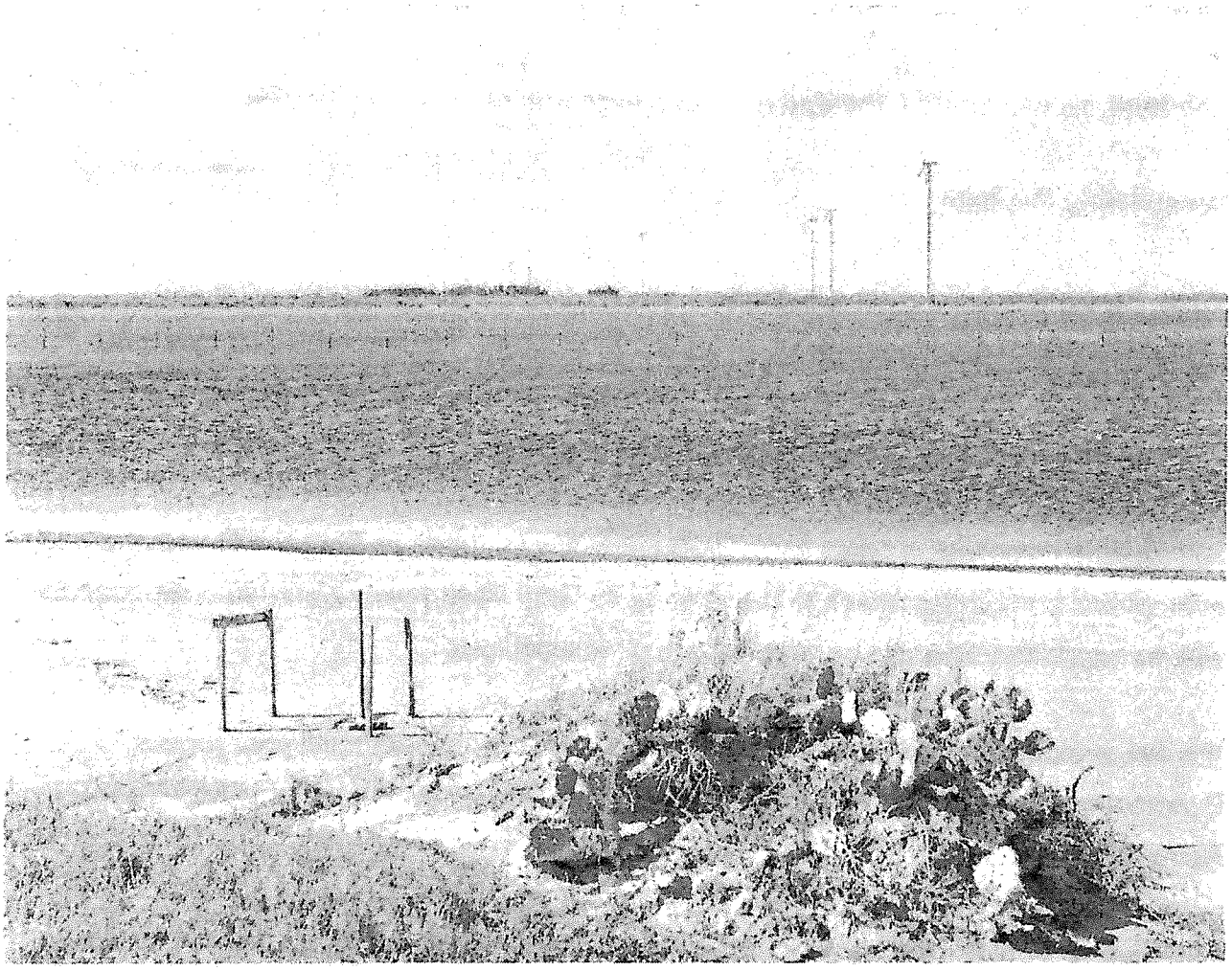
http://www.valleymorningstar.com/news/local_news/article_3a81176e-f65d-11e6-b1bb-b70957ccb19f.html

Retiring worn-out wind turbines could cost billions that nobody has

By RICK KELLEY Staff Writer Mar 3, 2017



Rick Kelley

HARLINGEN — This is a story about death and resurrection, and as with all such stories, faith plays its part.

Texas is by far the leading wind energy producer in the United States, generating more than 20,000 megawatts of electricity each year. That is about one-fourth of the nation's wind-energy production.

We can expect the Texas winds to blow forever, but the colossal turbines which capture the breeze and transform it into electricity will not turn forever. Like all mechanical things devised by man, no matter how clever, they eventually wear out.

But the question is, what will this mean to the landscape and future of the Rio Grande Valley and, in particular, the counties of Willacy and Cameron?

And here, as we confront the end days of a wind turbine, our story begins.

Deregulating the field

When Texas deregulated its electricity market in 2002, it forced power companies, transmission providers and electricity sellers to separate. For the most part, this has worked well for the state and electricity customers, with the Electric Reliability Council of Texas, known as ERCOT, ramrodding about 75 percent of the state's efficient power grid.

Deregulation also was a major factor in the rise of wind farms in Texas, with national and even global companies drawn to the state by its Wild West power-generation atmosphere with no regulatory agency, no permitting and no wind laws.

"It's like prospecting: You can basically go stake your claim and build your project," Sweetwater attorney Rod Wetsel, who co-wrote the book "Wind Law," told MIT Technology Review last fall.

And then, of course, there are the federal subsidies which make wind energy financially possible.

Wind energy production tripled thanks to the Obama administration's aggressive green energy agenda, going from 8,883 megawatts in 2005 to around 82,183 megawatts today, which is about 5.5 percent of the nation's total power generation.

The congressional Joint Committee on Taxation estimates the total cost to taxpayers of the wind production tax credit between 2016 and 2020 will be $23.7 billion.

Whether those subsidies will continue under the Trump administration remains to be seen.

One big question is how much money is being set aside for the inevitable decommissioning costs associated with removing aging, unprofitable and just plain worn out wind turbines now whirling across the horizons of Cameron and Willacy counties.

Wind turbine: The life and death

The life span of a wind turbine, power companies say, is between 20 and 25 years. But in Europe, with a much longer history of wind power generation, the life of a turbine appears to be somewhat less.

"We don't know with certainty the life spans of current turbines," said Lisa Linowes, executive director of WindAction Group, a nonprofit which studies landowner rights and the impact of the wind energy industry. Its funding, according to its website, comes from environmentalists, energy experts and public donations and not the fossil fuel industry.

Linowes said most of the wind turbines operating within the United States have been put in place within the past 10 years. In Texas, most have become operational since 2005.

"So we're coming in on 10 years of life and we're seeing blades need to be replaced, cells need to be replaced, so it's unlikely they're going to get 20 years out of these turbines," she said.

Estimates put the tear-down cost of a single modern wind turbine, which can rise from 250 to 500 feet above the ground, at $200,000.

With more than 50,000 wind turbines spinning in the United States, decommissioning costs are estimated at around $10 billion.

In Texas, there are approximately 12,000 turbines operational in the state.

Decommissioning these turbines could cost as much as $2.3 billion.

Which means landowners and counties in Texas could be on the hook for tens or even hundreds of millions of dollars if officials determine non-functional wind turbines need to be removed.

Or if that proves to be too costly, as seems likely, some areas of the state could become post-apocalyptic wastelands steepled with teetering and fallen wind turbines, locked in a rigor mortis of obsolescence.

Recycling or resurrecting?

Companies will of course have the option of upgrading those aging wind turbines with new models, a resurrection of sorts. Yet the financial wherewithal to do so may depend on the continuation of federal wind subsidies, which is by no means assured.

Wind farm owners say the recycling value of turbines is significant and recovering valuable material like copper and steel will cover most of the cost of decommissioning.

"The problem is, wind companies have argued vehemently that the cost of money set aside should net out the salvage value of turbines," Linowes said.

"If it costs $200,000 to take down a turbine, but once you take it down, you strip out the copper, the steel, the resellable components and sell them, then really you can make a profit," she says of the industry's pitch.

"So a company will say, 'So as to cost, subtract that benefit, so rather than $200,000 for a turbine we should only set aside $60,000,' so there's a fight over how much money should be set aside," she said.

In Texas, with virtually no regulatory oversight of wind farms, there is no requirement for wind companies to set aside any funds for decommissioning.

Yet extracting valuable materials from the turbines is not as easy as it sounds. For example, the copper in the wires used to transmit power from the turbine to the grid will have to be stripped of its plastic insulation, a task which would entail serious labor costs.

Also, the sheer size of the steel casings which provide the base of the turbines would take specialized cutting tools to reduce the steel to manageable or transportable chunks.

And the blades themselves are a high-tech wonder of composite material, which most experts agree cannot be separated into its component materials and is thus worthless for recycling.

"The blades are composite, those are not recyclable, those can't be sold," Linowes said. "The landfills are going to be filled with blades in a matter of no time."

Faith in doing the right thing

In Cameron and Willacy counties, the operational wind farms are Cameron Wind, Los Vientos I and II, Magic Valley Wind Farm and the new San Roman Wind Farm. The turbine count for these is approximately 400 operational turbines.

At a cost of $200,000 each, decommissioning these turbines when their working life expires would cost $80 million.

At Duke Energy's Los Vientos I and II wind farms in Willacy County, there are 191 wind turbines. Across Texas at various locations, Duke has around 900 wind turbines which are operational.

"At each of our wind sites, for example, built into the construction and operational costs is also a plan for decommissioning," said Tammie McGee, director of corporate communications for Duke.

Duke Energy, which has been in the power business for more than 100 years, is relatively new to the wind industry. McGee said Duke began investing in wind power generation about a decade ago.

She said although Duke hasn't been around long enough to decommission turbines, plans are in place to "repower" aging wind site locations by upgrading — resurrecting — the equipment.

"What does happen a lot of times, and is happening now around the country, is sometimes instead of decommissioning they will 'repower' a site," she said.

"That involves replacing the turbines on top of the towers with new technology," McGee added. "In the atowers, too, and put up new and more modern towers."

If a site is properly located, the winds will still be there, making repowering an attractive financial option since the costs of site selection and development have already been covered.

Most wind farms, which pay landowners on average around $8,000 a year per turbine, have contracts with renewal clauses that stretch out to 50 or 60 years.

If Duke decides to shutter a power plant, including its wind farms, the company is committed to restoring the site to its previous state, she said.

"Regardless of fuel type, whether its gas or coal or wind or solar, once a power plant is no longer in service we restore the land to how it was before we got there," McGee said.

Calls seeking comment from two other wind energy companies operating in Cameron County, Apex Clean Energy which operates Cameron Wind and Acciona United States, which runs the San Roman Wind Farm near Laguna Vista, were not returned.

Unlike Duke Energy, some of the smaller wind farm companies operating in Texas, with fewer financial resources, may be tempted to just walk away when aging turbines no longer spin a profit.

Linowes believes such moves may begin occurring even before wind turbines outlive their useful life as manufacturing warranties on the big turbines expire.

"At what point does the cost of maintenance tip over to the point it's not worth maintaining a turbine?" she said. "We're in something of an unknown or uncertain territory."

As wind turbine manufacturing has improved, the length of warranties on these products has decreased dramatically and today the terms of most cover between five and 10 years.

It seems paradoxical that warranties would become shorter as products become better, but many wind turbine manufacturers have found a valuable revenue stream in selling extended warranties, similar to companies which sell appliances to consumers.

"It could be a very ugly situation in the next five years when we see turbines need work, and are no longer under warranty and not generating enough electricity to keep running them," Linowes said.

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BEFORE THE SOUTH DAKOTA PUBLIC UTILITIES COMMISSION

DOCKET NO. EL17-055

IN THE MATTER OF THE CROCKER WIND FARM, LLC, PERMIT APPLICATION FOR A WIND ENERGY FACILITY AND 345 KV TRANSMISSION LINE IN CLARK COUNTY, SOUTH DAKOTA

Direct Testimony of David Lawrence
On Behalf of the Staff of the South Dakota Public Utilities Commission
March 28, 2018

Q: State your name and occupation.

A: My name is David Lawrence, and I am a real property appraiser.

Q: State your business address.

A: My business address is 4820 E. 57th Street, Sioux Falls, South Dakota.

Q: By whom are you currently employed?

A: I am a real property appraiser with DAL Appraisal & Land Services.

Q: Please state your educational and professional background.

A: I received a Bachelor of Business Administration from Western State College University in Gunnison, Colorado. After completing a four-year degree, I worked in real estate development, site acquisition, and management for a nationally branded franchise system. My career transitioned to real property valuation, and I began work with the RJ Hobson Appraisal Firm. I continued my real property studies with the Appraisal Institute earning the MAI designation, the SRA designation, and the AI-RRS designation. After completing my designations with the Appraisal Institute, I continued my real property studies with the International Right of Way Association, earning the SR/WA designation. I am currently active in the Appraisal Institute, the International Right of Way Association and the Professional Appraisers Association of South Dakota.

Q: Can you briefly describe the requirements to be a real property appraiser in South Dakota?

A: The South Dakota Appraisal Certification Program has four types of license levels for performing valuation services. The State-Registered Appraiser (entry level), State-Licensed Appraiser (mid-level licensure), State-Certified Residential Appraiser (highest level of residential certification), and the State-Certified General Appraiser (highest level of certification). The first three license levels have scope of practice limitations, with an emphasis on residential property. The State-Certified General Appraiser license is without limits to property type or complexity for an appraisal assignment. The residential license levels require holding an associate degree or higher from an accredited college. The State-Certified General Appraiser license requires a bachelor's degree or higher from an accredited college or university. Beyond the college or secondary education, each license level has specific appraisal education and experience requirements, national testing and peer work product review in conformance with the Uniform Standards of Professional Appraisal Practice (USPAP) and the laws of South Dakota.

Q: What level of appraisal credentials do you hold with the State of South Dakota?

A: I am a State-Certified General Appraiser.

Q: What are some of the relevant definitions and laws that apply in South Dakota for valuation services pertaining to appraisal practice?

A: Establishment of qualification and standards for appraisal practice in South Dakota was a direct result of the economic turmoil caused by the abuse of the appraisal process in the 1980s, commonly referred to as the savings and loan crisis. Prior to Title XI of FIRREA, the appraisal profession was unregulated, and any individual could represent themselves to the public as a real property appraiser. In 1989, the USPAP was developed with the express purpose of promoting and preserving public trust and confidence in the appraisal profession. The USPAP achieved legal authority in South Dakota by adoption and regulation in South Dakota Codified Law (SDCL) Chapter 36-21B and South Dakota Administrative Rules (ARSD) Article 20:14.

SDCL 36-21B-1 mandates, "*any person who performs a real estate appraisal or advertises or holds himself or herself out to the general public as a real estate appraiser in South Dakota shall be certified, licensed or registered by the Department of Labor and Regulation unless exempt under another provision of this chapter or another provision of the statute.*"

ARSD Article 20:14 provides the criteria for appraisal practice, and what valuation disciplines are regulated by the Appraisal Certification Program for providing valuation services within South Dakota. For the purposes of determining what

constitutes appraisal practice in South Dakota, the performance objectives are provided in ARSD Article 20:14 for practitioners providing valuation services.

Appraisal Practice is defined as, "*valuation services performed by an individual acting as an appraiser.*" It is the expectation of the valuation service that makes one an appraiser, not the holding of any specific credential or state license.

An Assignment is defined as, "*a valuation service that is provided by an appraiser as a consequence of an agreement with a client*." Assignment results include an appraiser's opinions or conclusions developed in an appraisal assignment and are not limited to value. For example, if a client hires an appraiser to provide opinions and conclusions about the certain impacts a project has on real property values, this would constitute an appraisal assignment.

An Appraiser is defined as, "*one who is expected to perform valuation services competently and in a manner that is independent, impartial and objective*."

An Appraisal is defined as, "*the act or process of developing an opinion of value of real estate for another and for compensation*." South Dakota has adopted a specific definition of what constitutes an appraisal. *"An appraisal must be numerically expressed as a specific amount, as a range of numbers or as a relationship."* For example, if an appraiser provides an opinion about the effects an overhead transmission line can have on residential properties values within the

vicinity of the project, that constitutes an opinion of value in South Dakota because it provides an opinion as to the relationship on value to a specific property type within the project. It doesn't matter if the value opinion is expressed as +10%, 0%, -5% or -50%, or a stated conclusion that a project will not have an effect on real property value; it is an opinion of the relationship of value to a specific property that is applicable to the definition that makes it an opinion of value.

In South Dakota, only appraisers can offer services that are considered appraisal practice that pertain to valuation services. South Dakota is a mandatory appraisal state and the laws are specific to any person representing themselves to the public as a real property appraiser. If a person is providing an opinion of value for compensation in South Dakota, that person is required to be licensed by the Appraisal Certification Program and have the required education, experience and competency for the assignment and property type, including being geographically competent within the market area of the assignment. South Dakota provides these requirements to appraisers in order to elevate appraisal practice to a level of objectivity and independence that is worthy of public trust and confidence.

Q: What work experience have you had that is relevant to your involvement in this project?

A: I have a wide range of appraisal experience and geographical competency across South Dakota and neighboring states including property types such as residential, commercial, ranch and farm. I've been fortunate in my appraisal career

to have worked across the diverse market areas of South Dakota, including East and West River. Most of my appraisal experience is in right-of-way, linear and energy projects. I have provided appraisals for right-of-way acquisitions, condemnation, and damage property cases. I have managed the appraisal process for several recent energy and large-scale linear project in South Dakota including Keystone L.P., Keystone XL and the Dakota Access pipelines. As part of my practice, I provide appraisal services for damaged property and diminution value studies. These assignments have ranged from measuring the impacts of a high-voltage transmission line on residential property values, to analyzing the impacts of the 2011 Missouri River flood on residential and agricultural property values in Union County. In the last nine years, I've completed several studies analyzing the impacts of underground pipelines on agricultural land values in Montana, South Dakota, Minnesota, and Nebraska. I have extensive experience in South Dakota developing damage studies and their relationship to properties values. I've developed South Dakota impact studies on the Keystone Phase I, Keystone XL, NuStar, SDIP, Northern Border, Lewis & Clark, Magellan, Rockies Express, and MDU pipelines. The scope of work for these projects, includes sales analysis studies, site impact studies, and highest and best use studies across South Dakota, from border to border. My various impact studies have relied upon survey-based research with hundreds of South Dakota market participants impacted by an energy project, and sales research in every county which the projects occupy. My experience with impact studies across the state has given

me the competency and knowledge to correctly research and apply the methodology for credible analysis.

Q: Have you testified before the South Dakota Public Utilities Commission?

A: No.

Q: On whose behalf was this testimony prepared?

A: This testimony was prepared on behalf of the Staff of the South Dakota Public Utilities Commission.

Q: What is the purpose of your testimony in this proceeding?

A: The purpose of my testimony is to assist the Commission in understanding South Dakota appraisal requirements, valuation principles and techniques, and how they can be appropriately applied to estimate value impacts from the Crocker Wind Project, and other wind energy projects in South Dakota.

Q: What materials have you reviewed in this matter?

A: I have reviewed the Application and Appendix I to the Application, "The Impact of Wind Power Projects on Residential Property Values in the United States." In addition, I reviewed the direct testimony of Mark Thayer, including Exhibits 1 through 19 attached to his testimony.

Q: In your opinion, do the studies and testimony of the applicant adequately reflect the potential impact to the value of properties in the vicinity of the proposed Crocker Wind project?

A: It is my opinion that the studies and testimony do not provide adequate market evidence that can be applied to the subject area of the Crocker Wind Project. Most of the studies only present a statistical analysis of a large, well-defined residential dataset not necessarily applicable to rural South Dakota property values impacted by wind energy projects. The studies and testimony do provide a starting point to gauge the potential impacts upon residential property values, but do not address the potential impacts, if any, that a wind farm can have on agricultural land classes.

Q: Please explain why the studies and testimony are not reflective of the potential impact the Crocker Wind project may have on land value.

A: Most of the studies, articles, and testimony focus on the hedonic regression method for determining the effects on residential property values resulting from a wind energy project. To estimate the value of real property using the hedonic mathematical equation, property characteristics or independent variables are identified that contribute to market value such as view, shape, topography, location, and utility. By including proximity or view of a wind energy project or wind tower as a variable in the regression the appraiser can better estimate the negative or positive impact the wind energy project or tower will have on the value of the property. The hedonic analysis has been an accepted methodology in the appraisal profession for years; however, it has limitations. One significant

weakness of hedonic analysis was pointed out in the winter 2012 edition of the Appraisal Journal. In the article James Chalmers, PhD states, "(hedonic analysis)...*does not rule out the possibility that some individual properties are significantly affected nor provide any insight into the conditions shared by those individual properties that make them vulnerable to transmission line impacts."* In my experience with damages studies, I have found Chalmers' statement to be valid in analyzing properties affected by an energy project. To truly gauge the value impacts from a project, the methodology needs to address more than just a mathematical analysis of a large data set from different market areas from around the United States. The study needs to analyze market evidence from specific and surrounding market areas that would be applicable to the impacted property type, and in some cases, individual analysis of an affected property.

Q: Please explain the limitation of the studies and direct testimony of the applicant as they would apply to the impacts upon property values in South Dakota, for the proposed Crocker Wind project?

A: While I have read through the exhibits, my comments will specifically address the report developed by Crocker's valuation expert, Mark Thayer:

- The study and direct testimony conclude that the LBNL research is transferable to South Dakota properties in the neighborhood of wind facilities. I disagree. The LBNL studies only focus on residential property values from populated areas in the United States including New York, Texas, Washington, Wisconsin, Illinois, and others. South Dakota property

characteristics are not comparable to the areas of LBNL studies. For example, on Page 13 of Mr. Thayer's direct testimony, the Applicant attempts to make the data applicable to South Dakota by concluding Minnesota and Iowa counties are quite similar to South Dakota counties...."*But the South Dakota counties look very much like their Minnesota counterparts, especially Cottonwood County and Jackson County and Franklin and Sac counties in Iowa are also quite similar to South Dakota counties.*" While I agree there are some overall similarities for comparison of highest and best use, the data shows these Minnesota and Iowa counties are all superior regarding population, median home value, population density, and production capability. Mr. Thayer's study averages Clark, Codington, and Grant Counties' demographics for comparison, but this can provide misleading results for analysis. For example, the population of Codington County is nearly eight times that of Clark County. The county seat, Watertown, is the fifth largest city in South Dakota with significant industrial and retail facilities. Clark is the sixty-second largest city in South Dakota and like many rural communities in our state face significant obstacles to growth and prosperity, including declining (-8% 2016) population. As well, median home values are skewed by Watertown's population and recreational homes on Lake Kampeska, Pelican Lake and Big Stone. Big Stone Lake is in Grant County and not a county impacted by the project. Franklin, Sac, Cottonwood, and Jackson have an approximately 65 percent larger population, 76 percent larger population density and a 17

percent higher median home value when compared to Clark County. Median income levels are similar for comparison; however, when compared to the median home value, the typical market participant in Franklin, Sac, Cottonwood and Jackson County has less effective purchasing power than the typical buyer in Clark County South Dakota. Additionally, land values are dramatically different, with Sac County reporting an average 2016 land value of $8,858 per acre, Franklin reporting an average 2016 land value of $7,538 per acre, and Jackson and Cottonwood reporting an average 2016 land value of $7,195 per acre as compared to the 2016 average land value for Clark County of $4,300 per acre[1]. County soil productivity comparisons are also superior to Clark County. Clark County has an average soil productivity index of 65.1 as compared to the soil index of Cottonwood at 86, Jackson at 84.5, Sac at 82.1 and Franklin at 79.2[2]. There are similarities; however, no basis for a direct comparison to Clark County.

- The direct testimony and study opine *"the planned wind projects in South Dakota will not significantly reduce the sale prices of properties in the neighborhood of the wind facility."* The conclusion is not supported by the evidence. The research and studies are limited to the impacts of wind energy projects on residential property values. The Crocker Wind Project is in Northwest Clark County. Approximately 94 percent of the county acreage

[1] AG Decision Market Iowa State University www.extension.iastate.edu/agdm 2016. SDSU Igrow 2017. University of Minnesota Agricultural and Natural Resource Sciences, 1990-2016

[2] Agridata Surety Pro

is used for agricultural production, and six percent for other uses. The county is rural in nature with farming as the principal economic enterprise. Hunting is another important economic enterprise, as the county is in the major flyway for migrating waterfowl. All Clark County agricultural land classes will be impacted by the Crocker Project area, including rural residential. The conclusion relies on the LNBL study that focuses on residential property values, and then broadly applies the results to all types of properties in South Dakota. There is no market data to support this conclusion. South Dakota property types include productive crop ground, native pasture, grass, hay, rural residential, and recreation highest and best uses. Analyzing mass residential sales data from around the United States and generally applying the analysis to all South Dakota property types could mislead the public and the Commission.

Q: In your opinion, does the services provided by Crocker's value expert fall under appraisal practice as defined by the laws and regulation in South Dakota?

A: Expectation is a crucial component for determining when an individual is providing valuation services as an appraiser. It seems clear by the evidence presented by Crocker, that Mark Thayer has been engaged as a valuation expert to answer the client's questions about effects on real property values from the Crocker Wind Farm. In the direct testimony and report by Mark Thayer, both

opinions and conclusions have been provided to measure the effects on the value of real property:

> *"Based on this extensive literature, the planned wind project in South Dakota will not significantly reduce the sales prices of properties around the wind facilities."*
>
> *"We would be confident that the LBNL studies would be a reasonable source for a benefit transfer (or damage) effort to South Dakota."*
>
> *"This leads to the overall conclusion that the planned wind projects in South Dakota will not significantly reduce the sales prices of properties in the neighborhood of the wind facilities."*

In South Dakota, any valuation service performed by someone who is acting as an appraiser is appraisal practice and subject to the laws and regulation of South Dakota. An individual must be licensed or certified by the Appraiser Certification Program or must apply for a non-resident temporary practice permit for a single appraisal assignment.

Q: Based on your experience, please explain what type of study would adequately reflect the potential impact to the value of properties in the vicinity of the proposed Crocker Wind project?

A: A comprehensive study from the market area of South Dakota will provide the evidence that is required to determine the potential impacts of a wind energy project on property values. In South Dakota, there are approximately thirteen operating wind energy projects. Some of these wind energy projects have been in operation since the early 1990's and includes all types of South Dakota property. The methodology that is applicable for comparison in this type of study is referred

to as the case-by-case sales comparison approach which provides a more reliable alternative to the hedonic analysis. This analysis uses the traditional appraisal methods of interviews, sales comparison, and paired sales analysis. A South Dakota study should include analyzing all operating wind energy projects from around the state and include a wide representation of the property characteristics including agricultural, residential and mixed land uses. The study should identify the characteristics that would make properties prone to value effects such as size and use and analyze if certain property types are more susceptible to value impacts from wind energy projects. The study should also incorporate survey-based research to measure the potential effects. The survey-based methods are used as an alternative to statistical price analysis to estimate potential impacts from a wind energy project. The survey would use a scientific method and acceptable methodology in the appraisal process that could be applied to geographical areas like South Dakota where the sales population is limited. The results of the case-by-case analysis could be compared to the LBNL studies to determine if the results are consistent with national market evidence.

Q: Please explain why this type of study would more adequately reflect the potential impact to land value.

A: Crocker Wind Farm, LLC has presented a study covering residential property values from different market areas of the United States. While I do agree these studies provide useful insight to understand the general impact on residential property values, they do not apply to the market characteristics and land classes

that are predominately impacted in South Dakota. To truly understand the impacts of a wind energy project in South Dakota, a valuation expert needs to use research that is applicable to the market area of study and market evidence specific to the property type.

Q: What is the process for preparing this type of study?

A: The general approach of this study would identify and examine all arm's length transactions involving properties within a wind energy project area in the South Dakota. The general steps for the study would be: 1) Identify properties affected by a South Dakota wind energy project since the time the project became operational; 2) Organize the properties into common ownership and property types; 3) Research the chain of title for each property ownership from the operational date of the wind project to current effective date of the study; 4) Study the title history to identify transfers in ownership that appear to be arm's length and qualify per South Dakota's definition of fair market value; 5) Conduct site inspections and interview buyers and sellers to establish the sales qualifies as an arm's length transaction, and if so, verify transaction details and gather information on terms of the sale, participant motivation and effect of the wind project, if any; 6) For each sale, collect and verify data on comparable property sales not within the proximity of a wind energy project for comparison (unaffected sales); 7) Conduct survey-based research with market participants as an alternative to statistical price analysis to estimate the potential impacts from a wind energy property; 8) Analyze the survey based research, interview data and the market data to reach a

conclusion in regards to the effect of the wind energy project or wind tower, on the value of the applicable property types; 9) Prepare a work file of the research to support the analysis and conclusions; 10) Prepare a study report summarizing the research and findings. The study would include individual sale analysis for all properties types impacted by wind energy projects statewide, including farm and ranch, residential, and rural residential.

Q: What would be the timeline necessary to prepare such a study?

A: Depending on the scope of work and project area selected, approximately six months would be an anticipated timeline for project completion.

Q: What is the approximate cost of preparing such a study?

A: Cost depends on the scope of work agreed to with the client. In South Dakota, a comprehensive study of this type would be required to have an extensive level of quality and research that could withstand scrutiny from courts and peer review, as well as assure the public that due diligence has been done to answer the questions about impacts on property values.

Q: Why did you not prepare a study like you just described?

A: I had several discussions about this with Staff. Unfortunately, it was impossible to properly conduct a study in the time provided by statute. As I stated previously, it would take six months to complete an accurate study. This would not include

the time it would take to contract for services, conduct discovery and do necessary investigation, prepare testimony, and participate in an evidentiary hearing.

Q: Are you aware of any available studies of this nature that would adequately reflect the potential impact to land value of properties in the vicinity of the proposed Crocker Wind project?

A: No. I'm not aware of any South Dakota study exactly like the one required.

Q: Does this conclude your testimony?

A: Yes.

Pam,

This is information that was requested by a couple of Commissioners and Mr. Knight. Please forward this email to Mr. Knight and all of the Commissioners.

Thank you,

Brenda Taylor

This letter is provided in response to the request by the board made at the Feb. 7, 2017 regular Commissioners' Meeting regarding Wind Tower effects on Property Values.

I spoke to Mr. David Janes of the Toronto area about his experience trying to sell his home. He told me that he tried to sell it himself for a short period of time. I also spoke with a person who looked at Mr. Janes' home during that time and decided his family could not live there because of all of the wind towers surrounding the property. Mr. Janes then contacted two realtors, one located in Sioux Falls and the other in Brookings. They both recommended to Mr. Janes that putting his home up for auction would be his best option.

After speaking with an appraiser and several realtors, the consensus was that it would be costly and would take many weeks, even months, to compile actual data to prepare a complete report. It was, however, recommended that governing bodies should pursue such information.

Katie Murray, a realtor with Century 21 in Brookings, did state that homes located near wind towers absolutely experience property devaluation. She gave as an example a home located in the middle of a wind farm in Brookings Co. which was listed and viewed 15 times. All of the prospective buyers walked away, not wanting to live near wind towers. She stated that homes that would normally sell quickly are not selling as they should when located near wind towers. A statement she sent via e-mail follows:

"In my experience, wind towers do affect a buyers desire to purchase a property. One particular listing was in a wind farm, had numerous showings, and the majority of feedback was an issue with the towers. This home was priced well, comfortable distance to a city, and almost fully remodeled. It should have sold quickly, but did take longer and for assumably [sic] less than what they would've gotten had the wind towers not been so close."

I also contacted an appraiser, Mr. Brian Gatzke, ARA, MBA, Certified Appraiser from Northern Plains Appraisals located in Brookings. Mr. Gatzke told me about two homes that were located in Brookings Co. before the wind towers went up and the homeowners tried to sell after the towers were built. Both homes were greatly discounted before they could be sold. One was sold to an adjacent landowner. Mr. Gatzke also said that wind towers do have a negative impact on residential properties. I asked him if appraisers take into account the surroundings of a residential property when writing their reports, and he replied, "Yes, appraisers do have rules and need to verify market conditions and the surroundings of a property and it does show up in a report. Surroundings do have an impact on appraisal values." He has concluded that wind towers do, in fact, negatively impact appraisal values. He also suggested that counties should do complete and thorough investigations giving three examples how this might be accomplished. It is a costly and time consuming endeavor.

My goal was to gather local information only regarding residences located near wind towers. Again, those who talked to me stated that they did not have time to do actual research but shared their experiences. I attempted contact with other resources that chose not to respond.

Mike and I have provided emails with links to property devaluation studies of residences due to close proximity to wind towers done by Michael McCann. Please feel free to contact me if you would like more information.

In light of what we have learned, we strongly advocate for Property Value Guarantees in the Ordinance.

Thank you for your time,

Brenda Taylor

My Name is David Janes. I live at 19574 479th Avenue in Deuel County. My phone numbers are land 605-794-2023 and mobile 605-695-5114.

My wife Linda and I bought acreage of 15 acres about 2 miles Southeast of Toronto in 1999. We built a new house with 2 x 6 studs, sheathing and a full brick veneer. Our walls are nearly 12" thick. We took occupancy in 2001. We intended for this to be our retirement home.

A few months after we moved in we were asked by a neighboring farmer if we had any objections to wind towers in the neighborhood. We were not in favor of any within our immediate area. Much to our surprise wind tower construction proceeded in 2003 without any prior notification to us.

While the 1,000 foot setback was probably used it makes no difference. The shadows from the turbine blades hit our house from all directions every day! And even with the limited available light at night you are still able to see shadows moving across the house. It is especially disturbing during any outdoor activities. Sometimes it is absolutely shocking and makes you think someone is creeping up behind you. The flashing red lights are almost as distracting as the blade shadows. There is never a peaceful night of solitude.

We installed blinds and draperies and are still getting that light sweep through and around the windows. The noise is even worse. We are NEVER left in silence when the turbines are active. When there is moisture in the air it can sound like the roar of a jet engine.

We invested over $500,000 in our home but we had to live with headaches caused by the constant flashing and noise. We even bought a camper for the sole purpose of getting away to a peaceful location for a month or more at a time. Unfortunately my wife Linda passed away last year. The peace and solitude we expected has been completely taken from us. If I could get my investment back I would do so and leave immediately.

David Janes 3-18-17

David Janes

19574 479th Avenue

Astoria, SD 57213

INDEPENDENT

Living with wind farms

Wind turbine noise too much for South Dakota homeowner

Photo by Jody Isaackson David Janes of rural Toronto, South Dakota, stands outside his home which is overshadowed by a wind turbine. His entire place is nearly in the middle of a wind farm, and the noise and shadow flicker are disturbing his peace in more ways than one.

TORONTO, S.D. — While the wind power companies tout the economic benefits of planting not one, but two wind farms in Lincoln County, some neighbors are fearing the possible negative impacts.

A Deuel County, South Dakota, resident says he found out the hard way there are drawbacks to having a renewable energy source in his backyard.

David Janes of rural Toronto, South Dakota, said he and his late wife had built a retirement home on their South Dakota farm site 17 years ago. They never suspected that the peace and tranquility of their location would be dramatically changed.

"I like to sit in the backyard and listen to the birds sing," Janes said. *"But when the turbines are running, I can't hear the birds. All I hear is swoosh, swoosh swoosh, like a jet plane engine."*

The wind farm was constructed nearly 10 years ago and Janes said he never received a notice that his neighbor had sold the land rights to an energy company. He also said he was given no warning about how noisy the turbines could be, even at the 1,200 feet setback.

"The nearest one is 1,200 feet away, but it towers over my house," Janes said.

He also said he purchased special window shades for those times in the morning and evening that the shadow flicker from the rotating propellers creates quite a distraction inside the house.

"It gave us headaches," he said. *"They don't have to be so close to people's house. They're not good for people to live near. They're only good for farmers who don't live near the towers."*

Janes has also noticed grease leaking from the turbines. The gray discoloration was slowly making its way down from the gear house at the

top of the tower behind his house. He was wondering if that was going to slow down the energy production or just create an environmental hazard.

"I tried selling the place once, but there were no takers," Jane said. He's afraid property values have dropped because of the wind turbines that dotted the fields on three sides of his place.

"If it was me, I wouldn't buy it either," he said. *"I guess I'm going to stay here quite a while."*

The project manager for the Red Pine wind turbine project in Lincoln County vows her company will work with area residents to deal with any possible issues that may come up.

"As a company with more than 30 years of experience, we know the value that robust due diligence, preparatory analysis and siting research can provide to the community who will live in our project area," Shanelle Montana said. *"As an integrated developer, owner and operator since 1985, this is something we do not take lightly. Should an issue arise during operations that affects a farming operations or household, we will work through every issue to identify a reasonable solution."*

Janes' friend, Jim Ekholm of the Lake Cochrane area, is a opponent of wind farms and claims to have studied the their negative effects on neighbors. He claims that taxpayers end up paying for wind power twice. Government subsidies help pay farmers for the land on which wind towers are built, he said.

"The companies making money are using foreign materials and sending their profits off shore," Ekholm said. *"The Bloomington subdivision is from London, England. The power they generate cannot sell to electric companies without a government subsidy. The subsidies will go away in 10 years after they start."*

But Montana disputes that allegation. She said that the majority of wind turbine components and manufacturing is in the U.S. She said there are more than 20 companies manufacturing wind turbine components just right here in Minnesota.

Ekholm said he's all for clean energy, but wind power isn't reliable because the wind doesn't blow all the time, only about 35 to 40 percent of the time by Lake Cochrane, and that is the highest in the area, he said.

The other problem with wind towers is the human factor, Ekholm said.

"They're very noisy. And, shadow flicker is extremely irritating. It gets into your mind," he said.

Additionally, companies like to compare their wind turbines to the 40-foot windmills our grandparents had, but these are over four times that, Ekholm said.

Special roads have to be plowed and accessible year round, he said. Then the roads have to be removed when the turbines are no longer in use.

"Wind companies try to tell residents we don't have to worry about land restorations, but they should," he said.

Ekholm also said wind energy companies tried to set up in Lake Cochrane, South Dakota, but residents around the lake are against it. They fear that the change in the quality of recreational life wouldn't be worth it.

"Our laws are lax," Ekholm said. *"You'll still hear the turbines a mile away, not just if a bearing is out. That's something we shouldn't have to live with."*

Ekholm said that every wind tower has to have a backup coal or hydroelectric plant because the wind lets up and/or the energy fades over great distances.

The 3.5 megawatts from wind turbines sounds like a lot, he said, but it's not 24/7 (constant).

"Why are we dumping money into something that can't run without subsidies?" Ekholm said. *"It's a fact that you'll never see your taxes go down because of wind towers. The energy companies want townspeople to vote for it. Townspeople won't have a problem with it because they won't be living near the turbines) and will only see the money that will be coming back to them."*

Montana agrees wind does have a production tax credit from the federal government. But she said this credit is being phased out starting in 2020.

"Like every energy industry in the U.S. including gas and coal, the federal government has helped to spur innovation and domestic production," Montana said. *"Wind is now cost competitive. Many times beating out coal and natural gas."*

Montana cited a recent interview of Xcel Energy's CEO Ben Fowke by UtilityDive

"By 2021, the utility expects wind will be its largest energy source — not in terms of capacity, but actual generation," Fowke was quoted in the article.

"What's even more amazing is the prices. We're looking at (prices)in the low teens to low 20s (in dollars/MWh) — not starting prices, but levelized across the 25-year life of the project."

"That beats gas, even at today's prices," he said. *"I like to say we backed up the truck because the fuel of tomorrow was on sale today."*

David Janes Property

Toronto Area Interviews

The purpose of these interviews is to investigate how residents are reacting to living next to the wind turbines south of Toronto in Deuel County.

There are 24 existing wind turbines in Deuel County according to 2015 satellite imagery. Interviews were conducted with residents who live within 1 mile of the existing wind turbines.

According to 2015 satellite imagery, 17 Deuel County residences were counted within 1 mile of the existing wind turbines.

15 interviews were conducted as shown on the following pages. 13 of the interviews were with Deuel County residents. The 2 interviews in Brooking County were with residents who live just south of the Deuel-Brookings county line road.

The number of wind turbines within a mile of each residence is shown on each interview. Distances listed were measured off satellite imagery from the center of the house to the center of the wind turbine. All distances were rounded to the nearest 100 feet. The distances are also shown in miles for informational purposes.

Residents were simply asked what it was like living next to the wind turbines. If a resident voluntarily shared concerns about noise or shadow flicker, some follow up questions regarding the level of noise and frequency of shadow flicker were asked. All interviews were conducted in person (by Mark Junker) at the residence.

Also noted on each interview is any other relevant information that was volunteered. All interviews were ended with a question regarding if the owner was receiving any compensation from the wind developer.

Conclusion:

Although not scientific, there is nothing unique about the residents that were interviewed. Therefore, the sample of people interviewed is representative of the Toronto – White area wind development. All interviews conducted (both negative and positive) are contained within this report.

There is a wide range of reactions from residents living next to the wind turbines.

There is sufficient evidence from the interviews to demonstrate that a substantial number of Deuel County residents are negatively impacted from noise and shadow flicker generated from wind turbines.

Therefore, the current Deuel County ordinance does not protect a substantial number of residents from noise and shadow flicker generated from wind turbines.

District 225
ARMSTRONG TOWNSHIP HIGH SCHOOL

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School: (217) 569-2122
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William Mulvaney, Superintendent
Darren Loschen, Principal

Dear Chairman Weinard,

My name is Bill Mulvaney and I am the Superintendent of Schools for Armstrong Township High School and Armstrong-Ellis CUD #61. I also served on the wind panel that met to try and give direction to the county board on wind turbine ordinances. Our panel did not come up with any recommended changes, but I would like to share a few thoughts with you.

I have noticed that we have some children in our district that appear to be having some medical issues related to the wind turbines. Headaches, lack of sleep and jaw issues seem to be the most common. The students also complain about not being able to sleep or not getting a full night's sleep due to sound issues.

We have also been advised that we will be losing a couple of families because the wind turbines were placed close to homes and the families can no longer handle the flicker and noise issues.

While these issues were brought up at our panel discussions, I was not fully aware of the impact that the wind turbines would have to my school districts. It is never a good thing when children have health issues or families have to leave their homes to get away from the turbines. The revenue generated by the turbines is a blessing to our schools, but the unintended consequences are real.

I hope this letter sheds some light on real issues that affect districts that house wind farms. I also hope that when ordinances are discussed in the future, that these issues are considered.

Sincerely,

William C. Mulvaney
Superintendent
Armstrong Schools

NOISE: A startling case of two schools in proximity to wind turbines

Dear Mme Héroux,

I should be grateful if you would ensure that this report reaches the ladies and gentlemen of the panel reviewing the WHO's noise guidelines for Europe.

In an effort to assist a society in danger, I feel obligated to make this case public. I am employed in schools within a rural area. The projects I am involved in run throughout the school year. I hope it will be understood why I cannot reveal names and locations. Sadly, I must protect myself against the professional consequences which could result from a fully detailed testimony.

During the past two years, I have worked in a school located ***5 km to the east*** *of a small wind farm, whose elevation is about 300 feet above that of the establishment. Most of the time, the school is* ***downwind*** *from the 2 MW wind turbines. In 2014/2015, I worked with the kindergarten consisting of 20 children aged 2.5 to 5 years of age. I've been engaged in this work for a long time, and I know the region and its people very well.*

I was surprised how hard it was to manage this class of very young children. Actually, the teacher would systematically divide the class into two groups of 10, although I usually have no problems working with whole classes. Nonetheless, I found it hard to maintain the concentration of many of these children. In addition, a lot of pupils exhibited unusual and completely improper behaviour, which was violent and disruptive. I had rarely encountered this before with children of that age group, and never in such proportions. I did not understand why at first. It wasn't the teacher's fault: he was kind and rigorous at the same time, which is perfect for such small children.

During the second school year, I was again assigned to that school, but this time in two classes: the kindergarten divided into two groups, and a class with children aged 6 to 7.

This second class was absolutely unmanageable during the five first sessions. Its experienced teacher commented to me it was like that most of the time, he just could not handle those children. Yet again, nothing was wrong with the teacher. Several children seemed to be extremely ill at ease, a feeling shared by the teacher. ***There were instances of fits, outbursts of rage, rolling on the floor, knocking tables over and provoking each other into violent behaviour****. The teacher was losing confidence and was also beginning to feel ill himself, on one occasion coming very close to a burn-out. The tiredness etched upon his face reflected his struggles. It should be noted that he also had problems with his memory, and it was becoming obvious that the children's behaviour was not the only cause of his troubles, but that the location as well was a highly plausible culprit.*

I soon made the connection with the wind turbines*, because this behaviour reminded me of two children I had worked with a couple of years ago: they lived 800 yards from a wind farm. Having realised that, I started to check on the wind direction every time I drove to the school, when passing the wind turbines which in any event can be seen from the village.*

From the start of the 6th session the change was dramatic: this class was the most peaceful I had ever taught. The children were remarkably calm and took part in the experiments in a very constructive way, intervening advisedly, all without pushing and shoving or fighting. Notably, the wind was blowing from the east, ***from the village to the wind farm****, not the other way around as it did previously. I informed the teacher about my observation.*

Some time later, having worked during the morning in the kindergarten, I was having lunch with their teacher in the classroom before going to another school. At noon, he was called by his third colleague. The 6-7 year olds' teacher had left the school in tears, after a horrible morning spent with his pupils who had behaved particularly violently and unbearably. While we were eating, we stopped talking for a moment. This is when I felt the school vibrating, as if a lorry were passing on the country road 300 feet away. This vibration however, did not cease. In fact, the whole school was vibrating strongly, and we listened to that humming sound for a long moment. We opened the window, but there was no noticeable source of noise outside. It wasn't the air extraction fan either, for we could hear its less obtrusive noise separately.

The classrooms had probably been vibrating during the whole morning, but this had been covered by the background noise of our activities. There is therefore very good reason to believe that this could have been the cause of the particularly strong malaise felt in the disruptive class of 6-7 year olds during the morning. That particular room faces the wind turbines and clearly acts as a sound box. The two other classrooms are more protected, but that didn't prevent us from hearing strong vibrations in the kindergarten room, situated at the back of the building. The teacher of that class had also heard the noise very well. It is important to note that a sustained wind had been blowing ***from the direction of the wind turbines*** *for several days.*

The children all live in villages situated below the wind turbines, and were born after the construction of the wind farm. I recently met the mother of one of the children. She told me about the problems caused by the highly excitable nature of her two children and their classmates. She didn't know what to do, so she had called a woman who claimed to be able to 'demagnetise' her children. She also had special EMF electricity outlets installed. When I told her about my observations, her face immediately lit up and her comment was: « it's quite possible ! »

I had worked previously in the same school, in the same conditions and within its ancient building before the turbines were built. I retain happy memories of these times.

I have also worked, twice, in ***another school****, located* ***2 km west from a similar wind farm****. First it was before the wind project was built, and I had found the children to be quick-witted, with many brilliant pupils among them, one being even recognised as exceptionally gifted. The second time around, it happened 4 and 5 years after the erection of the turbines. This was a part-time job which lasted 18 months, with 8-10 year olds.*

When I took that assignment, I found that ***a very large proportion of the pupils had special education needs, a large number of them bound to low attainment, and many had learning disabilities officially recognised (dyslexia, dyscalculia, dyspraxia etc.)****. Out of a class of 25 pupils, not a single one was considered brilliant. The same problems could be found in the second class, again with no children obtaining high grades. Given the high pedagogical quality of the teachers (they were the same as before the wind turbines), the eventual social problems of some of the children (not more than anywhere else) couldn't justify the massive failure in this primary level schooling.*

I thought this failure might have been caused by EMF pollution from permanent WIFI signals, and the faint natural light in the classes. But it was the same as years ago, and the same in other schools, where I had met numerous brilliant children. ***Again, the only difference here was the wind farm's proximity.***

Unlike the first school, and considering the prevailing westerly winds, this one was located ***upwind*** *from the turbines, and at the same altitude. The children here didn't exhibit the same violent temperaments and behaviour as those described earlier in the first case, or as the two children living 800 yards from wind turbines. On the contrary, this was a very peaceful class, almost lifeless, lacking in concentration,*

vitality and reactivity, with poor oral participation. A large proportion of children exhibited serious learning difficulties. In addition, when working in that school ***I became dizzy*** *whenever rising from my desk, or when leaning over a child and straightening up. Here again, I thought the WI-FI was the cause (in fact it could have contributed some).*

Comparing the two schools*, the first one is located* ***downwind*** *about 300 feet below and 5 km away from wind turbines, with pupils born after these were erected, living in homes in much the same topographical situation as the school.* ***They exhibit severe behaviour outbursts when the wind blows from the direction of the turbines.***

In the second case we have a school located ***upwind****, 2 km from another wind farm and at roughly the same elevation as its turbines, with pupils born before the construction of the wind farm, living in the same village as the school.* ***A high proportion of them have severe learning difficulties which didn't exist in that school before the wind turbines.***

As the inquiry is about ambient noise, generally speaking, I also wish to report the harm done by air extraction fans and milking robots, which have invaded our farms. Contrary to the earlier milking machines, they don't only work 2 x 2 hours a day, but keep humming around the clock, causing health problems to cattle and humans alike. This is not counting with the heat pumps. Actually, sources of infrasound are springing up everywhere. And although out of topic, please allow me to briefly mention the digital boards, the operation of which requires teachers to close the blinds, thus depriving a whole generation of children of natural light for a large proportion of their school day. In short, in an increasing number of schools, all these negative impacts on health add up. ***But clearly, from my experience as summarised above, wind turbines are responsible for the most harmful impacts.***

I hope my testimony will enable you to write directives that will protect our children from these most harmful effects. I did not sign it, because too many "politically-incorrect" whistle-blowers have lost their jobs, which is something, you will appreciate, myself and my family cannot possibly risk or afford. Only authorised persons in very senior positions know my identity. ***This report is, therefore, only anonymous with regard to its release into the public domain.***

I should be grateful for confirmation of receipt of this letter.

Sincerely
Signature: *identity legitimely withheld* **(see last paragraph above)**

Letter posted online Dec.13.16: https://wcfn.org/2016/12/13/windfarms-affect-children

Sensing but Not Hearing: The Problem of Wind Turbine Noise (Interview with acoustician Steven Cooper, AU)

masterresource.org/windpower-health-effects/sensing-not-hearing-problem-wind-turbine-noise-interview-acoustician-steven-cooper-au/

February 2, 2018

Editor Note: **Steven Cooper has advanced our understanding of how people react to real recorded pressure pulsations from industrial wind turbines. In the last six months he has presented eight papers at Acoustic Meetings in Zurich, Boston and New Orleans. With this interview, he breaks down some of the salient points of his research discoveries. Cooper's work is expanding our knowledge about "soundscapes" near projects, which could result in new legal requirements for manufacturers and developers.**

> "In general, wind farm applications claim that turbines do not generate any low-frequency, tonal, or impulsive characteristics, which is a matter disputed by residential receivers. The consequence of the pulsating signal generated by turbines (whether audible or inaudible) could potentially require a further adjustment to any perception or impact generated by wind turbines."
>
> "On discussing the resident's observations (with the residents) for the first two weeks I found the use of describing the impacts in terms of **Noise, Vibration, and Sensation** was accepted by the residents as a better concept."
>
> Stephen Cooper (below)

Q. Paul Gipe back in his 1995 treatise (*Wind Power Comes of Age*, pp. 371-73): stated, "Next to aesthetic impact, no aspect of wind energy creates more alarm or more debate than noise." He explained in his book how "all wind turbines create unwanted sound" and that sound can carry for great distances. Given this, why, twenty years later, is noise pollution and health effects therein just entering the mainstream?

Cooper:

First, some background. Sound is all around us unless we are in a vacuum. Noise is defined as unwanted sound and has been used as a descriptor by acousticians and authorities for more than 50 years.

'Noise pollution' could be taken as the concept of considering noise overall as being evident and affecting people to various extents with the concept of noise pollution being expressed in the late 1980s possibly more as a side issue to the common concept of air pollution.

Excessive noise or sound that may impact upon a person's health has been well-known for 60-plus years via occupational noise with relevant standards being issued for noise levels in a workplace environment.

With new investigation, the noise criteria applicable to occupational noise has been modified for general factory-type noise and then expanded for different type noises that do not accord with general everyday noise and result in different impacts on people's hearing, i.e. impulsive noise associated with hammering of steel, explosions, or firing of rifles.

In relation to general noise pollution (in terms of mainstream noise), the issue of health effects associated with road traffic noise, rail-traffic noise and aircraft noise entered mainstream issues before the 1995 extract that you have quoted. The general concept in terms of ascertaining appropriate **noise limits** for those types of noise involve community surveys and socio-acoustic studies to derive a dose-response curve where a noise limit was set to ensure that 90% of the population was not subject to an excessive degree of noise (with respect to annoyance) for 90% of the time.

With respect to wind turbine noise, in the mid-1990s the provision of wind turbines in rural communities came to the fore with respect to unwanted noise. Clearly the noise generated by such turbines was totally different to that of the existing environment. Whilst persons in proximity to wind turbines identified annoyance and sleep disturbance in mainstream acoustics, the number of people so affected is a small proportion of the total population and therefore did not warrant socio-acoustic studies.

If in the general sense the impact of turbines is limited to a small area around a wind farm (when compared with the total area of a regional county or the state) then the environmental authorities do not consider it to be a significant issue warranting further investigation.

Material conducted in relation to community response to wind turbines in Sweden and the Netherlands identified a dose-response curve significantly lower than that for road, rail or aircraft noise and suggested the appropriate limits for wind turbine should be significantly lower. However, that work related to relatively small turbines and an increase in the capacity of turbines to those which exist today results in a greater level of noise emitted from turbines.

Environmental authorities, encouraged by the wind industry, utilize noise criteria for turbines based upon road-traffic noise, notwithstanding the two noises are not the same.

The WHO 2009 European night-time noise guidelines identifies that ongoing noise disturbance, particularly with respect to sleep disturbance can lead to health impacts. It is necessary to note that most of the noise data contained in the 2009 guidelines relates to road traffic noise in urban areas. There is no data contained in the study related to wind turbines.

The various WHO guidelines that have been published identify where a noise contains a dominant low-frequency component then a further penalty should be added to any assessment criteria. Similarly, if a noise contains an impulsive characteristic then a further penalty should apply.

In general, wind farm applications claim that turbines do not generate any low-frequency, tonal, or impulsive characteristics, which is a matter disputed by residential receivers.

The consequence of the pulsating signal generated by turbines (whether audible or inaudible) could potentially require a further adjustment to any perception or impact generated by wind turbines.

In general, the noise criteria specified for wind turbine facilities is related to external noise levels, not internal noise levels. The spectrum of wind turbine noise can often be masked by external noise sources at an external location. But when assessed inside the dwelling, the reduction in sound provided by the building envelope dramatically reduces the high frequency components of both the external noise and the wind turbine noise, leading to a totally different spectral balance of the sound inside the dwelling that can make the audible characteristics of such turbines more apparent.

Q. How long have you been researching noise, vibration, sound, ILFN (Infra and Low Frequency Noise), and now, pressure pulsations, from industrial wind? How did you become interested in this?

A. I have been an acoustic engineer for 39 years and had a basic grounding in large scale industrial plants then helicopter and aircraft noise. I am involved in development applications for different types of projects and provided expert evidence on acoustic matters, primarily before planning courts.

In 2012, I was asked to review a proposed wind farm application and found a lack of evidence for the basis of the acoustic criteria that was proposed. The level of disturbance reported by residents in proximity to existing wind farms contradicted the acoustic material supporting the application.

Based on previous investigations of noise complaints one needs to take on board complaints in the investigation. This led to me requesting access to several residences in proximity to an operational wind farm. My attendance and measurements found the presence of noise levels significantly greater than predicted and a unique signature subsequently found near other wind farms.

Since 2012 I have been involved in seeking to identify and quantify the acoustic signature associated with wind turbines so as to permit the necessary medical investigations to be undertaken by others.

Q.Your interviews and studies at homes of impacted persons at Cape Bridgewater are groundbreaking. Can you describe the creative process involved in your discoveries? In what way was this study/research so important?

A. On previous testing at the Waterloo wind farm I found residents could identify pulsations from the wind farm even though it could not be heard. It was something they felt rather than heard. The wind farm could be sensed when the narrow band frequencies around 4 – 5 Hz had a level in the order of 50 dB (or more).

I was subsequently approached by the operator of the Cape Bridgewater wind farm to undertake an investigation to address complaints from local residents that could not be resolved by the dBA method and was given a free hand to undertake testing to explore the concepts I had presented to describe wind turbine noise impacts.

I was given a brief to undertake measurements and determine certain wind speed and noise levels that corresponded to complaints from specific local residents. The conduct of medical studies at the same time and have a control group was refused by the wind farm operator.

I based the study on the complaints and observations by the residents for comparison with the measurement results. I took the view that the primary function was to take account of the resident's observations without ANY preconceived opinions.

I took measurements inside and outside residential dwellings and was given access to the wind farm and all operating data over a 9-week period.

I was to attend the site every two weeks to download data and meet with the residents (a house at a time) to discuss the analysis of the previous fortnight and what they had reported. We processed the diaries and the data separately to each other, then combined the results for discussion.

I trialed a diary format based upon the EPA Waterloo study to see if I could match the results. But the residents couldn't agree with the noise descriptions.

On discussing the resident's observations (with the residents) for the first two weeks I found the use of describing the impacts in terms of **Noise, Vibration, and Sensation** was accepted by the residents as a better concept.

The challenge we had was finding a way to identify a pattern in the complaints versus the operation of the wind farm. I work best in a visual format and we tried various permutations of graphical tracking of the results versus the dBA levels, the power outputs of the wind farm and the wind speed and direction.

Initially I found a pattern versus changes in the wind farm power output as the residents were only reporting changes that they perceived. I changed the reporting to 1 or 2 hourly intervals.

Based on the complaints we found certain wind speeds (power outputs) that gave rise to complaints. The challenge was then finding the sound levels that related to complaints.

dBA doesn't work. We found it correlated well with the wind speed but not with the noise from the wind farm.

We then tried 1/3 octave bands and various acoustic parameters that have been used for noise and wind farm investigations and still no trend.

It was not until we tried the complaints versus the infrasound narrow band signature that we found a trend. *And sensation came out as the major impact.*

We tried plotting the greatest level of sensation (when the residents actually left their properties or wanted to leave) and found patterns of disturbance that related to the power output of the turbines trying to start, when at high wind settings that the blades were angled to depower the turbine or changes in the power output (up or down) of over 10%.

I also noted intermittent vibrations in the floor of house 88, even during the shutdown period, that related to wind gusts. This led to vibration measurements on some turbines and in the ground on the wind farm and the residences.We have since used the Cape Bridgewater data for further testing and research.

Q. How did you convince the developers at Cape Bridgewater to turn off the turbines for your control/blind study?

A. They were trying to get the testing done before or after the planned shutdown. The shutdown was to facilitate high voltage cabling at the substation and would occur on ten days with the wind farm operating at night. I convinced them that having testing during the shutdown would be an essential part of satisfying the brief as we could see if there were complaints without the wind turbines – and get the true ambient background noise levels without any power to the turbines.

It became an essential part of the study in that it clearly showed the different acoustic signature with and without the turbines operating, that the natural environment did not have a discrete infrasound signature and that wind gusts did excite resonances of the turbines, both in terms of noise and ground vibration.

Q. What recent papers have you presented, where, and about what? We understand that you are changing the language around "noise" and wind turbine effects possibly with the eventual understanding for legislators and policy makers.

A. The Cape Bridgewater study revealed further investigations were required as the scope of the study was limited by the wind farm operator and as such was called a pilot study.

I was invited by Dr. Paul Schomer to be a member of the Acoustical Society of America Wind Turbine Working Group to discuss further investigations of wind turbine noise. The group has had sessions at the last six ASA meetings with the opportunity to present papers on the topic. I have now given 14 presentations on my on-going research into wind turbine noise.

On the technical side we have developed a graphical presentation (a movie) for showing the variation in the acoustical signature that conveys a number of concepts in the time and frequency variations of the signal. I have raised the issue of sample speed and the error in using a digital simulation rather than the original wave file recordings.

Using a digital equivalent of a time average narrow band analysis of a wind turbine signal is not the same as the original signal. Whilst having the same energy content if used for subjective testing, it is dramatically dissimilar as identified in Annex D of ANSI Standard S12.9-2016/Part 7; but this seems to be conveniently ignored by some people.

Using inaudible digitized energy equivalent signals restricted to just infrasound can only give rise to a conclusion of nothing being heard/detected. Or, using an inaudible single tone at 4 or 9 Hz and saying it is wind turbine infrasound, is completely wrong.

We modified our reverberation chamber to investigate the threshold of perception versus the threshold of hearing in the infrasound region. Headphones don't work the same as immersing the body to the sound field. We investigated the reproduction of the wind turbine signals normal sound and infrasound in our chamber with a large baffle of speakers to find the limits of reproducing the signal.

This is where the issue of sensation comes into play. If the residents cannot hear the turbines yet they can sense them, then the Leventhall mantra of "what you can't hear cannot hurt you." is incorrect.

As in many cases residents can perceive the operation of the turbines even though they cannot hear them, we first worked on the threshold of perception of infrasound versus the threshold of hearing in one of our test chambers. The perception occurs below the threshold of hearing and has a hysteresis effect in that the thresholds are different when the levels is increased (from inaudibility) compared to going down.

I have questioned what makes up the acoustic signature or the mechanism that gives the infrasound signature. The accuracy of the analysis and whether the turbines generate infrasound and sound waves (like that of a tuning fork), or whether there was a pulsation of the sound occurring at an infrasound rate based upon the blade passing frequency. This is the number of times a blade passes a fixed point (say the tower). For a three-bladed turbine operating at 17 rpm this gives 3 X 17 = 51 times a minute or 51/60 = 0.85 Hz.

There have been a series of papers on that subject and the ability to accurately reproduce the signal in a laboratory.

We have found there are issues with the mathematics of the analysis as the signals are not sine waves, but pulses that vary in their level over time due to different loadings on the turbines and interaction of multiple turbines.

We have identified several researchers who have used digitized infrasound signals, claiming that they are actual wind turbine infrasound, to lead to the conclusion of a nocebo effect. We have tried that approach and when increasing the gain to be audible and/or speeding up the signals into the audio range they sound totally different. Why not use the recorded wave files? Why go through a process of converting the signal into a modified digital signal that is not the same?

We looked at the subjective evaluation of wind turbine noise and the issue of amplitude modulation. We found audible and inaudible modulation and that the use of stereo imaging to give (in all cases) an overwhelming preference by the test subjects when compared to a mono signal. This outcome is obvious if you go and listen to wind turbines. However, there are

papers on wind turbine subjective assessment based upon mono signals. The papers presented over the last 12 months have focused on those issues and the accuracy of reproducing the test signal from wave files recorded on site.

The question of the perception of inaudible wind turbine noise was investigated for the first paper given in New Orleans last month. It seems nobody else has undertaken such an exercise and we were able to show that persons sensitized to wind turbine noise could identify the operation of the test signal even though it was completely inaudible.

Q. The "sensing but not hearing" may be oblique to some. Can you explain the process and effects on the whole person, from the unique pressure pulsing of industrial wind turbines?

A. In 2013, monitoring at the Waterloo wind farm at a number of different houses found that residents could identify the operation of the turbines at certain times and not at others. I was unable to hear the turbines, but by viewing the narrowband frequency spectrum covering the infrasound region the analyzer showed discrete frequencies associated with the blade pass frequency (the number of times a turbine blade would pass a fixed position in a second) and multiple harmonics of that frequency.

I observed that when the levels of the frequencies around 4 to 5 Hz exceeded 50 dB then there was a very good correlation with the perception of the operation of the turbines. However, such levels of noise at those frequencies are deemed to be inaudible.

What I asked residents to do, whilst I was undertaking measurements, was to simply use their hand to identify the pulsations that they could detect such that the hand moved in time with those pulsations.

This led to the concept of sensation and by communication with colleagues in America as to the limits where the perception of the operation the turbines occurred led to the rediscovery of the work in 1980 by Dr Kelley.

When I tried the diary concept for the Cape Bridgewater residents I utilized the South Australian EPA's diary format from the Waterloo study to find that the residents did not fully comprehend or agree with the diary because the descriptions associated with noise were not necessarily satisfying what the residents were detecting. I then suggested the concept of something that they sensed rather than heard or felt by tactile vibration as another descriptor that could be used. This sensing involved pressure in the head, in the throat, in the chest, feeling dizzy, feeling lightheaded, a tingling in the legs, **whatever sensation they experienced which could not be explained by something that they were hearing or a vibration that they were feeling.**

(Our note: See here for a previous article at MR regarding the Cape Bridgewater findings.)

All the residents involved in the Cape Bridgewater study agreed that the concept of sensation was more appropriate in describing what they were experiencing, and that in many cases what they had complained about as noise impacts was incorrect and was the wrong description.

When describing the concept of sensation to other people that are exposed to wind turbine noise I have received confirmation that, yes, sensation is the appropriate mechanism for describing what they are experiencing.

As described earlier, the operation of a turbine generates pulses at the blade pass frequency. Due to there being different wind speeds at different elevations above the ground then the pressure differential across a blade at the top of the swept path is different to that at the bottom. Accordingly, along the length of the blade one can imagine the windspeed and the pressure differential across the entire length of the blade will vary as the blade rotates.

For example, for a three-bladed turbine that is operating at 17 revolutions per minute, then for any fixed point on the circumference of the swept path of the blades there will be 3 x 17 = 51 passes per minute. Because acousticians work in Hertz or cycles per second, then the blade pass frequency is 51/60 = 0.85 Hz.

As frequency is the reciprocal of the timing between the pulses a blade pass frequency of 0.85 Hz means that there is a pulse every 1.177 seconds.

One only needs to listen to operational turbines to observe that the nature of the acoustic emissions generated by turbines is not one of a constant noise. One can hear the regular pattern of the swish noise which occurs at the blade pass frequency.

Spend some time at a turbine and it becomes apparent that the overall noise varies up-and-down in its level due to the different wind speeds. The character of the noise may vary in a matter of minutes due to a significant variation in the level of the noise (the amplitude) where that variation changes at the rate of the blade pass frequency.

If you examine the frequency spectrum you will find that the variations in the amplitude and the pulsations that occur affect all the frequencies across the audible range and occur below the nominal threshold of hearing which means that there are inaudible pulsating signals.

The natural environment where there are low frequency and infrasound signals generated by the wind, waves on the beach, waterfalls etc. do not exhibit this unique periodic function of a blade pass frequency, and harmonics of that frequency. This permits one to simply use the narrowband infrasound analysis to identify the operation of a turbine.

Many residents report unexplained disturbance or impacts when they are unable to hear the turbines but can identify the operation of the turbines by way of what they sense; that led me to undertake the latest research by creating inaudible wind turbine noise as recorded inside houses and then subjecting people to that noise.

As an acoustic engineer with years of investigating industrial noise complaints and complaints from the community concerning, in particular music from licensed premises, the important thing in considering impacts from any noise source is listening to the complaints, conducting measurements and observations with an open mind and then seeing if there is any relationship between those three inputs in addressing the problem.

That is the approach that I adopted in trying to understand what were the complaints from residents associated with wind turbines when on my first experience the noise was extremely low, could not be detected inside the dwelling and I didn't understand why the residents would be so vocal and genuinely distressed from the turbines.

Now I am summarizing in a relatively short space of time the result of four years of research work into what constitutes the acoustic signal from wind turbines and investigating the limitations in producing such signals. This work has been the subject of 14 presentations/papers presented to the Wind Turbine Working Group of the Acoustical Society of America. It has been a long and frustrating process to identify how to reproduce the original signal in a laboratory (and more importantly what doesn't work) that has questioned and debated what is the actual acoustic signature associated with turbines, and are we correctly measuring those signals?

Chapters 9 and 10 of the Cape Bridgewater report identified by way of the specific on-off testing of the entire wind farm the unique signature that is associated with wind turbines, and I understand that is the first time that multiple simultaneous measurements repeated on a number of occasions with turning off entirely a wind farm that this material has been obtained. A stopped wind turbine/wind farm generally still has equipment operating inside the turbines such as pumps and fans et cetera operating that in turn can radiate noise from the turbine tower and effect the "off" results, which was the case under the EPA Waterloo study.

Q. What triggers are there for sensitive or sensitized persons? Do you plan more research on specifics of these (possibly PTSD impacts)?

A. I am just a noise engineer and therefore not qualified to answer that question in terms of how the body responds to different acoustic stimuli.

What we have found is that we can present to people inaudible wind turbine noise and get a reaction whilst we can provide inaudible road traffic noise or wind noise similar levels or for that matter constant tones and not get any reaction.

We were investigating noise complaints associated with an underground coal mine that has a very large ventilation exhaust fan with an operating speed well down in the infrasound region and was subject to some level of pulsation. In an audible sense that a kilometer from the discharge point one could hear a low frequency noise around 120 Hz that over a very slow rate the amplitude of that noise would vary.

When the family that was the subject of the investigations attended our laboratory, and was exposed to a constant level and 120 Hz (pure tone) at about 50 dB there were no issues. That level of sound is clearly audible. However, when we sought to turn the volume control up and down on a repeated basis the residents noticed a difference. As we slowed the rate of turning the volume control up-and-down the sound became more disturbing, and when we attained a rate of about two seconds, the family felt very uncomfortable and left the test room.

This material was reported to the Wind Turbine Working Group at the Salt Lake meeting in May 2016 together with a movie concept that we had developed showing the variation in amplitude and frequency of the original source signal to have the acousticians immediately recognizing relationships to motion sickness.

Normally people look at the physical movement of the body in terms of vibration as to motion sickness but there was no physical movement of the body but simply a pressure wave to the body and the head which is one issue that raises the question of trigger that you have expressed.

In the Wind Turbine Working Group meeting in Hawaii in December 2016 I raise the issue of the **startle reflex,** and whether one needed to consider the holistic effect of noise vibration and tactile perception which could incorporate the entire body.

We found that residents in proximity of a coal-fired power station (15 – 30 km) experienced significant sleep disturbance when the power station was operating at low fire rates, in a run up or run down when they obtained about a 25% capacity, or if the two turbines when operating the maximum capacity had a difference of about 10 MW. Examination of the signatures during that time indicated that the 50 Hz mains frequency was subject to variation and an infrasound rate, pulsations.

It would seem that my work has shown that inaudible pulsating noise can create impacts. As such it would appear that I have provided some validation of a hypothesis provided by Dr. Nina Pierpont in 2009.

> "Wind Turbine Syndrome, I propose, is mediated by the vestibular system—by disturbed sensory input to eyes, inner ears, and stretch and pressure receptors in a variety of body locations. These feed back neurologically onto a person's sense of position and motion in space, which is in turn connected in multiple ways to brain functions as disparate as spatial memory and anxiety. Several lines of evidence suggest that the amplitude (power or intensity) of low frequency noise and vibration needed to create these effects may be even lower than the auditory threshold at the same low frequencies. Re-stating this, it appears that even low frequency noise or vibration too weak to hear can still stimulate the human vestibular system, opening the door for the symptoms I call Wind Turbine Syndrome." Pierpont 2009

In 2012, from my initial analysis and investigations of complaints in relation to wind facilities, I was of the view that we needed to identify the acoustic signature associated with operational wind turbines, and only when that signature had been identified and able to be reproduced, could you then move to the next stage, which would allow the medical investigations into wind turbine noise.

The problem that existed in 2012 was that there be no medical studies to identify the impacts of wind turbine noise (a common statement from the wind industry). However, there is equally the same position that there are no medical studies to identify that there are no impacts from wind turbine noise.

On a statistical basis whilst adverse impacts attributed to wind turbines represent a small proportion of the community, the proportion of the community affected is more than a background proportion and indicates that there is a statistical anomaly that supports a problem.

For the people who are adversely affected by wind turbines to the extent that it affects their daily lives and in extreme cases causes them to abandon their homes, it is clearly a problem. If one restricts the catchment area for a community to be within 10 km of a wind farm (and not as in some studies, consider the community out to 100 km away), then on the restricted catchment area on a statistical basis there is a high proportion of the community being affected.

Where do we go from here? It seems we have a facility that can faithfully reproduce various acoustic signals across the audible frequency range and in a limited capacity we can reproduce infrasound levels in a test environment. We are presently exploring better quality digital to analog converters to overcome some technical limitations.

With our recent pilot study results if funding can be provided we would seek to rerun the study but with say 50 test subjects who are being sensitized to wind turbine noise but at the same time we would have appropriately qualified people undertake medical monitoring of the test subjects including EEG monitoring. We would not only just examine wind turbine noise, but we would compare the general environmental noise (also inaudible) that is often used as a comparison to wind turbine environments.

Q. Why are some persons near projects impacted, and others less so? Is it possible that some are impacted without knowing it long term? If so, what might those health impacts be?

A. In 2015 I presented a paper to the Wind Turbine Working Group of the Acoustical Society of America where I raised the matter of **'sensitization over time.'**

Over the last six years I have attended various wind farms on a number of occasions as part of my research work an investigation into wind turbine noise. I have met residents and have stayed at their houses several times over the years; it seems to me as a general observation that the people become more sensitized to the operation the turbines in that they are able to detect the operations at a lower level than previously, and that in the number of households more members of the household have been able to detect sensations or were being impacted by the turbines than on previous site visits.

The residents report a greater sleep disturbance over time and more people have had to abandon their homes.

For some people when abandoning their homes and residing at other locations there is an improvement in their overall demeanor and well-being and from my observations their conversation appears to be more normal and not exhibiting (to me) signs of depression.

However, for some people there are still lingering issues of impacts and the degree of sensitization that has developed has become affected by other "normal" noise sources such as traffic.

At the New Orleans Wind Turbine Working Group meeting Melissa Ware (who has a hearing impairment and was one of the participants in the Cape Bridgewater study) presented how she has been impacted because of the turbines.

Figure 4.3 of the WHO 2009 European night-time guidelines identifies how ongoing noise disturbance can lead to health impacts and cites cardiovascular disease as one possible outcome. The WHO discussion in Chapter 4 in relation to health impacts, primarily related to road traffic and aircraft noise, should be placed in the context of the suggested dose response curves to indicate impacts from wind turbine noise occurs at lower thresholds than that of Road Traffic or Aircraft Noise.

Q. You have testified in many instances, in various countries, about these findings, and the very real and verified impacts on "victims." Have these testimonies had impact on policy changes?

A. The wind industry relies upon compliance with guidelines or criteria issued by regulatory authorities.

In many cases the court relies upon guidelines or criteria issued by regulatory authorities, despite hearing evidence from residents as to the extent of disturbance they experience because of operating wind turbines.

In the end the court or tribunal uses the escape clause that it is not for them to set guidelines or criteria, but it is the regulatory authorities responsibility and therefore they must abide by that criteria.

So, to date there have been no policy changes as a result of my investigations or the many "victims'" impact statements to Courts and Tribunals. The escape clause is the published guidelines and standards.

When one examines the guidelines or standards used in Australia for wind turbines, it becomes obvious that there is no scientific basis to identify the noise targets proposed for wind farm facilities with respect to an acceptable level of noise that will not give rise to disturbance or unacceptable impacts for residents.

This fact is obvious because there are no scientific studies into determining the dose-response curve to identify the level of annoyance that would satisfy 90% of the population or to identify the level of noise from wind turbines that would not give rise to sleep disturbance.

The regulatory authorities are the ones who should be accountable to the community for permitting adverse impacts and in turn health impacts.

Policy change in terms of guidelines and standards for wind turbines in Australia, or in America, will simply not occur if left to the regulatory authorities. For example, the community of Waterloo in South Australia have publicly expressed no confidence in the South Australian EPA who steadfastly support their guidelines as being appropriate, without providing any material to support the basis of those guidelines other than simply referring to WHO guidelines (based upon road and air traffic).

With the mounting evidence of the negative impacts created by wind turbines, and if one can get to the point of the medical studies to confirm the actual impacts, then one could expect damages claims against the regulatory authorities for their lack of scientific rigor and failure to apply the precautionary principle.

In late last year, the Administrative Appeals Tribunal (a federal Judicial body) in relation to the charity status of the Waubra Foundation, was presented with a significant degree of evidence in relation to wind turbines creating adverse impacts on the community and the inadequacy of current guidelines to protect the community.

The Waubra Foundation has assisted members of the community in seeking to understand the ramifications of wind turbines and to be in effect the first point of contact to obtain information or advice in relation to wind turbines.

The foundation lost its charity status, but it is of huge significance that the Administrative Appeals Tribunal clearly stated that dBA was useless. *The AAT found that the operation of wind turbines did generate both audible and inaudible sound, did create an impact on the community that gave rise to disturbance and that more research (to that proposed and supported by the Waubra Foundation) should be undertaken.*

The week following the AAT decision, five papers from Australians were presented to the ASA Wind Turbine Working Group, of which the first paper was my recent one concerning the pilot study of inaudible wind turbine noise being detected by residents who are sensitized to wind turbine noise.

Q. In your response to the previous question you referred to the need for appropriate criteria for wind turbines and noted that there are **'no criteria** based upon wind turbine studies.' Some people say the Health Canada study provided that information. What is your view of that study?

A. I am unable to comment on the socio-acoustics or the medical components of the study, but understand there has been significant criticism of the Health Canada study by persons appropriately qualified in those areas. Master Resource has published some of those; other criticisms are listed here.

The authors of the Health Canada study identified that it was only site specific and should not be used as generic conclusions.

The study had limitations on the age of people involved in the study and left out houses that were vacant. Community representatives have identified that a high proportion of the vacant houses related to people who had left the area (abandoned their homes) because of the wind turbines.

The ASA Wind Turbine Working Group (Acoustical Society of America) was advised in the middle of last year that there would be an investigation undertaken by Health Canada in conjunction with the community to look at the people who are sensitized to wind turbines and/or who had abandoned their homes, but that material has not been published.

The determination of the actual noise from wind turbines when utilizing the dB(A) or the dB(C) parameter is difficult in the real-world environment, which is the position that we found in the Cape Bridgewater study.

A problem with the Health Canada study is the lack of actual acoustic or measurements to relate to the community response material in that the **study relied upon predicted noise levels** and not actual noise levels. As such the Health Canada study did not (and could not) provide any validation of the predicted levels versus the actual wind turbine noise levels.

The analysis to show a constant 15 dB difference between dB(A) and dB(C) is simply from a mathematical analysis of distance attenuation using a constant spectrum without any adjustment for excess attenuation over distance due to atmospheric absorption and this can only relate to a theoretical exercise for external noise. Due to the attenuation characteristics of different building envelopes, the internal noise level from wind turbines cannot be simply extrapolated from an external noise level, and this is an issue of concern.

The interpretation of annoyance excessive to background levels as published by the principal author of the Health Canada study, simply defies logic as to what it means and ends up contradicting other acoustic components of the study.

Some of the ambient noise levels that have been provided in the Health Canada study seen to be extraordinarily high if one is considering a rural environment. Yet there is no information to identify the nature of the acoustic environment and the influence of agricultural activities or traffic noise that may have required some of those data points to be removed.

The study appeared to be constructed around existing general acoustic criteria and other than some excellent work in terms of infrasound monitoring (then reported upon by others), there does not appear to have been an attempt to undertake a lateral thinking approach in looking at other indices or issues that may be giving rise to the reported disturbances.

Q. It seems that the primary complaint that first occurs with wind turbines is sleep disturbance. The WHO 2009 European Night Time Guidelines show in Figure 4.3 that on-going sleep disturbance becomes a health impact. The WHO reports that some of these, by no means the exhaustive list, are attributable to poor sleep patterns, often a result of environmental noise:

fatigue, lack of ability to concentrate, memory impairment, lack of energy, proneness to errors or accidents, tension, social or vocational dysfunction, headaches, and gastrointestinal symptoms related to worry about sleep.

In your opinion is sleep disturbance from wind turbines a relevant matter that should be investigated?

A. Most definitely YES.

If we have guidelines or standards that claim they have criteria to protect against sleep disturbance or identify the sleep disturbance is an adverse impact, or criteria that purport to protect the amenity of the surrounding community from adverse noise impacts then surely there must be some data to substantiate the criteria that have been nominated for wind turbines.

However, I have yet to see any material/data that relates to the current capacity of wind turbines being installed around the world. A few papers related to studies at the beginning of this century in Sweden and the Netherlands on relatively small wind turbines, indicated dose response curves significantly lower than that applicable to road traffic noise (in urban areas) or aircraft noise.

Wind turbines are generally located in rural areas then the acoustic environment of rural areas, and therefore the identification of the acoustic amenity that residents in those areas experience must be different to that in an urban environment.

From my investigations and examination of various studies into wind turbine noise, it seems to me that the following questions need to be answered by the Regulatory Authorities in relation to the criteria that those authorities have issued to permit wind turbines to operate in proximity to residential receivers. It does not hurt to repeat these, if some have not understood the basic nature of these requests for sources and studies.

1. Please provide studies upon which the wind turbine/farm criteria have been developed?
2. Please identify the noise source(s) that have been used in the studies related to question 1?
3. Please provide the dose-response data related to wind turbine/farms on which the criteria are based, and the corresponding level that represents 10% of the population that is highly affected?
4. The most common complaint from residents relates to sleep disturbance. Please provide the studies of wind farm noise that identifies the noise (in any relevant acoustic index) that gives rise to sleep disturbance?
5. Please provide studies of wind farm noise that identify the noise level (in any relevant acoustic index) that will not give rise to sleep disturbance.

6. Please provide studies of wind farm noise that identifies the noise level that would protect the acoustic amenity of residents in proximity to wind farms.

7. In light of the above, please identify who would be liable (in a damages claim) for the consequences of adverse impacts.

I came up with the above questions in December 2016 and to date, neither I nor community representatives in Australia have been able to get any response from the regulatory authorities or a Commonwealth Government appointed Wind Farm Commissioner to these relatively simple questions.

Those same questions were put to the Administrative Appeals Tribunal, but they were unable to answer those questions simply because the data is not available.

The provision of scientific data to identify the dose-response curve and sleep disturbance criteria in relation to wind turbine noise would then place in context the appropriateness or otherwise of criteria issued by Regulatory Authorities.

We thank Steven Cooper for his detailed and extremely current exploration and overview of wind turbine "noise" and again, his studied reminders of the profound relationship between sleep and health. As Mr. Cooper indicates yet again, let developers or wind promoters provide the dose response curve for sleep disturbance, provide all the data that should be tabled, in full protection of human health, before contemplating building wind factories.