Ex. A12

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION BY DEUEL HARVEST WIND ENERGY LLC FOR ENERGY FACILITY PERMITS OF A WIND ENERGY FACILITY AND A 345-KV TRANSMISSION LINE IN DEUEL COUNTY, SOUTH DAKOTA FOR THE DEUEL HARVEST NORTH WIND FARM

SD PUC DOCKET EL18-053

PRE-FILED SUPPLEMENTAL DIRECT TESTIMONY OF DR. MARK ROBERTS ON BEHALF OF DEUEL HARVEST WIND ENERGY LLC

February 14, 2019

I. INTRODUCTION

Q. Please state your name, employer, and business address.

A. My name is Dr. Mark Roberts. I am employed by Exponent, Inc. ("Exponent"), and my office is located at 525 West Monroe Street, Suite 1050, Chicago, Illinois 60661.

Q. Please describe your educational and professional background.

A. I am a Principal Scientist in the Chicago office of Exponent, a scientific research and consulting company headquartered in Menlo Park, California. I have worked at Exponent since November 2003.

Prior to working at Exponent, I held a series of positions with advancing responsibility in the areas of public health, occupational medicine, and academia. I was employed at the Oklahoma State Department of Health from 1972 to 1990 and held a series of positions culminating in my appointment as the State Epidemiologist, a post that I held from 1979 to 1982, followed by the position of Consulting Medical/Environmental Epidemiologist from 1983 to 1990. In both of these capacities, I directed epidemiologic investigations consisting of a broad range of health concerns, from food-borne outbreaks to cancer clusters.

I was a faculty member of the Department of Preventive Medicine at the Medical College of Wisconsin from 1990 to 1997, and I completed my tenure as Associate Professor and Acting Chairman of the Department. I have also served as Corporate Medical Director for several global companies. While on faculty at the Medical College of Wisconsin in Milwaukee, Wisconsin, I was contract Medical Director for Wisconsin Centrifugal, a foundry in Waukesha, Wisconsin. In this role, I supervised the health monitoring programs, both company-mandated and Occupational Safety and Health Administration ("OSHA") required, in addition to the day-to-day clinical aspects of the employee health service. My responsibilities included biological surveillance of employee population as well as worksite reviews and inspections.

I earned a M.Ed. in Education in 1972, an M.P.H. in Epidemiology and Biostatistics in 1974, and a Ph.D. in Epidemiology and Biostatistics in 1979. I completed medical school in 1986, an internship in Family Medicine in 1987, and a residency/fellowship in Occupational and Environmental Medicine in 1990.

I am a Fellow of the American College of Occupational and Environmental Medicine. I have unrestricted licenses to practice medicine in Oklahoma and Wisconsin. In addition to my employment experience, I am a past member (2000–2007, 2008–2011) of the Board of Directors, Vice President (2013-2014), and President (2015-2016) of the American College of Occupational and Environmental Medicine in Arlington Heights, Illinois. I have been a member of the Board of Directors of Vysis, Inc. in Downers Grove, Illinois and the Board of Scientific Counselors for the Agency for Toxic Substances and Disease Registry in Atlanta, Georgia. In addition, I have served as an active participant on numerous state and national professional committees. My statement of qualifications is attached as Exhibit 1.

Q. Did you previously provide Direct Testimony in this docket?

A. No.

Q. What exhibits are attached to your Supplemental Direct Testimony?

A. The following exhibit is attached to my Supplemental Direct Testimony:

- Exhibit 1: Statement of Qualifications.
- Exhibit 2: Letter, Kim Malsam-Rysdon, Secretary of Health, South Dakota Department of Health (Oct. 13, 2017), *In the Matter of the Application by Crocker Wind Farm, LLC for a Permit of a Wind Energy Facility and a 345 kV Transmission Line in Clark County, South Dakota, for Crocker Wind Farm*, Docket No. EL17-055.
- Exhibit 3: Crichton, F., et al. (2014). The link between health complaints and wind turbines: Support for the nocebo expectations hypothesis. *Frontiers in Public Health* 2:220.

- Exhibit 4: Frits van den Berg, Public Health Service Amsterdam, and Irene van Kamp, National Institute for Public Health and the Environment (2017). Health effects related to wind turbine sound. Swiss Federal Office for the Environment.

II. PURPOSE OF TESTIMONY

Q. What is the purpose of your Supplemental Direct Testimony?

A. The purpose of my testimony is to briefly address the topic of potential health impacts from wind turbines, including those attributed to sound and shadow flicker. As discussed further in my testimony, no specific health condition caused by wind turbines has been scientifically proven in the peer-reviewed published literature.

III. OVERVIEW OF HEALTH-RELATED WIND TURBINE RESEARCH

Q. Are assertions that wind turbines cause adverse health effects being considered?

A. Yes. The multiple governmental reviews and reports of public health officials show that concerns related to wind turbines' potential for adverse health effects have been and are being taken quite seriously. Following are examples of articles published in journals employing a peer review process as well as state, national and international scientific panels' literature which summarizes the peer reviewed literature:

- Eja Pedersen, Högskolan I Halmstad (2003). Noise Annoyance 116 from Wind Turbines: A Review. Swedish Environmental Protection Agency.
- Danish Energy Agency (2009). Wind Turbines in Denmark.
- Australian National Health and Medical Research Council (2010). Wind Turbines and Health: A Rapid Review of the Evidence.
- Stephen Chiles (2010). A new wind farm noise standard for New Zealand, NZS 6808:2010. Proceedings of 20th International Congress on Acoustics, ICA 2010.

- Massachusetts Departments of Environmental Protection and Public Health (2012). Wind Turbine Health Impact Study: Report of the Independent Expert Panel.[1]
- Australian National Health and Medical Research Council (2014). Review of Additional Evidence for NHMRC Information Paper: Evidence on Wind Farms and Human Health – Final Report.
- Crichton, F., et al. (2014). The link between health complaints and wind turbines: Support for the nocebo expectations hypothesis. *Frontiers in Public Health* 2:220. (Exhibit 3.)
- Wisconsin Wind Siting Council (2014). Wind Turbine Siting – Health Review and Wind Siting Policy Update.
- Australian National Health and Medical Research Council (2015). NHMRC Statement: Evidence on Wind Farms and Human Health.
- Australian National Health and Medical Research Council (2015). Systematic Review of the Human Health Effects of Wind Farms.
- Public Service Commission of Wisconsin (2015). Review of Studies and Literature Relating to Wind Turbines and Human Health. Prepared for the Wisconsin State Legislature.
- Hitomi Kimura, Yoshinori Momose, Hiroya Deguchi, and Nameki, Mimi (2016). Investigation, Prediction, and Evaluation of Wind Turbine Noise in Japan. Ministry of the Environment of Japan.
- Michaud, et al. (2016). Effects of Wind Turbine Noise on Self-Reported and Objective Measures of Sleep. *Sleep* 39:1.[2]
- Ministry for the Environment, Climate and Energy of the Federal State of Baden-Wuerttemberg, Germany (2016). Low-frequency Noise Incl. Infrasound from Wind Turbines and Other Sources. LUBW Landesanstalt fur Umwelt, Messungen and Naturschutz Baden-Wuerttemberg.

[1] *See* Exhibit 2 of the Supplemental Testimony of Dr. Jeffrey Ellenbogen.

[2] *See* Exhibit 5 of the Supplemental Testimony of Dr. Jeffrey Ellenbogen.

- Letter, Kim Malsam-Rysdon, Secretary of Health, South Dakota Department of Health (Oct. 13, 2017), *In the Matter of the Application by Crocker Wind Farm, LLC for a Permit of a Wind Energy Facility and a 345 kV Transmission Line in Clark County, South Dakota, for Crocker Wind Farm*, Docket No. EL17-055. (Exhibit 2.)
- Akira Shimada and Mimi Nameki (2017). Evaluation of Wind Turbine Noise in Japan. Ministry of the Environment of Japan.
- Colloca, L. (2017). Nocebo effects can make you feel pain: Negative expectancies derived from features of commercial drugs elicit nocebo effects. *Science*, 358(6359):44.
- French National Agency for Food Safety, Environment and Labor ("ANSES") (2017). ANSES Opinion regarding the expert appraisal on the "Assessment of the health effects of low-frequency sounds and infrasounds from wind farms."
- Frits van den Berg, Public Health Service Amsterdam, and Irene van Kamp, National Institute for Public Health and the Environment (2017). Health effects related to wind turbine sound. Swiss Federal Office for the Environment. (Exhibit 4.)
- Joseph Rand and Ben Hoen (2017). Thirty Years of North American wind energy acceptance research: What have we learned? Energy Analysis and Environmental Impacts Division, Lawrence Berkeley National Laboratory, Electricity Markets and Policy Group.

I note that the scientific panels reviewed peer–reviewed, published literature, governmental documents, and information they considered as scientifically valid.

Q. Why is it important to utilize scientific methodology when there are case studies and/or personal testimonials asserting that wind turbines can cause adverse health effects?

A. The scientific methodology is an accepted process used to evaluate population-based data, and make sound, scientifically supportable decisions. There have been

numerous examples where an agent first thought to be the cause of a disease was confirmed not to be so as a result of the scientific process of hypothesis generation, research, and peer review. For example, in the following instances associations between an exposure and disease were disproven: coffee and pancreatic cancer (Hart 2008,[3] Dong 2011[4]); silicone breast implants and autoimmune diseases (Hölmich et al. 2007)[5]; saccharin and bladder tumors (NCI 2018);[6] Bendectin and birth defects (McKeigue, et al. 1994).[7] In some instances, an alternative cause is proven: spicy food and ulcers (turns out many are caused by bacteria) (Abdukarim 2010).[8] Clearly, initial observations and hypotheses are not always supported by more thorough scientific investigation. Even strongly held beliefs by groups of people do not provide proof of causation and at times can be detrimental to the scientific process and to public health. A timely example of such a situation is the current belief by some that immunizations cause autism.

Q. Have wind turbines been proven to cause adverse health conditions?

A. No. Despite the attribution of various health events to wind turbines, there has not been a specific health condition documented in the peer-reviewed published literature or recognized by the medical community or professional societies as a disease caused by exposure to sound levels and frequencies generated by the operation of wind turbines. In written testimony I provided in prior proceedings before the South Dakota Public Utilitiies Commission, I noted that this is the

[3] Andrew Hart, High Kennedy, and Ian Harvey (2008). Pancreatic Cancer: A Review of the Evidence on Causation. Clinical *Gastroenterology and Hepatology* 6: 275–282.

[4] Jie Dong, Jian Zou, and Xiao-Feng Yu (2011). Coffee drinking and pancreatic cancer risk: a meta-analysis of cohort studies. *World J. Gastroenterol* 17:1204–1210.

[5] Hölmich, et al. (2007). Breast implant rupture and connective tissue disease: a review of the literature. *Plast. Reconstr. Surg*. 120:62S-69S.

[6] National Cancer Institute, Artificial Sweeteners and Cancer, available at https://www.cancer.gov/about-cancer/causes-prevention/risk/diet/artificial-sweeteners-fact-sheet (last accessed February 13, 2019).

[7] McKeigue, et al. (1994). Bendectin and birth defects: I. A meta-analysis of the epidemiologic studies. *Teratology* 50:27-37.

[8] Abdulkarim, et al. (2010). Spices, herbal xenobiotics and the stomach: Friends or Foes? *World J Gastroenterology* 16(22): 2710-2719.

conclusion that has been reached by governments and public health officials when they have evaluated wind turbines' potential for adverse health effects.[9] In contrast, the subjective, non-specific complaints that have been raised, which show a great deal of variability, do not provide support for a science-based conclusion that wind turbines are the cause of adverse health effects.

Q. Has the State of South Dakota addressed claims of an association between wind turbines and health effects?

A. The State of South Dakota has not specifically studied alleged health effects and wind turbines. However, the Department of Health was asked to opine on the issue in another docket, *In the Matter of the Application by Crocker Wind Farm, LLC for a Permit of a Wind Energy Facility and a 345 kV Transmission Line in Clark County, South Dakota, for Crocker Wind Farm*, Docket No. EL 17-055. The South Dakota Secretary of Health, Kim Malsam-Rysdon, submitted a letter consistent with my testimony (Exhibit 2):

> The South Dakota Department of Health has been requested to comment on the potential health impacts associated with wind facilities. Based on the studies we have reviewed to date, the South Dakota Department of Health has not taken a formal position on the issue of wind turbines and human health. A number of state public health agencies have studied the issue, including the Massachusetts Department of Public Health[10] and the Minnesota Department of Health. These studies generally conclude that there is insufficient evidence to establish a significant risk to human health. Annoyance and quality of life are the most common complaints associated with wind turbines, and the studies indicate that those issues may be minimized by incorporating best practices into the planning guidelines.

IV. WIND TURBINES AND SOUND

Q. Are you aware of any health concerns being raised in this docket with respect to wind turbines and sound?

[9] Pre-filed Supplemental Testimony of Dr. Mark Roberts, SD PUC Docket EL18-026, pp. 12-13 (Aug. 10, 2018) and Prefiled Testimony of Mark Roberts, SD PUC Docket EL18-003, pp. 10-12 (Apr. 6, 2018).

[10] See Exhibit 2 of the Supplemental Testimony of Dr. Jeffrey Ellenbogen.

A. I am aware that comments prepared by Richard James regarding alleged infrasound and low frequency noise health impacts from wind projects were filed in the docket by George and Ruby Holborn.

Q. Do you agree with Mr. James' comments?

A. I agree with Mr. James that wind turbines produce audible sound, infrasound, and low frequency sound. However, Mr. James' comments regarding potential health effects from wind turbine noise are not supported by the peer-reviewed literature discussing studies of the potential health effects of wind turbines that utilize the scientific methodology. He is merely using findings in other scientific areas to support a hypothesis that is unproven and unfounded in basic science.

Q. Based on your review of the available scientific literature, are there potential adverse health effects from the audible sound of wind turbines?

A. No, not at the levels of sound that will be produced by this Project. Substantial research has been done on sound level exposures to humans. This body of scientific research has identified a number of health-related links to high level industrial sound in the workplace. For example, OSHA has set a limit of 90 dBA for the 8-hour work day based on a finding that exposure to levels of noise above 90 dBA in the workplace can cause hearing damage and set an 85 dBA level as the set point of initiation of a hearing protection program in the workplace. However, this same science has not identified a causal link between any specific health condition and exposure to the sound patterns generated by contemporary wind turbine models. In addition to my own conclusions, several other respected organizations and agencies have reached similar conclusions.[11]

Q. What is infrasound?

[11] *See* Pre-filed Supplemental Testimony of Dr. Mark Roberts, SD PUC Docket EL18-026, pp. 12-14 (Aug. 10, 2018), and Prefiled Testimony of Dr. Mark Roberts, SD PUC Docket EL18-003, pp. 11-13 (Apr. 6, 2018).

A. Infrasound, sometimes referred to as low frequency sound, is sound that is between 0 hertz ("Hz") and 20 Hz. Although the human hearing threshold has been found to be as low as 4 Hz in an acoustic chamber, a level of 20 Hz is commonly considered the low end of the range of hearing.

Q. Is there reliable evidence that infrasound from wind turbines causes adverse health effects?

A. No, I am not aware of any such evidence. Multiple health experts, in individual peer-reviewed publications or as part of public health type advisory panels, have confirmed this point. Specifically, infrasound at frequencies lower than 20 Hz are audible at very high levels (110+ dBA), and these sounds may occur from man-made but also many natural sources, such as meteors or volcanic eruptions. Anthropogenic (i.e., human-caused) sources, which often are the predominant type of sound, can also generate infrasonic noise (e.g., heart, lung and digestive tract sounds as well as machinery, ventilation systems, large combustion processes and naturally occurring winds).[12] Heart sounds are in the range of 27 to 35 dBA at 20-40 Hz[13] and lung sounds are reported in the range of 5-35 dBA at 150-600 Hz.[14] Note that these sources are in the range of infrasound produced by wind turbines. Thus, infrasounds – both man-made and naturally-occurring – are all around us.

Q. Are you aware of assertions that infrasound from wind turbines can cause adverse health effects?

A. Yes, as I noted, Mr. James makes generalized claims of adverse health effects which are based on self-reported symptoms that have not been objectively

[12] Berglund, B., Hassmen, P., and Job, R. F. (1996). Sources and effects of low-frequency noise. *Journal of the Acoustical Society of America*. 99(5), (2985-3002); Leventhall, G. (2007). What is infrasound? 93(1-3), (130-137); Sienkiewicz, Z. (2007). Rapporteur report: Roundup, discussion and recommendations. *Progress in Biophysics and Molecular Biology*. 93(1-3), (414-420).

[13] Sakai, A., Feigen, L. P., and Luisada, A. A. (1971). Frequency distribution of the heart sounds in normal man. *Cardiovascular Research*. 5(3), (358-363).

[14] Fiz, J. A., Gnitecki, J., Kraman, S. S., Wodicka, G. R., and Pasterkamp, H. (2008). Effect of body position on lung sounds in healthy young men. 133(3), (729-736).

evaluated. His claims lack clinical or scientific merit. In addition, the publications by Dr. Paul Schomer upon which Mr. James relies did not use epidemiologic study methods such that specific conclusions could be scientifically supported or demonstrate a causal relationship between wind turbines and health complaints reported by some residents. As I explained above, and in detail in my testimony in prior proceedings before the Commission, use of the scientific methodology, such as that used in a well-designed epidemiologic study, is essential for a study's results to be reliable in terms of identifying a potential causal relationship.[15]

Q. In his comments, Mr. James relies upon the Shirley Wind Farm in Wisconsin to support his opinion that a 38 dBA (Leq) sound limit should be imposed on wind farms by local governments. Is this reliance justified?

A. In my opinion, no. None of the claims relating to the Shirley Wind Farm in Brown County, Wisconsin, which was built in 2011 and consists of eight 2.5 megawatt wind turbines, have been confirmed by a physician. Also, in December 2015, the Brown County health officer (Ms. Chau Xiong) declared that there was insufficient scientific evidence to support the relationship between wind turbines and health concerns.[16] I believe that further allegations of health effects based on the Shirley Wind Farm are unfounded.

V. WIND TURBINES AND SHADOW FLICKER

Q. Have you evaluated the potential for shadow flicker from wind turbines to have health effects?

A. Yes. I found no scientific studies indicating any demonstrated health effects arising from shadow flicker produced by wind turbines, or any other type of flicker humans commonly experience, such as from computer monitors, TV screens or fans. With

[15] Pre-filed Supplemental Testimony of Dr. Mark Roberts, SD PUC Docket EL18-026, pp. 9-12 (Aug. 10, 2018) and Prefiled Testimony of Dr. Mark Roberts, SD PUC Docket EL18-003, pp. 8-10 (Apr. 6, 2018).

[16] Proceedings of the Board of Health Special Meeting, UW Extension, Green Bay, Wisconsin, December 15, 2015, available at: http://www.co.brown.wi.us/i_brown/minutes/895edb5ae8ce/boh_minutes_12-15-15_draft_2.pdf.

respect to claims that shadow flicker from wind turbines may affect persons with epilepsy, there is no indication that a wind turbine would have an impact because the frequency of shadow flicker from wind turbines is not the frequency that induces epileptic seizures. Specifically, the Epilepsy Foundation has stated that light flashing frequencies greater than 10 Hz (600 RPM) may trigger epileptic seizures but seizures are unlikely at less than 2 Hz (120 RPM). This level is well below the usual wind turbine operation blade passage frequency of approximately 0.5 Hz (30 RPM).

Q. Are you aware of shadow flicker limits that have been imposed on wind turbines?

A. Yes. There are state and national jurisdictions that have imposed shadow flicker limits. The typical limit I have seen is 30 hours annually. However, such requirements and recommendations have no scientifically supported health-based justifications.[17]

Q. Are you aware of any health-related reason to impose a certain shadow flicker limit on this project?

A. No. I am not aware of any health-based justification for setting any limit on shadow flicker, as there is no scientific evidence that shadow flicker causes health effects.

VI. OTHER HEALTH ISSUES RAISED IN PUBLIC COMMENTS

Q. Apart from the issues already discussed in this testimony, are you aware of any public comments submitted in this docket thus far regarding health concerns?

A. Yes. The following articles regarding wind turbines and human health were submitted or referred to in public comments:

[17] Haugenm, K. M. B. (October 19, 2011). International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences: Setbacks, Noise, Shadow Flicker, and Other Concerns. Minnesota Department of Commerce: Energy Facility Permitting. *See also* Knopper, L. D., Ollson, C. A., McCallum, L. C., Whitfield Aslund, M. L., Berger, R. G., Souweine, K., and McDaniel, M. (2014). Wind turbines and human health. *Frontiers in Public Health*, 2(63):1–20.

- A letter posted on National Wind Watch by Hakan Enbom, M.D., Ph.D., titled “Infrasound from wind turbines can trigger migraine and related symptoms” (the “Enbom Letter”).
- A report compiled by Carmen Krogh, PSCPharm, titled “Industrial Wind Turbines and Health: Wind Turbines Can Harm Humans if too Close to Residents” (the “Krogh Report”).
- A report by Jerry L. Punch and Richard R. James titled “Wind Turbine Noise and Human Health: A Four-Decade History of Evidence that Wind Turbines Pose Risks” (the “Punch and James Report”).
- An article posted on National Wind Watch by Hakan Enbom and Inga Malcus Encom titled “Infrasound from wind turbines – an overlooked health risk” (the “Enbom Article”).

Q. Please describe the Enbom Letter.

A. The Enbom Letter is a discussion of divergent medical concepts not related to wind turbine sound or exposure and proposing a causation hypothesis. A review of the scientific articles they list in the referenced article does not indicate that their hypothesis is proven. The article shows a pattern of applying concepts out of context and/or not directly applicable to wind turbine sound (as I discuss in more detail below).

Q. What is your response to the Enbom Letter?

A. While the Enbom Letter includes small pieces of recognized science references, the author fails to acknowledge that no reliable scientific publications support the author’s hypotheses. A review of the references also reveals statements that contradict Dr. Enbom’s hypothesis, including:

- **Farboud 2013**: This article states that “[t]here is an abundance of information available on the internet describing the possibility of wind turbine syndrome. However, the majority of this information is based on purely anecdotal evidence. Whilst it is biologically and physically plausible that low frequency noise generated by wind turbines could affect people,

there is insufficient evidence on which to base conclusions. The fact that the ear may respond to low frequency noise at the frequency and levels generated by wind turbines does not necessarily mean that such noise will be perceived or will disturb function." (Farboud 2013, p. 225.)[18]

- **Shepherd 2011:** This article explains, "[o]f further interest are the likely mechanisms involved in the degradation of [health-related quality of life] when exposed to turbine noise. Studies show that the level of turbine noise is a poor predictor of human response, and dose-response relationships typically explain little of the association between turbine noise and annoyance." (Shepherd 2011, p. 337.)

- **Woolf 2011**: This reference does not mention wind turbines and thus does not say anything about wind turbines and specific adverse health effects. (Woolf 2011.)[19]

- **Todd 2009**: This reference makes observations about 100 Hz vibrations at 70dB which are significantly different from that produced in the typical wind turbine. In addition, Todd has cautioned about applying his work to the wind turbine claims. (Todd 2009.)[20]

Q. Please describe the Krogh Report.

A. The Krogh Report is a collection of material from various sources which offer opinions but do not include reliable scientific analysis showing an adverse health effect associated with wind turbines.

[18] Farboud, et al. (2013). Wind turbine syndrome: fact or fiction? *J. Laryngol Otol.* 127(3):222-6.

[19] Clifford J. Woolf (2011 Mar.). Central sensitization: Implications for the diagnosis and treatment of pain. *Pain*. 152 (3 Suppl): S2-15.

[20] Neil Todd (2009). Hot Topic 1: Low frequency sensitivity of the vestibular system and its significance. Hot Topics in Vestibular Research. Manchester, UK.

Q. What is your response to the Krogh Report?

A. The Krogh Report is neither reliable nor helpful. It is nothing more than a listing of documents that appear to be favorable to a hypothesis that, as the article is titled, "[w]ind turbines can harm humans if too close to residences." The Krogh Report does not analyze its sources reliably, and the "sources" appear to be a mix of personal opinion pieces, lay articles, articles promoted by organizations whose sole goal is to stop wind development, and other articles that do not show any link between wind turbines and adverse health effects. None of these sources appears to be peer-reviewed, evidence-based, or reliable.

Q. Please discuss your response to the Punch and James Report.

A. Although its authors claim that it is a "systematic review of legitimate sources," the Punch and James Report is not a peer-reviewed article and is, at best, simply a more carefully-crafted collection of "sources" than the Krogh Report. It systematically excludes and ignores a majority of the articles published in peer-reviewed journals on this topic. The Punch and James Report weaves a strong anti-wind narrative of articles favorable to opinions of its authors that is contrary to the numerous reviews by state, national and international organizations which they dismiss as biased. Like the Krogh Report, it is neither reliable nor helpful – it has not been published in a peer-reviewed, scientific journal and thus has not been objectively reviewed in an unbiased fashion.

Q. Overall, in your professional opinion, do any of the above references from public comments show a connection between wind turbines and adverse human health effects?

A. No. These references do not provide scientifically-based evidence that wind turbines adversely affects the physical wellbeing of residents. As I discuss previously in this testimony, the scientifically-based evidence weighs in favor of the opposite conclusion – that there is no relationship between wind turbines and adverse health effects.

VII. CONCLUSION

Q. Does this conclude your Supplemental Direct Testimony?

A. Yes.

Dated this 14th day of February, 2019.

Dr. Mark Roberts

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