard methods of measuring sound may not capture the low-frequency sound and amplitude modulation characteristic of wind turbine noise

Measurement of sound for health surveillance and research uses standard methods. The most commonly used methods include A-weighting, which emphasizes the frequencies according to human hearing sensitivity, and de-emphasizes low and very high frequencies. Although A-weighted measurement is an essential method, it may fail to capture the low-frequency components of wind turbine sound. In addition, measurement is often averaged over time (L_{eq}), which does not convey changes in sound pressure levels occurring in short periods (for example, within a second). Time-averaged measurement may thus fail to capture amplitude modulation.

A-weighted measurements are an important first step in determining people's exposure to audible sound in most cases, but more detailed measurements may be necessary in order for researchers to fully investigate the potential health impact of specific sources of wind turbine noise. The metrics of sound exposure most relevant to potential health outcomes are not completely understood, however, and remain an important area for further research.

WIND TURBINE NOISE AND ADVERSE HEALTH EFFECTS

The relevant empirical evidence was reviewed and weighted in order to determine the strength of evidence for a causal link between wind turbine noise and each potential adverse health effect.

3. The evidence is sufficient to establish a causal relationship between exposure to wind turbine noise and *annoyance*

The evidence consistently shows a positive relationship between outdoor wind turbine noise levels and the proportion of people who report high levels of annoyance. However, many factors can modify the strength of this relationship, such as a person's attitudes toward wind turbines

and any economic benefits the person derives from them. As well, visual and noise effects of wind turbines are difficult to isolate from each other. The current state of the evidence does not allow for a definite conclusion about whether annoyance is caused by exposure to wind turbine noise alone, or whether factors such as visual impacts and personal attitudes modify the noise-annoyance relation — and to what extent, since the studies completed to date do not measure these factors independently of each other. It is also unclear which sound characteristics contribute to long-term chronic annoyance, although low-frequency components and periodic amplitude modulation have been investigated as likely candidates.

4. There is limited evidence to establish a causal relationship between exposure to wind turbine noise and *sleep disturbance*

The available evidence suggests that a direct causal relationship or an indirect (via annoyance) relationship between exposure to wind turbine noise and sleep disturbance might exist. While sleep disruption has been investigated in several studies, the resulting evidence base is smaller than that which examines the relationship between wind turbine noise and annoyance.

5. The evidence suggests a lack of causality between exposure to wind turbine noise and *hearing loss*

There is convincing evidence that exposure to wind turbine noise at typical levels associated with regulated noise limits and setbacks (distance from structures) does not cause loss of hearing, even over a lifetime of exposure.

6. The Panel found inadequate evidence of a direct causal relationship between exposure to wind turbine noise and *stress*, although stress has been linked to other sources of community noise

Available evidence suggests that a direct or indirect mechanism between exposure to wind turbine noise and stress might exist, similar to the finding for sleep disturbance, but the evidence lacks methodological and statistical strength. *Stress* has been identified as a risk factor for a number of other diseases, such as cardiovascular diseases, in the context of long-term exposure to community noise from other sources, such as road, rail, and air traffic. The current evidence related to exposure to wind turbine noise and stress is inconsistent, however.

7. For *all other health effects* considered (fatigue, tinnitus, vertigo, nausea, dizziness, cardiovascular diseases, diabetes, etc.), the evidence was inadequate to come to any conclusion about the presence or absence of a causal relationship with exposure to wind turbine noise

Hypertension and other cardiovascular diseases, diabetes, tinnitus, cognitive or task performance, psychological health, and health-related quality of life have all been the subject of empirical, population-based, wind-turbine noise studies. The evidence, however, was inconsistent or the studies had methodological limitations preventing the determination of a causal relationship between these effects and exposure to wind turbine noise. None of the other health effects considered have been the subject of a population-level study or experiments in the context of wind turbine noise. Therefore, the evidence for a causal association is largely lacking for these other effects. Conclusions about causal relationships are therefore lacking for most of the health effects postulated in a wide variety of sources reviewed by the Panel, mainly as a result of lack of evidence or problems with the quality of evidence. However, research on environmental noise has shown that annoyance can be a contributing factor or precursor to adverse health effects such

as sleep disturbance, stress and cardiovascular diseases. The Panel thus developed a conceptual framework of pathways through which sound from wind turbines could plausibly result in health outcomes. Figure 2 shows this framework and summarizes the Panel's findings on the potential causal pathways between exposure to wind turbine noise and the development of adverse health effects, or the exacerbation of existing health conditions.

KNOWLEDGE GAPS AND FURTHER RESEARCH

8. Knowledge gaps prevent a full assessment of public health effects of wind turbine noise

The Panel identified specific knowledge gaps for each health condition studied, where specific types of evidence would help clarify the strength of associations, minimize bias, or eliminate possible confounding factors with respect to exposure to wind turbine noise. For example, it is unclear whether the possible pathway that could lead to sleep disturbance or stress is the direct result of exposure to wind turbine noise or of annoyance as a mediating factor.

Most existing epidemiological studies of wind turbine noise lack sufficient power to detect small changes in the risk of adverse health effects, or were designed in a way that could not rule out bias in responses or adequately control confounding factors. The Panel also identified an absence of longitudinal studies. The Panel stresses that there is a paucity of research on sensitive populations, such as children and infants and people affected by clinical conditions that may lead to an increased sensitivity to sound.

The use of adequate methods and procedures for measuring and modelling sound exposure from wind turbines, particularly indoors, would improve the quality of future studies on adverse health effects (see Key Finding 2).

9. Research on long-term exposure to wind turbine noise would provide a better understanding of the causal associations between wind turbine noise exposure and certain adverse health effects

Chronic annoyance and sleep disturbance have been linked to stress responses in studies of long-term exposure to other sources of noise, such as air and road traffic. Furthermore, these health effects are themselves risk factors for other diseases, such as cardiovascular diseases, which have previously been associated with long-term exposure to other sources of community noise. Given the burden of cardiovascular diseases on society and Canada's health care system, further research on the long-term effects of exposure to wind turbine noise, in particular on stress and sleep disturbance, would provide more data to assess the health effects of wind turbine noise. Finally, the Panel stresses that the available evidence does not allow conclusions with regard to the prevalence of annoyance or other health effects within the population exposed to sound from wind turbines in Canada. Further research and surveillance would provide a better understanding of this prevalence, both in those exposed to wind turbine noise and in the general population.

PROMISING PRACTICES AND TECHNOLOGIES TO REDUCE ADVERSE COMMUNITY RESPONSE TO WIND TURBINE NOISE

10. Technological development is unlikely to resolve, in the short term, the current issues related to perceived adverse health effects of wind turbine noise

Wind turbine designs, modifications, and technology that could reduce sound emissions are currently being explored by wind turbine manufacturers. Ongoing technological development has contributed to lower sound emissions for turbines of a given size over the previous generation of turbines, with further improvements expected. Other factors such as power output favour larger turbines, however, which can offset overall reductions in sound emissions per kilowatt of electricity produced.

11. Impact assessments and community engagement provide communities with greater knowledge and control over wind energy projects and therefore help limit annoyance

Equity and fairness have been crucial for the acceptance of wind turbines in many communities, with perceived loss of social justice and disempowerment being significant barriers to acceptance in some cases. One important regulatory approach is to conduct a noise impact assessment of any proposed project; several Canadian provinces and other countries require such an assessment. In some of the international practices reviewed by the Panel, wind energy developers engaged in consultation and communication with local authorities and residents beginning at an early stage of project development, through all stages of implementation, and even after installation. Community engagement helps to inform and educate local residents, as well as involve them in a wind energy project with the goal of fostering social acceptance.

Wind turbines are a progressively familiar sight in Canada and contribute an increasing share of the electricity consumed in Canada. Concerns over the health effects of wind turbine noise have been expressed in many ways but rarely with detailed, reproducible, and rigorous data sufficient to support a conclusion on either causation or magnitude of any potential health effect. The Panel's final report is an attempt to objectively and rigorously review empirical research on the causal link between wind turbine noise and adverse health effects, as well as potential solutions to noise-related issues contemplated elsewhere, all of which may help in addressing concerns about wind turbine noise in Canada. The report is intended not only as a tool to inform decision-making and academic research on the subject, but also to inform the continuing dialogue across Canada and internationally, and across many sectors, about wind turbine noise and adverse human health effects.

Health Canada Wind Turbine Noise and Health Study: Summary of Results
http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php#share

Background and Rationale

The Government of Canada is committed to protecting the health and well-being of Canadians. Jurisdiction for the regulation of noise is shared across many levels of government in Canada. Health Canada's mandate with respect to wind power includes providing science-based advice, upon request, to federal departments, provinces, territories and other stakeholders on the potential impacts of wind turbine noise (WTN) on community health and well-being. Provinces and territories, through the legislation they have enacted, make decisions in relation to areas including installation, placement, sound levels and mitigation measures for wind turbines.

Globally, wind energy is relied upon as an alternative source of renewable energy. In Canada wind energy capacity has grown from approximately 137 Megawatts (MW) in 2000 to just over 8.5 Gigawatts (GW) in 2014 (CANWEA, 2014). At the same time, there has been concern from some Canadians living within the vicinity of wind turbine installations that their health and well-being are negatively affected from exposure to WTN.

The scientific evidence base in relation to WTN exposure and health is limited, which includes uncertainty as to whether or not low frequency noise (LFN) and infrasound from wind turbines contributes to the observed community response and potential health impacts. Studies that are available differ in many important areas including methodological design, the evaluated health effects, and strength of the conclusions offered.

In July 2012, Health Canada announced its intention to undertake a large scale epidemiology study in collaboration with Statistics Canada (*Statistics Canada Official Title: Community Noise and Health Study*). The study was launched to support a broader evidence base on which to provide federal advice and in acknowledgement of the community health concerns expressed in relation to wind turbines.

Research Objectives and Methodology

The objectives of the study were to:

- Investigate the prevalence of health effects or health indicators among a sample of Canadians exposed to WTN using both self-reported and objectively measured health outcomes;

- Apply statistical modeling in order to derive exposure response relationships between WTN levels and self-reported and objectively measured health outcomes; and,
- Investigate the contribution of LFN and infrasound from wind turbines as a potential contributing factor towards adverse community reaction.

The study was undertaken in two Canadian provinces, Ontario (ON) and Prince Edward Island (PEI), where there were a sufficient number of homes within the vicinity of wind turbine installations. The study consisted of three primary components: an in-person questionnaire, administered by Statistics Canada to randomly selected participants living at varying distances from wind turbine installations; collection of objectively measured outcomes that assess hair cortisol, blood pressure and sleep quality; and, more than 4000 hours of WTN measurements conducted by Health Canada to support the calculation of WTN levels at residences captured in the study scope. To support the assessment and reporting of data, and permit comparisons to other studies, residences were grouped into different categories of calculated outdoor A-weighted WTN levels as follows: less than 25 dB; 25-<30dB; 30-<35dB; 35-<40dB; and greater than or equal to 40 dB[Footnote1].

Detailed information on Health Canada's *Wind Turbine Noise and Health Study*methodology, including the 60-day public consultation and peer review process is available on the Health Canada website. The detailed methodology for the study is also available in the peer reviewed literature (*Michaud et al., Noise News International, 21(4): 14-23, 2013*).

Preliminary Research Findings[Footnote2]

Health Canada has completed its preliminary analysis of the data obtained. Research findings are presented below in accordance with the study component in which they were obtained i.e. in-person, self-report questionnaire findings, objectively measured responses, and noise measurements and calculations. As with other studies of this nature, a number of limitations and considerations apply to the study findings including:

- results may not be generalized to areas beyond the sample as the wind turbine locations in this study were not randomly selected from all possible sites operating in Canada;
- results do not permit any conclusions about causality; and,
- results should be considered in the context of all published peer-reviewed literature on the subject.

A. *Study Population and Participation*

The study locations were drawn from areas in ON and PEI where there were a sufficient number of homes within the vicinity of wind turbine installations. Twelve (12) and six wind turbine developments were sampled in ON and PEI, representing 315 and 84 wind turbines respectively. All potential homes within approximately 600 m of a wind turbine were selected, as well as a random selection of homes between 600 m and 10 km. From these, one person between the ages of 18 and 79 years from each household was randomly selected to participate.

The final sample size consisted of 2004 potential households. Of the 2004 locations sampled, 1570 were found to be valid dwellings[Footnote3] of which a total of 1238 households with similar demographics[Footnote4] participated, resulting in an overall participation rate of 78.9%. Participation rate was similar regardless of one's proximity to wind turbines and equally high in both provinces. The high response rates in this study help to reduce, but not eliminate, non-response bias[Footnote5].

B. *Self-Reported Questionnaire Results*

Results are presented in relation to WTN levels. For findings related to WTN annoyance, results are also provided in relation to distance to allow for comparisons with other studies. WTN is a more sensitive measure of exposure level and allows for consideration of topography, wind turbine characteristics and the number of wind turbines at any given distance. To illustrate, two similar homes may exist in similar environments located at the same distance from the nearest turbine operating in areas with 1 small and 75 large wind turbines respectively. These homes would be treated the same if the analysis was conducted using only distance to the nearest wind turbine, however they would be completely different in terms of their WTN exposure levels.

The following were not found to be associated with WTN exposure:

- self-reported sleep (e.g., general disturbance, use of sleep medication, diagnosed sleep disorders);
- self-reported illnesses (e.g., dizziness, tinnitus, prevalence of frequent migraines and headaches) and chronic health conditions (e.g., heart disease, high blood pressure and diabetes); and
- self-reported perceived stress and quality of life.

While some individuals reported some of the health conditions above, the prevalence was not found to change in relation to WTN levels.

1. Self-reported Sleep

Long-term sleep disturbance can have adverse impacts on health and disturbed sleep is one of the more commonly reported complaints documented in the community noise literature. Self-reported sleep disturbance has been shown in some, but not all, studies to be related to exposure to wind turbines.

The Pittsburgh Sleep Quality Index (PSQI) is a frequently used questionnaire for providing a validated measure of reported sleep pathology where scores can range from 0-21 and a global score of greater than 5 is considered to reflect poor sleep quality. The PSQI was administered as part of the overall questionnaire, which was supplemented with questions about the use of sleep medication, prevalence of sleep disorders diagnosed by a healthcare professional and how sleep disturbed people were in general over the last year.

Results of self-reported measures of sleep, that relate to aspects including, but not limited to general disturbance, use of sleep medication, diagnosed sleep disorders and scores on the PSQI, did not support an association between sleep quality and WTN levels.

2. Self-reported Illnesses and Chronic Diseases

Self-reports of having been diagnosed with a number of health conditions were not found to be associated with exposure to WTN levels. These conditions included, but were not limited to chronic pain, high blood pressure, diabetes, heart disease, dizziness, migraines, ringing, buzzing or whistling sounds in the ear (i.e., tinnitus).

3. Self-reported Stress

Exposure to stressors and how people cope with these stressors has long been considered by health professionals to represent a potential risk factor to health, particularly to cardiovascular health and mental well-being. The Perceived Stress Scale is a validated questionnaire that provides an assessment of the degree to which situations in one's life are appraised as stressful.

Self-reported stress, as measured by scores on the Perceived Stress Scale, was not found to be related to exposure to WTN levels.

4. Quality of Life

Impact on quality of life was assessed through the abbreviated version of the World Health Organization's Quality of Life scale; a validated

questionnaire that has been used extensively in social studies to assess quality of life across the following four domains: Physical; Environmental; Social and Psychological.

Exposure to WTN was not found to be associated with any significant changes in reported quality of life for any of the four domains, nor with overall quality of life and satisfaction with health.

The following was found to be statistically associated with increasing levels of WTN:

- annoyance towards several wind turbine features (i.e. noise, shadow flicker, blinking lights, vibrations, and visual impacts).

5 Annoyance

5.1 Community Annoyance as a Measure of Well-being

The questionnaire, administered by Statistics Canada, included themes that were intended to capture both the participants' perceptions of wind turbines and reported prevalence of effects related to health and well-being. In this regard, one of the most widely studied responses to environmental noise is community annoyance. There has been more than 50 years of social and socio-acoustical research related to the impact that noise has on community annoyance. Studies have consistently shown that an increase in noise level was associated with an increase in the percentage of the community indicating that they are "highly annoyed" on social surveys. The literature shows that in comparison to the scientific literature on noise annoyance to transportation noise sources such as rail or road traffic, community annoyance with WTN begins at a lower sound level and increases more rapidly with increasing WTN.

Annoyance is defined as a long-term response (approximately 12 months) of being "very or extremely annoyed" as determined by means of surveys. Reference to the last year or so is intended to distinguish a long term response from one's annoyance on any given day. The relationship between noise and community annoyance is stronger than any other self-reported measure, including complaints and reported sleep disturbance.

5.2 Community Annoyance Findings

Statistically significant exposure-response relationships were found between increasing WTN levels and the prevalence of reporting high annoyance. These associations were found with annoyance due to noise, vibrations,

blinking lights, shadow and visual impacts from wind turbines. In all cases, annoyance increased with increasing exposure to WTN levels.

The following additional findings in relation to WTN annoyance were obtained:

- At the highest WTN levels (≥ 40 dBA in both provinces), the following percentages of respondents were highly annoyed by wind turbine noise: ON-16.5%; PEI-6.3%. While overall a similar pattern of response was observed, the prevalence of WTN annoyance was 3.29 times higher in ON versus PEI (95% confidence interval, 1.47 - 8.68).
- A statistically significant increase in annoyance was found when WTN levels exceeded 35 dBA.
- Reported WTN annoyance was statistically higher in the summer, outdoors and during evening and night time.
- Community annoyance was observed to drop at distances between 1-2km in ON, compared to PEI where almost all of the participants who were highly annoyed by WTN lived within 550m of a wind turbine. Investigating the reasons for provincial differences is outside the scope of the current study.
- WTN annoyance significantly dropped in areas where calculated nighttime background noise exceeded WTN by 10dB or more.
- Annoyance was significantly lower among the 110 participants who received personal benefit, which could include rent, payments or other indirect benefits of having wind turbines in the area e.g., community improvements. However, there were other factors that were found to be more strongly associated with annoyance, such as the visual appearance, concern for physical safety due to the presence of wind turbines and reporting to be sensitive to noise in general.

5.3 Annoyance and Health

- WTN annoyance was found to be statistically related to several self-reported health effects including, but not limited to, blood pressure, migraines, tinnitus, dizziness, scores on the PSQI, and perceived stress.
- WTN annoyance was found to be statistically related to measured hair cortisol, systolic and diastolic blood pressure.
- The above associations for self-reported and measured health endpoints were not dependent on the particular levels of noise, or particular distances from the turbines, and were also observed in many cases for road traffic noise annoyance.
- Although Health Canada has no way of knowing whether these conditions may have either pre-dated, and/or are possibly exacerbated

by, exposure to wind turbines, the findings support a potential link between long term high annoyance and health.
- Findings suggest that health and well-being effects may be partially related to activities that influence community annoyance, over and above exposure to wind turbines.

C. *Objectively Measured Results*

Objectively measured health outcomes were found to be consistent and statistically related to corresponding self-reported results. WTN was not observed to be related to hair cortisol concentrations, blood pressure, resting heart rate or measured sleep (e.g., sleep latency, awakenings, sleep efficiency) following the application of multiple regression models[Footnote6].

1. Measures Associated with Stress

Hair cortisol, blood pressure and resting heart rate measures were applied in addition to the Perceived Stress Scale to provide a more complete assessment of the possibility that exposure to WTN may be associated with physiological changes that are known to be related to stress.

Cortisol is a well-establish biomarker of stress, which is traditionally measured from blood and/or saliva. However, measures from blood and saliva reflect short term fluctuations in cortisol and are influenced by many variables including time of day, food consumption, body position, brief stress, etc., that are very difficult to control for in an epidemiology study. To a large extent, such concerns are eliminated through measurement of cortisol in hair samples as cortisol incorporates into hair as it grows. With a predictable average growth rate of 1 cm per month, measurement of cortisol in hair makes it possible to retrospectively examine months of stressor exposure. Therefore cortisol is particularly useful in evaluating the potential impact that long term exposure to WTN has on one of the primary biomarkers linked to stress.

The results from multiple linear regression analysis reveal consistency between hair cortisol concentrations and scores on the Perceived Stress Scale (i.e., higher scores on this scale were associated with higher concentrations of hair cortisol) with neither measure found to be significantly affected by exposure to WTN. Similarly, while self-reported high blood pressure (hypertension) was associated with higher measured blood pressure, no statistically significant association was observed between measured blood pressure, or resting heart rate, and WTN exposure.

2. Sleep Quality

Sleep was measured using the Actiwatch2™, which is a compact wrist-worn activity monitor that resembles a watch. This device has advanced sensing capabilities to accurately and objectively measure activity and sleep information over a period of several days. This device is considered to be a reliable and valid method of assessing sleep in non-clinical situations. The following measured sleep impacts were considered: sleep latency (how long it took to fall asleep); wake time after sleep onset (the total duration of awakenings); total sleep time; the rate of awakening bouts (calculates how many awakenings occur as a function of time spent in bed); and sleep efficiency (total sleep time divided by time in bed).

Sleep efficiency is especially important because it provides a good indication of overall sleep quality. Sleep efficiency was found to very high at 85% and statistically influenced by gender, body mass index (BMI), education and caffeine consumption.

The rates of awakening bouts, total sleep time or sleep latency were further found in some cases to be related to: age, marital status, closing bedroom windows, BMI, physical pain, having a stand-alone air conditioner in the bedroom, self-reports of restless leg syndrome and being highly annoyed by the blinking lights on wind turbines.

While it can be seen that many variables had a significant impact on measured sleep, calculated outdoor WTN levels near the participants' home was not found to be associated with sleep efficiency, the rate of awakenings, duration of awakenings, total sleep time, or how long it took to fall asleep.

D. *Wind Turbine Noise Measures Results*

Note - To support a greater understanding of the concepts included in this section, Health Canada has developed a short Primer on Noise.

Scientists that study the community response to noise typically measure different sounds levels with a unit called the A-weighted decibel (dBA). The A-weighting reflects how people respond to the loudness of common sounds; that is, it places less importance on the frequencies to which the ear is less sensitive. For most community noise sources this is an acceptable practice. However, when a source contains a significant amount of low frequencies, an A-weighted filter may not fully reflect the intrusiveness or the effect that the sound may have (e.g. annoyance). In these cases, the use of a C-weighted filter (dBC) may be more appropriate because it is similar to the A-weighting except that it includes more of the contribution from the lower frequencies than the A-weighted filter.

1. A- Weighted

More than 4000 hours of WTN measurements conducted by Health Canada supported the calculations of A-weighted WTN levels at all 1238 homes captured in the study sample.

- Calculated outdoor A-weighted WTN levels for the homes participating in the study reached 46 dBA for wind speeds of 8m/s. This approach is the most appropriate to quantify the potential adverse effects of WTN. The calculated WTN levels are likely to be representative of yearly averages with an uncertainty of about +/- 5dB and therefore can be compared to World Health Organization (WHO) guidelines. The WHO identifies an annual outdoor night time average of 40 dBA as the level below which no health effects associated with sleep disturbance are expected to occur even among the most vulnerable people (WHO (2009) *Night Noise Guidelines for Europe*).

2. Low Frequency Noise

Wind turbines emit LFN, which can enter the home with little or no reduction in energy potentially resulting in rattles in light weight structures and annoyance. Although the limits of LFN are not fixed, it generally includes frequencies from between 20Hz and 200Hz. C-weighted sound levels can be a better indicator of LFN in comparison to A-weighted levels, and were calculated in order to assess the potential LFN impacts.

- Calculated outdoor dBC levels for homes ranged from 24 dBC and reached 63 dBC.
- Three (3)% of the homes were found to exceed 60 dBC[Footnote7].
- No additional benefit was observed in assessing LFN because C- and A-weighted levels were so highly correlated (r=0.94) that they essentially provided the same information. It was therefore not surprising that the relationship between annoyance and WTN levels was predicted with equal strength using dBC or dBA and that there was no association found between dBC levels and any of the self-reported illnesses or chronic health conditions assessed (e.g., migraines, tinnitus, high blood pressure, etc.)
- Sound pressure levels were found to be below the recommended thresholds for reducing perceptible rattle and the annoyance that rattle may cause.

As LFN is generally considered to be an indoor noise problem, it was of interest to better understand how much outdoor LFN makes its way into the home.

- At a selection of representative homes, Health Canada measurements showed an average of 14dB of outdoor WTN is blocked from entering a home at low frequencies (16 Hz - 100 Hz) with closed windows compared to an average reduction of 10dB with windows partially open.

3. Infrasound

Long-term measurements over a period of 1 year were also conducted in relation to infrasound levels.

- Infrasound from wind turbines could sometimes be measured at distances up to 10km from the wind turbines, but was in many cases below background infrasound levels.
- The levels were found to decrease with increasing distance from the wind turbine at a rate of 3dB per doubling of distance beyond 1km, downwind from a wind turbine.
- The levels of infrasound measured near the base of the turbine were around the threshold of audibility that has been reported for about 1% of people that have the most sensitive hearing.

Due to the large volume of acoustical data, including that related to infrasound, analysis will continue over subsequent months with additional results being released at the earliest opportunity throughout 2015.

Data Availability and Application

Detailed descriptions of the above results will be submitted for peer review with open access in scientific journals and should only be considered final following publication. All publications by Health Canada related to the study will be identified on the Health Canada website.

Raw data originating from the study is available to Canadians, other jurisdictions and interested parties through a number of sources: Statistics Canada Federal Research Data Centres, the Health Canada website (noise data), open access to publications in scientific journals and conference presentations. Plain language abstracts outlining the research and identifying the scientific journals where papers can be found will further be published to the Departmental website.

Health Canada's Wind Turbine Noise and Health Study included both self-reported and physically measured health effects as together they provide a more complete overall assessment of the potential impact that exposure to wind turbines may have on health and well-being.

Study results will support decision makers by strengthening the peer-reviewed scientific evidence base that supports decisions, advice and policies regarding wind turbine development proposals, installations and operations. The data obtained will also contribute to the global knowledge of the relationship between WTN and health.

TEXT AMENDMENT NO. 15009

TEXT AMENDMENT NO. 15009 TO AMEND THE LANCASTER COUNTY ZONING REGULATIONS REGARDING SECTION 13.018 "COMMERCIAL WIND ENERGY CONVERSION SYSTEMS" TO REVISE THE SPECIAL PERMIT CONDITIONS FOR WIND TURBINE PROJECTS.

PUBLIC HEARING BEFORE PLANNING COMMISSION: August 19, 2015

Members present: Beecham, Cornelius, Corr, Harris, Hove, Lust, Scheer, Sunderman, and Weber.

Staff recommendation: Approval

Beecham disclosed that she received a phone call from Marilyn McNabb, a member of the Wind Energy Working Group.

Staff presentation: **Steve Henrichsen of Planning staff** explained that two weeks ago, Commission was given a technical briefing on the text as proposed in the staff report; those details will not be repeated today. There will be a presentation by Scott Holmes of the Health Department regarding why the noise standard was chosen since this is an aspect that has received many comments.

There were three memos handed out to clarify items. The first was to clarify that the total turbine height is measured by going up to the hub height and adding the length of the fully extended blade. Most turbines approved in Nebraska are approximately 400 feet total height. The second was a clarification to language to make clearer that we consider the impact of multiple turbines on one lot, and not just any single turbine. The last memo was information requested by Commissioner Beecham. A table was provided showing regulations in other states for comparison. This information was compiled last April for the working group. There was also a question about whether there are noise standards and noise study requirements in other parts of the County zoning regulations for other types of uses and the answer is yes, for motor sports facilities.

Scott Holmes of Health Department staff stated that the exiting noise standards in the code were adopted in 2011, which were approved by both the Planning Commission and the County Board. As they exist, there is a 35 decibel (dB) limit at all times, which is measured at the property line and it allows that a noise study would probably be required. The proposed changes include a relaxation of these standards to 40 dB during the day, 37 dB at night, measured at the dwelling unit, with the requirement of a noise study, and that complaints to be handled by the County Board.

Holmes went on to give definitions for terminology related to noise and annoyance. Noise ordinances in general are intended to protect people from hearing loss and annoyance. Noise annoyance can have health impacts which are physiological and can be measured objectively by checking physical responses through blood pressure, heart rate, and cortisol levels. Holmes stated that wind turbine noise is unique and complex and cannot be accurately compared to other sounds even at the same dB level. Modulation effects are the main cause of noise complaints and turbines also produce inaudible infra sounds.

Holmes said the Health Department reviewed dozens of studies in making the health-based noise limit recommendations. The top studies were excellent studies that underwent rigorous review and examined multiple factors. He explained that epidemiological studies conclude whether or not exposure to wind turbine noise results in health effects. They are not designed to find causality but rather associations. When all data has been compiled, then conclusions about causality might be made. There is a limited connection between noise and annoyance which does not mean there is no connection; it means it cannot be ruled out entirely and it cannot be explained by other factors like chance, bias, and confounding. Limited evidence suggests there is also a link between turbines and sleep disturbance. Health impacts of wind farms cannot be comprehensively assessed at this time because they are relatively new; there are some data gaps and no long-term studies.

Holmes said that turbine noise is more annoying than other kinds of noise at the same levels. Noise metrics were used to calculate a range percentage of the population who may experience significant annoyance at particular levels. Compared with noise levels from around the world, 37 dB is roughly average. A range of 35 - 40 dB appears to be acceptable to around 80% of people.

DaNay Kalkowski of Seacrest and Kalkowski came forward representing landowners in Lancaster County and stated that although there is no doubt in the value of providing renewable energy and creating economic development, commercial wind farm installations are not necessarily compatible with other uses allowed in the AG Zoning in Lancaster County because the population is denser and there is a greater variety of agricultural and residential uses in place. Therefore, it is imperative to provide adequate protection for abutting landowners, especially to non-participating landowners. The proposed noise limits are reasonable and necessary standards and they protect the health and safety of neighbors. There are issues with the proposed setback language and a motion to amend is being proposed. The first request is to change reference in G1 and G2 from 10 acres to 20 acres due to the impact on small acreages verus larger farm parcels. The standard lot size in the AG zoning district is 20 acres, so protection should extend to those owners. The second request is to lengthen the setback distance to a half-mile or five times the full height of the turbine. A 1,000 feet is not enough to protect a non-participating property owner. The implementation of wind energy should not come at a cost to neighboring landowners.

Cindy Chapman, 1850 Gage Road, Firth, came forward representing residents of Lancaster County concerned with the effects of turbines on health, safety, and property values, many of whom were in attendance. Chapman participated in the working group that met last spring to discuss the proposed text amendment. She shared testimony of several residents who live near commercial wind turbines and who testified before public service commissions in Wisconsin and Michigan. "Sara" stated her 6 month old child quit sleeping through the night and woke screaming due to pressure in her ears. "David" said that no person should have to live with the array of health problems experienced. "Carrie" and "Karen" reported headaches, pressure in ears, exhaustion, and lack of sleep. These are examples of individuals who are suffering as a result of proximity to turbines. Many abandoned their homes and filed lawsuits against their county and the developers.

Chapman continued by stating the proposed sound limits are protective of all residents but there is significant concern with the proposed setback limits. According to sound modeling that was submitted as part of an application to the Planning Department last fall, the 40dB limit was about a half-mile distance. It is counterintuitive to have a setback that is less than what the sound levels would require in order to be in compliance. Even the developer who submitted applications states on their website that 500 to 1,000 meters from a dwelling unit is the

minimum setback they would use. Gage County is considering one-half mile. Creating conflicting standards encourages developers to manipulate sound models and once the turbines are in, there is no going back and residents are stuck.

Chapman concluded by saying that Lincoln is growing and acreage lots are increasing. If 500-foot turbines are placed in these areas, acreage development will stop. No matter how worthy the cause, other people's health, safety, and welfare should not be diminished in order to achieve the goal.

Larry Chapman, 1850 Gage Road, Firth, came forward to state his concern over flaws in the proposed amendment. The first knowledge he had of a proposed wind farm caused alarm because the project seemed to be so far down the path to development with very little public input. As a result, residents began meeting with County Planning and Health staff. The information appeared consistent with what developers were providing to departments all across the nation, which was all pro wind energy. Weeks later after a public meeting, it became apparent that the dozens of people who showed up were upset.

During the meetings, the Planning Department was provided with a number of peer reviewed scientific studies that point out the dangers of turbines located too close to homes, including one from the Brown County Board of Health, which declared wind turbines to be a human health hazard. People are waking up to these concerns.

Chapman went on to say that it seems obvious that a property 1,000 feet away from a turbine is not going to sell for the same value. Some real estate studies show property values are diminished by 15 to 20 percent. The World Health Organization says that with noise above 40 dBA, adverse effects are experienced among a diverse population, people have to adapt their lives to cope with night noise, and vulnerable groups are more severely affected. Raising it above that would be irresponsible. If a turbine were installed at the edge of a property, it limits how that property can be used. People have the right to expect to be protected and the proposed draft fails to address these issues. Please take a longer and harder look at what is going on.

Judy Daugherty, 1333 W. Gage Road, came forward in opposition to state that zoning a wind farm is a complex issue that needs more research. Planning staff has not acknowledged any of the sound evidence provided to them from various public sources. They appear to be willing to do whatever it takes to get wind development in the county. Wind developers, specifically Volkswind, appear to have written many of the zoning changes and their letter was attached to amendments and not cataloged with the rest of the letters sent in. It is a sad day when developers who are only thinking of profits dictate local zoning regulations and the public gets shoved to the sidelines. At the briefing to the Commissioners, the Planning staff stated that turbines could be built within the 1,000 foot setback but that is not true. According to manufacturer recommendations, minimum setbacks like the 1,300 feet suggested by GE and Vestas are a "no-build" zone for the reason of safety. Vestas recommends that in the event of an emergency, a 1,600-foot radius must be cordoned off. The National Fire Protection Agency recommends a 1,500-foot area of no vegetation around turbines in case of fire. The staff report reached a different conclusion. Daugherty questioned the authority of Planning to suggest a setback that is less than what is recommended by many other agencies. She stated she is not against turbines but these

suggested setback regulations put people in danger. She implored the Commissioners to do more research, stating that the Planning Department has failed to do their research and has been misleading in their answers to the Commission.

Curtis Schwaniger, 3650 W. Hallam Road, Hallam, came forward to state that he hopes Commissioners will consider the newest health and safety information that has come out since 2013. Citizens are getting more aware of them and local officials have changed their thinking and amended ordinances previously passed. He gave several examples of locations around the country who have amended their codes to change to a greater setback distance and reduce the dB limit. There is a lot of change in wind tolerance and the 1,000-foot setback is not acceptable anymore. The laws must address the most vulnerable--elderly, ill, and especially to kids. The risk to kids is hard to realize at this time. World Health Organization recommends that night sound levels be less than 30 dB and a minimum setback of 1,500 meters for the average population. Anything less than one mile for vulnerable populations would be irresponsible.

John Hansen, 1305 Plum Street, Lincoln, came forward as a member of the Nebraska Farmers Union. He stated he has been involved in renewable energy zoning issues since the 1970s. He represents the interests of both landowners and renewable energy and acknowledged that there is a fine line between protecting the public and representing the interests of those groups. In his experience, there has always been a tradeoff between traditional family farms and those who move into rural areas. Newcomers must be willing to accept traditional farm activities. There are those who feel strongly they have a right to develop their wind resources when appropriate and that is now among the list of normal kinds of activities go on in farming. These are not urban environments and wind develop has to be considered in that same kind of category as farm activities, but there must be balance. It is difficult to determine what levels should be used. He said that on his own farm in Madison county, he does not have any neighbors or towns for 12 miles. Just the sound of the wind itself is well above 37 dB. It is a challenge in Lancaster County to come up with setbacks that are going to make people happy and still allow a wind project to be built. An immense amount of capital is invested and it adds to the tax base. There must be a balanced approach that still allows projects to be built.

Greg Schwaniger, 2401 W. Hallam Road, Hallam, came forward to state that multiple generations of his family have farmed in the area. He feels it is important to protect health and still allow farmers like him to have wind turbines if that is a farming activity they choose. Other farm sounds create noise. This is one activity that protects farmers from the volatility of prices and many other factors of the industry. Many wind farms in other areas are fine. It is not fair to limit what he and other individuals do on their land. The sound limit should be raised to 50 dB.

Anne DeVries, 684 E. Aspen Road, Cortland, stated that as a mechanical engineer, she has kept up on much of the research. The latest includes information that wind turbines may become quieter. She stated she opposes some of the recommendations made by Planning and Health staff and very much supports the development of wind energy. She supports a higher dB level. Global warming is a serious issue and blocking the development of turbines is a step in the wrong direction. Everyone will feel pain from global warning and she would rather it be from noise than from no drinking water. People must fight misinformation from the fossil fuel industry. There is not time to wait for accurate studies. Wind development in Iowa has created cheaper rates and no health impacts. Noise annoyance is a part of life and she would rather take her chances with that in order to avoid climate change. These decisions will affect those made in other counties. This state should not fall behind when it comes to helping with climate change.

David Levy, 1700 Farnam Street, Omaha, stated that he has been involved in numerous zoning regulations related to wind energy. There have been very few issues with regulations far less restrictive than the ones proposed today. The examples given earlier about severe health impacts did not occur in Nebraska or even in Iowa where there is a great deal of wind development. These provisions need to be workable and, as proposed, they are unduly restrictive. First, using Leq levels to determine an average is biased toward higher levels and is not accurate. Treating participating and non-participating land owners the same is unprecedented. If one is choosing to participate, they should be allowed to choose any consequences associated with it. Making sure that no one is annoyed is a futile effort, so those who wish to participate should not have that opportunity taken away from them. There are no published findings of significant health effects. No other county has a table showing less than 50 db and these restrictions are significantly more restrictive than the rest of the state. The 30-minute/day amount for shadow flicker is also unworkable due to seasons. These regulations fail to strike a balance.

Joe Wood, Project Manager at Volkswind, gave a very brief overview of the applications Volkswind submitted that involved 13 participating landowners in Lancaster County. He stated they have also submitted alternate language that both protects the public and is reasonable and in line with most other counties in this state and throughout the Midwest. The sound levels proposed severely limit development and overlook the significant economic benefits, landowner compensations, good jobs, and environmental benefits of wind development.

Beecham asked what the justification is for the 75 dB limit suggested. Wood clarified that their proposal is for 55 dB for participating and 50 dB for non, with an allowance for 5 dB above ambient noise levels.

Cornelius inquired about suggested manufacturer distances. Wood stated that he has not seen or read through a safety manual. Of the 48,000 projects that are installed, he has never heard of any case where a 1,000-foot area has been cordoned off for safety reasons. In most places, land owners continue normal activities right up to the turbines.

Harris asked how the turbines are made quieter at night. Wood replied that there are different types of turbines with different options. In the wind industry, slowing the blades down is called "curtailment". There can also be adjustments to the angle of the blades which will reduce the amount of air sweeping through.

Hove asked if Wood knew the amount of land that would be eliminated in Lancaster County based on the proposed amendment. Wood said that would be difficult to answer without looking closely. It would be significant with the 10 acres vs. 20 acres, with the amount of acreages out there and more significant setbacks.

John Atkeison, 2601 N. 44th Street, Lincoln, stated that this is a difficult topic and there is a tremendous volume of information out there and that information gets shaped. Many of the health impacts appear to be subjective, based on studies. One issue that needs more emphasis is what is being done in terms of climate policy and how to decrease greenhouse pollution while there is still time. The effects of climate change have been accepted. There is still time to act. If climate change became more severe, it is important to question if agriculture would even continue to be viable. Environmental factors should play in to your decision making because this amendment is shaping energy policy. He offered information about a local event, adding that experts in the climate change field are always available to Commissioners.

Kelly Carstens, 2601 N. 44th Street, came forward to state that she has lived in Nebraska her entire life. She will not repeat what others have already said, but she has invested her time tonight to make public testimony that there is a need to stop burning fossil fuels and to think about impacts to future generations. She supports the development of wind energy.

Larry Oltman, 899 E. Gage Road, Cortland, stated that he is a small- to mid-size farmer and his family has farmed the same location for over 100 years. Not everyone in the county agrees but most believe everyone has the right to independence. If the setback were greater that 1,000 feet, no small farmer would be able to participate. In his family's case, wind generation will help with taxes and provide greater diversification. As dryland farmers who do not rely on water, this is a major step in providing additional income. Iowa is an agricultural state, too. They also have almost 100% more population per acre than Nebraska. Wind development has been there a long time with very little complaint. There doesn't appear to be much information about people getting ill. Nebraska citizens should be allowed progress in the area and to participate in generating more electricity. Longevity shows that property values do not drop after the first 6 months to a year. Nebraskans should be allowed to harvest the wind.

Harris asked Mr. Oltman if, as a farmer who may participate, he is in support of the proposed setback for participating landowners working with the wind company. Mr. Oltman replied that he supports the 1,000 foot setback but nothing larger because opportunity is eliminated for those who own a quarter or even half section.

Ken Haar, 13901 NW 126th, Malcolm, came forward to express support for less stringent sound regulations than proposed, more in line with what is present in other states. There are many myths about living in rural areas. The country is not idyllic, clean and quiet. In reality, there can be dust in the air during harvest; there are odors and noise from cattle operations; and there is noise associated with other farm operations like grain driers. There are already many lights on the horizon and some farm lights stay on all night. These can all be considered annoyances, but no one asks for regulations to remove them because they are part of living in a rural area. Iowa has six times the wind development of Nebraska and that is not inconsequential. There has been $10 billion of investment and all the economic development that comes with it. Economic development is an important consideration. When considering health, there is annoyance but the effects of climate change also have the potential to bring major health problems. You are setting energy policy as well. He strongly encourages a balance between development and protecting the public.

Graham Jordison, 221 S. 27th Street, Lincoln, came forward to state that he is a former resident of Carroll County, Iowa. He loves living in Lincoln now and it is considered one of the healthiest and most well-educated cities in the Midwest. People have different ideas of living in rural areas. His home in Iowa had a population of 20,000 for the entire county, so it was much smaller in population but was very similar to Lancaster County in terms of the diversity of land uses. In his former community, many people made their living from the land so when wind development arrived over a decade ago, many were concerned. But many were also excited and realized this would be a great opportunity to rejuvenate the community. All have benefitted. There are good neighbor agreements and non-participants also benefit from property tax relief and new jobs. He stated he wanted to share his personal story because with strict sound limits such as the ones proposed, it would be difficult to build and he wondered why the County would pass on such an opportunity. The regulations should be more in line with other counties. In Carroll County, there was no noise limit. The setback distance guaranteed safety and citizens appreciated the tax dollars and jobs. He showed a sound meter and stated his speaking voice is probably at 75 dB. Even though the sound is not the same, most things in a home would violate the noise limit.

BREAK: 8:24 P.M. MEETING RESUMED: 8:30 P.M.

Barrie Marchant, 611 N. 26th Street, Lincoln, came forward to state that living near the football stadium, he and his neighbors deal with traffic, noise, and cars parked along every street on game days. Most neighbors get along with it because it is accepted and people generally like the games. Some do not like it and would love it if the traffic issues could be fixed and the crowds could be quieted during games. It seems reasonable at first to complain about it, but after more complaints, it becomes clearer that those who continue to do so just don't like the games in the first place. He stated that he doesn't know the people who are opposed to wind development but maybe they are totally against wind farms and there are no regulations that would ever be acceptable. Please listen to your staff about what really makes sense and don't let those who are against it in general pretend that they are giving rational reasons.

Jeff Brown, 13500 W. Pella Road, Wilbur, stated that at his location, he could be surrounded on three sides by turbines if the setback is 1,000 feet. He is worried about the impact to his taxes and the long-term value of his property as a non-participant. The land will not be worth as much if it is surrounded by towers. Also at his location near the Blue River, there are many bald eagles. When people talk about environmental impact, they should mention the impacts the turbine will have and include the maintenance. He wondered about the depth of the counter balance in the ground and if it affects ground water. There are too many unanswered questions and he is totally opposed. Turbines might be fine in an area where there are less people, but he spends three quarters of his time outdoors and he does not want to see them and be surrounded. He asked the Commissioners to please give special consideration to the people who live near wind development projects. Many people who are in favor do not even live in the areas so they will not be negatively affected.

Russell Miller, 341 S. 52nd Street, stated that the Planning Commission represents all 300,000 people in county and this is a big deal. This is a unique opportunity to reduce pollution from Sheldon Station. He listed some amounts of pollutants emitted from the station and the many health problems associated with exposure to those pollutants. When the plant updates to hydrogen, numbers will be reduced by about half. Wind energy could reduce emission by another 40%, so that would be a dramatic reduction. Kids and the elderly are very susceptible to air pollutants. That segment of the population is growing. He urges the sound limit be raised to 50 dB in the day and 45 dB at night. Some will suffer, but more will benefit from the improvement to the air quality.

Carolyn Butler 621 Lakewood Drive, Lincoln, came forward in support of wind development. As a single parent and a home and business owner, she is not politically oriented, but people who try to be good citizens must do more. She felt compelled to add her voice. At age 57, this is her first time testifying. Climate change is the issue of our time. Switching to green energy quickly and safely is an answer. The cost of burning fuel is more and more evident. It causes health issues, extreme weather events, and creates threats to national security. She urged the Commissioners to look at ways to harness energy at safe levels and to do as much as possible to make sure all have been heard and that the process is swift and uncomplicated.

Jane Kleeb, 1010 N. Denver Avenue, Hastings, came forward representing Bold Nebraska, a group focused on local food and energy issues. Over 1,500 people have signed a petition – 894 in Nebraska and 335 in Lancaster County. Bold Nebraska supports the proposed ordinance but is not taking a position on sound levels and will trust the position of health experts. The group has worked intensely on zoning issues when it comes to oil pipelines. Many hours have been dedicated to dealing with landowners in favor of and against pipelines and to

establishing safe practices for setbacks. Oil pipelines do not have decommissioning plans. If there is no plan, there should be a clear way that citizens can file a complaint and that developers are fined for noncompliance. Protecting property rights and standing up for landowners are cornerstones of Bold Nebraska. We are happy that wind does not have eminent domain because then it would not even matter what landowners think. This is difficult, but important. Nebraska is an agricultural state but it could also be a clean energy state. It is just as important to make sure property rights are protected while adding clean energy.

Darren Compton, 7800 W. Hallam Road, Hallam, stated he is located just inside of the proposed project area. There has been much testimony about protecting land to be used as owners see fit. Those who are not participating ask for the same rights. Protection should be for all 80 of his acres. There is already a noise ordinance in place and it is 35 dB measured to the property line. Sheldon Station has no contract with Volkswind to purchase the electricity so it could go out of state if there is no agreement. He stated he does not believe there will be benefits to the tax base. Noise from farming is not like the modulating sound of turbines; it is white noise that can be tuned out. The setbacks are fine if the noise limit is 37 dB measured at the property line. The proposed Volkswind towers produce 110 dB at the hub, so if you account for sound dissipation, it sets the turbine back to a half mile. If the noise limit is reduced, that reduces the need for setbacks.

Tom Schuerman, 2000 W. Princeton Road, Hallam, came forward to state that as an engineer and certified energy manager, he is generally in favor of wind energy; however, as a citizen who lives on the edge of one proposed wind farm, these decisions will have a direct long-term impact. Good or bad, he and his family will be stuck. This subject needs a careful and well thought out approach. One thing that should be added is that the setback recommendation of the manufacturers should be followed. No private citizen designed the turbines, selected materials, or conducted quality control tests. It is rumored that the information is confidential and proprietary but there is no reason one company would gain advantage over another by sharing the information. Locally, there should be setback distance, but if the manufacturer recommendation is greater, that distance should be used. There is no harm in holding the manufacturer accountable for their own equipment.

Lisa Sullivan, Director of Wind Development for Nextera Energy, stated that Nextera is the largest builder and operator of wind energy in the world. They have been in business for 26 years and have over 100 wind farms with more than 10,000 turbines in 19 states and 4 Canadian provinces. Though Nextera is not developing in Lancaster County at this time, the changes being implemented here may impact regulations made in other counties.

Sullivan went on to explain the siting process that is used for designing a wind farm. The first iteration eliminates areas that cannot have turbines sited due to interference of cellular or radar signals. Also during this phase, the developer works with the Fish and Wildlife Service and the Nebraska Game and Parks Commission to eliminate all sensitive riparian and wetland areas. The next iteration avoids roads, pipelines and existing structures such as farm silos and center pivots. Next, setbacks to residential structures are measured. Nextera's standard setback is 1,400 feet. Finally, the effects of sound and shadow flicker are taken into account. She went on to say that some typical restrictions that have been used are 30 hours of shadow flicker per year and a 50 dB noise limit. This process leaves a very limited amount of land available for siting turbines. If the regulations were more restrictive and reduced the sound level to 37 dB, one would not be able to develop a wind farm. When it comes to shadow flicker, shadow occurs in the fall and spring. To restrict it to 30 minutes per day would limit development because there are many days where there is no flicker, but there are other days that exceed 30 minutes. These restrictions would limit development altogether.

~~Corr~~ Harris asked how tall the Steele Flats turbines in Gage and Jefferson are. Sullivan replied that she believes they are 80 meter towers with 100 meter blades. Corr went on to ask about the setbacks in Gage County. Sullivan replied Nextera's company standard is 1,400 feet regardless of local ordinances. ~~Corr~~ Harris asked the reasoning for maintaining that setback. She answered that it is a safe distance and it is our company standard.

Corr asked Nextera's per day standard as it relates to shadow flicker. Sullivan explained that Nextera does not have a per day, but a per year because it depends on the position of the sun – in the fall and spring, there is flicker. It is difficult to gauge minutes per day. Corr asked if there is a common allowed time limit on flicker among states. Sullivan said it the 30 hours per year. Nextera tries to lessen the impacts of flicker through landscaping or working with homeowners to install awnings and also in the siting to keep them far enough away to avoid having the issue.

Hove asked what the dB sound levels are at Nextera's 1,400 foot setback. Sullivan replied it really depends on atmospheric conditions but the standard is typically 50dB.

Beecham asked for clarification about whether the setback is measured to the lot line or the dwelling. Sullivan said to the dwelling unit.

David Schwaniger, 28500 SW 14th Street, Martell, came forward to state that his home would be right in the middle of the wind farm that was proposed last fall. He urges consideration of a 50dB level because at 37, it effectively limits wind development. Turbines will provide benefits from the income to the tax base and participating and non-participating land owners. He stated that his real estate taxes have gone up 150% in the last 5 years. While corn was at $6 - $8, that cost was bearable. Now that it is at $3.25, it is not. The ground that generations of his family worked very hard to pay for with after-tax dollars is being taxed at a rate of $81 per acre. That will not go down. Help with real estate taxes would be positive. The country is not an ideal place – there are lights, noise, and livestock odors. Those are all parts of living there. Schwaniger went on to say that flashing lights can be seen in every direction from his property and he had no say in whether or not they were installed. Relief from any increase in taxes caused by wind turbines are paid for by the developer according to stipulations of contracts with Volkswind

STAFF QUESTIONS:

Corr asked what the designated future land use is in the Hallam area in the 2040 Comprehensive Plan. She stated she is aware this amendment will apply to all of Lancaster County and not just this area. Henrichsen explained that an incorporated community has jurisdiction over their 1-mile area. The 2040 Comp Plan tries to reflect each community's comp plan. Generally, the southeast portion of the county is shown as agricultural. There are not many specifically designated low-density acreage sites such as are found in the southeast or southwest of the 3-mile jurisdiction. That said, prior to 1979, the zoning designation was different so there were many 10-acre lots and farmstead splits. Even in an area designated for agricultural use, there are a fair amount of smaller acreage lots that develop over time.

Corr wondered if the northern part of the county is still designated as primarily agricultural use. Henrichsen said yes, the vast majority of the county is. The Comp Plan has tried to cluster acreages in certain areas such as along West Denton Road and South 68th Street. Partly because there is no rural water district in the north, there are not large areas designated for acreage subdivisions. There is the AG CUP which allows for 8 cluster lots.

Corr continued by asking if there was knowledge of Denmark's residential composition for comparison. Holmes stated he could not answer that question specifically without more research. In Denmark, they have different sound levels for what they call residential, small village and on up. It is a different structure.

Corr then referenced the letter from Volkswind dated June 12th, they provided a chart comparing counties in Nebraska. She asked if staff verified that information. Henrichsen said yes, that chart was submitted in 2014. It was used as a starting point in compiling information for the working group and their representation was accurate. Corr went on to note that Jefferson County is not among the counties compared. She asked about the levels in Jefferson County. Henrichsen responded that staff used websites and not all 90 counties were checked, but from looking in depth at over 20, it is clear they all follow very much the same format. It is not uncommon to take ordinances of another county to be used as a "best practices" boiler plate. Certainly, each one is then tailored based on their particular circumstances.

Corr asked for verification of some data. A report stated that when an individual has less control, the perceived annoyance is higher and that increased sound equates to increased annoyance. Holmes confirmed that is correct. Corr asked if the smell of a cattle yard is an annoyance. Holmes said yes, it would probably be classified as an odor nuisance under local and state codes. Corr then said that there are annoyances out there and this is fairly normal in agricultural circumstances.

Corr then inquired if staff has been able to get any recommended safety setbacks from manufacturers. Henrichsen answered that manuals were viewed and appeared to be for technicians who were approaching the turbine for maintenance. In one, there was some reference made to parking your vehicle more than 1,000 feet away. That said, when staff was trying to set up tours with Steele Flats, this question was brought up. They said they have one facility where they can control all of the turbines and turn them off when necessary, so they have access roads and drive right up to the location. It was hard to equate the focus of the safety manuals with how people relate on a day-to-day basis living within a turbine area.

Corr said that someone brought up decommissioning and the consequences if violated. She asked if it is correct that developers are required to put up a bond so if they don't complete the decommissioning, they would forfeit that money. Henrichsen said that the general idea is that there be a decommissioning plan. The ordinance is not as specific as some others in detailing every last part of a decommissioning plan. Instead, there is the special permit process. The developer would likely propose a decommissioning plan during the application process and it would be part of the conditions for approval. The review also includes working with the County Attorney's Office regarding what isan appropriate amount for bond. The idea is that if the work is not done, the legal right exists to use those funds to do whatever is necessary. He went on to say that in many counties, the focus of the bond is to protect the conditions of roads. The turbine itself is left to the property owner. This regulation is trying to look from the point of view of removing some of the base. If the entire base is required to be removed, it costs more than the entire turbine. What we heard from developers is that the materials and the metal in the turbine itself would be valuable to someone even 20 years from now and would be worth someone salvaging even if a company walked away. There is a proposal from Volkswind that the bond is not presented until the 15th year when the turbine is nearing the end of its life cycle, rather than letting the bond sit idle for 25 years.

Corr said she understands there are no landscaping requirements and asked about the possibility of working with neighbors to do awnings and plantings to negate flicker. Henrichsen said that in the testimony from the Nextera representative, the point was that rather than trying

to figure flicker by minutes per day, it is better to use the cumulative amount of 30 hours per year. Non-participants may still have to put up with some amount of flicker at certain times of the year, but that 30 hours would add up quickly. Corr said that one letter compared flicker to the flicker of tree leaves and asked if that was an accurate comparison. Henrichsen said he viewed a video of one hour of flicker and it was very different. It was a constant pace, on/off again effect. The lack of control over shadow flicker is also a factor. A tree can be removed, but the flicker cannot be stopped. Corr asked if it can be masked with a room darkening blind. Henrichsen said yes, that is possible, but the point is that residents feel that if it is a beautiful day, they should not have to do that.

Corr asked for clarification about the differences in dB levels, stating that 10 dB does not sound like half of 20 dB. Holmes said that is correct. The dB scale is logarithmic so to the human ears, if you go from 40dB to 50dB, it is twice as loud.

Lust asked why both the 30-hour per year and the 30-minute per day amounts were used regarding shadow flicker. Henrichsen said that other regulations were looked at for reference and it was a judgement call; 30 minutes per day seemed like a reasonable amount to put up with per day. Lust asked if this regulation basically came from another county's ordinance. Henrichsen said yes, and it was one that made sense when it was considered.

Weber asked if more flicker is present in winter. Henrichsen said shadows are longer certain times of year and that was part of the discussion. Weber went on to ask how it is handled if a citizen notified someone of excessive flicker, but by the time anyone arrived to investigate it the flicker was gone. Henrichsen said that if someone is dealing with a violation, a likely place staff would start would be with the modeling. Then if the complaints said it was more than that amount, staff would get out there as quickly as possible to be there at the appropriate time of day and to get an idea of whether shadows are getting longer or shorter.

Beecham asked how much flicker is affected by direct sunlight versus a hazy day. Henrichsen said that type of deduction was not made, but that if it is sunny, the shadow is bright and crisp.

Lust asked about the Canadian studies and said they did not offer any recommended dB levels. Holmes said the Health Canada study was an epidemiological study that was descriptive and identified what they found. The Canadian Academy's was different. They provided data that talked about the level of annoyance identified in the Health Canada and other studies as well and were providing a review where they identified the levels at which they found health connected annoyance issues.

Holmes continued, saying that one thing to take into account in the Health Canada study is that they surveyed 1,238 homes and measured cortisol in hair and other indicators and almost none of those homes were exposed to levels above 45 dB.

Lust read a statement from a study that said the current state of evidence about whether annoyance is caused by exposure to wind turbine noise alone, or whether factors such as visual impacts and person attitudes modify noise annoyance relations, and to what extent those factors can be measured independently. She asked for staff response to people who say these studies don't support the dB levels that are being proposed. Holmes said that would be an odd interpretation to say that it does not support it because the study does not say anything about the dB levels. All it reports is what data says relative to annoyance. Annoyance is measurable. It acknowledges that one cannot ferret out from annoyance whether it is strictly caused by the noise, or other factors like the tower, lights, shadow, and property use issues. Those factors cannot be separated out because once the turbine is there, it is there.

Holmes went on to say there have been double blind studies and they have identified that turbine noise is associated with affects in people who did not know whether or not turbines were in operation. This study came out more recently. That would be one study to consider as part of the evidence, but one study cannot be taken to mean that is the final result. Lust asked if that study was provided in the packet to Commissioners. Holmes said it is referenced but not provided in entirety.

Lust asked how much confidence there is that the dB levels suggested will eliminate annoyance. Holmes said that Planning Commissioners have the difficult decision of deciding how much annoyance is acceptable. Health staff set a level that where it is believed the vast majority of people will not be affected. If the goal is to eliminate annoyance, the only option is not have turbines. We looked at potential health impacts and established a level that we believe less than 10% would be affected.

Lust said there was also testimony about some of the polluting affects of coal burning. She asked if the numbers mentioned tonight were accurate. Holmes said the numbers provided by testifier Russ Miller are not current, but are historic numbers. The Health Department regulates Sheldon Station and has a full air quality program. Sheldon meets all federal, state, and local air quality criteria requirements. They are various controls to reduce emissions and those emissions have been significantly reduced from what was reported. The other issue in relation to NPPD is that they are going to partner with a company called Monolith to take down a unit and run with Hydrogen and not coal which will further reduce emissions by half. The assumption that wind is going to eliminate the use of coal is probably not accurate and is something that NPPD should be asked about.

Lust asked if Holmes would agree that wind energy is emission free. He responded that in general it is, though nothing is zero emissions. It takes energy to build the parts, so it is not zero. But when operational, they produce no emissions.

Harris noted that in ordinances in other states and countries, it seems common to have wind speed conditions factored into the noise levels. She asked if that was considered. Holmes said there are some that do include that but most do not. That is a much more complicated formula. Health previously proposed a level that measured noise which should not exceed a certain level 10% of the time and frankly, it was too confusing. There are levels that increase with wind speed like in Denmark. That is something this body could consider.

Harris asked what the rationale was for making the level the same for participating and non-participating land owners. Holmes said that as a public health professional, he has developed regulation for various issues. It is never the case that environmental regulations are established where the population who benefits gets higher allowable levels of exposure than people who are not benefitting. Our recommendation is that there should be a single, truly health-based standard that is not based on economic factors.

Harris asked if it would be accurate to say that the health impact of noise on someone who participated and had a positive association with wind energy would not have the same risk as for those who were opposed to it. Holmes said that could be suggested, but that is not what the Health Canada study suggested. It was not only non-participating people who had health impacts, but there is strong evidence that people who benefit do not complain about noise. It is hard to assess whether or not they are having the health consequences, but there are fewer reports of annoyance. The real issue is that there is no long-term data that shows whether or not people have other health consequences. As far as annoyance and initial impacts, it appears to be less for those who participate.

Scheer asked if there is another aspect to the participating versus non-participating standards being similar to noise standard in that the regulations refer to a special permit for a piece of property that stays with property and not the participant. Henrichsen said that correct, the permit runs with the land. If, in a few years, a participating property is sold, one could assume after the turbines are built, the potential buyer would be aware of associated contracts and the permit.

Beecham said that the conversation about mitigating health risks revolves around annoyance. She asked if annoyance is as great a risk as air quality and if there is a matrix showing which factors rank the highest in terms of posing health risks. She explained that she is trying to get a handle on annoyance. Holmes said there is not a matrix. Heath Department did not attempt to do a comparative analysis because that was not the question at hand. The question involved one issue: how much noise the wind turbines would generate and how this noise affects health, so it was very much focused on annoyance and the results of that.

Lust noted that annoyance is subjective, so it is the case that Commissioners are trying to come up with an objective measure to prevent a subjective level of annoyance. Holmes agreed and said that is what most noise regulations do. Most communities have a general noise code. Those are built on the potential for hearing loss, but also on annoyance. It should not feel odd that there would be a code that addresses annoyance. He has personally administrated such a code in Lincoln for 25 years.

Hove said there was testimony about how close a turbine on a participating property can go to a property line and whether non-participants are prevented from building on there own land within the 1,000 foot setback. Henrichsen said the setback applies only to the turbine. The property owner retains the right to build within the property as long as they follow the normal setbacks. Earlier testimony may have been getting at the fact that if a turbine is that close, it is undesirable to build there. As a result, they feel prevented from doing it, but legally, they still have the right. If the turbine is there and then a property owner builds within the 1,000 feet, the turbine does not have to go away. It becomes non-conforming, but it has the right to be there.

Hove asked if a turbine can be built right at the property line of participating owners. Henrichsen said in most cases, one would not build along the property line due to proximity to non-participating owners. When there is a whole series of participating properties, then the property lines are not as important. Hove asked Henrichsen to address the 1,400 foot limit set by Nextera. Henrichsen said that the proposed setback for Lancaster County is 1,000 feet or 3 times the full height. So, for example, the Steele Flats turbines are 422 feet tall. Three times that height is over 1,200 feet, so the taller turbines will be well over the 1,000 setback. As far as the health impacts, if there is a 40 dB limit, the distance will be beyond 1,400 feet.

Hove wondered about the testimony regarding tax benefits. Henrichsen said those are to the county as a whole. There were examples given of $200,000 or more that went to a county nameplate tax and was distributed among various agencies. Hove asked if taxes could go down. Henrichsen said that is potentially the case if the county were able to lower the overall levee. In a county with a smaller population and a smaller tax base, this will have a bigger impact. In Lancaster, with more industry and a higher population, the relative impact is probably less, though many city and county officials would say that any amount of taxes coming in is a benefit.

Hove asked if any thought has been given to the proposed amendments. Henrichsen said the amendments proposed by DaNay Kalkowski were trying to address the need for a larger setback. In a previous discussion, it was suggested that staff did not put enough emphasis on safety. That is not true. The health impacts are addressed by the noise standards and

language regarding shadow flicker and ice throw. The setback has more to do with the visual impact and on property value of smaller acreages. Hove wondered if noise would not be revealed as an issue until after the turbine was built. Henrichsen replied that is why there is also a requirement for a noise study in advance. He said Chapman showed a sound model from an initial proposal that showed noise contours in her testimony. If a special permit application came before Planning Commission, you would see similar models. Then even after it is approved, there are actual measurements to see what is happening on the ground and a process for investigating complaints.

Weber said his house is near S. 67th Street and there are days when it is much noisier than others due to many variables. He wondered how this was factored in. Holmes responded that the way that was addressed was by incorporating the requirement to do noise studies in all four seasons and in "worst case scenarios", which could include factors like high humidity, inversions, and wind direction. Consideration would also be given to what percentage of time that worst case could be expected.

Lust questioned the structure of the language in the section covering noise levels and which level would be used among the choices given. Holmes gave the example of an area with a 40 dB ambient noise level. A level of 3 dB above that would be allowed, so 43 dB. Lust said that language should clarify that it is "whichever is more" from among the choices. Henrichsen said that is addressed in the first sentence where it states no level would be "in exceedance of". Lust asked, if a level of 3 above ambient is allowed, why set a 40 dB level at all. Holmes said that could be done, but there are ambient levels much lower than 37 dB in areas, which would exclude the operation of turbines. Sunderman stated that he would also feel more comfortable if the language were clarified to read "the greater of". Holmes said that would be up to Law to change. He added that the change would not address the issue of 3 dB above the ambient level. He further clarified that if the ambient noise levels were 25 dB, 3 above that would be 28 dB, so a turbine would have to be five miles away to meet that level and could not be sited anywhere. Lust said the intent was for this to mean whichever was the greater level. Holmes said yes.

Cornelius asked if it is possible to calculate the worst-case given the variability of factors that affect noise. Holmes said yes. The modeling packages allow you take in all of those variables.

Lust asked if this meant that the level would be 40 dB on the worst day. Holmes said no, it means an average Leq of 40 dB over a time period. Lust asked about the 10-minute measure period. Holmes said there is an international standard for measuring turbine noise. It is highly complicated and includes use of specific equipment. Complaints go to County Board because they would have to order the turbine company to do noise monitoring and measuring which would be done by a third party firm.

Cornelius asked if the third party firms are reliable. Holmes said yes, the third party process will result in accurate measurements. Henrichsen added that when it comes to worst-case levels, letter 'J' in the regulations is about information that must provided up front for consideration of the application. The worst-case level is provided, but is not a standard used later. It is just for information to judge the impact on non-participants.

Cornelius clarified that his question pertained more to the accuracy of predicting or deriving the various levels using math. Holmes responded saying that in recent monitoring and modeling, they were able to predict almost to a 0.01 level of accuracy. The data continues to be refined and incorporated into the modeling practice. Hove asked if the modeling has been done with local properties so we know they would be within the dB levels. Holmes said no models were provided. There were photos of the modeling results that showed simple circles but that would

not include worst-case scenarios. If you look at wind modeling for the county, you would realize that in the winter the wind blows from north and summer from south, so you would definitely see oblong shapes. Scheer said that it is not unusual to have not seen that modeling yet, since it would come with the special permit applications. Holmes said basic modeling was done to assess where turbines could be sited.

Beecham said that there was testimony that using Leq was already skewed to favor higher level sounds. Holmes said that if there was an acoustician or noise specialist here, they would not agree, and neither would he. Leq is the average level of noise over time so if the sound goes up and down, it is the average level between the highs and lows. It is not skewed towards higher or lower level noises. It is the most commonly used measurement with noise.

Hove asked if this modeling would be done in the entire project area before the project proceeds. Henrichsen said yes. He stated he wanted to clarify that last autumn, Volkswind submitted a proposed text amendment and seven special permit applications in Lancaster County. The applications started down the process and as it neared time to appear before Planning Commission, Volkswind agreed there should be a greater public participation process. They withdrew the text amendment and put the special permit applications on hold. They needed to see what would be adopted by the Lancaster County Board and then adjust their applications based on those regulations. Those permits are still on hold. Staff formulated these regulations for county-wide use. There are fewer acreages in the north so there are possibilities for turbines there as well. Hove asked if more complete modeling would be available at that time. Henrichsen said yes, that is all public information and is available now on the seven applications that are on hold.

Cornelius requested the County Attorney approach to hear thoughts on the position of manufacturer suggested safe distances versus the liability of the County.

Brittany Behrens, County Law Department, came forward and stated that information can be requested from manufacturers, but there is nothing that can be done legally to require them to turn it over. There will be some differentiation between companies and setbacks. If the Planning Commission and the experts in the field have brought forward regulations based on their expertise, then our office does not have any questions with that. Today was the first time we heard from one of the developers about their own company standard setback. She went on to say that there are two issues--(1) the liability of county and (2) that of the developer. Those would be determined as a case-by-case analysis dependent on the situation and the damages that arise. Many factors were considered up front such as the likelihood of towers tipping and damage to roads. We are confident that those issues have been addressed industry wide. If evidence were brought forth that showed a clear delineation between the 1,400 foot and the 1,000 foot setback, that would certainly be looked into.

Harris questioned that if a company had to live up to the sound levels, turbines would have to be located greater than the proposed setback, which is three times the height of the turbine or 1,000 feet, whichever is greater. Henrichsen said that in looking at the preliminary modeling that was presented, the type of noise standard as proposed would create a large space between tower locations and other properties and that could make it difficult to locate in Lancaster County. In looking at the maps presented, yes, when you model the 40 dB level, it is often more than the 1,000 feet setback level.

Harris asked if there is a realistic idea of what type of setback will be followed. Henrichsen said he hesitates to use the word "setback" because the noise level is not requiring a specific setback distance. Harris said she understands that it is not a set distance, but rather a buffer area of space. Henrichsen agreed it creates separation. But there were no measurements from

turbines to see on average how far away that 40 dB level would be met because the sound modeling does not create perfect lines. It also takes into account elevation and many, many other factors, so it is never a perfect number.

Harris asked a followup question – why suggest allowing the physical structure to go that close if it is not realistically possible to meet the sound levels. Henrichsen said the minimum distance from other properties addresses other factors. Setbacks are a standard part of most of the ordinances and in many counties, the setback is the bigger of the two because the noise level is set at 50 dB. It is important to have that minimum because there could be areas where the background noise level is high and turbines do not add anything to the noise, so the setback is still there to provide some protection from other impacts. Harris concluded that the decisions about distance are primarily driven by noise. Henrichsen said setbacks were also included to account for the fact that the actions of Planning Commission and the County Board are unknown. If noise standards are increased, then the setback standards become more important.

Lust said if dB levels remain at what is proposed, it most likely limits the chances of a wind farm going forward. Henrichsen replied that he is not able to give that rendered opinion. There are parts of the county where there could be enough participating property owners or where development could cross into an adjacent county. Lust said but this project as proposed would not go forward. He said that would be a question for Volkswind.

Joe Wood, Volkswind, approached to answer questions. He stated that this is a tough question. There are many variables in the way the sound is modeled and there is an exception for background noise, so to truly answer that, baseline ambient noise levels would need to be established to see if compliance would still be a possibility. If you look at other factors like curtailment to reduce noise during certain periods, a lot of investors would shy away from the performance of the project. These models need to be based on point of emission of sound, so in a way it is "chicken before egg" because the locations need to be established before accurate modeling can be done. Most developers would agree that sound limits at the proposed levels would make it very hard, if not impossible, to construct turbines.

Harris noted that Volkswind proposed 55 dB level for participating and 50 for non. She asked if projects become more feasible if the ordinance had 55 dB for participating, but kept the lower standards for non participants. Wood said it makes a difference, but still the setbacks associated with the lower limit dB are very large and it would still be tough to comply.

Lust said that there was testimony that the 30-hour per year on shadow flicker was more appropriate. Volkswind did not propose that particular change. She asked if it would move things forward. Wood said yes, it would help, but he added that his experience with shadow flicker modeling is limited.

Cornelius asked if proposed text changes in Section B referred to a single turbine, or all of them. Henrichsen replied that all of them would be looked at. Cornelius said that the sun behind an entire line of turbines would produce separate flicker. Corr asked if it is a cumulative effect or individual. Henrichsen said that as it is drafted, it talks about any one. He pointed out it is a shadow, so they would overlap. It would be hard to say one is not doing as much as another. The language talks about any one. Cornelius said that is not hard to construct a model or imagine that a line of turbines could each get sun over a period of time. So some locations could see flicker for an amount of time, several times per day, depending on location. Henrichsen agreed and reiterated that as drafted, it is singular; any one turbine could be allowed 30 hours per year.

Beecham pointed out several items in the Health Canada report that measured physical and self reported effects. It appeared that the study is saying that those who self reported that they were stressed did show measurable signs of stress, but they could not find a direct causal link physically between wind turbine noise and the symptoms. So in other words, it is not causing high blood pressure, it is the annoyance that causes other symptoms. Holmes said that is at least correct in that large study. Beecham said she agreed with the statement Lust made about the difficulty of objectively regulating something subjective.

Beecham went on to refer to a table in the staff report comparing the dB levels of various other common sounds. She questioned if the sound output of wind turbines would need to be as low as that of a quiet living room. Holmes reiterated that turbine noise cannot be compared to any other common noise because it is a completely different type of sound. The measurable levels are low, but it is a particularly irritating sound. It is not constant like another noise that could be louder, constant, and considered "white noise" that covers up other noises. It is a modulating noise and people can expect to be more annoyed by it.

Holmes went on to say there have been suggestions as to why studies identify effects in some people but not others. It may not simply be that they are personally annoyed by it. But people have different susceptibilities. There is a suggestion in the literature that one of the problems is identification of people who are more susceptible to sound exposure. That is a data gap and is proven in many other studies. That is another potential explanation.

Beecham said, so to build on that, if Commissioners were tasked with writing guidelines for a lunchroom and there are some who are allergic to peanuts, for example, do Commissioners write a policy that says no one can bring peanut butter, because some have allergies. She stated she is struggling with that component because it is difficult to figure out how much to dictate based on something so subjective.

Beecham went on to say that the World Health Organization (WHO) says the outdoor annual night time average of 40 dB is the level below which no sleep disturbance should occur even amongst the most vulnerable. She wondered why Health recommended the 37 dB level. Holmes said the 40 dB from WHO was completed in 2008 or 2009 and was addressing traffic and airport noise. If they included turbines it would not be surprising if they had a lower level for that noise. A level where 20% of people are highly annoyed is significant; that is 1 in 5 people and does not even include children. Health landed on the 37 dB based on the number of people that would likely be annoyed. If we pulled a number out of the air, the current 35 dB level appears to be "no observable affect" level which means that below 35 dB, it appears you do not have annoyance levels. Health was trying to consider what some level of acceptable lever of noise would be. Corr asked if the 37 dB means that approximately 90% would not be annoyed. Holmes said that is what is estimated.

Beecham noted that the Mass study uses 37 as their residential number. Holmes said they put out a table of what they call "promising practices" and that is based on Denmark's current levels. That is relevant to siting issues because there have been many turbines sited around the world with restrictions more stringent than what we are talking about here. Beecham noted they had the noise level in sparsely populated areas listed as 44 dB. Something else that study said was that it was important when looking a noise level ranges was to take into account trade-offs between environmental and health impacts of different energy sources. We have talked about Sheldon Station. She wondered why those trade-offs were not considered, saying

that while we look at annoyance, it should also be factored in that water and air quality are not being impacted the way they are with Sheldon Station. Again, it is that matrix of air quality versus water quality versus annoyance and how we look at them against each other. She stated she thinks that is relevant.

Holmes responded that the Mass study was a statewide panel that had expert members. Massachusetts is one of the most, if not the most, progressive state when it comes to energy policy. Nebraska does not have a statewide review of wind noise versus the potential economic benefits or the potential energy benefits. As you know, Nebraska is even in a lawsuit with the EPA over the carbon rule. So there is no statewide review of this. Health Department clearly tries to control air pollution and supports the concepts of wind energy from a large world view. However, this body and the County Board are looking at the health and safety of local residents and that is something that we as a department promote and protect. That is a key factor here, looking at what this would do to people in this county.

Lust said she went through Volkswind's proposed changes and she wanted to know Planning Department's position on them. She referred to the statement regarding avoidance of any impact to endangered species and wondered why that was rejected. Henrichsen said that there is a list of the exact species that are either on the State or Federal lists. Native prairies are not on either. The recommendation from staff is very similar in that any endangered or threatened species on the list cannot be impacted. It then says "rare" natural resources, such as native prairies and grasslands. Volkswind is saying just focus on the ones that are actually on the rare and endangered lists and Planning's recommendation goes one step further to include other areas to protect, as specified by the Comprehensive Plan. Lust said their sentence does end with native prairies and wetlands. Henrichsen stated that, as worded, Volkswind's proposed changed was taken to mean that it only included species actually on the lists.

Beecham asked what is in place to keep someone from claiming to have wetlands on the property. She wondered if areas were tracked somehow. Henrichsen said these areas have been identified on GIS maps. Again, this is something to take into consideration when an application comes forward. It is quite possible for a turbine and a wetlands to be on the same property, in the same area, but with no impact. This should be taken into account as a goal when an application comes forward, because they are an important part of the Comprehensive Plan.

Lust questioned the language on setbacks that states that the distance to any public right-of-way or roadway shall not be less than the height. Volkswind suggests to any public roadway, and the setback to any unpaved roadway, shall be no less than the rotor diameter. Henrichsen said the County Engineer specifically commented on this proposal because they felt the full height of the turbine should be the setback whether the road is paved or unpaved because if it were ever to fall over like a tree, they did not want it landing in the right-of-way.

Lust asked for explanation about the language on Page 4 - letter "h". Henrichsen replied that the goal of this language is to leave a substantial area outside of the 1,000-foot setback and 40 dB noise contours for potential future building. On the previous draft it said "significant'. In this iteration, that amount needed to be specific so at least three acres of property was chosen. It is important to consider the potential impact to anyone who has not yet built on their property. This is not an item seen in most ordinances.

Hove noted that the three acres will not be decided by the landowners. Henrichsen replied that this is meant as guidance on special permit applications. If someone turned in an application and the setbacks and noise left zero acres on the property, we would ask that they be moved.

Weber reiterated that the landowner does not get to choose the three acres. Henrichsen said that was a criticism of this wording because what if the three acres is way at the back when a property owner wants to build by the road. It was difficult to craft something objective and measurable. Cornelius said that this is a special permit ordinance, so this body will see the applications come forward and will see the degree to which the land is impacted, including if the three acres is left in a terrible area, for example.

Corr said that a landowner can still build anywhere, it might just make a turbine nonconforming. She went on to say that there would be a period of delay between the special permit and the time it goes through the process, so a landowner could potentially submit a plan to build. Henrichsen said yes, hypothetically, if someone had a building permit in progress, that would need to be taken into consideration at that time. It would be a risk for someone to actually start their house based on that.

Harris whether anyone would realistically have time to apply for a building permit, and if they did and there were already an existing application for a wind farm, which permit would win in terms of who gets there first.

Behrens apologized that she could not specifically answer off the cuff. She said that with many of these issues, if one side has a vested right, then their interest trumps. There are situations where if the turbine is already located, they already have a vested right. If a house is located after the fact, the turbine becomes nonconforming. That situation may arise more commonly. The situation would depend on many factors such as what point in the special permit process they are at. If it was just an application, there would be minimum reliance because they do not yet know what the special conditions of the application will be so in that case, it is safe saying the building permit could move forward with little to no damage to the wind developers. But that weighing of factors is going to depend on how far along the special permit application is. Sunderman asked for the definition of nonconforming use. Behrens read the following definition from Chapter 2 of the County Zoning Regulations:

> 2.095. Nonconforming Use. Nonconforming use shall mean the use of any dwelling, building, structure, lot, land or premises, or part thereof, which was existing and lawful immediately prior to the effective date of this title and which does not conform with the provisions of this title and any amendments thereto.

Behrens continued, saying, clearly at the time that the turbine was located, they would have been in compliance if there was no dwelling unit. After this language changed and a house goes into effect, they were in compliance at the time they built, and there have been amendments thereto - that have essentially made them noncompliant with new regulations, so they become non conforming and have a vested property right remaining there.

The reason that discussion and that concept is difficult is because nonconforming use changes become much more important when we change the code to measure to the dwelling unit instead of the property line.

Beecham asked who gets notification of these applications. Henrichsen said it would be the standard distance a half mile out. Staff would post as many as possible, but some application areas cover 20 square miles, so there would not necessarily have a sign on every single property.

Weber asked for clarification about the decommissioning bond or equivalent enforceable resource and about the idea of not asking for that for 15 years. Henrichsen said there are other financial instruments available where a bank is saying, yes, these funds will be available though usually it is a bond or letter of credit. There may be some merit waiting until the 15th year. Weber wondered would happen if, after 10 years, the developer ran into financial

difficulty and no bond had been collected. Henrichsen said you would have to rely on the fact that after ten years, there still enough value left in the materials of the wind turbine to salvage it so all that is left is the concrete in the ground. Some communities do not require that any the concrete be removed since it is below the soil. It is a lot of concrete, but it is not as much of a negative as a hulking, rusty turbine.

Weber asked who sets the baseline ambient noise level, and if it is a third party. Holmes answered that it would be done as part of the pre-construction and the developer would have to have a certified noise consultant confirm the levels. They are required to meet certain standards, similar to hiring a PE to do a soil survey, and it is accepted as part of the review process.

Corr asked how the preconstruction noise modeling differs from the preconstruction noise levels or the modeling differs from the monitoring. Holmes said modeling is done on computers based on many factors that are input as variables. Monitoring is done by actually measuring the noise levels under specific protocols.

Beecham asked for a response about the Volkswind proposal that says that in the case of a complaint, discretionary measurements are not taken unless a complaint has not been resolved after six months. Henrichsen said that in general, the practice is to see if the complaint is valid. There would probably have to be monitoring so, in general, there is no problem with that, although six months seems like a fairly long period. The greater concern with their proposal is that there are two tests and if they are found to be invalid, any future complaints have to be paid for by the person making the complaint. That seems unfair to someone who buys the property five years after two complaints were found invalid.

Beecham asked if there is other wording that could be recommended that would address the issue of anyone who would file complaint after complaint. Henrichsen said that is why the language was chosen. There are so many hypotheticals and we ultimately decided to leave it up to elected officials where there would be a quorum, both sides could tell their story, and staff would be present as a third party. Corr said that in this case, being more generic covers more situations. Henrichsen agreed. Beecham asked if there should be language that includes a waiting period that gives them chance to fix a problem. Behrens said that from a legal standpoint, this language is broad and consistent with other language in Chapter 23 of the Nebraska Statutes with regard to zoning codes. Setting out time lines is not typical. The way it is drafted is consistent with other codes regarding revocation or suspension of special permits and zoning code violations.

BREAK: 10:53 P.M. **MEETING RESUMED:10:58 P.M.**

Corr asked about the decommissioning process. Henrichsen said that from what was read about other communities, there is some minimum soil level on top of the old base to help with farming or so that someone wouldn't hit the cement. We thought at the very least if someone goes out of business and the tower comes down and there is no money to do anything else, hopefully there would still be that amount of soil. We hear that to remove the whole thing would be more than the value of the entire turbine installation. Corr asked about the comment that Volskwind made on the proposed amendment where they said specifying a legal depth is not appropriate. Henrichsen said that is an extra measure of protection for the county, but it is not a key item of the regulations.

Corr asked whether, if a turbine is built first, and someone then comes in and builds a house, they can't come in after the fact and complain about the flicker. Henrichsen said they can certainly make the complaint. Staff might go to the point of identifying it is more than 30 hours, but nothing would be done about it because the tower was there first.

Corr went on to ask about the about the setbacks to private versus public roads. Her understanding is that the tower collapses in on itself. Henrichsen said yes, it is very rare for one to collapse anyway, but they tend to collapse in on themselves. In the county there are far fewer private roads than are in the city. But the thought was that if there was going to be one hypothetical for not blocking the roads in case of collapse, it should be same whether public or private. Corr said she wondered if it was due to concern about damage to public roads from heavy weight. Henrichsen said that is covered by a different part or the regulations where they must work out an entire plan with the County Engineer as to what routes can be taken, what will be done to the roads.

Corr asked how the three times the height limit was reached for the setbacks and if it was based on other rules. Henrichsen said most counties have just a set number. There are more that are trying to have the amount times the height because it makes more sense as turbines get taller and taller. So it is looking at particular circumstances. It was a judgment call.

ACTION BY PLANNING COMMISSION: August 19, 2015

Members present: Beecham, Corr, Cornelius, Harris, Hove, Lust, Scheer, Sunderman, and Weber.

Cornelius moved approval. Scheer seconded. Scheer asked if the motion included the corrections that were received. Cornelius said yes, confirmed by Lust.

Cornelius made a motion to amend Section D referring to shadow to shadow flicker, to require the total shadow flicker effect duration for all proposed turbines within any one-half mile of any non-participating dwelling unit shall not exceed 30 hours per any calendar year, and strike "for more that 30 minutes in any one day". Seconded by Beecham.

Cornelius said he made the amendment because it addresses his earlier question about shadow flickers from an array of turbines and their shadows falling on one dwelling unit over time.

Lust stated that given the seasonal nature of when you would have shadow flicker, the 30 hours seems more workable than any one day.

Weber wondered if the intent was indeed to limit it to 30 minutes per day because realistically, it is possible that for 2 or 3 months of the year and there might be flicker.

Cornelius said it couldn't happen for more than 30 weeks.

Lust said she thinks the 30 hours per year solves the problem since there will be months with no flicker.

Weber agreed, but the 30 minutes is a figure they came up with because it is an annoyance. Henrichsen that type of language was present in other counties' regulations and it was taken to mean how much one should have to put up on a given day.

Cornelius said he wanted to strike it because there was expert testimony that it is not long enough.

Beecham says it also doesn't take into account the time of day, so she prefers the cumulative calculation.

Cornelius said that Weber makes a good point that a house could get shadow flicker all day if things lined up right. It isn't that difficult to calculate how long per day the maximum amount would be and this amendment goes forward, it might be worthwhile to ask and astronomer to calculate the exact amount of flicker.

Corr said she support this amendment because of the expert testimony that said that 30 minutes per day would may any project hard to come to fruition.

Motion to amend carried 8-1; Weber dissenting.

Cornelius made a motion to amend Section I regarding noise to reflect a maximum level measured at the wall of a dwelling unit to be 50 dBA during the day, 7:00 a.m. to 10:00 p.m., and 42 dBA from 10:00 p.m. to 7:00 a.m., with the provision that it can be 3 dBA above ambient noise levels, if that is greater. Seconded by Beecham.

Corr asked for clarification if the hours of 7:00 a.m. to 10:00 p.m. would also include the 3 dBA above ambient levels. Cornelius confirmed.

Cornelius stated those numbers were not pulled out of the air. He took the 50 dB as being within a standard of deviation of the mean of the comparables provided, on the low side. It is in line with regional norms. 42 comes from the Mass report's "Promising Practices", which lists 42 dB as the recommendation for rural, sparsely populated, with light wind. Neither levels are particularly high.

Beecham asked if that level is for both participating and non-participating. Cornelius said it was particularly for non-participating, but he had not distinguished. Lust said that as it exists, says it is for both. He clarified that he is happy with that part of the text as written. Lust asked if this also includes whichever is greater? Cornelius said yes.

Hove asked for clarification about which numbers he used. Cornelius said that Commissioners were given a list of ordinances and their maximums. That is where he calculated a max from. For the minimum, he used the Mass report.

Harris asked the rationale for keeping it the same for participating and nonparticipating. Cornelius said the anticipation is that this is a health and safety related requirement.

Hove said asked for clarification that the amendment is suggesting going from 37 dB to 50 dB. Cornelius said 47 to 42 at night, and 40 to 50 during the day.

Cornelius said that part of his rationale is that this in not directly about the Hallam project, this is about the entire county. A key question being asked is, is wind energy conversion an agricultural use. Under the conditions of a special permit, it is. We are trying to settle on parameters and a wind energy company is telling us they are not workable. This commission is establishing is a set of conditions for a special permit, that will help to guide this body in granting the permits.

Weber said that if he is reading correctly, the comparables were measured to the property lines and not the dwellings. Cornelius said that is fair, but he is sticking to his original amendment. Weber said that he would then have to disagree. If the levels are going to be changed, they should be measured at the property lines, not the dwelling unit.

Hove said that he is also going to vote against this amendment. There is not enough information about going from a 37 dB to a 42 dB in order to make a recommendation. Health experts made suggestions, and those should stick.

Lust said she supports this amendment because there is support for the dB levels that Cornelius has chosen in the studies and presentation materials. More importantly, she doesn't think Lancaster County should be the most restrictive in the State or even in the region. Setting at the Health Department levels would prevent any wind project in Lancaster Country from going forward. The other amendments we have in the ordinance provide protections for adjacent landowners and they are well though out. The setbacks have been based on standards that already exist. It seem the noise ordinance is driving the bus of the rest of the setback standards. If this body is going to say the setback should be three times height, it doesn't make any sense to make the noise level such that it would set the turbines back even farther. These projects are going to be difficult to place when considering the neighbors, landowners, and the wind developers. It is important and there is always going to be struggle when placing something new in the county. To regulate them out of existence is not appropriate.

Sunderman said he is not going to support the amendment for two reasons. First, he has faith in what staff have put forward in terms of recommendations. This process is just beginning and it is tougher to pull back from restrictions. It is easier to say, for example, 40 dB is too restrictive, maybe a higher number is more appropriate. But it is tough to come back from that, especially when there is already a huge project built. Second, the standard will be on the books for a long time and we don't know what technology will come, so the noise the turbines generate now is not necessarily what they will generate ten years down the line.

Weber stated that he is extremely uncomfortable with adjusting regulations to make something fit into a box. He does not want to jeopardize the health of citizens to make this work. Lancaster County is unique and very densely populated compared to many other counties. To adjust these noise levels to make it work is not the wisest thing to do.

Scheer stated that he is not going to support the amendment. The Health Department has done a great job in gauging what is best for the county. There is no intent by staff to not permit, or to inhibit the development of wind energy. It must be done within the parameters our experts have given us and to see how it fits.

Beecham will support the amendment based on the scientific evidence provided which shows that there is not statistical proof that turbines cause sleeplessness and high blood pressure, though they cause annoyance. It is important to consider annoyance, but also to look at what other states have done. Some are in very populous areas.

Harris said she will also support the amendment. She feels that this use is being singled out since there are other farm activities that do not have to abide by the same noise regulations. Sensitive to the nuisance that it will be to some land owners, but on principle, she has a problem for asking for something that is not workable, so in that sense, it would make more sense to say we are not going to do this at all if it is not workable. Otherwise, it is just there "on the books" and doesn't mean much in the real world.

Corr said situations like this are a balancing act with many components including economic, neighbors, health, energy, climate, wildlife, and so many competing interests. It was hard to find a line to walk. She supports the 50 dB level because when looking at the rest of the state and the nation, the average is 50 dB. The Health Department's recommendations remove the annoyance for 90% or the population. Some of the studies were looking at 80%. That factor is

so subjective and goes away if the same sound level is on the property of a participant. This issue of fitting a project into a box is done all the time by this body. Another important consideration is this is an AG use and what the Comp Plan suggests for this area – it is agriculture. This could help many farmers struggling with property taxes, so the economic opportunities are very present.

Motion carried 5-4; Hove, Scheer, Sunderman, and Weber dissenting.

Corr made a motion to amend that the word "occupied" be added every time "dwelling unit" is used. Seconded by Beecham.

Corr explained that in the core of the city, there are many vacant houses for a variety of reasons. It is important to distinguish that just because there is a dwelling unit, but it isn't occupied, then things like the flicker do not harm anyone.

Lust said she supports the intent, but that it seems unworkable. To have something that is permanent, like a special permit, allows the building of things based on the presence of the dwelling unit. The fact that it might be unoccupied for six months, but then sells, makes it too difficult to enforce. If it were only applying to the sections on shadow flicker, that might make sense.

Beecham agreed with Lust. If a home is for sale, you don't want consequences to fall on the next owners.

Sunderman asked for staff input. Henrichsen said this was brought up numerous times. The concern was whether a structure was "habitable" because if it seems uninhabitable, it is possible it should not get special consideration. There were similar concerns about "occupied" because there could be a home for sale for a year due to a tough market. It would also be difficult for anyone coming in to figure out when something is occupied. If the point is to address if the house is a wreck and no one has lived there for 20 years, maybe the term "habitable " would work. Staff did not think it was worth adding because it would be such a rare circumstance, and also, the applicant can make the case that a particular structure is not really a house. It would be better to consider case-by-case rather than attempting to predict every alternative.

Corr said she would be willing to change to "habitable" or to add the amendment only to appropriate sections like flicker. Henrichsen clarified that the motion would be to change where it says "dwelling" to "habitable" in the sections relating to noise and shadow. Beecham seconded.

Behrens said that in the typical process for complaints, it would be difficult for Building and Safety to monitor that type of standard. Corr asked if that were true if the word "habitable" instead of "occupied". Behrens replied "habitable" is better, but it is still difficult.

Beecham said that people rehabilitate houses. Lust said there is a way to address that through the special permit process. Henrichsen agreed.

Behrens said that was a large portion of the discussion. Dwelling unit is a relatively defined terms. Once the adjectives are added, it becomes very difficult and more arguable as to what that means.

Corr asked if dwelling unit basically means habitable. Henrichsen said if a house is out there and it is just a pile of boards, the applicant can make that case that it is not a dwelling unit. Behrens said it is so the argument would have to go to an established definition of dwelling unit, which is specific.

Sunderman stated his preference is that dwelling unit be used throughout. To change it could have the opposite effect from what was intended.

Henrichsen said the definition for a dwelling unit is one or more rooms in a dwelling occupied, or intended to be occupied, as a living quarters by a single family as defined therein. Lust stated one could claim it is not intended to be occupied. Henrichsen agreed, saying that if has been unoccupied for thirty years, and there is no intention on the part of the property owner to occupy it.

Motion failed, 0-9.

Harris made a motion to correct a clerical error on Page 11, under G-2, to insert the article "a" in front of "nonparticipating lot" so it reads "for a nonparticipating lot...". Henrichsen said that for that type of clerical correction, staff is comfortable making the correction without a motion.

Cornelius reiterated that this in not directly about the Hallam project, but about the entire county. He stated he would go back on his amendment about the measurement being taken at the dwelling unit and urge the County Board to consider the option of the property line, in appreciation of the arguments made by Weber earlier in discussion. On the whole, he supports this as he supports the idea of wind energy. It will likely have some adverse impacts on some and positive impacts on others. This is a very complex issue. He appreciates all of the information.

Beecham expressed her appreciation to staff. Everyone has tried to balance the new, potentially great economic industry with citizen concerns. She bases her decision on looking at surrounding areas and finding that the proposed regulations are in line with what has been found acceptable. The scientific research said wind turbine noise is a cause of annoyance, but not causal of health problems.

Lust thanked staff and the task force that aided in this process. It is an important decision and Commission always struggles with these types of changes because it is always a balancing act between neighbors and developers. In this case, she is swayed because wind energy is important for the economic development of the county, and for the planet, and this type of development needs to move forward even though it creates difficult decisions.

Weber stated that he feels that he is the rural representative for the group as an acreage and farm owner. He sees both sides of the issue. Property taxes are high for all. Wind power is a good thing. Many who testified in opposition also agreed it was positive. He does not agree with the dB levels. In terms of existing sounds, yes, they are there, however, they are already there. Large buildings and grain elevator are there. But they are not 400-500 feet tall. If turbines were there now, I would say that people who move out there know what they are getting into. When people testify, there are several items to consider. Among them are design standards, scenic corridors, and historic preservation. These are to protect the local area from things happening that do not belong. With health and safety, we must consider, is this a fit in this area? There may be areas that are sparse enough to allow development. If it is too dense, then the regulations have done their job. There will be less demand for housing near turbines. The amendment to raise the dB levels causes great concern. Health made recommendations and we did not even seen what the annoyance levels are at 50 and at the dwelling units, as opposed to the property line. We do not know how these factors affect health. We should err on the side of caution. He stated he would to see it go back to 40 dB at the most, and in five years, maybe there will be quieter turbines.

Sunderman stated he is not going to support this. He agrees with most of the amendment, but that the sound levels should be measured to the property line, not the dwelling unit. If people asked the normal aspects of farming 20 years ago, the answer would be totally different from today. The idea that rural area will stay as they are is not realistic. At some point, wind farms will be out there. He is pro wind and it is part of the future. But it needs to be done carefully and a step process into this would be better than going so high on the dB levels.

Hove said these decisions are looking 20 or 30 years out. This county will change vastly in that time. Lincoln is in the middle of the county and is fortunate to be able to continue to grow in all directions. Wind is very viable here, but Lancaster County has a higher, better use for these properties and there are a lot of other places where wind energy is more viable.

Scheer said he is also pro-wind but his comments are for the Board. For him, this comes down to approving parameters for land use under the special permit process to determine and mold land use. It is less about wind energy and he separates those things. It is about setting the parameters of land use as to how the property is developed.

Harris said she would like to reiterate that Planning Commission is not the final decision making body and the amendment will go on to Bounty Board. The reason she voted for the higher noise limit was to put before the final deciding body something that will spark discussion about whether we want wind energy in Lancaster county and if it is a viable investment. It has to be a higher noise level to make it work. She encourages those who disagree to speak again before County Board.

Corr said that tonight restores her faith in the democratic process that so many people spoke. That helps Commissioners make decision. This is just a recommendation so people can still participate and make feelings known. No matter what happens, she suggests that those who could be affected to stay in touch about how things are going because the text amendments can be modified. This is not set in stone forever. She prefers measuring at the dwelling unit rather than at the property line since that is where the sound will have the most impact.

Motion carried 5-4, Hove, Scheer, Sunderman, and Weber dissenting.

There being no further business to come before the Commission, the meeting was adjourned at 11:59 p.m.

Note: These minutes were formally approved as amended by the Planning Commission at their regular meeting on September 2, 2015.

MEMORANDUM

TO: **Planning Commission**

FROM: Stephen Henrichsen, Planning Department

SUBJECT: Corrections to Sections (h) and (j) in Recommended Text

DATE: August 18, 2015

CC: Judy Halstead, David Cary, Scott Holmes, Chris Schroeder, Brittany Behrens,

Two items in the staff report need to be clarified. First, in section (h) the intent was that impact of any turbine or group of turbines on a property should leave at least three acres outside of the setbacks and noise contours. However, the text appears to read that the measure would be only taken for each turbine individually. So it needs to be corrected to clarify it is the impact of any one turbine or turbines together that needs to be considered. The impact would be measured on a lot wether it is vacant or occupied by a house.

Second, in section (j) it calls for a noise study to show the impact on any lot with a dwelling. However, the noise study needs to show the impact on vacant lots as well in order to determine the impact in section (h) as noted above. So the text needs to be correct to delete the reference to a dwelling.

The staff reported is hereby corrected to state:
"(h) ~~Any single~~ The turbine(s) shall not impact a non-participating lot, (vacant or occupied; of any size), to the extent that, because of the location of turbine(s), the lot owner is left with less than 3 acres of land outside of the CWECS setbacks and ~~or~~ the noise impact area in Section (i) below, unless they are part of an agreement with the CWECS owner/operator.

(j) A professional pre-construction noise study shall be conducted which includes all property ~~with a dwelling~~ within one mile of a tower support base. The protocol and methodology for such studies shall be submitted to the Lincoln-Lancaster County Health Department for review and approval. ..."

Lincoln City-Lancaster County Planning Department
555 S. 10th St., Rm. #213 • Lincoln NE 68508
Phone: (402) 441-7491 • Fax: (402) 441-6377

MEMORANDUM

TO: **Planning Commission**

FROM: Stephen Henrichsen, Planning Department

SUBJECT: Correction on Wind Turbine Total Height in Staff Report

DATE: August 18, 2015

CC: Judy Halstead, David Cary, Scott Holmes, Chris Schroeder

In the conclusion on the first page of in the staff report we noted that:

"Large commercial wind turbine projects have successfully located in other counties in Nebraska. However, the land use characteristics in Lancaster County are not like most other counties in Nebraska. There is significant residential development on smaller lots scattered throughout Lancaster County. In addition, wind turbines which are generally less than 275 in height in other counties, now could range up from 400 to 500 feet or more in height."

The reference to 275 feet in height only reflected the height to the hub, not the total height as discussed in the rest of the staff report. The total height is basically the height from the ground to the tip of the blade when extended to the highest point above the ground. The total height is typically calculated as the hub height plus half the diameter of a rotor blade.

The sentence in the staff report should have referenced total height of wind turbines in Nebraska have generally been around 400 feet as shown by the table on the next page. Some of the largest wind turbines in the world are over 600 feet in total height.

The staff reported is hereby corrected to state:

"Large commercial wind turbine projects have successfully located in other counties in Nebraska. However, the land use characteristics in Lancaster County are not like most other counties in Nebraska. There is significant residential development on smaller lots scattered throughout Lancaster County. In addition, wind turbines which are generally around 400 feet in height in other counties, now could range up to 500 feet or more in height."

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Total Turbine Height
of Various Wind Turbine Projects
in Nebraska

Project Name	Number of Turbines	Capacity (MW)	Year	Total Height (feet)	Approximate Location
Ainsworth	36	59.4	2005	365	Ainsworth, Brown Co.
Broken Bow I	50	80.0	2012	398	Broken Bow, Custer Co.
Broken Bow II	43	75.0	2014	426	Broken Bow, Custer Co.
Creston	4	6.8	2015	n/a	Creston, Platte Co.
Crofton Bluffs	22	42.0	2012	410	Southwest of Crofton, Knox Co.
Elkhorn Ridge	27	81.0	2009	410	Bloomfield, Knox Co.
Flat Water	40	60.0	2010	398	Near Humboldt in Richardson Co.
Grande Prairie	266	400.0	2015	388 to 521	O'Neill in Holt Co.
Kimball	7	10.5	2002	466	Kimball in Kimball Co.
Laredo Ridge	54	81.0	2010	398	Petersburg in Boone Co.
Petersburg	27	40.5	2011	398	Petersburg in Boone Co.
Prairie Breeze	118	200.6	2014	426	Antelope, Boone & Madison Co.
Prairie Breeze II	40	73.5	underway	426	Antelope & Boone Co.
Prairie Breeze III	20	36.0	underway	426	Southeast of Elgin, Antelope Co.
Salt Valley	2	1.3	1998	290	Lincoln, Lancaster Co.
Springview II	2	3.0	2011	339	Springview in Keya Paha Co.
Steele Flats	44	74.8	2013	422	Gage County
Valley Station	1	0.6	2001	n/a	Valley, Douglas Co.
Verdigre	47	81.5	near start	n/a	Verdigre in Knox Co.

Total Height was calculated as hub height plus 1/2 of the rotor diameter.

Sources: Total height based on various sources and available information. Typically only the hub height and rotor diameter is listed in online information, not a specific "total height." Newspaper accounts often use the hub height as the height of the turbine.

"n/a" means total height was not found in search of information online.

MEMORANDUM

TO: **Planning Commission**

FROM: Stephen Henrichsen, Planning Department
Scott Holmes, Lincoln/ Lancaster County Health Department

SUBJECT: Information Request from Cathy Beecham

DATE: August 18, 2015

CC: Judy Halstead, David Cary, Chris Schroeder

1. Since we have a couple of neighboring states with developed wind energy, do we have any info on the noise regulations for any of the following?

   Polk County, Iowa (Des Moines)
   Dickenson, Iowa
   Riley County, KS (Manhattan)
   Reno County, KS (Hutchinson)
   Sedgewick, County, KS (Wichita)

Yes, we looked at the setbacks in several other states. The attached table is the examples we presented to the Working Group in April. In regards to two specific examples you noted, **Polk County Iowa** does have wind turbine regulations which can be found at: https://www.polkcountyiowa.gov/media/29023/ordinanceregulatingwindenergyconversionsystems.pdf which include setbacks and noise levels, both of which are measured to the property line, not the dwelling unit. Their ordinance states:

*"**4. Setbacks.** WECS shall be setback a minimum distance from the base of the structure to all property lines equal to 1.1 times the height of the tower and rotor as measured from the base to the highest reach of its blade, thus should the structure collapse or topple, it shall come to rest wholly within the property lines on which it is located.*

***a.** WECS including guyed wires and anchors shall not be located within a required principal structure setback in any zoning district.*

***b.** Single use residential production WECS shall not be located in front of the residence.*

***c.** A tower that is part of a shared (multiple towers and/or multiple properties) project may be located closer to interior property lines than 1.1 times the height of the tower when located within the project area as defined on the WECS Permit application. Written consent and fall easements must be provided by the appropriate submittal deadline. In no case shall a WECS be located closer than 1.1 times the overall height to any public road right-of-way. All*

easement shall be shown on an appropriate drawing and recorded at the Polk County Recorders Office by the project applicant(s) and/or tower owner.

d. An Energy Production WECS shall be located only in the AG zoning district and shall be a minimum 1320 feet from any other Zoning District line, residence, not included in the application, or any public park and/or recreation property line with the following exceptions:

i. Owner(s) or homeowners association for the placement of shared residential production WECS.

ii. Any public park or recreational land when approved by the appropriate County, State, or Federal administrative staff, boards, and/or commissions for a demonstrated public purpose.

***7. Noise Levels.** The noise level measured at the property line of the property on which the WECS has been installed shall not exceed 55 decibels, or cause a noise disturbance as defined in the Polk County Noise Pollution Ordinance. In no event shall the WECS create a nuisance. While the Polk County Ordinance does not specify a noise study, that would be the only way they would be able to determine, prior to construction, if they would meet the noise level established in the ordinance. Also interesting is the fact that the Polk County Noise Pollution Ordinance applies and WECS are covered by it as far as if they create a nuisance."*

Riley County Kansas also has regulations that can be viewed at:
http://www.rileycountyks.gov/DocumentCenter/View/10234

They are quite different and much more extensive, requiring multiple assessments, including: visual modeling of impacts (3 D GIS renderings), cost benefit analysis, environmental assessment, noise modeling (both A and C at the nearest dwelling unit and at property line), water quality, soil erosion, etc. On the noise side they regulate noise a the property line and use both dBA (65) and dBC (50) and a penalty for "tonality". Set back is 1.5 times turbine height at the property line. Both of these differ significantly from what is proposed in Lancaster County and it would be very difficult to compare them to what is proposed since our focus on the noise is at the dwelling unit, not the property line.

2. Can you tell me our current process for other industries that might create noise issues in the county, such as airports, drag strips, etc.? Sounds like we do not have a blanket noise ordinance that covers these activities so does each industry have to meet state guidelines and then we decide project by project if additional conditions are needed? Do we require a Pre-construction Noise Pollution Level study for certain industries or is it on a case by case basis at the recommendation of Planning or Health Dept.?

Yes, we do address noise in the special permit requirements for some other uses in the County zoning regulations. The most extensive requirement is for Section 13.016 Permitted Special Use: Race Tracks, Drag Strips, and Motor Sport Facilities in "AG" District;

"(11) A professional sound assessment of the proposed race track, drag strip or motor sports facility shall be submitted by the applicant to the Health Department for review and recommendation for approval or denial. The professional sound assessment may be done in one of two ways: computer modeling or Health Department approved on-site noise generation and monitoring. If the professional sound assessment predicts or identifies NPL levels that exceed the regulatory limits established in Section 13.016(d), a sound mitigation strategies plan

shall be proposed by the applicant. Such sound mitigation strategies plan shall be signed by an accredited engineer with speciality or advanced knowledge in acoustics. The sound mitigation strategies plan shall be submitted to the Health Department for review and recommendation for approval or denial of the sound mitigation strategies plan. The Health Department shall take action to recommend approval or denial of the plan within 30 days of receipt.

(d) The operation of a race track, drag strip or motor sports facility shall not created an A weighted Noise Pollution Level (NPL) sound level (dBA) which exceeds the current conditional NPL on the nearest receiving properties with occupied residences in existence on the date of approval of the special permit by more than 10 dB between the hours of 10:00 a.m. and 6:00 p.m., nor more than 6 dB between the hours of 6:00 p.m. and 10:00 p.m. In addition, the NPL level shall not exceed 81 dB, no matter what the baseline NPL level. The current condition NPL noise levels shall be established by conducting noise monitoring at the closest residence(s) in outside areas that will likely be actively used for the enjoyment of their property.

(1) Noise samples shall be acquired continuously for one hour using a one second sampling rate.

(2) The sound level meter shall be set to the "A" weighting and "fast" mode.

(3) The sound level meter shall be calibrated to an approved standard before and after each measurement period.

(4) The current condition NPL shall be established by measuring both during what is believed to represent the peak noise conditions and during evening hours.

(5) Noise measurements shall be made with a sound level meter meeting the standards of the American National Standards Institute (ANSI S1.4-1983 as amended by S1.4A-1985, or the latest approved revision thereof), or its successor body, using a Type I or Type II meter.

(6) Noise monitoring shall be conducted by the Health Department.

(7) Noise measurements for enforcement purposes shall be conducted using the same protocol as provided in subsection (d)(1), (2), (3), (5) and (6) above. The formula for calculating the NPL shall be: NPL = (L50 + L10 - L90) + [(L10 - L90)² / 60]

(8) Before a special use permit is issued for a race track, drag strip or motor sports facility, a professional sound assessment of the proposed race track, drag strip or motor sports facility shall be submitted by the applicant to the Health Department for review and recommendation for approval or denial. This may be done in one of two ways: computer modeling or Health Department approved on-site noise generation and monitoring. If this sound assessment predicts or identifies NPL levels and exceed the regulatory limits established herein, sound mitigation strategies shall be proposed by the applicant. Such sound mitigation strategies shall be signed by an accredited engineer with speciality or advanced knowledge in acoustics. The noise mitigation plan shall be submitted to the Health Department for review and recommendation for approval or denial. The Health Department shall take no action to recommend approval or denial of the plan within 30 days of receipt.

(9) Prior to operation, the race track, drag strip or motor sports facility shall install an approved continuous noise monitoring device at a location to be determined by the Health Department. Data collected from this monitor shall be made available to the Health Department. The Health Department shall be provided access to the race track, drag strip or motor sports facility at any reasonable time to inspect, investigate complaints or conduct noise monitoring."

The use of the NPL as the metric was to specifically address the kind of noise that would be generated by drag racing, motor sports, etc. It is NOT comparable to using dBA as a noise metric. Dr. Cheene assisted the County in developing these regulations. This was the result of over a year long process with an advisory committee. There is no general noise regulation in the Lancaster County resolution and there are no state regulations on noise.

Examples of Commercial Wind Energy Setbacks

April 29, 2015

Selected examples of setbacks from various states:

Location	NOISE LIMIT AT OCCUPIED RESIDENCE(dBA)	SETBACK FROM OCCUPIED RESIDENCE	SETBACK FROM NON PARTICIPATING PROPERTY LINES	SETBACK FROM ROAD RIGHT OF WAY	County Reg. Page #
Polk Co., IA	55 at property line	1,320	1.1 x total height	1.1 x total height	Chapter 22
Sioux Co., IA	60 *	2 x total height or minimum 1,000'	Shall not encroach over property line	1.1 x total height	128
Emmet Co., IA	50 at property line	1,250	1.1 x total height	1.1 x total height	Ord. VI-III A
Mason City, IA	Separate section	1,000	1.1 x total height (350' is maximum height of any tower)	1.1 x total height	Title 12 Chapter 33
Boone Co., IA	50	750	1.25 x total height	1 x total height	Sec. 8.04
Perry City, IA	55	1,000 to property line	1.1 x total height	1.1 x total height	Chapter 159
Rock Island Co., IL	None	1,000	1.1 x total height	1.1 x total height	NREL
Doniphan Co., KS	55 at property line	1,320	Greater of 500 feet or 1 x total height	Greater of 500 feet or 1 x total height	Article 14
Riley Co, KS	65 at property line *	None listed, at least 1.5 x total height	1.5 x total height	1.5 x total height	NREL
Huron Co. MI	Greater of 50 or ambient + 5 dBA *	Greater of 2 x total height or 1,000	2 x hub height	Greater of 400 feet or 1.5 x hub height	NREL
Long Lake Township, MI	Ambient + 10 dBA at property line	None listed, at least 2 x total height	2 x total height	5 x total height	NREL
Fillmore Co., MN	State regulation	750	1.1 x total height	1.1 x total height	NREL
Nicollet Co., MN	State regulation	750	1.1 x total height	1.1 x total height	NREL
Swift Co., MN	State regulation	750	1.1 x total height	1 x total height	NREL

Location	NOISE LIMIT AT OCCUPIED RESIDENCE(dBA)	SETBACK FROM OCCUPIED RESIDENCE	SETBACK FROM NON PARTICIPATING PROPERTY LINES	SETBACK FROM ROAD RIGHT OF WAY	County Reg. Page #
Hamlin, NY	Ambient + 6 dBA at wall *	1,200	600 or 500 feet to public property	600 feet	NREL
Brookings Co., SD	50	1,000	Greater of 500' or 1.1 x total height	Greater of 500' or 1.1 x total height	NREL
Door Co., WI	50 at property line; 45 inside *	Greater of 2 x total height or 1,000	1.1 x total height	1.1 x total height	NREL
Iowa Co., WI	50 day/ 45 night	Lesser of 1,250 or 3.1 x total height	1.1 x total height	1.1 x total height	Ord. 400.17
Wisconsin State	50 day/ 45 night	Lesser of 1,250 or 3.1 x total height	1.1 x total height	1.1 x total height	PSC 128.13, 128.14

Notes: 1) Table displays many types of city and county regulations, but is not intended to be all inclusive of all jurisdictions in U.S. Multiple sources were used with some information summarized from "An Overview of Existing Wind Energy Ordinances" National Renewable Energy Laboratory (NREL) at http://www.nrel.gov/docs/fy09osti/44439.pdf

2) * = Includes reductions and various qualifications on noise level.

3) WECS Setback Examples:

		Resulting setback based on:			
Total Tower Height	Rotor Diameter	1 x total height	2 x total height	½ blade diameter	Diameter + Setback
325	235	325	650	117.5	285
400	300	400	800	150.0	350
465	355	465	930	177.5	405

Table is generalized for comparison purposes only. Assumes a 50 foot building setback for comparison purposes.