Applicant Exhibit 41

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Firelands Wind, LLC for a Certificate of Environmental Compatibility and Public Need to Construct a Wind-Powered Electric Generation Facility in Huron and Erie Counties, Ohio.	)))))	Case No. 18-1607-EL-BGN

DIRECT TESTIMONY OF

Eddie Duncan
Resource Systems Group, Inc.

on behalf of
Firelands Wind, LLC

September 11, 2020

/s/ Christine M.T. Pirik
Christine M.T. Pirik (0029759)
(Counsel of Record)
Terrence O'Donnell (0074213)
William Vorys (0093479)
Jonathan R. Secrest (0075445)
Madeline Fleisher (0091862)
DICKINSON WRIGHT PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
(614) 591-5461

James M. Lynch (PHV 21869-2020)
Adam N. Tabor (PHV 21870-2020)
K&L Gates LLP
925 Fourth Avenue, Ste. 2900
Seattle, Washington 98104
(206) 370-7652

1. Please state your name, current title, and business address.

My name is Eddie Duncan. I am a Director at Resource Systems Group, Inc. ("RSG"). My business address is 55 Railroad Row, White River Junction, Vermont 05001.

2. Please summarize your educational background and professional experience.

I am Board Certified in Noise Control Engineering by the Institute of Noise Control Engineering and am a member of the Acoustical Society of America where I served as a member of the Technical Committee on Architectural Acoustics for over 10 years. I have a Bachelor of Science degree in Engineering Science from Rensselaer Polytechnic Institute ("RPI") and a Master of Science degree in Environmental Studies from Green Mountain College.

I have 17 years of experience in the field of acoustics with much of that experience measuring, modeling, and analyzing noise from renewable energy sources and power transmission projects. I have worked across many different public and private sectors, including power transmission, renewable energy, transportation, public lands, recreation, mining, manufacturing, healthcare, education, and commercial and residential development. A copy of my resume is attached to my testimony as Attachment ED-1.

3. On whose behalf are you offering testimony?

I am testifying on behalf of the Applicant, Firelands Wind, LLC ("Applicant" or "Firelands"), which is seeking to develop the proposed Emerson Creek Wind Farm ("Project").

4. What is the purpose of your testimony?

The purpose of my testimony is to sponsor the Noise Impact Assessment Report ("Noise Report"), which is Exhibit G to the Application for Certificate of Environmental Compatibility and Public Need ("Application") filed with the Ohio Power Siting Board ("Board") on January 31, 2019, by Firelands. My testimony, together with the other witnesses for Firelands testifying in this case, supports the Board's adoption of the Joint Stipulation and Recommendation ("Stipulation"), which was filed in this docket on

September 11, 2020, and is being offered in this proceeding as Joint Exhibit 1.

5. Please discuss the Board's construction and operational noise requirements that apply to the Project.

The Board requires applicants to submit certain information regarding potential noise impacts. This information includes:

- Ohio Administrative Code ("O.A.C.") 4906-4-08(A)(3)(a) - An analysis of construction noise levels expected at the nearest property boundary;
- O.A.C. 4906-4-08(A)(3)(b) - An analysis of operational noise levels expected at the nearest property boundary;
- O.A.C. 4906-4-08(A)(3)(c) - The location of any noise-sensitive areas within one mile of the facility;
- O.A.C. 4906-4-08(A)(3)(d)- A description of the equipment and procedures that will be used to mitigate the effects of noise emissions during construction and operation; and
- O.A.C. 4906-4-08(A)(3)(e) - Preparation of a preconstruction background noise study of the project area that includes measurements taken under both day and nighttime conditions; and
- O.A.C. 4906-4-09(F)(2) - Imposes a sound level standard of 5 dBA above nighttime ambient sound levels measured in the area, using the equivalent continuous sound level (L_{eq}) as the metric.

6. Please generally describe the process of preparing the Noise Report.

The first step was to establish the existing nighttime ambient sound level. Sound monitoring locations were selected to represent the unique soundscapes in the project area. In selecting locations, RSG considered land use, roads and railways, ground cover, and population density. Monitors were then deployed to collect ambient sound levels. The results were analyzed and used to describe the existing acoustical environment within the Project area. In addition, the data was processed and summarized to derive the nighttime ambient equivalent continuous sound levels (L_{eq}). This is used to establish the noise limit for the Project. Once the sound monitoring was complete, the Project sound propagation model was developed with current project and turbine information. The model was used to calculate operational project sound levels at each receptor location, as well as providing sound level contours. At each receptor location, compliance was evaluated relative to the Project sound level limit of 5 A-weighted decibel ("dBA") above the nighttime ambient equivalent continuous sound level. With all receptors determined to be in compliance with the Project sound level limit, the noise assessment report was prepared, which presents Project information, methodology, and results of the ambient sound monitoring and sound propagation modeling.

7. Why is it important to determine the pre-existing ambient sound levels of the Project area?

The Project noise impact must be evaluated based on the change to the existing ambient sound levels. To comply with O.A.C. 4906-4-09(F)(2) project sound level limits, the pre-existing ambient sound levels must be measured for comparison in the acoustical analysis.

8. Please describe the standards and methodology you followed when analyzing the pre-existing ambient sound levels in the Project area?

Background sound levels were measured at nine locations around the Project area. A map showing all nine locations is provided in Figure 2 of Exhibit G. Monitoring was conducted over two periods. The sound levels in the northern half of the project area (Monitors 1 through 5) were measured from March 14 to March 28, 2018, and sound levels in the southern half of the project area (Monitors 6 through 9) were measured from September 13 to September 27, 2018.

Sound levels at each location were measured using either a Cesva SC-310 or a Svantek SV979 sound level meter, which are both ANSI/IEC Type 1 instruments. All meters logged A-weighted and 1/3 octave band equivalent continuous sound levels once each second. The Cesva meters were attached to external audio recorders (Roland R-05), while the Svantek recorded audio internally to aid in source identification and soundscape characterization. All audio recordings were collected through the same microphone that collected sound level measurements.

Each sound level meter's microphone was mounted on a wooden stake at a height of approximately 1.5 meters (5 feet) and covered with a seven-inch diameter weather-resistant windscreen. Data was collected at one-second intervals, which was then compiled into 10-minute periods during post-processing. During this process, data collected during periods with high wind or rain were removed from the data set, along with sounds due to human or animal interaction with the equipment and seasonal sources in close proximity to the monitors.

Data post-processing focused on two sound level metrics: L_{eq} and 10^{th} percentile sound levels (L_{90}). The L_{90} is the sound level exceeded 90% of the time and gives information about the residual level of sound during quieter periods. It typically removes all transient sound sources, which may include sources that are intrinsic to the monitored locations. The L_{eq} is one of the most common ways of describing environmental sound levels. It measures the average sound energy present over a given period of time. The sound level standard in O.A.C. 4906-4-09(F)(2) specifies the use the L_{eq} in determining compliance. Even though the applicable standard specifies the L_{eq}, the L_{90} is also presented in the noise assessment to provide additional soundscape context including the range of sound levels at each monitoring location.

9. How did you select your monitoring locations?

Each location was selected as representative of a given landscape or soundscape experienced by sensitive receptors in and around the project area. Factors such as land use, road traffic, distance to roadways, population density, and distance to geographic features (rivers, relative elevation, ground cover, etc.) were considered in selecting the sound monitoring locations. Consideration was also given to accessibility in winter weather and to the security of the monitoring equipment. By selecting locations near residences and with varied activity levels, an accurate characterization of existing sound levels throughout the project area could be obtained. The characteristics that are represented at each monitor location that played a role in monitor location selection are listed in the Table below:

Monitor	Factors for Selection	Distance to Nearest Road
1	-Northern extent of the Project area. -Slightly over half a mile south of I80/I90. -Representative of sensitive receptors that are in the vicinity of I80/I90, such as those near the most northern proposed turbine locations (T24, T75, T27, T23, T28, T31, T33, etc.).	787 feet
2	-Rural residential area without a farming operation on the monitored parcel. -Setback from local road, comparable to setback distances for residences along local road. -Near a rail line (with a crossing slightly less than half a mile to the north), but not directly adjacent to the rail line. -Representative of residential areas on local roads near northeastern turbine locations (T14, T15, T17, T19, T20, etc.), but over 2 miles away from I80/I90.	203 feet
3	-Rural residential area in the northern portion of the project area without a farming operation on the monitored parcel, but next to an agricultural field. -Rail-line slightly under 1 mile to the north with the nearest crossing approximately 1.2 miles to the northeast. -Near a major collector road (525 feet south of Edison Highway) which has residences along it. -Adjacent to a local road which has residences along it. -Representative of residential areas on local roads but near a major collector road near northern turbine locations (T18, T21, T22, etc.)	328 feet
4	-Rural residential area near the middle of the project area adjacent to agricultural fields, but without a farming operation adjacent to the monitor. -On a local road with residences along it. -Near a minor arterial road (738 feet east of OH-4) which has residences along it. -Representative of residential areas on local roads but near a minor arterial road near turbine locations in the middle of the project area (T29, T32, T26, T75, etc.)	246 feet
5	-Rural residential area in the middle of the project area near a forested area as nearby residences are. -On a local road away from heavier traveled roads.	75 feet

Monitor	**Factors for Selection**	**Distance to Nearest Road**
	-Representative of residential areas on local roads away from more well-traveled roads near turbine locations in the middle of the project area (T42, T77, T44, T45, T76, etc.)	
6	-Farm residence near the southern portion of the project area.	154 feet
	-Along a minor arterial road as other residences within the project area are.	
	-Agricultural operation at the monitoring parcel similar to other farm residences throughout the project area.	
	-Representative of farm residences on a minor arterial road that runs through the project area.	
7	-Rural residence in the southern portion of the project area.	121 feet
	-Adjacent to a local road which has residences along it.	
	-Near agricultural fields similar to nearby residences, but without agricultural operations at the monitored parcel.	
	-Representative of rural residences on local roads away from more well-traveled roads near turbine locations in the southern project area (T54, T55, T58, etc.).	
8	-Rural residence in the southern portion of the project area.	131 feet
	-Adjacent to a local road which has residences along it.	
	-Near agricultural fields similar to nearby residences, but without agricultural operations at the monitored parcel. Parcels with larger sections of forest nearby.	
	-Representative of rural residences on local roads away from more well-traveled roads near turbine locations in the southern project area (T60, T62, T79, etc.)	
9	-Farm residence at the southern extent of the Project area.	197 feet
	-Along principal arterial road as are other residences in the area.	
	-Agricultural operation at the monitoring parcel similar to other farm residences throughout the project area.	
9 (cont…)	-Representative of farm residences on or near a principal arterial road near turbine locations at the southern end of the project area (T82 and T83).	

10. Did you follow any particular industry standards when you selected your monitoring locations?

The selection of the monitoring locations was based on best practices in the industry, professional judgment, and my experience evaluating sound levels within similar areas for this type of project. In addition, I followed relevant guidance in ANSI S12.9- 2005/Part 2 (Quantities and Procedures for Description and Measurement of Environmental Sound – Part 2: Measurement of long-term, wide area sound) and ANSI S12.9-2013/Part 3 (Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short-term Measurements with an Observer Present) as applicable. The purpose of the monitoring was to summarize long-term wide area sound, similar to the intent of ANSI S12.9 Part 2, but also to characterize sound sources, similar to the intent of ANSI S12.9 Part 3. The wide-area survey method used is similar to the "deterministic spatial sampling method" described in Section 5.1.1 in ANSI S12.9 Part 2. The methods used by RSG in this case are the same as those previously employed for other Ohio-based projects 17-2295-EL-BGN (Republic Wind), 13-197-EL-BGN (Northwest Ohio Wind), 13-1177-EL-BGN (Scioto Ridge Wind), and 10-2865-EL-BGN (Black Fork Wind).

11. What did you determine to be the average nighttime ambient sound level for the Project area?

Among all nine sites in the Project area, the average nighttime sound level is 44 dBA. The nighttime sound level limit for this Project is, therefore, 49 dBA L_{eq}.

12. In your opinion, is 44 dBA an accurate reflection of the ambient nighttime average sound level in the Project area?

Yes. It is based on sound monitoring under a variety of meteorological conditions at representative soundscapes in the Project area.

13. Did you perform an acoustical analysis regarding the potential noise impacts of the project during operation?

Yes. To determine the potential noise impacts from the proposed wind turbines, RSG performed sound propagation modeling.

14. Please describe the standards and methodology you used in your sound propagation modeling for this project?

RSG's sound propagation modeling was performed in accordance with the standard ISO9613-2, "Acoustics – attenuation of sound during propagation outdoors, Part 2: General Method of Calculation." ISO 9613-2 specifies an engineering methodology for calculating the attenuation of sound during propagation outdoors to predict the levels of environmental noise at a distance from a variety of sources. The modeling takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, barriers, and terrain. The acoustic modeling software we used was CadnaA, from Datakustik, GmbH. CadnaA is a widely accepted acoustical modeling propagation tool, used by many noise control professionals in the United States and internationally. CadnaA implements the ISO 9613-2 standard. Parameters used in RSG's sound propagation modeling are considered to provide accurate but conservative results for conditions where receptors are downwind of turbines, or equivalently, with a moderate nighttime inversion. The model assumes all wind turbines are producing their maximum sound emissions. Sound emissions information used for each turbine was the most recently available from the manufacturer. RSG's modeling approach has been accepted by the OPSB in prior cases and are commonly used in professional practice in the United States and abroad.

15. Please describe the different scenarios you considered when analyzing the proposed wind turbine models.

Sound propagation modeling for this Project was performed for the following wind turbine models:

- 87 Vestas V150, 4.2 MW with a hub height of 105 meters
- 87 Vestas V150, 5.6 MW with a hub height of 105 meters
- 87 Vestas V150, 5.6 MW with a hub height of 125 meters
- 87 Nordex N149, 4.8 MW1 with a hub height of 109 meters

[1] The Project was initially considering the Nordex N149, 4.5 MW turbine. In a memorandum, "Nordex N149 4.8 MW turbine proposed for the Emerson Creek Wind Farm", dated April 30, 2019, RSG discussed how switching to the 4.8 MW version from the 4.5 MW version would not influence the sound propagation model results.

- 87 Nordex N149, 4.8 MW1 with a hub height of 125 meters
- 87 Siemens Gamesa SG 4.5-145, 4.5 MW with a hub height of 107.5 meters
- 87 GE 3.0-140 3.0 MW with a hub height of 110 meters
- 22 GE 3.0-140 3.0 MW with a hub height of 110 meters and 65 GE 5.5-158 5.5 MW with a hub height of 107.5 meters
- Cumulative effect: 27 Republic Wind turbines (SG 4.5-145) within 3 miles of Emerson Creek, 31 Seneca Wind turbines (mixture of GE 2.5-127 and 2.3-116 turbines per the Seneca Wind permit application) within 3 miles of Emerson Creek, and 87 Emerson Creek turbines using Siemens Gamesa SG 4.5-145, 4.5 MW with a hub height of 107.5 meters.

Sound propagation modeling was performed for each of the proposed models at all 87 of the proposed turbine locations. Each model run also included the sound emissions from two transformers at the project substation. The transformers have a National Electrical Manufacturers Association ("NEMA") TR-1 sound pressure level of 82 dBA with no cooling (Oil Natural Air Natural "ONAN"), 84 dBA with stage 1 cooling, and 86 dBA with stage 2 cooling (Oil Natural Air Forced "ONAF"), but it is our understanding that Apex intends to specify from the transformer manufacturer that the transformers meet a sound specification of at least a 5 dB less than the NEMA TR-1 sound level. As such, the transformers were modeled as a sound pressure level of 81 dBA with stage 2 cooling.

16. Based on your initial modeling results, would any of the scenarios result in operational noise that exceeds 5 dBA over ambient for any non-participating landowners?

A summary of the sound propagation model results for each turbine model is provided in Table 4 of Exhibit G, and Appendix D of Exhibit G provides a list of the calculated overall sound pressure levels at each discrete receiver for all nine model runs and maps showing all receiver identification numbers for reference to the chart.

As shown in Tables 4 & 8 of Exhibit G, all non-participating sensitive receptors are projected at 48 dBA or less from all four model runs that include only the Emerson Creek turbines. That is less than the 49 dBA Board limit that is applicable to this Project.

The highest participating sensitive receptor is 54 dBA which is adjacent to the project substation. The modeled sound level at that receptor is due to the two project transformers during stage two cooling ("ONAF") which would involve cooling fans operating. The cooling fans typically operate periodically during the day when the ambient temperature is high (e.g. hot summer day). At night, the transformers would typically operate with natural convection cooling ("ONAN") which does not involve cooling fans. Under ONAN conditions the sound level at the closest participating receptor to the substation would be 49 dBA.

17. How would you describe the soundscape for the Project?

Generally, the soundscape of the Project area is one of a rural, working landscape with a few transportation corridors that pass through the area and run along portions of the perimeter. Sounds of agricultural, transportation, and residential land uses are common throughout the project area along with biogenic and geophonic sounds typical of rural Ohio. Background sound levels in the area are primarily driven by a combination of traffic conditions from roadways near and far and wind conditions. A sample of a variety of these conditions was gathered from across the Project area and is captured in the background

18. Has the World Health Organization ("WHO") issued environmental noise guidance for wind turbines regarding sound levels at residences?

The 2018 WHO Europe Environmental Noise Guidelines for the European Region (WHO 2018) contain a "conditional" recommendation of 45 dB L_{den} (annual average day-evening-night level) limit for wind turbines. A "conditional" recommendation as the WHO uses it, carries less strength than a "strong" recommendation. As the document states, "A strong recommendation can be adopted as policy in most situations." However, a conditional recommendation, "requires a policy-making process with substantial debate and involvement from various stakeholders." Moreover, there is less certainty of its efficacy owing to lower quality of evidence. Thus, there may be circumstances where WHO 2018 does not apply. WHO 2018 outlines the shortcomings of their work in Section 3.4.2.3, "Consideration of additional contextual factors." Among several shortcomings, Section

3.4.2.3 states that: 1) there is minimal evidence about the adverse health effect of long-term exposure to wind turbine noise; 2) other than annoyance, evidence of health effects from wind turbine noise is either absent or rated low or very low quality; 3) the recommendation for wind turbines remains conditional due to insufficient evidence to provide a strong, certain, and definitive recommendation; and 4) there are serious issues with noise exposure assessments relating to wind turbines found in the literature. Furthermore, the applicability of the guideline is questionable due to the use of the L_{den}.

The WHO 2018 report does not state any prediction methodologies for wind farms. In addition, it does not state how to measure an annual average L_{den} for wind turbines, and there are currently no standardized methods to do this. Assessing compliance with the L_{den} would require measurement of turbine-only sound levels during all times of day and during all meteorological and operational conditions. Due to the number of other sound sources at most wind turbine sites, this would be difficult, if not impossible. Compliance assessment for a project with the L_{den} as a regulatory limit would require a months-long, if not years-long, compliance measurement period. If the L_{den} metric had been demonstrated to be the best assessment of wind turbine noise impacts, then its use as a metric would be more justifiable. As is mentioned by the WHO, this has not been demonstrated. The primary reason for its use as the guideline metric is due to its inclusion in the European Noise Directive, and is not applicable in the U.S. In any event, WHO guidelines have not been adopted as noise standards by the OPSB in Ohio.

19. Have you reviewed the Stipulation that was filed in this docket on September 11, 2020?

Yes.

20. Is it your opinion that Condition 33 laid out in the Stipulation requires the Applicant to comply with O.A.C. Rule 4906-4-09(F)(2)?

Yes.

21. Are your opinions and conclusions in your testimony made with a reasonable degree of scientific certainty?

Yes.

22. Does this conclude your testimony?

Yes. However, I reserve the right to update this testimony to respond to any further testimony, reports, and/or evidence submitted in this case.

CERTIFICATE OF SERVICE

The Ohio Power Siting Board's e-filing system will electronically serve notice of the filing of this document on the parties referenced in the service list of the docket card who have electronically subscribed to these cases. In addition, the undersigned certifies that a copy of the foregoing document is also being served upon the persons below this 11th day of September, 2020.

/s/ Christine M.T. Pirik
Christine M.T. Pirik (0029759)

Counsel/Intervenors via email:

werner.margard@ohioattorneygeneral.gov
brett.kravitz@ohioattorneygeneral.gov
katherine.walker@ohioattorneygeneral.gov
norwichtwp1339@gmail.com
richardwiles@willard-oh.com
rstrickler@huroncountyohprosecutor.com
jstephens@huroncountyohprosecutor.com
ggross@eriecounty.oh.gov
heather@hnattys.com
jvankley@vankleywalker.com
pjleppla@leplaw.com
michael.gerrard@arnoldporter.com
hwa2108@columbia.edu
missyeb3@gmail.com
baanc@aol.com
r_ladd@frontier.com

Administrative Law Judges via email:

jay.agranoff@puco.ohio.gov
michael.williams@puco.ohio.gov

Attachment ED-1

Resume

the science of insight

EDDIE DUNCAN, INCE BD. CERT.

Director

Eddie Duncan conducts noise assessments for a wide range of public and private organizations and develops solutions to mitigate noise impacts. He is involved in all aspects of environmental noise and architectural acoustics projects including measurement, analysis, modeling, design, testimony, policy development, stakeholder discussions, and project management. Eddie has over a decade of experience in computer modeling and monitoring of environmental noise and has conducted noise analyses for projects from many different industries, some of which include transportation, mining, renewable energy, power transmission, parks and tourism, commercial developments, and residential developments.

EXPERIENCE

17 years

EDUCATION

MS, Environmental Studies, Green Mountain College (2013)

BS, Engineering Science, Rensselaer Polytechnic Institute (2003)

PROJECT EXPERIENCE

Velco, Vermont. Consulted on a number of Velco substation projects throughout the state, some of which include the Y-25 Interconnect Project, the Southern Loop Project, the East Avenue Loop Project, and the Northwest Reliability Project, among others. Most projects include pre-construction monitoring according to IEEE protocols, modeling of projected sound emissions, proposing mitigation as necessary and post-construction monitoring. (2004 – Current)

Green Mountain Power, Vermont. Provided sound monitoring and modeling services on a number of Green Mountain Power projects throughout the state including substation projects and power production projects. (2008 – Current)

Blazing Star Wind Farm & Blazing Star Wind Farm 2, Minnesota. Developed a noise study protocol in compliance with the Minnesota Department of Commerce's "Guidance for Large Wind Energy Conversion Systems Noise Study Protocol and Report." Conducted two noise assessments (one for each project), each of which included pre-construction background sound level monitoring, data analysis, sound propagation modeling, and assessment of compliance with local and Minnesota standards. Received positive feedback from the State regarding the clarity, completeness, and understandability of our reports. Provided on-going support during the turbine micro-siting process. Preparing for post-construction compliance monitoring. (2016-Current)

Crocker Wind Farm, South Dakota. Conducted a noise assessment for a ~200 turbine, ~400 MW wind power project in South Dakota. The assessment included pre-construction background sound level monitoring, data analysis, sound propagation

Eddie.Duncan@rsginc.com

modeling, and assessment of compliance with the State recommended limits. Provided expert testimony before the South Dakota Public Utility Commission. (2016-2018)

Northwest Ohio Wind Project, Ohio. Managed the noise assessment of the Northwest Ohio Wind Project in Paulding County, Ohio. Conducted pre-construction background sound level monitoring throughout the project area and developed a sound propagation model to project future sound levels from the project. Provided project siting and mitigation support as needed including the development of a noise reduced operation (NRO) plan. Provided a report summarizing the applicable noise limits and the monitoring and modeling results. (2013, 2015-2017)

Weymouth Natural Gas Compressor Station, Massachusetts. Reviewed the state air permit application with regard to noise impacts and the FERC Environmental Assessment for a natural gas compressor station. Evaluated noise portions of the material including ambient sound level monitoring, proposed mitigation, and sound modeling results of the proposed natural gas compressor station and advised the Town of Weymouth on the applicant's completeness, accuracy, and adherence to standard practice with regards to their noise analyses. (2016-2017)

Addison Rutland Natural Gas Project, Vermont Gas, Vermont. Managed a pre-construction sound monitoring program for ARNGP Phase 1 gate stations. Conducted long-term background sound level monitoring at three gate station sites, analyzed the data, and provided a report documenting the existing conditions at the site. The data will be used for comparison with post-construction sound levels. (2015)

Kingdom Community Wind, Lowell, Vermont. Measured pre-construction background sound levels at several locations around the proposed site. Conducted sound propagation modeling for several different turbine layout and model options. Provided mitigation and siting recommendations as necessary. Provided a report summarizing the applicable noise standard, recommended mitigation, and projected sound levels from the proposed project. Managed and conducted an extensive post-construction monitoring program and provided testimony before Vermont's Public Service Board. (2010 - 2015)

Massachusetts Research Study on Wind Turbine Acoustics, Massachusetts. Managed the data collection for a comprehensive study on the generation and propagation of sound from wind turbines. Overall, the study evaluated sound at five sites, with an average of five monitoring locations per site. Long-term measurements were made over a two-week period and short-term attended monitoring was conducted at each site. The study will help the State of Massachusetts Clean Energy Center and Department of Environmental Protection improve the regulation of wind turbines in the State and includes factors such as infrasound, amplitude modulation, sound levels, and sound propagation modeling. (2013 - 2014)

Arnold Brothers Solar Project, Rehoboth, Massachusetts. Conducted sound propagation modeling of noise emissions from transformers and inverters to project sound levels throughout a community from a 3.3 MW solar power project. (2014)

Combined Heat & Power Hospital Project, Vermont. Modeled sound levels from a proposed gas turbine and reciprocating engine for a combined heat and power (CHP) project at a hospital. Assessed potential noise impacts of the project by comparing model results with historical background sound level data in a nearby community and client noise threshold goals. Provided maps showing sound level propagation throughout the community. Proposed noise mitigation for both CHP options to meet client goals. (2011)

Black Fork Wind Farm, Richland & Crawford County, Ohio. Conducted pre-construction monitoring of background sound levels throughout a proposed wind power project site with an area of approximately 100 square miles. Correlated background sound levels with wind speed. Modeled projected sound levels from the proposed 200 MW project. Provided mitigation and siting recommendations as necessary. Provided a report summarizing the applicable noise limit precedents, recommended mitigation, and projected sound levels from the proposed project. (2011)

PUBLICATIONS

Duncan, E., Kaliski, K., Old, I., and Lozupone, D., Methods for Assessing Background Sound Levels during Post-Construction Compliance Monitoring within a Community, Proceedings of the 6th International Meeting on Wind Turbine Noise 2015.

Kaliski, K, and Duncan, D. “The Challenges of Modeling Percentile Sound Levels from Mining and Other Environmental Noise,” National Council of Acoustical Consultants Newsletter, Fall 2015

Kaliski, K., Duncan, E., et al, The Massachusetts Research Study on Wind Turbine Acoustics – Methods and Goals, Proceedings of the 2014 Institute of Noise Control Engineers NOISE-CON 2014.

Duncan, E., Using Public Input to Develop Scientifically Sound Noise Pollution Policy for Vermont’s Rural Land Uses and Communities, MSES Thesis, Green Mountain College, October 2013.

Duncan, E., Using Public Input to Develop Scientifically Sound Noise Pollution Policy for Vermont’s Rural Land Uses and Communities: Methodology and Initial Results, Proceedings of the 2013 Institute of Noise Control Engineers NOISE-CON 2013.

Duncan, E., Sustainable Noise Pollution Policy, Proceedings of the 2012 Institute of Noise Control Engineers INTER-NOISE 2012.

Duncan, E., Protecting Wildlife from Noise Impacts: A Review of Legislation and Legal Precedents in New England and by the Federal Government, Proceedings of the 2012 Institute of Noise Control Engineers INTER-NOISE 2012.

Kaliski, K., Duncan, E., Wilson, K., and Vecherin, S., Improving Predictions of Wind Turbine Noise using PE Modeling, Proceedings of the 2011 Institute of Noise Control Engineers NOISE-CON 2011.

Duncan, E., and Kaliski, K., A Case Study in Cooperation: A Gravel Pit and Its Community, Proceedings of the 2010 Institute of Noise Control Engineers NOISE-CON 2010.

Kaliski, K., and Duncan, E., Calculating Annualized Sound Levels for a Wind Farm, Proceedings of Meetings on Acoustics (POMA), Vol. 9-159th Meeting of the Acoustical Society of America/NOISE-CON 2010.

Kaliski, K., and Duncan, E., “Propagation Modeling Parameters for Wind Power Projects,” Sound & Vibration Magazine, Vol. 42 No. 12, December 2008.

Kaliski, K., and Duncan, E., Propagation Modeling Parameters for Wind Turbines, Proceedings of the 2007 Institute of Noise Control Engineers NOISECON 2007.

Kaliski, K., Duncan, E., and Cowan, J, "Community and Regional Noise Mapping in the United States," Sound & Vibration Magazine, Vol. 41 No. 9, September 2007.

Duncan, E., Kaliski, K., Collier, R., and Maher, M., Design of a Small Reverberation Room for Use in ANR and Other Testing, Proceedings of the 2006 Institute of Noise Control Engineers INTER-NOISE 2006.

PRESENTATIONS

Duncan, E., Understanding Noise Complaints from Relatively Low-Noise Utility Projects, Energy, Utility & Environment Conference 2016 (EUEC 2016), February 2016.

Duncan, E., Noise from Wind Power Projects: Assessment, Regulation, & Management, Renewable Energy 2014 (RE 2014), October 2014.

Duncan, E., Using Public Input to Develop Scientifically Sound Noise Pollution Policy for Vermont's Rural Land Uses and Communities: Methodology and Initial Results, Public Outreach Workshop on Noise in Communities & Natural Areas, Denver, Colorado, August 2013.

Duncan, E., Philosophical Viewpoints on Noise from Wind Power Projects, 161st Meeting of the Acoustical Society of America, May 2011

Kaliski, K., et al., Modeling Hikers' Exposure to Transportation Noise in National Parks and Wilderness, 161st Meeting of the Acoustical Society of America, May 2011

Old, I., Eros, E., and Duncan, E., Wind Turbine Noise Ordinances: A Review of Selected State and Local Regulations, 161st Meeting of the Acoustical Society of America, May 2011

Duncan, E., and Kaliski, K., Improving Sound Propagation Modeling for Wind Power Projects, Joint Meeting of the Acoustical Society of America (ASA) and the European Acoustics Association (EAA) Acoustics'08.

Duncan, E., and Kaliski, K., Design and Construction of a Small Sound Testing Room in an Office Building, 4th Joint Meeting of the Acoustical Society of American and the Acoustical Society of Japan, November 2006.

LICENSES, CERTIFICATIONS, MEMBERSHIPS, AND AFFILIATIONS

- Institute of Noise Control Engineering
  - Board Certified, 2009-Current
- Acoustical Society of America
  - Member of the Technical Committee on Architectural Acoustics, 2007-2018
  - Co-Chair of Technical Session: Wind Turbine Noise, 161st Meeting of the Acoustical Society of America, May 2010
  - Co-Chair of Structured Session: NS05 – Noise from Wind Power Projects, Acoustics '08