Baron Winds Project

Case No. 15-F-0122

1001.19 Exhibit 19

Noise and Vibration

TABLE OF CONTENTS

EXHIBIT 19 NOISE AND VIBRATION

This exhibit includes a detailed analysis of the potential sound impacts associated with the construction and operation of the Facility. In order to assess the potential sound impacts, a Preconstruction Noise Impact Assessment (PNIA) for the construction and operation of the Facility was prepared by Kenneth Kaliski, PE, QEP, INCE Bd Cert. and Isaac Old of RSG Inc. (RSG). The PNIA is attached as Appendix Z to this Application. Mr. Kaliski is Board Certified through the Institute of Noise Control Engineering of the USA and has over 25 years' experience in noise modeling and monitoring, including modeling and monitoring wind farms. Kenneth Kaliski is one of the leading acoustical engineers in the area of wind turbine acoustics, working with both industry and state regulators. He has performed sound modeling for numerous wind farms and is the author and co-author of articles, conference papers, and research studies on sound modeling and the sound characteristics of wind turbines. The modeling performed by RSG for the Facility is sufficiently conservative in predicting sound impacts and is based on the turbine with the highest sound power levels presented in the Article 10 Application.

The Facility has been designed so that no Sensitive Sound Receptors, as defined below, will exceed 45 dBA $L_{8\ hr}$, and no participating receptors will exceed 55 dBA $L_{8\ hr}$. These proposed regulatory limits minimize and mitigate any adverse impacts associated with the sound produced by the construction and operation of the Facility, and are consistent with World Health Organization (WHO) and WHO Europe guidelines to address sleep disturbance and health effects, respectively. Other Project Design Goals and suggested regulatory limits are described further below.

(a) Sensitive Sound Receptor Map

A map of the Noise Impact Study Area showing the location of Sensitive Sound Receptors and participating receptors within 1 mile of any proposed turbine location in relation to the Facility is provided in Figure 19-1. Sensitive Sound Receptors are defined as non-participating residences, including non-participating seasonal cabins or residences identified by property tax codes (e.g., 260 seasonal residences) at the time of the filing of the Application and seasonal residences with septic systems/running water, hospitals, care centers, schools, libraries, places of worship, public areas and public facilities. Sensitive Sound Receptors included 1,482 non-participating residences, of which 19 are cabins, one is a church, 1,291 are full-time or seasonal residences, and 171 are of unknown usage. In addition, 45 participating receptors were modeled along with 10 property line locations. A desktop analysis using aerial imagery and field verification was used to develop and classify Sensitive Sound Receptors. If access for field verification was not possible and aerial imagery could not provide an obvious classification of a structure (i.e. residential vs. non-residential) then the structure was assumed to be a Sensitive Sound Receptor (i.e. non-participating residence).

(b) Ambient Pre-Construction Baseline Noise Conditions

Ambient Noise Monitoring Locations

On behalf of the Applicant, RSG completed winter (leaf off) and summer (leaf on) background sound level monitoring at seven representative locations within the Noise Impact Study Area. Monitoring sites were chosen to capture a variety of existing soundscapes. Criteria characterizing potential soundscapes of the area were developed and sites that were diversified amongst these criteria were selected for monitoring. The various representative areas include rural residential, active farm, small town, low and high traffic roads, high truck traffic, recreational areas, and remote areas.

Each of the seven locations are described below. See Figure 5 and Table 9 of the PNIA for locations of the monitoring sites. Photographs of the setup monitors are also included in the PNIA.

- Monitor 1: Brasted Road – This monitor was installed at 8332 Connor Hill Road in Avoca, near the intersection of Saxton Road and Country Road 70. It was located near an active dairy operation. The monitoring location is representative of a rural residential landscape surrounded by an active farm on a local (low traffic) road. The monitor was installed near the fence dividing the lot containing a house and dairy barn from an adjacent pasture.

- Monitor 2: Rex/Dye Road – This monitor was installed near 3101 Rex Road in Cohocton, in a wooded area approximately 157 feet from the road near an open field. The monitoring location is representative of a location adjacent to low traffic roads with commercial truck traffic.

- Monitor3: Haskinville Road – This monitor was installed at 8731 Haskinville Road, Cohocton, approximately 328 feet from Haskinville Road and about 492 feet from the intersection of State Route 21, Haskinville Road and County Road 55. The monitor was located near several residences in one of the more densely populated areas of the Facility Site, representing a small town setting. The monitor was placed under an apple tree on the northside of a church parking lot. An anemometer was co-located with the microphone.

- Monitor 4: Henkle Hollow – This monitor was installed at 3323 Henkle Hollow Road in Cohocton, approximately 239 feet from Henkle Hollow Road and 95 feet from a residence. The monitoring location is representative of a rural residential property with an active farm in a low traffic area. The monitor was placed toward the top of a hill behind a residence.

- **Monitor 5: Loon Lake** – This monitor was installed at 9487 State Route 21 in Wayland, near the intersection of State Route 21 and Chapel Road. The monitor was located approximately 131 feet from State Route 21 and 259 feet from Chapel Road. The monitoring location is representative of a recreational area near a high traffic road. The monitor was placed in an isolated clump of cedar trees with a clear view of the surrounding valley. An anemometer, temperature gauge, and rain gauge were also included in the installation.

- **Monitor 6: Rose Road** – This monitor was installed near 7731 Rose Road in Hornell, approximately 558 feet across a cornfield from Rose Road and 266 feet uphill through the woods form Tuttle Road. The monitoring location is representative of a rural residential property with an active farm in a low traffic area. The monitor was placed in the woods. An anemometer was co-located with the microphone.

- **Monitor 7: Walter Kurtz Road** – This monitor was installed near 2287 Walter Kurtz Road in Wayland, approximately 328 feet from a seasonal road. This monitoring location is representative of a remote area near a low traffic road. The monitor was placed in the woods. An anemometer was co-located with the microphone.

Ambient Sound Level Monitoring

Background sound level monitoring was performed at these seven locations in the winter (leaf-off) of 2015 (February 24 through March 12, 2015) and the summer (leaf-on) of 2015 (July 15 through July 31, 2015). Monitoring was interrupted between March 3 and March 4, 2015 while batteries were changed and data was downloaded. Sound level data were collected using Cesva SC310, Larson David LD831, and Svantek 979 ANSI (American National Standards Institute)/IEC (International Electrotechnical Commission) Type I sound level meters, in accordance with standards ANSI S1.4-1983, "Specifications for Sound Level Meters" and IEC 61672-1 (2002-05), "Electroacoustics – Sound Level Meters – Part 1: Specifications". The sound level meter performance specifications including noise floor and temperature and relative humidity range for the three meters used are described in Figure 6 of the PNIA. Each sound level meter's microphone was mounted on a wooden stake at a height of approximately 4 feet and protected by an ACO-Pacific hydrophobic seven-inch diameter windscreen. Before and after measurement periods, sound level meters were calibrated with Cesva CB-5 or Larson Davis CAL200, or Brüel and Kjær 4231 calibrators. The sound level meter frequency response and settings are included Table 8 of the PNIA and certificates of calibration are included in Appendix H of the PNIA.

The meters continuously logged overall and one-third-octave band sound pressure levels once each second. Audio signals from each microphone were recorded continuously throughout the monitoring period to allow for sound source identification. The Cesva SC310 and Larson Davis LD831 sound level meters were connected to Roland R-05 or R-09HR digital sound recorders. The Svantek 979 meter recorded digital audio internally. Over 4,000 hours of sound level data were collected during this study.

Sound level data from each monitor were averaged into sequential 10-minute periods and summarized over the entire monitoring period. Data were excluded from averaging under the following conditions: precipitation in the form of rain, sleet, or ice, thunderstorm events, wind gust speeds above 11 miles per hour, temperatures reaching below zero degrees Fahrenheit (ºF), intermittent noise not characteristic of the area, seasonal sound sources, and during microphone calibration. Periods that were not excluded from averaging are referred to in the PNIA and in this Exhibit as “valid periods.”

Particularly during summer monitoring, biogenic sounds, including insects, frogs, and birds, were present. These are considered “seasonal” sounds. To exclude these sounds, the “ANS” frequency-weighting network was applied to all logged summer data to which tonal bird, amphibian, or insect sound were found. That is, if tones[1] above 1.25 kHz were detected, then the A-weighted sound level was recalculated by summing one-third octave bands from 20 Hz to 1.25 kHz. This effectively removes the high-frequency portion of the sound.

Meteorological stations were co-located with selected monitors in the field. Wind speeds were logged at four of the seven monitoring locations (Haskinville Road, Loon Lake, Rose Road, and Walter Kurtz Road), while air temperature and precipitation were logged at one of the locations (Loon Lake). Wind data are presented as the maximum gust speed occurring at any time during each 10-minute interval - they are not averaged. All other meteorological data were logged every minute. Wind speed and temperature recorded at each site during the monitoring period are presented in Section 6.0 of the PNIA.

Because wind speed data were collected at only four out of the seven sites, wind data from some sites are applied to others nearby. The four northernmost locations had two sites measuring wind speed between them. Henkle Hollow data is shown with the other northern monitor (excluding Loon Lake) as the other monitors were also at higher

[1] Sounds considered tonal that get the Ai weight applied are those for which a prominent discrete high frequency (>1.25 kHz) tone is found using either of the two methods:

1. If a one-third octave band exceeds the neighboring one-third octave band on either side by more than 5 dB (as in ANSI S12.9 Part 3 Annex B), or
2. If a one-third octave band exceeds the average of the two neighboring lower and two neighboring upper one-third octave bands on each side by more than 5 dB, the latter method is used to capture complex bird harmonic sounds that would not be considered tonal under the first method.

elevations. For the three sites in the south, the agricultural site (Brasted Road) was the only site without an anemometer. The wind gusts at the Haskinville site were typically stronger than those at Rose Road. Therefore, Haskinville wind data is shown for the agricultural site (Brasted Road), since it was in the middle of open fields. The rain and temperature gauges at Loon Lake were used to eliminate rain events and temperatures outside of equipment thresholds in the determination of valid monitoring periods.

Temperatures ranged from a low of -17 ºF to a high of 49 ºF during winter monitoring and from 42 ºF to 94 ºF during summer monitoring. Winds varied widely among the four ground anemometer sites and throughout monitoring periods, ranging from calm to a maximum 1-minute average of 9 meters per second (m/s) (20 miles per hour [mph]). Maximum measured wind and gust speeds from all sites are shown in Tables 13 and 14 of the PNIA.

Baseline Noise Monitoring Results

Baseline noise data were analyzed and are reproduced in the PNIA in both temporal and spectral formats. Results were presented in three different ways, described in the bullets below. A discussion of the format of the results is provided here and a summary of the results is presented below, graphics and plots are contained in the PNIA.

- Time history graphics – for each location, results are presented as graphs of sound level, temperature, and maximum wind gust speed as a function of time throughout the monitoring period. Each point on the graph represents data summarized for a single 10-minute interval. Equivalent continuous sound levels (L_{eq}) are the energy-average level over 10 minutes. 10th-percentile sound levels (L_{90}) are the statistical value above which 90% of the sound levels occurred during 10 minutes. The data from periods which were excluded from processing are included in the graphs but shown in lighter colors. The bands at the bottom of the graph indicate that data were excluded in the particular 10-minute period; the color designates the reason that data were excluded. Wind speed data came from the four anemometers (five in the summer) which were paired with monitoring locations as discussed above. Wind data are presented as the maximum gust speed occurring at any time during the 10-minute interval; they are not averaged.

- One-third octave band summaries – Plots of overall unweighted spectral levels for all valid periods are provided for each monitoring site. Each point on the plot represents the statistical level of the respective one-third octave band for the specified period. Four sets of L_{eq}s, L_{50}s, or L_{90}s are presented in each plot: day and night for winter and summer monitoring periods.

- Tonal prominence of one-third octave bands was quantified for all valid periods for each monitor in each season. Tonality is defined by S12.9-2005 (R2013) Part 4 – Annex C which sets a frequency dependent quantity, K_T, to indicate if a one-third octave band is tonal or not. A particular one-third octave band is considered tonal if it exceeds the level of the adjacent one-third octave by the prescribed limit. The tonality limits, K_T, are shown below in Table 19-1. Every second of monitor data was analyzed for tonality, which is expressed as seconds of tonality per 10-minute period (up to 600 seconds).

Table 19-1. Limits for One-Third Octave Band Tonality Designation

One-Third Octave Bands	Tonality Limit (K_T)
25 to 125 Hz	15 dB
160 to 400 Hz	8 dB
500 Hz to 10 kHz	5 dB

A summary of ambient noise monitoring results at each of the monitoring sites in the winter and summer is provided, see the PNIA for full detail regarding these results.

- Monitor 1: Brasted Road – Winter background sound levels at the Brasted Road monitoring location were dominated by farm activities, aircraft overflights, dogs barking and wind. Higher sound levels during the day were caused by farming activity, which consisted of tractor operation and dairy barn equipment operation. Because farm operations would sometimes continue into night, daytime and nighttime statistical sound levels were close. When those sources were not present, the nighttime L_{90} was relatively low. Tonal analysis of winter sound monitoring data showed there was no consistent tonal sound source. The relatively infrequent tonality source in the 31.5 Hz one-third octave band was due to farm equipment. There was a mid-frequency "hump" (between 100 Hz and 1 kHz) in the winter sound levels due to increased wind or changes in the way the ground reflects sound (because of the different sound absorption properties of snow cover than grass or dried types of ground cover). Figures 9 through 12 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Brasted Road.

  The summer soundscape was controlled by the same factors as those in the winter as well as vehicle passbys. The site had a particularly high number of intermittent, loud sound sources but low sound levels overall. Birds and insect activities appeared as a higher incidence of tonality in the 5 kHz and 8 kHz octave bands. Periodic operation of farm equipment resulted in tonality in the 25 Hz, 31.5 Hz, and 250 Hz one-third octave band. The dominant difference between summer and winter sound levels is the increase in mid-to-high frequency sound caused by high frequency sound sources such as leaf rustle, birds and insects. Figures 14 through 17 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Brasted Road

Figures 18 through 20 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

- Monitor 2: Rex/Dye Road – Winter background sound levels at this site were dominated primarily by wind blowing through nearby trees. Brief periods of high sound levels were a result of large trucks climbing Dye road. Frequent jet aircraft flyovers at cruising altitude and occasional propeller driven aircrafts at lower altitudes were also recorded. The remote location of the monitoring site resulted in a lack of consistent tonality. The relatively infrequent tonal events were caused by local vehicle traffic and bird calls. Figures 23 through 26 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Dye Road.

  The summer soundscape was similar to winter with occasional large increases in sound level caused by local traffic and the occasional airplane flyover. Other sound sources recorded were wind blowing through nearby trees, and bird calls. Sound levels resulting from wind blowing through the trees were more dominant at this site than any other. Similar to winter, there was minimal tonality due to anthropogenic sources. Tonality from birds and insects was primarily in the 5kHz and 6.3 kHz one-third octave band. Tonality, caused by nearby birds, in the 1.25 kHz and 1.6 kHz octave band occurred less frequently. The sound level spectra for day and night are similar, as are the spectra for winter and summer. The biggest difference between summer and winter is due to higher winds or sound attenuation caused by snow and the increase of biogenic sounds in the summer. Figures 28 through 31 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Dye Road.

  Figures 32 through 34 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

- Monitor 3: Haskinville Road – Winter background sound level recordings at this site show a diurnal pattern that extended slightly beyond typical daytime hours due to vehicle passbys from 5 am to midnight. The recordings also indicated frequent aircraft traffic. There were no major tonal sound sources at this location during the winter. Figures 37 through 40 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Haskinville Road.

  The summer soundscape shows a similar diurnal pattern as winter as well as nearby building construction and yard work. Recordings of birds and insects were also present. Tonality from birds and insects in the summer was common in the higher frequency range from 2.5 kHz to 8 kHz one-third octave bands. Less frequent tonality in the 500 Hz and 160 Hz one-third octave band were recorded from dogs barking and machinery operation, respectively. Due to the traffic on State Highway 21, there is an increase in sound levels between approximately 400 Hz and 2 kHz in the summer. As at other sites, there is a mid-frequency "hump" caused by the change in sound absorption for winter snow cover or an increase in wind and an increase in high frequency sound levels from insects and birds. Figures 42 through 45 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Haskinville Road.

Figures 46 through 48 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

- Monitor 4: Henkle Hollow – Winter background sound level recordings at this site included a significant amount of activity from vehicle traffic and car doors opening and closing due to the location directly above the driveway of a residence. Additional recordings included a tractor operating throughout the property and snowmobiles. Although the time history showed a diurnal pattern of anthropogenic activity, much of the noise was attributed to seldom calm wind blowing through the trees. Tonality in the 1.25 kHz one-third octave band was attributed to birds. Figures 51 through 54 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Henkle Hollow.

  Similar to winter, the background sound levels during summer monitoring did not exhibit a purely diurnal pattern. The sources included wind through trees, tractor operations, airplane overflights, truck traffic on the interstate and a household window air condition unit. Traffic noise from the interstate could be heard during the quieter times in the morning. As found at other sites, major tonal sources were from birds and insects at higher levels of tonal incidence in the 5 kHz, 6.3 kHz, and 8 kHz one-third octave bands. Overall, the winter spectra have higher sound levels in mid frequency range and the summer spectra have a higher overall sound levels in the upper frequency range. There were tones in both summer spectra due to insects or amphibians at 5 kHz and 8 kHz. Figures 56 through 59 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Henkle Hollow.

  Figures 60 through 62 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

- Monitor 5: Loon Lake – Winter background sound levels at Loon Lake included large contributions from car, truck and snowmobiles passbys. These transient sound levels contributed to the large difference between the L_{eq} and L_{90}. The data showed regular daytime patterns, an indication of anthropogenic influence in the area. Figures 65 through 68 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Loon Lake.

The summer monitoring period showed the dominant sound source was from traffic passbys on Route 21. The increased volume of traffic during the day created at diurnal pattern. Steady tonal sources were minimal at this site. Daytime sound levels were between 400 Hz and 2 kHz due to the increase in traffic. There was however, minimal high frequency sounds form birds and insects in the summertime and minimal mid frequency sound levels increasing during the winter. The increase in sound levels to 63 Hz during summer days was like due to truck engine noise. Figures 70 through 72 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Loon Lake.

Figures 73 through 75 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

- Monitor 6: Rose Road – Winter background sound levels at this site were predominately from Tuttle Road below as there was no activity in the nearby cornfield in the winter season. The residential sounds recorded from below included engines, residential construction and a chainsaw. Other sources of sounds included distant snowmobiles, trucks on the interstate, aircraft overflights, wind through the trees and songbirds. Human activities contributed to a day time pattern at this site. As at other sites, there is a winter mid-frequency hump that is not present during the summer. Figures 78 through 81 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Rose Road.

  The summer background sound levels at Rose Road were predominately from wind-caused leaf rustle. Daytime sound patterns were primarily from anthropogenic sources such as operations from the dairy barn, including daily tractor work and milk pumps. Although the patterns were recorded in the winter, these patterns were at a lower level due to the attenuation caused by snow cover on the ground. No cornfield operations took place during the monitoring period. Activities from residents below were dominant at the monitor. A resident below worked on a motorcycle during the day and night. These activities were retained in the data as being "characteristic of the area". Tonality for the summer monitoring period shows a variety of human related sources at 500 Hz or below as well as bird and insect sources above 1 kHz. Higher frequency sound levels at this site are higher in the summer due to increases in bird and insect sounds. Figures 83 through 86 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Rose Road.

Figures 87 through 89 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

- **Monitor 7: Walter Kurtz Road** – This site was located on a seasonal road. Because it was not plowed in the winter there was very little traffic-related noise at the site in the winter. Besides occasional sound from snowmobiles there was little anthropogenic recordings during the winter monitoring period. The predominant recorded patterns were wind blowing through the trees, songbirds, and aircraft flyover. Bird activity caused a slight increase in sound levels at dawn and dusk. This monitoring site was the quietest of all the sites with almost equal day and night sound levels due to the lack of human activity. Figures 92 through 95 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the winter monitoring at Walter Kurtz Road.

  The summer background sound levels included more anthropogenic sources such as large vehicle and motorcycle or ATV passbys. The dominant source of sound at the site was from wind blowing through the leaves in the trees. Airplane overflights were also consistent during the monitoring period. Much of the tonal activity was from bird and insects in 2.5 to 8 kHz one-third octave bands. There was a greater difference between the daytime and nighttime low frequency spectra during the summer than winter. This was likely due to vehicle traffic on the seasonal road. As with other sites, there was an increase in high frequency biogenic sound in the summer and mid-frequency sound level in the winter. Figures 97 through 100 of the PNIA show the time history 10-minute L_{eq}, 10-minute L_{90}, and tonality results from the summer monitoring at Walter Kurtz Road. Figures 101 through 103 of the PNIA show the one-third octave band median (L_{50}), lower 10th-percentile (L_{90}), and equivalent average (L_{eq}) sound levels by season and time of day for the monitor.

The ANS-weighted sound levels measured at each monitor location for each monitoring period are summarized below for the winter season and summer season in Tables 19-2, and 19-3 respectively. The ANS-weighted sound levels remove seasonal effects. A-weighted sound levels are presented in Table 12 of the PNIA and are higher than ANS-weighted levels because they add in seasonal sound sources like frogs, insects, and birds. During the winter, the equivalent continuous sound levels (L_{eq}) at night were less than (or equal to) those measured during the daytime, which is typical. Due to the lack of anthropogenic sounds, the daytime and nighttime levels at Walter Kurtz Road were similar. The large differences between the L_{eq} and L_{90} indicate that the soundscapes at all the sites are dominated by transient or intermittent sounds (such as aircraft flyovers or nearby traffic). The winter nighttime L_{eq} averaged over all seven sites was 39 dBA.

During the summer, sound levels are typically higher than winter primarily because of the addition of foliage, water flow, and yard/farm equipment. The main exception is Rose Road, where anthropogenic sound sources were decreased during the summer, leading to lower overall sound levels. The Brasted Road monitoring location has higher sound levels during the winter at night, due to equipment operation at the nearby dairy operation. There is a wide spread between the L_{90} and L_{10} sound levels at all locations, indicating dominance by transient and intermittent sounds. The summer nighttime L_{eq} over all seven sites was 39 dBA.

Table 19-2. ANS-Weighted Sound Pressure Levels at Preconstruction Monitoring Locations, Winter

Location	Average Sound Pressure Level (dBA)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Brasted Road	44	19	29	41	45	22	31	42	44	17	26	39
Rex/Dye Road	35	19	27	36	35	20	27	35	35	17	25	38
Haskinville Road	39	22	33	43	40	25	35	44	37	20	28	40
Henkle Hollow	39	22	29	41	39	23	30	42	37	22	28	39
Loon Lake	47	24	36	50	48	27	39	52	43	21	31	46
Rose Road	35	20	27	38	36	21	28	39	32	19	25	35
Walter Kurtz Road	32	18	26	34	32	19	26	33	32	17	25	36
Season Average	41	21	31	44	42	23	33	45	39	19	27	41

Table 19-3. ANS-Weighted Sound Pressure Levels at Preconstruction Monitoring Locations, Summer

Location	Average Sound Pressure Level (dBA)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Brasted Road	47	19	27	43	49	23	32	47	37	16	22	31
Rex/Dye Road	38	23	29	40	40	25	31	42	32	21	27	35
Haskinville Road	42	21	35	46	44	28	39	47	39	19	26	43
Henkle Hollow	36	25	31	39	38	26	33	40	33	23	29	36
Loon Lake	50	26	38	53	51	33	42	54	46	24	30	47
Rose Road	35	24	30	37	36	25	31	38	32	23	28	34
Walter Kurtz Road	40	23	32	43	41	25	34	45	35	20	29	39
Season Average	44	23	33	46	46	28	37	48	39	22	28	41

Table 19-4 below summarizes the combined monitoring period, in which statistical averages were calculated for the entire data set, including summer and winter data. Overall, most sites exhibited highly variable sound levels, with intermittent sounds dominating the L_{eq}. There was no case where a single, constant source dominated the soundscape. The overall nighttime L_{eq} averaged over all seven sites was 39 dBA.

The divergence of overall equivalent continuous levels, 90th-percentile (L_{10}) and 10th-percentile levels (L_{90}) at the monitoring locations indicates that the soundscapes were dominated by transient or intermittent sounds (such as aircraft overflights or passing automobiles). Statistical nighttime and daytime levels were similar at Walter Kurtz Road due to the lack of anthropogenic sounds. The Brasted Road monitoring station had higher sound levels at nighttime because of dairy operation nearby. Sound levels were typically higher in the summer than winter. The main exception was Rose Road because anthropogenic sources were decreased, leading to lower overall sound levels.

Measured sound levels were widely distributed, depending on the proximity to human activity and industry. Anthropogenic (human-caused) sounds were prominent in daytime sound levels at six of the seven monitoring locations. The seventh monitoring location (Walter Kurtz Road) was located on a seasonal road in a sparsely populated and wooded area, where biogenic and meteorological sources dominated the overall sound levels, although occasional aircraft, vehicle pass bys, and other human activities were observed. The overall equivalent average (L_{eq}) sound levels ranged from 36 to 47 dBA during the day and 32 to 45 dBA during the night, including both summer and winter monitoring results. The L_{90} sound levels, which are sound levels exceeded 90 percent of the time, ranged from 22 to 39 dBA during the day and 17 to 39 dBA at night. The L_{10} sound levels, which are sound levels exceeded 10 percent of the time, ranged from 37 to 53 dBA during the day and 26 to 46 dBA during the night. Facility-wide logarithmic averages of the overall levels calculated at each monitoring location are given in the bottom row of Table 19-4.

Table 19-4. ANS-Weighted Sound Pressure Levels at Preconstruction Monitoring Locations, Overall (Winter and Summer)

Location	Average Sound Pressure Level (dBA)											
	Overall				Day				Night			
	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}	L_{eq}	L_{90}	L_{50}	L_{10}
Brasted Road	46	19	28	42	47	22	31	45	41	17	24	35
Rex/Dye Road	37	21	28	38	38	22	29	39	34	20	27	36
Haskinville Road	42	21	34	45	43	27	37	37	42	39	19	26
Henkle Hollow	38	23	30	40	39	24	32	41	35	22	29	37
Loon Lake	48	25	37	51	49	29	40	53	45	22	30	46
Rose Road	35	22	29	37	36	23	30	38	32	20	27	35
Walter Kurtz Road	38	20	29	41	39	22	30	42	34	19	27	38
Average	43	22	32	45	44	25	35	46	39	20	27	41

Comparison of Sound Levels to Windspeed

The 10-meter wind speed is the wind speed as it was measured at the Facility's Sand Hill meteorological tower at 40- and 60-meter heights, and extrapolated down to a 10-meter height. The sound pressure levels of both L_{90} and L_{eq}

were plotted against 10-meter wind speed to determine whether there is a correlation between wind speed and ambient sound level. Wind speeds below 3 meters per second were excluded because the proposed wind turbines would not be operational at wind speeds lower than 3 meters per second. The analysis plotted the median sound pressure level, as well as the middle 80th percentile of sound pressure level against 10-meter wind speed. In addition, the PNIA includes a comparison between the hub height wind speed compared to the 10-minute sound level (L_{eq} and L_{90}) for each individual 10-minute period. A linear regression is shown for the comparison, with the equation for the best-fit line and coefficient of determination (R^2) to indicate the quality of relationship between 10-meter wind speed and monitored sound levels. For both L_{eq} and L_{90} metrics, there was weak positive correlation between sound pressure level and wind speed, and this became stronger as wind speeds increased. The coefficient of determination for the L_{eq} ranged from 0.0056 to 0.2659 and for L_{90} ranged from 0.0247 to 0.3984. While there is a correlation between sound level and hub height wind speed, there is still considerable variability in sound level at a given wind speed. This indicates that wind speed is not the sole determinant of the background sound level.

Temporal Accuracy

Temporal accuracy of the monitoring data was analyzed according to ANSI S12.9 Part 2. The standard analyzes the representativeness of the measurement data for a particular measurement location. This is accomplished through calculating the day-night average sound level (L_{dn}) for each day within the monitoring period and then determining the 95th percentile confidence interval for the data series. These confidence intervals are categorized into three classes. Class “A” is for precision measurements, with Class “B” and Class “C” being less precise. Normality of the data set is then calculated using a Kolmogorov-Smirnov test. As required in the Stipulation, the PNIA applied the methodology to the L_{90} and L_{eq} metrics.

Analysis results are shown below in Table 19-5 for L_{eq} and 19-6 for L_{90}. All except on site achieved Class “A” status required for precision measurements, and all sites fit the criteria for normality. The site that did not meet Class “A” precision is the Walter Kurtz site. This site is more isolated, with minimal influence from anthropogenic sound sources such as cars or agricultural equipment. As a result, the daily-to-day sound levels are more variable. The more remote sites in the project area, such as Brasted Road, Rex/Dye Road, and Walter Kurtz Road, have higher standard deviations than those near major roads (Haskinville Road or Loon Lake). This is because road traffic is the dominant soundscape at these sites. At more rural sites, there is less likely to be dominant sound sources that provide a consistent day-to-day sound level. Instead the sound source level is led by sound sources such as dogs, farming activity, birds, insects, and weather patterns that may be inconsistent.

The ANSI 12.9 Part 2 method is primarily intended for areas with major sound sources such as military installations, airports, roadways, and railways and is not specifically developed for rural sites.

Table 19-5. Monitoring Temporal Accuracy (ANSI 12.9 Part 2) – Based on Daily L_{eq} Sound Levels

	Brasted Road	Rex/Dye Road	Haskinville Road	Henkle Hollow	Loon Lake	Rose Road	Walter Kurtz Road
Number of Samples	33	32	29	33	25	31	32
Upper Confidence Interval (dB)	1.6	1.5	0.7	1.2	1.0	1.0	2.1
Lower Confidence Interval (dB)	1.4	1.4	0.7	1.1	1.0	0.9	1.8
Measurement Class	A	A	A	A	A	A	B
Normality	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 19-6. Monitoring Temporal Accuracy (ANSI 12.9 Part 2) – Based on Daily L_{90} Sound Levels

	Brasted Road	Rex/Dye Road	Haskinville Road	Henkle Hollow	Loon Lake	Rose Road	Walter Kurtz Road
Number of Samples	33	32	29	33	25	31	32
Upper Confidence Interval (dB)	1.5	1.6	1.5	1.6	1.4	1.7	2.7
Lower Confidence Interval (dB)	1.4	1.4	1.3	1.4	1.3	1.5	2.2
Measurement Class	B	A	A	A	A	A	B
Normality	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(c) Future Noise Levels at Receptors During Facility Construction

Construction of wind power projects requires the operation of heavy equipment and construction vehicles for various activities including construction of access roads, excavation and pouring of foundations, the installation of buried and above ground electrical interconnects, and the erection of turbine components. Construction of the turbines will take place primarily on remote ridgelines and in the middle of farm fields throughout the Facility Site, generally away from residences. Any work done on roads and utilities could be close to sound receptors, but this work will be conducted for only a short duration.

Noise resulting from construction was modeled with the ISO 9613-2 environmental noise prediction methodology, as implemented in Datakustik's CadnaA sound propagation modeling software package. Construction sound propagation modeling was conducted at proposed Turbine 40, which is the turbine that has a non-participating receptor that most closely matches the Applicant's internal setback requirement of 1,500 feet (428 meters). Noise was also modeled at the area surrounding the northern and southern laydown yards and concrete batch plants. The closest non-participating receptor to the northern batch plant is approximately 460 feet (140 meters) and the nearest non-participating receptor to the southern batch plant is approximately 710 feet (216 meters).

Table 19-7 shows the modeled A-weighted sound power level generated by equipment that will be used in construction at wind turbine sites and at the two laydown area/concrete batch plant sites, as well as sound pressure levels at the closest non-participating receptor from the turbine site or laydown area. Maps showing sound pressure level contours around these four sites are included in Figures 160 through 163 of the PNIA.

Table 19-7. Modeled Maximum Sound Pressure Levels for Construction

Equipment	Modeled Sound Power (dBA)	Sound Pressure level at Closest Non-Participating Receptor from T40 (dBA)	Sound Pressure Level at Closest Non-Participating Receptor from Northern Laydown Yard/Batch Plant (dBA)	Sound Pressure Level at Closest Non-Participating Receptor from Southern Laydown Yard/Batch Plant (dBA)
Turbine Construction Site				
Bulldozer	117	46	-	-
Backhoe	112	41	-	-
Concrete Truck	113	42	-	-
Chipper	131	60	-	-
Heavy Truck	115	40	-	-
Medium Truck	110	36	-	-
2250 S3 Lift Crane	110	39	-	-
M250 Auxiliary Crane	114	44	-	-
Excavator	115	45	-	-
Pneumatic Drill	132	55	-	-
Truck Being Loaded with Rock	118	48	-	-
Total – Site Clearing	131	60	-	-
Total – Turbine Erection	117	46	-	-
Total – Foundation	119	49	-	-
Total - Excavation	132	58	-	-
Laydown Area/Concrete Batch Plant				
Cement Blower	115	-	61	57
Cement Blower Truck	101	-	47	43
Concrete Truck - Mixing	113	-	60	56
Backup Alarm	109	-	55	52
Heavy Truck	115	-	60	56

The results of the modeling are shown as maximum 1-second L_{eq} with all pieces of equipment operating. Under actual operations, not all pieces of equipment will be operating simultaneously and the emitting the highest sound levels.

The highest 1-second L_{eq} at a non-participating receptor near T40 was 62 dBA with all sources operating, and 60 dBA during the clearing phase. The "all sources" scenarios will not happen in practice, since sources from different construction phases will not operate simultaneously. The highest sound level at a non-participating receptor is 66 dBA near the northern laydown area/batch plant and 62 dBA near the southern laydown area/batch plant.

Construction is proposed to take place from April to October at turbine sites. Major construction work, such as clearing for the access roads, will be conducted during the hours as permitted by the local laws. In addition, certain work, like tower section and blade erection could extend into the night, depending on conditions.

Construction at each turbine site will take approximately 60 days, not including turbine erection. Due to the setbacks involved and the limited duration of the activities, construction noise should create minimal adverse impacts. The potential for structural damage due to vibration during construction is minimized, as no blasting is proposed.

Each turbine location will require deliveries from approximately 40 concrete trucks, 20 gravel trucks, three trucks carrying the blades, four trucks carrying tower sections, a truck each for the tower and nacelle, and a truck for each crane. This results in a total of approximately 138 truck trips, for a total of 276 passbys at each turbine location, occurring over a 60-day period. According to Federal Highway Administration (FHWA) categorization, 240 of these passbys would be with "medium" trucks and 36 would be with "heavy" trucks. Assuming an L_{Afmax} metric, a passby distance of 50 feet, and a speed of 50 miles per hour with the truck accelerating, the passby sound pressure level for "medium" trucks is 80 dBA, and 84 dBA for "heavy" trucks.

(d) Estimated Sound Levels to be Produced by Operation of the Facility

Discussion of Selected Modeling Methodologies

Sound propagation modeling was conducted under two methodologies: ISO 9613-2 and CONCAWE. A discussion of selection of these methods is provided here, in accordance with Stipulation 19(d). Specific methodologies, ground absorption values, and assumptions of these modeling methods are described under the headings below.

In the United States ISO 9613-2 is the most common methodology used for sound propagation modeling, particularly for wind turbine noise. To RSG's knowledge, the only other algorithm used in the United States is CONCAWE, but only in conjunction with ISO 9613-2 for special cases of modeling annualized sound levels under varying meteorological conditions.

CONCAWE was originally developed for the petroleum energy industry in Europe. Characteristics of the model that are unique are the ability to predict sound levels for particular wind speeds and atmospheric stability classes. The CONCAWE meteorological adjustments, used with ISO 9613-2, was used for the Kingdom Community wind project, in Lowell, Vermont during permitting. In that case, one of the residences most exposed to wind turbine sound was modeled to have an annualized equivalent sound level of 40 dBA. Post-construction measurements of the same project and at the same location were conducted for seven seasons, for a minimum of two weeks per season. The turbine-only sound level averaged over all seasons was measured to be 35 dBA. That is, the model over-predicted annual average sound levels by about 5 dB. This indicates that the modeling, performed for the project, in a similar manner as described above, is conservative.

Other algorithms that have been used in wind turbine noise modeling include Nord2000, Harmonoise, and NZS 6808-1998. Both Nord 2000 and NZS 6808-1998 are the approved method for specific countries (Nordic countries for Nord 2000 and New Zealand and Australia for NZS 6808-1998). NZS 6808-1998 is a simplified method that assumes hemispherical sound propagation as uses the air absorption method from ISO 9613-2. Nord2000, Harmonoise, and CONCAWE have refinements that include the ability to calculate sound levels under varying meteorological condition. Harmonoise was developed with the aim of becoming the standard algorithm for noise predictions in Europe; although this never occurred. The algorithm is available as an open source code and is implemented in several noise prediction software packages. Harmonoise allows modeling of various meteorological conditions, beyond the capabilities of ISO 9613-2, along with more sophisticated methods of handling shielding and ground effects. The use of this model for wind turbine noise has been limited, with few studies validating its accuracy.

Sound Propagation Modeling – ISO 9613-2

Modeling of noise levels for operation of the Facility was in accordance with the standard ISO 9613-2, *Acoustics – Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation*. Originally developed to predict outdoor sound propagation for well-developed moderate ground-based temperature inversions or, equivalently, downwind propagation, which commonly occurs at night, was used assuming the least attenuation due to temperature (10 degrees Celsius [ºC], 50 ºF) and humidity (70% relative humidity).

The model takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain. The acoustical modeling software used here was CadnaA, from Datakustik GmbH. ISO 9613-2 assumes downwind sound propagation between every source and every receiver, consequently, all wind directions, including the prevailing wind directions, are taken into account.

Model input parameters are listed in Appendix B of the PNIA. Seventy-six turbine locations were modeled with the Vestas V136 3.6 MW turbine sound power data. This turbine was selected to model because the Applicant is committing to select a turbine model that can achieve a manufacturer maximum apparent sound power level of 105.5 dBA or less in order to minimize sound impacts. The Study Area was modeled with mixed ground (G=0.5) and a 2 dB additional uncertainty factor added to the turbine sound power. Foliage was not modeled. These model parameters have been shown to yield conservative results for noise impacts from wind turbines, though the level of conservativeness depends on several factors including: turbine layout, meteorology, receiver height, and topography (Duncan and Kaliski, 2008; Bowdler et al., 2009; Evans and Cooper, 2012). Turbines were modeled at the manufacturer's maximum apparent sound power level, except that the low-frequency octave bands were replaced by the highest octave band sound power of any turbine considered for the Facility. All turbine data used is the most recently available from the manufacturer at the time the PNIA was prepared. Results calculated with these parameters represent the highest 1-hour equivalent average sound level that will be emitted by the Facility.

These parameters are most conservative for flat terrain and least conservative, but still conservative, for concave terrain. To assess the concavity of the terrain around the Facility, we evaluated the mean propagation height for any non-participating receptor with a maximum one-hour L_{eq} of 43.5 dBA or greater. Concave terrain was reported when the mean propagation height exceeds $1.5(|h_s – h_r|/2)$, where h_s is the turbine height above ground (82 meters) and h_r is the receptor height above ground (4 meters). The result of the analysis showed that no receptor, with a modeled sound level of 43.5 dBA or greater, had concave terrain between the receptor and closest source. The remaining terrain could be considered flat for modeling purposes.

The transformer sound power was determined using the manufacturer's design sound pressure level of 81 dBA (measured according to IEEE C57.12), along with the dimensions and spectrum of a similar sized transformer measured elsewhere by RSG.

Unmitigated Results

One-hour equivalent average (L_{1h}) sound power level contours resulting from operation of the Facility are shown in Table 31 of the PNIA. In this case, the highest sound level at a Sensitive Sound Receptor is 52 dBA, between 4 and 8 dB above the Town limits. Sound levels at the modeled property lines range from 47 to 52 dBA.

Mitigated Results

Mitigation was achieved through use of noise reduced operations (NROs) or shutdowns on appropriate turbines. Mitigated short-term sound propagation modeling results are shown in Figures 139 to 150 of the PNIA. Sound propagation modeling results at each individual receptor are shown in Appendix C of the PNIA. Sound levels are at or below 43.9 dBA L_{1h} at all non-participating residences in the Town of Cohocton and at or below 45 dBA L_{1h} everywhere else, indicating compliance with all Town limits.

Table 18 of the PNIA shows low-frequency sound propagation modeling results for the worst-case nonparticipating receptor. Results are less than or equal to ANSI S12.9 Part 4 Annex D and ANSI S12.2 Section 6 criteria in the 31.5 Hz and 63 Hz full octave bands. The 65 dB threshold is exceeded in the 16 Hz full octave band by up to 1.5 dB. Note that the 16 Hz octave band data is extrapolated based upon measurements at other wind power projects and this extrapolation is based on the 31.5 Hz and 63 Hz bands of the worst-case turbine considered for this project. If low-frequency data were used for the Vestas V136 3.6 MW, there would not be an exceedance. In other words, there is only an exceedance of the low frequency design goal if both the worst-case low-frequency and A-weighted sound powers are modeled simultaneously, which is an infeasible result.

Modeling included extrapolated infrasonic emissions at the worst-case non-participating receptor based on the slope of low-frequency and infrasonic sound level data for the Vestas V136 3.6 MW turbine for the 16 and 8 Hz full octave bands, as well as the measured slope of infrasound from wind turbines in other research studies. Results show sound levels, ranging from 20 to 80 dB below infrasonic hearing thresholds.

Annualized Modeling Using Hourly Meteorological Adjustments - CONCAWE

As described below in 19(g), WHO, in its *Guidelines for Community Noise* (1999), recommended 45 dBA averaged over an eight-hour night and a 60 dBA maximum, measured outside the bedroom window, to protect against sleep disturbance. In October 2009, the World Health Organization for Europe updated the 1999 review of the scientific literature, and found a no-adverse-effect noise level of 40 dB $L_{night,outside}$, which is the A-weighted annual average nighttime sound level.

The sound propagation modeling methodology described above under the heading *Sound Propagation Modeling* calculates the maximum one-hour sound level for the proposed Facility, based on a worst-case meteorology of a moderate nighttime inversion, or equivalently, winds blowing from each source to each receptor. In reality, only one wind direction occurs at a time, and winds are not such that they are always generating the highest sound output from the turbines. As a result, the eight-hour, and annual average nighttime, L_{50}, and even L_{10} sound levels will tend to be less than the maximum one-hour L_{eq}.

To model the maximum eight-hour, and seasonal and annual average nighttime, L_{50}, and L_{10} sound level, sound resulting from the Facility was modeled under a procedure that uses 8,760 hours (1 year) of hourly wind speed, wind direction, and temperature data collected from the existing Facility meteorological tower as well as cloud cover and relative humidity data from the closest National Weather Service station, the Dansville Municipal Airport, to model sound propagation under meteorological conditions that exist at the Facility Site (data from the meteorological tower will be submitted under confidential cover pursuant to 16 NYCRR Section 6-1.4). In this method, atmospheric stability was calculated based on wind speed, cloud cover, daytime/nighttime, and ceiling height, in accordance with USEPA's *Onsite Meteorological Program Guidance for Regulatory Modeling Applications*. A sound propagation model was run for 64 different combinations of wind speed, wind direction, and atmospheric stability, using the CadnaA model and meteorological adjustments from CONCAWE's *The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighboring Communities*, as implemented in CadnaA. A raw unadjusted sound level was obtained for each receptor for each hour by matching each hour's wind speed, wind direction, and stability class to those used in the model runs. The model was calibrated for each receptor such that the maximum hourly sound level was the same as that run using ISO 9613-2. After calibration, the calculations were repeated. The hourly sound level at each receptor was adjusted to account for the different sound power by hub height wind speed using the manufacturer sound curves. No sound will be generated below cut-in and above cut-out wind speeds. The sound power assumed in the model is adjusted based on a randomized normal distribution between -2 dB and +2 dB, such that during every hour, a randomly assigned value is added to the result. The randomly selected number is held constant for each hour at each receptor. Because the uncertainty is added after the calibration, the methodology gives a higher one-hour maximum sound level than the L_{1h} modeling. Therefore, the results from this section are only valid for comparing to averaging periods equal to or greater than eight hours. The results include 8,524 hours of sound levels for each receptor (236 hours are invalid due to missing met tower data most likely due to icing and/or maintenance downtime). From these, annual statistics are calculated, including the maximum nighttime sound level, $L_{night, outside}$, and daytime and nighttime L_{10} and L_{50} by season and over the year. Please see Section 9.6 of the PNIA for additional information on annual sound propagation modeling using meteorological adjustments.

Results

Results from annualized modeling using hourly meteorological adjustments from site-specific weather data are provided in Appendix C of the PNIA, which show ambient and predicted noise levels modeled for all Sensitive Sound receptors in the Noise Impact Study Area. Under all circumstances and for all Sensitive Sound Receptors, the modeling results show that WHO (1999), Town of Wayland, and WHO Europe (2009) guidelines are met. This methodology gives a higher one-hour maximum sound level than the unadjusted method from the previous section because this method uses more conservative assumptions.

Cumulative Impact Modeling

Prior to cumulative impact modeling, RSG performed a screening assessment to determine if other wind projects, specifically Cohocton/Dutch Hill and Howard wind projects would contribute to the sound levels at the receptors. To start the screening assessment, 10-minute L_{90} sound levels for the closest monitors to the Cohocton/Dutch Hill and Howard were collected. Henkle Hollow (Monitor 4) was closest to the Cohocton turbines located north of the Facility, Dye Road (Monitor 2) was closes to Cohocton turbines near the middle of the Facility, and Rose Road (Monitor 6) was closes to the Howard turbines. The 10-minute L_{90} sound levels for the remaining locations were used as background. The data were screened to include only periods when background contamination would be limited and remaining background sound levels were arithmetically averaged for each 10-minute period. The average background sound levels were logarithmically subtracted from the cumulative impact locations to obtain a "Howard-only" or "Cohocton-only" sound level for each 10-minute period. These sound levels were collated into the maximum 8-hour L_{eq} and overall average L_{eq}. These levels were then compared to the 45 dBA L_{8h} and 40 dBA $L_{night, outside}$ design goals. If the arithmetic difference was greater than 10 dB, the wind project was included for interactive modeling for that time period. Based on the results of the screening analysis, Cohocton North and Cohocton Middle wind projects would need to be included in a cumulative impact analysis for L_{8h}. The screening analysis is described in greater detail in Section 9.5 of the PNIA.

With the Cohocton/Dutch Hill projects added into sound propagation modeling, sound levels increase around portions of the Cohocton/Dutch hill Wind Farm project area, primarily around the three Cohocton turbines located near the collector substation. Figures 152 and 153 of the PNIA show a map of the cumulative sound levels. Near the three southwestern Cohocton/Dutch Hill turbines of the Facility Area some receptors to exceed 45 dBA L_{1h}, but all are mainly influenced by the Cohocton wind turbines. Results of the cumulative impact are provided in Table 20 of the PNIA.

(e) Future Noise Levels at Receptors During Facility Operation

This section of the Article 10 Application will provide the following:

1. Future Noise Levels During Operation

Future noise levels during Facility operation have been calculated using the methodology described above in 19(d) under the heading *Sound Propagation Modeling – ISO 9613-2*. Table 32 of Appendix C provides unweighted full octave band sound levels at all sensitive sound receptors. Appendix B of the PNIA also includes ISO 9613-2 mitigated and unmitigated sound levels produced by Facility components (Table 28), and measured at the discrete receptors (Table 31). Appendix C of the PNIA includes A-weighted ambient and future sound levels for a variety of conditions at all Sensitive Sound Receptors (Tables 33 and 34).

2. Tonal Evaluation

Aerodynamic noise is the primary source of noise associated with wind turbines. These acoustic emissions can be either tonal or broadband. Tonal noise occurs at discrete frequencies, whereas broadband noise is distributed with little peaking across the frequency spectrum. Criteria for tonal noise at different one-third octave bands are defined in ANSI 12.9-2013 Part 4 (see Table 19-1, above in 19(b)). A particular one-third octave band is considered tonal if it exceeds the level of the two adjacent one-third octaves by the prescribed limit.

While unusual, tonal noise can originate from unstable air flows over holes, slits, or blunt trailing edges on blades. Most modern wind turbines, including the Vestas V136 3.6 MW turbine modeled in this study, have upwind rotors designed to prevent blade impulsive noise and reduce tonal noise.

Tonal prominence of the Vestas V136 3.6 MW turbine does not meet the ANSI 12.9 Part 4 criteria in any one-third octave band. Therefore, tonal noise associated with the operating wind turbines is not anticipated. The transformer meets the criteria for the Fans Off (ONAN) conditions, but not the Fans On (ONAF) condition. Since the particular model for the transformer has not been chosen, the tonal prominence of the transformer that will be used is not known. Transformers are usually tonal in the 125 Hz, 250 Hz, 315 Hz, 500 Hz, or 630 Hz one-third octave bands during the ONAN condition, but not the ONAF condition due to masking from the cooling fans. The higher sound power of the ONAF configuration was modeled as a conservative assumption. Please see Section 9.2 of the PNIA for additional information.

3. Turbine Model Selection and Avoidance/Minimization Measures

As described above in 19(d), sound propagation modeling assumed the wind turbines built for the Facility would be the Vestas V136 3.6 MW turbine, which is the loudest turbine model currently proposed. Although the turbine model has not yet been selected for the Facility, the model ultimately chosen will not have sound power levels greater than the V136 3.6 MW, and could have sound power levels less than this model.

A discussion on the Applicant's avoidance and minimization of sound impacts is provided below in 19(j).

4. Potential for Low Frequency and Infrasound

“Infrasound” is sound pressure fluctuations at frequencies below about 20 Hz. Sound below this frequency is only perceptible at relatively high magnitudes. “Low frequency sound” is in the nominal audible range of human hearing, that is, above 20 Hz, but below 100 to 200 Hz depending on the definition.

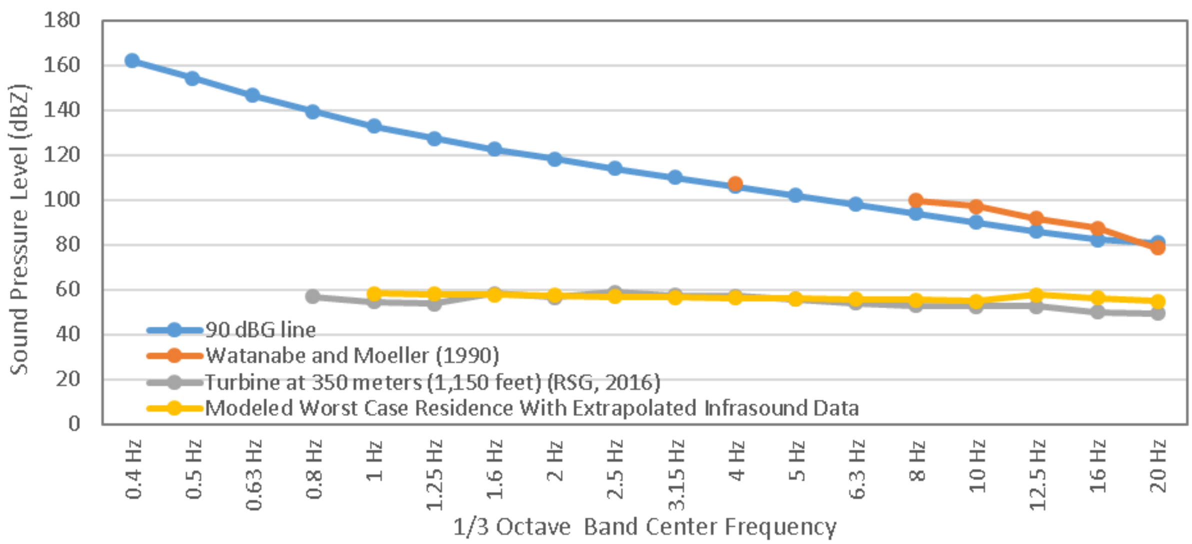
Low frequency aerodynamic tonal noise is typically associated with downwind rotors on horizontal axis wind turbines. In this configuration, the rotor plane is behind the tower relative to the oncoming wind. As the turbine blades rotate, each blade crosses behind the tower’s aerodynamic wake and experiences brief load fluctuations. This causes short, low-frequency pulses or thumping sounds called blade impulse noise. Large modern wind turbines are “upwind”, where the rotor plane is upwind of the tower. As a result, this type of low frequency noise is at a much lower magnitude with upwind turbines than downwind turbines, well below established infrasonic hearing thresholds. A full review of the literature regarding wind turbines and perception of infrasound is provided in Section 3.5 of the PNIA, and is also reproduced below in 19(k)(3)(i). The review shows that wind turbine sound is often perceived as more intrusive than other environmental sound sources. This is due to the amplitude modulated character of the sound, tonal content, and low frequency content. Although wind turbines produce infrasound, it has been found to be below human hearing thresholds at receiver distances, and there is no conclusive proof that sub-audible infrasound is perceptible and can cause adverse health impacts.

While infrasound from wind farms has not been shown to be perceptible by humans, infrasound and low-frequency sound can create noise-induced vibration in lightweight structures. The American National Standards Institute (ANSI) standard ANSI S12.2, “Criteria for Evaluating Room Noise”, establishes low frequency noise criteria to prevent “perceptible vibration and rattles in lightweight wall and ceiling structures.” ANSI S12.9 Part 4 addresses the annoyance of sounds with strong low-frequency content; Annex D of this standard establishes a standard for minimal annoyance. Sound power levels at 16 Hz, 31.5 Hz, and 63 Hz for criteria under these two standards is provided below in Table 19-8, in comparison to extrapolated infrasonic and modeled low frequency levels predicted at the worst case non-participating receptor. The 16 Hz full octave band was extrapolated from the 31.5 Hz results assuming a slope of -4 dB per octave. The modeling results show that exterior infrasound from the Facility will exceed the interior threshold to produce moderately perceptible building vibrations under ANSI 12.2-2008 by up to 1 dB at the closest non-participating receptors in the 16 Hz full octave band. This is assuming low frequency and infrasound data for the worst-case turbine considered for this Facility applied to inside sound attenuation at this frequency. Taking into consideration an outside to inside attenuation of 3 dB at the 16 Hz octave band, the interior infrasound threshold of ANSI S12.2-2008 would not be exceeded.

Table 19-8. Low Frequency Noise Compared with ANSI 12.2 and ANSI 12.9 Standards

Full Octave Band Center Frequency	16 Hz	31.5 Hz	63 Hz
Modeled Worst Case Non-Participating Residence Sound Level	66 dB	64 dB	60 dB
Low Frequency Guidelines			
Clearly perceptible vibration and rattles likely (ANSI 12.2-2008 Section 6)	*75 dB*	*75 dB*	*80 dB*
Moderately perceptible vibration and rattle likely (ANSI 12.2-2008 Section 6)	*65 dB*	*65 dB*	*70 dB*
Sound Level Below Which Annoyance is Minimal (ANSI 12.9 Part 4 Annex D)	*65 dB*	*65 dB*	*65 dB*

Figure 151 of the PNIA, reproduced below as Graph 19-1 of this Exhibit, shows extrapolated modeling results from the worst case non-participating receptor. The data are based on the slope of low frequency and infrasonic sound level data for the Vestas V136 3.6 MW turbine for the 16 and 8 Hz full octave bands, as well as the measured slope of infrasound from wind turbines. Results show sound levels, ranging from 20 to 80 dB below infrasonic hearing thresholds.



Graph 19-1. Extrapolated Infrasonic Emissions for Baron Winds Project Compared with Measured Data and Infrasonic Hearing Thresholds

5. Basis of Sound Power Levels Used

Modeled sound power levels of wind turbines corresponded to the manufacturer's maximum apparent sound power level of 105.5 dBA, with an additional 2 dB uncertainty factor (resulting in a modeled sound power level of 107.5). All turbine noise data used was the most recently available from the manufacturer at the time the PNIA was prepared. As described above in 19(d), some turbines were modeled with NROs that would be applied in order to achieve Facility design goals. Sound power levels modeled at these turbines was up to 7.5 dBA lower than sound power levels modeled without NROs.

The transformer sound power was determined using the manufacturer's design sound level of 81 dBA (measured according to IEEE C57.12), along with the dimensions and spectrum of a similar sized transformer measured elsewhere by RSG.

6. Amplitude Modulation

Amplitude modulation (AM) is a fluctuation in sound level that occurs at the blade passage frequency. At lower magnitudes, this modulation is called "blade swish," which is a standard characteristic of wind turbine noise. There is no consistent definition how much of a sound level fluctuation is necessary for blade swish to be considered AM, however sound level fluctuations in A-weighted sound level have been found at up to 10 dB. Fluctuations in individual one-third octave bands are typically more and can exceed 15 dB, although unusual. Fluctuations in individual one-third octave bands can sometimes synchronize and desynchronize over periods, leading to increases and decreases in magnitude of the A-weighted fluctuations. Similarly, in wind farms with multiple turbines, fluctuations can synchronize and desynchronize, leading to variations in AM depth (McCunney et al., 2014). Most AM is in the mid-frequencies and most overall A-weighted AM is less than 4.5 dB in depth (RSG et al., 2016).

There are many confirmed and hypothesized causes of AM including: blade passage in front of the tower, blade tip sound emission directivity, wind shear, inflow turbulence, and turbine blade yaw error. It has recently been noted that although wind shear can contribute to the extent of AM, wind shear does not contribute to the existence of AM in and of itself. Instead, there needs to be detachment of airflow from the blades for wind shear to contribute to AM (Renewable UK, 2013). While factors like the blade passing in front of the tower are intrinsic to wind turbine design, other factors vary with turbine design, local meteorology, topography, and turbine layout. Mountainous areas, for example, are more likely to have turbulent airflow, less likely to have high wind shear, and less likely to have turbine layouts that allow for blade passage synchronization for multiple turbines. AM extent varies with the relative location of a receptor to the turbine. AM is usually experienced most when the receptor is between 45 and 60 degrees from the downwind or upwind position and is experienced least directly with the receptor directly upwind or downwind of the turbines.

To determine turbulence intensity conditions present at the site, RSG analyzed one year of meteorological data taken from Sand Hill, at the Facility Site. The wind speed at two anemometer heights (40 meters and 60 meters) and wind speed standard deviation were used to calculate the turbulence intensity present at the site. Turbulence intensity is the ratio of wind speed standard deviation to the wind speed at a given measurement height. Results of the analysis showed that turbulence intensity is higher during the day than at night. Figure 154 of the PNIA show the turbulence intensity by hour at the Facility Site. Turbulence intensity levels were not higher than levels measured by RSG at other proposed wind energy projects.

Wind shear was also evaluated based on one year of meteorological data from Sand Hill, at the Facility Site. Wind shear was determined by using the equations found in Annex D of IEC 61400-11. The equation is included in Section 10.0 of the PNIA. The analysis showed that wind shear is generally higher overnight and particularly in the early morning, when the atmosphere is more stable, than it is during the day. In addition, wind shear is highly variable at this site at night. Wind shear is highest at the cut-in speed for the turbines, (i.e., when sound emissions will be lowest), and decreases with wind speed. A comparison of turbulence intensity and wind shear for the same periods showed that periods of particularly high wind shear and particularly high turbulence intensity do not occur at the same time. The stable atmosphere required for high wind shear should not also be turbulent.

In summary, the Facility Site does not have higher turbulence intensity, but does have higher wind shear than other projects RSG has worked on, mostly located on ridge tops. Figure 156 of the PNIA shows the wind shear as measured at Sand Hill tower by hour and Figure 157 shows the wind shear by hub height wind speed. However, it is important to note that that most periods with high wind shear do not also simultaneously have high turbulence intensity. As mentioned above, wind shear alone can exacerbate amplitude modulation, but it is not sufficient to cause amplitude modulation, so high wind shear has to be coincident with high turbulence intensity to cause high levels of amplitude modulation, an uncommon condition at the Facility Site (see Figure 158 of the PNIA).

(f) Predicted Sound Levels Table

The predicted sound levels based on ambient noise monitoring and sound propagation modeling are included in Appendix C of the PNIA. Table 33 of the PNIA provides modeling results for periods were rotors are not spinning due to low wind speeds. Table 34 shows the annualized modeling results with low wind periods excluded. Graphical format sound contours are depicted in 1 dB increments for representative external property boundaries in Figures 139 through 150 of the PNIA. Both Tables 31 and 32 (Appendix C), and Figures 139 through 150 of the PNIA provide sound pressure levels modeled with applied NROs, as described in 19(e)(5).

(g) Applicable Noise Standards

Noise standards applicable to the Facility Site, as well as noise guidelines that are not required but are recommended by various agencies, are described below. More information on these standards is included in Section 4 of the PNIA.

Local Regulations

The Facility is located in three towns with formal quantitative sound level standards: the Towns of Fremont, Cohocton, Dansville, and Wayland. The standards in each town are similar, but there are nuances with exceptions, measurements, and other factors that differ in each of the standards. The ordinances in these towns are summarized here, and more detail is provided in the PNIA. The Town of Dansville is in the process of adopting a wind law with sound standards. A full discussion of all local ordinances is provided in Exhibit 31. In each town standard, the limit is either 45 dBA $L_{eq,}$ or 50 dBA L_{10} at non-participating receivers, unless the ambient sound level exceeds the standard. In that case, the limit is the ambient sound level plus 5 or 6 dB. If a facility emits a tonal sound, the sound level limit is reduced by 5 dB. Some of the town standards also have a property line limit of 50 dBA L_{eq}. In the case of Cohocton, the 45 and 50 dBA L_{eq} limits are based on the arithmetic average of three 15-second L_{eq} samples. Some of the ordinances require the noise evaluation to be conducted by competent acoustical consultant, who shall document the noise levels at property lines and at the nearest residence not on the site. The Fremont and Cohocton ordinances require post-construction noise testing by a Town Code Enforcement officer, which may be required periodically.

State Standards

NYSDEC Program Policy

There is no quantitative state noise standard that applies to this Facility. There are, however, guidelines provided by the New York State Department of Environmental Conservation (NYSDEC), in *Assessing and Mitigating Noise Impacts* (NYSDEC, 2000). The document includes information about background sound level measurements, jurisdiction limits of the NYSDEC, and a review of guidelines from the other sources, among other topics. The sound level guidelines are found in Section V.B.1.c. Two types of thresholds are mentioned – one that is relative to existing background sound levels, and the other that is fixed.

Relative to existing background sound levels, the document states that permitted operations should minimize increases in sound pressure levels above ambient levels. Increases below 3 dB are have no appreciable effect on sounds receptors, and increases between 3-6 dBA have potential to cause adverse impacts to only the most sensitive receptors. Sound pressure increases above 6 dB may require a closer analysis of impacts, depending on existing ambient noise. The document states that "in non-industrial settings, the sound pressure level should probably not exceed ambient noise by more than 6 dB(A) at the receptor." Increases approaching 10 dB result in a perceived doubling of noise levels, which would warrant avoidance and mitigation measures in most cases.

The NYSDEC guidelines suggest that addition of any noise source in a non-industrial setting, should not raise the ambient noise level above 65 dBA, and that 65 dBA represents the upper limit of what would be acceptable noise conditions. Lower maximum sound pressure levels may be more appropriate when there are sensitive receptors nearby. The guidelines state that they do not "supersede any local noise ordinances or regulations."

NYSDPS Article 10

In 2012, the New York Department of Public Services (NYSDPS) revised its rules for electric generation and siting, contained in New York Code, Rules, and Regulations 16, Article 10. Exhibit 19 of these regulations requires "a study of the noise impacts of the construction and operation of the facility, related facilities and ancillary equipment," along with a list of requirements that the Article 10 Exhibit must contain. The Article 10 Regulations do not list a specific sound level limit, but instead describe information requirements and analysis requirements for a permit application. This Application is being prepared in accordance with the Article 10 regulations, and Stipulations agreed upon by DPS, New York State Department of Health (NYSDOH) and NYSDEC for this Facility.

World Health Organization Guidelines

The United Nation's World Health Organization (WHO) has published "Guidelines for Community Noise" (1999) which uses research on the health impacts of noise to develop guideline sound levels for communities. Please note that these guidelines were not specifically developed for wind turbine noise.

The WHO guidelines suggest a daytime and nighttime protective noise level. During the day, the levels are 55 dBA L_{16h}, that is, an average over a 16-hour day, to protect against serious annoyance and 50 dBA L_{16h} to protect against moderate annoyance. During the night, the WHO recommends limits of 45 dBA L_{8h} (the equivalent average sound level, averaged over eight nighttime hours) and an instantaneous maximum of 60 dBA LF_{max} (fast response maximum). These are to be measured outside the bedroom window. These guidelines are based on the assumption that sound levels indoors would be reduced by 15 dBA with windows partially open. So long as the sound levels outside of the house remain at or below 45 dBA, sound levels in the bedroom will generally remain below 30 dBA. Given the climate in the vicinity of the Facility Site, this is essentially a summertime standard, since residents are less likely to have their windows open during other times of the year. By closing windows, an additional ~10 dB of sound attenuation will result. In addition to protection against annoyance, these guidelines are intended to protect against hearing impairment, speech intelligibility, sleep disturbance, and hearing impairment. Of these factors, protection against annoyance and sleep disturbance require the lowest limits.

The WHO suggest that full sentence intelligibility requires a signal to noise ratio of about 15 dB. For speech volume of 50 dBA, this would indicate some speech interference as low as 35 dBA for "smaller rooms".

The WHO long-term guideline to protect against hearing impairment is 70 dBA L_{24h} over a lifetime exposure, and higher for occupational or recreational exposure.

The WHO indicate that sound sources with high levels of low frequency can be more intrusive. The guidelines do not include specific limits and instead state:

> "When noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided. For noise with a large portion of low-frequency sound a still lower guideline is recommended."

In October, 2009, WHO Europe conducted an updated literature review and built upon WHO's guidelines for nighttime noise in Europe. They added an annual average nighttime guideline level to protect against adverse effects on sleep disturbance. This guideline is 40 dB L_{night}, measured outside the bedroom window.

Federal Standards and Guidelines

There are no federal standards that apply to wind turbines on private land. Many federal agencies have adopted guidelines and standards that apply to other types of facilities; the Federal Interagency Task Force is set up to develop consistency of noise standards among federal agencies. A summary of some of these standards is provided in the PNIA. Notably, the U.S. Environmental Protection Agency (USEPA) established a guideline to protect public health and welfare with an adequate margin of safety. The maximum noise level recommended in this guideline is 55 dB L_{dn}, which is the A-weighted day-night L_{eq}, where a penalty of 10 dB is applied to nighttime sound. More information on additional guidelines established by federal agencies is included in Section 3.4 of the PNIA.

National Academy of Sciences Study

In 2008, the National Research Council of the National Academy of Sciences issued *Environmental Impacts of Wind-Energy Projects*. This report summarized the state of understanding of wind energy projects with respect to its ecological and human impacts, the latter of which includes noise. The report found that noise is typically not an issue for residences over approximately one half a mile because sound propagation is limited by technologies that limit noise impacts. These include upwind turbines, where the rotor is in front of the tower, and variable speed turbines, where rotor speeds are lower at low wind speeds. Variable speed, upwind turbines are proposed for the Baron Winds Project. These will reduce noise impacts as indicated in the National Academy of Sciences Study.

National Association of Regulatory Utility Commissioners

In 2012, the National Association of Regulatory Utility Commissioners (NARUC) sponsored a report by the National Regulatory Research Institute, "Put it There! Wind Energy & Wind Park Siting and Zoning Best Practices and Guidance for States" (Stanton/NARUC, 2012). This document recommends, in part, noise standards that could be applied to wind energy facilities. Table ES5 of the report summarizes the author's recommended approach to wind park siting and zoning criteria. Under "Noise, sound, and infrasound," the report recommends the following:

- "Noise standards should allow some flexibility.
- Noise standards should vary depending on the area's existing and expected land uses, taking into account the noise sensitivity of different areas (e.g., agricultural, commercial, industrial, residential).
- Determine pre-construction compliance using turbine manufacturer's data and best available sound modeling practices.
- Apply a planning guideline of 40 dBA as an ideal design goal and 45 dBA as an appropriate regulatory limit (following Hessler's proposed approach, 2011).
- Allow participating land owners to waive noise limits.
- Establish required procedures for complaint handling.
- Identify circumstances that will trigger, and techniques to be used for: (a) mandatory sound monitoring; (b) arbitration; and (c) mitigation.
- Do not regulate setback distance; regulate sound."
-

The 40 dBA ideal design goal and 45 dBA regulatory limit referred to above are long term mean sound levels. That is, they are not maximum hourly or nightly levels, but arithmetic averages over a period of weeks. This study does not adopt these levels as design goals, but note that the specific design goals of 45 dBA L_{8h} at night and 40 dBA $L_{night, outside}$ are more protective than a long-term mean of 45 dBA as recommended by Stanton/NARUC (2012).

Stanton/NARUC (2012) does not recommend specific standards for low-frequency sound, infrasound, amplitude modulation, or vibration impacts. Hessler /NARUC (2011) writes, "When the swishing, thumping or beating noise alluded to above does occurs [sic] it is usually at a rate of about once per second, or 1 Hz, which is the blade passing frequency of a typical three-bladed rotor turning at 20 rpm. Although the "frequency" of its occurrence at 1 Hz obviously falls at the very low end of the frequency spectrum, this noise is not "low frequency" or infrasonic noise, per se. It is simply a periodic noise where the actual frequency spectrum may contain some slightly elevated levels in the lower frequencies, but where the prominent noise is roughly centered around 500 Hz near the middle of the audible frequency spectrum. In general, the widespread belief that wind turbines produce elevated or even harmful levels of low frequency and infrasonic sound is utterly untrue as proven repeatedly and independently by numerous investigators. And probably arose from a confusion between this periodic amplitude modulation noise and actual low frequency noise. Problematic levels of low frequency noise (i.e. those resulting in perceptible vibration and complaints) are most commonly associated with simple cycle gas turbines, which produce tremendous energy in the 20 to 50 Hz region the spectrum – vastly more than could ever be produced by a wind turbine." [footnotes removed]

Proposed Regulatory Limits for Sound

Given the scientific evidence regarding sleep disturbance and other impacts, the Facility is being designed to not exceed a proposed regulatory limit of 45 dBA $L_{eq\ 8h}$, which is averaged over the entire night (11 pm to 7 am) outside of non-participating permanent residences, plus the local zoning noise standards applicable to wind projects. These proposed regulatory limits are more stringent than all of the federal guidelines mentioned above and will be well below the level that can cause hearing impairment according to WHO, the EPA, and the Occupational Safety and Health Administration (OSHA). The goal is both protective of human health and hearing loss, and prevents any quality-of-life concerns. For daytime periods, the Facility will comply with existing town limits.

Based on research regarding human response to wind turbine noise (Michaud et al 2016), approximately 8 percent of the population are annoyed indoors and 12 percent outdoors by exterior sound levels of 45 dBA (L_{eq} at 8 m/s).

Please see 19(e)(4) for information on standards with respect to infrasound.

(h) Noise Standards Comparison Table

Noise standards applicable to the Facility, including local regulations, state guidelines, WHO guidelines, and other federal agency guidelines are provided below in Table 19-9. As is indicated in Table 19-9, the Facility is in compliance with all of the standards and guidelines applicable to the Facility, where applicable.

Table 19-9. Noise Standards and Degree of Compliance

Municipality/Organization	Standard or Guideline	Overall Level	Metric	Tonal Penalty	Does Facility Comply with Standard or Guideline
Town of Fremont	Standard	50 dBA or Ambient Sound Level plus 5 dB if the Ambient Sound Level is Above 50 dBA	L_{10}	5 dB	Yes
Town of Cohocton	Standard	45 dBA	L_{eq}	5 dB	Yes
Town of Wayland	Standard	45 dBA at nonparticipating receivers 50 dBA at nonparticipating property lines 50 dBA at participating residences	L_{8h}	-	Yes
Town of Dansville	Standard	45 dBA or ambient sound level plus 6 dB if ambient sound level is 45 dBA or greater	L_{1h}	-	Yes
NARUC	Guideline	45 dBA Regulatory Limit 40 dBA Ideal Design Goal	Long-term mean	-	Meets "Regulatory Limit"
NYSDEC	Guideline	55 dBA L_{dn}/ Ambient Sound Level plus 6 dB	L_{dn}	-	Yes/Yes[1]
NYSDPS Chapter 10	Guideline	-	-	-	-
Word Health Organization (Night)	Guideline	45 dBA	L_{8h} - L_{eq} Averaged Over the Night	-	Yes
World Health Organization (Day)	Guideline	50 dBA for moderate annoyance, 55 dBA for serious annoyance	L_{16h} - L_{eq} Averaged Over the Day	-	Yes
Environmental Protection Agency	Guideline	55 dBA	L_{dn} – Annual day-night average	-	Yes
Federal Interagency Task Force	Guideline	55 to 65 dB	L_{dn} - Annual day-night average	-	Yes

[1]Comparing modeled annual L_{eq} to monitored overall L_{eq}.

(i) Noise Abatement Measures for Construction Activities

In addition to the Complaint Resolution Plan for the Facility, which is attached as Appendix T, a Sound Monitoring and Compliance Protocol, including a complaint resolution plan specific to wind turbine noise is included in Appendix AA. This plan serves as the noise complaint-handling procedure for the life of the Facility. The Applicant takes seriously any complaints that it receives from members of the public. Complaints will be able to be made in person, via phone, or by writing. The contact information for complaints will be posted with the Town Clerk of each town in which the Facility is located. The Applicant will contact the individual within two business days of the complaint. The Applicant will implement a comprehensive complaint response for all registered complaints, which will include community engagement, gathering information, response to the complaint, a follow up after the response has been issued, and further action if the complainant believes that the issue continues to exist.

Although impacts related to construction noise will be temporary, and are not anticipated to be significant, measures employed to minimize and mitigate temporary construction noise shall include:

- Implementing best management practices for sound abatement during construction, including use of appropriate mufflers and limiting hours of construction where practicable, and turning off construction vehicles when not in use.

(j) Noise Abatement Measures for Facility Design and Operation

Wind turbine noise can be abated using either factory-installed measures, siting methods implemented during final Facility design, or measures implemented after the Facility is constructed. These methods are described below.

- Wind Turbine Design – Horizontal axis wind turbines, with three blades, positioned upwind of the tower are the only type used for utility-scale wind power. Turbines with the blades positioned downwind of the tower are obsolete and cause more noise issues than upwind designs due to the blades passing through the wake of the tower. Vertical axis wind turbines are not available in megawatt scale. The design of the blade can have a substantial impact on noise generation. Some turbine models are available with serrated trailing edges that reduce wind turbine aerodynamic noise by smoothing the flow of air behind the blade, reducing turbulence and therefore noise emissions. Depending on the turbine model selected, serrated trailing edge technology may or may not be available. On some models, serrations can be installed even after the project is constructed.

- Facility Siting – Changing of turbine setbacks from residences can be used to decrease sound levels; however, wind turbine layouts are chosen to maximize energy production, comply with wind ordinance setback requirements, comply with setback requirements for other environmental conditions (water, flora, fauna, etc.), meet spacing requirements for the turbines themselves, facilitate access, and accommodate landowner preferences. As a result, modification of turbine arrangements to decrease sound pressure levels at receptors can have adverse effects on project performance and feasibility.

- **Noise Reduced Operations (NROs)** – NROs Noise Reduced Operations (NROs) are operational changes to reduce noise generation. NROs are usually accomplished by adjusting turbine blade pitch, slowing the rotor speed of the turbines, which reduces aerodynamic noise produced by the blades. NROs are a readily available technology on most modern wind turbines and may be used to reduce turbine sound power to a level at or below the sound power of the turbine modeled in the Application. NROs can be implemented on an as-needed basis. For example, they can be programmed for selected wind speeds, wind directions, and times of day. The programs can be adjusted at any time after the wind turbines have commenced operations. Sound propagation modeling presented in this Exhibit has taken into account NROs that could be used to bring the Facility into compliance with design goals. Please see discussion of NROs above in 19(d) and 19(e)(5).

- **Physical Abatement –** Due to the inherent size of wind turbines, physical noise control measures, such as noise barriers, active noise control, and tree plantings, tend to be impractical. At receptors, white noise machines can be used to reduce the prominence of wind turbine noise, and the sound insulation of residences can be improved to reduce interior sound level.

(k) Community Noise Impacts

(1) Potential for Hearing Damage

The Facility's potential to result in hearing damage was evaluated against three guidelines established by the OSHA, USEPA, and WHO. Comparison of sound propagation modeling to these guidelines shows that construction and operation of the Facility will not result in potential for hearing damage. Each of the standards and the Facility's compliance with them is further described below.

OSHA sets legal limits on noise exposure in the workplace, which are based on a worker's time weighted average over an 8-hour day. OSHA's permissible exposure limit (PEL) is 90 dBA for all workers for an 8-hour period (OSHA, undated); above this level, potential for hearing damage becomes more likely. Sound pressure levels as generated by Facility construction and operation at Sensitive Sound Receptors will be well under this threshold, so the Facility will be in compliance with OSHA standards. Therefore, based on the OSHA standard, the Facility will not result in potential for hearing damage.

The USEPA established a noise guideline for protection against hearing loss in the general population. The guideline sets an L_{eq} of 70 dBA or less, averaged over a 40-year period. Because this standard assumes long-term exposure, only operational noise concerns are applicable (USEPA, 1978). The USEPA also recommends an L_{dn} of 55 dBA to protect the public from the effect of broadband environmental noise in typically quiet outdoor and residential areas (USEPA, 1974). This is not a regulatory goal, but is 'intentionally conservative to protect the most sensitive portion of the American population' with 'an additional margin of safety.' With sound propagation modeling using NROs, the highest sound level at a permanent non-participating residence would be 45 dBA L_{8h}. Therefore, the Facility is not expected to result in hearing damage based on USEPA guidelines.

Similar to the USEPA guideline is the WHO long-term guideline to protect against hearing impairment, which establishes a 70 dBA L_{24h} over a lifetime exposure, with higher levels for occupational or recreational exposure. As described above, the highest construction sound level at a non-participating receptor would be 65 dBA, and the highest operational sound level at a non-participant residence would be 45 dBA L_{8h}. Therefore, the Facility is well in compliance with WHO noise standards for protection against hearing impairment. The Facility is not expected to result in hearing damage based on WHO guidelines.

(2) Potential for Speech Interference

The Facility's potential to result in indoor and outdoor speech interference was assessed using the framework provided in the WHO (1999) document *Guidelines for Community Noise*. This document states that for speech to be intelligible when listening to complicated messages (e.g., at school, listening to foreign languages, telephone conversations), it is recommended that the speech be at least 15 dBA higher than the background ambient noise. The WHO Guidelines present 50 dBA as a casual speech level typical for both men and women, and this recommendation states that background noise not exceed 35 dBA where complicated messages are being relayed. Although speech interference is influenced by the spectrum of the masking sound, no particular guidance is given to adjust the WHO's guidelines for sound sources of different frequency content. Since speech may range from 100 Hz to 6 kHz, there will be overlap between the spectra of wind turbine noise and speech. This guideline is generally intended for classrooms and so includes corrections for the hearing impaired, reverberation, children, and lack of language proficiency. Fifty dBA is also a low sound level for speech at close distances, with most normal speech being 60 dBA at close distances, as stated in ANSI 12.65-2011. Assuming that being indoors results in a 15 dBA decrease in sound pressure levels from the outdoors (WHO, 1999, p. 28), areas with outdoor levels of sound measured at 50 dBA or more would comply with this recommendation for indoors. Because all Sensitive Sound Receptors are predicted to have a maximum operational sound level at 45 dBA L_{8h}, the Facility will not result in interference with indoor speech, according to the WHO's recommendations.

In addition, according to WHO (1999), with a raised voice, sentences may be 100% intelligible for background noise levels up to 55 dBA. Using a strained voice, sentences spoken can be 100% intelligible even at background noise levels of 65 dBA. Modeling of sound pressure levels presented in the PNIA was done for outdoor environments, and as previously stated, sound pressure levels are not expected to exceed 45 dBA L_{8h} at Sensitive Sound Receptors. Therefore, some receptors will have outdoor noise levels higher than the most conservative noise threshold (see above) under which complicated messages should be relayed (35 dBA), but will not have background noise levels equaling or exceeding the level at which the voice needs to be raised in order for sentences to be 100% intelligible (55 dBA). Therefore, any impacts to outdoor speech resulting from noise generated by the operating Facility are expected to be minor. Please see Figures 139 to 150 of the PNIA to see predicted future noise levels in 1 dBA increments at all outdoor areas in and immediately adjacent to the Facility Site.

In USEPA's *Protective Noise Levels* (1978), the agency sets thresholds above which noise could interfere with indoor and outdoor speech. In the document, USEPA states that "the highest noise level that permits relaxed conversation with 100% sentence intelligibility throughout the room is 45 dBA" (USEPA, 1978). Outdoor noise levels described in the guidelines depend on distance from speaker to listener and whether a raised voice or a normal voice is used, but establishes a 55 dBA conservative threshold, which would guarantee 95% sentence intelligibility outdoors with a normal speaking voice at a distance of three meters, including a 5 dBA safety margin. Because all Sensitive Sound Receptors were modeled to have the highest operational sound level at 45 dBA (measured outdoors), and because USEPA indicates that sound from the outdoor to the indoor environment attenuates approximately 15 dB with windows partly open, the Facility will not result in interference with indoor or outdoor speech, as defined in USEPA guidelines.

(3) Potential for Annoyance/Complaints

(i) Review of Annoyance Literature

Sound level standards and guidelines such as those published by the World Health Organization are typically based on research conducted for transportation noise. There have been some studies that conclude that wind turbine noise is more intrusive to some listeners than a transportation source of equivalent magnitude. Suggested reasons for increased annoyance include: amplitude modulation, tonality, low frequency content, and the newness of wind turbine noise as an environmental noise source.

Some studies have looked at the response of residents surrounding wind farms relative to the audio frequency (20 Hz to 20,000 Hz) and sound level emitted by the wind turbines. Similar wide-spread studies have not compared annoyance to low frequency or infrasound levels, though there is a high correlation between A- and C-weighted sound levels (Tachibana et al., 2014). The studies that have been performed for human response to low frequency sound and infrasound from wind turbines have largely been laboratory studies.

Response in the Audio Frequency Range

Studies of human response to wind turbine sound were performed in Sweden (in 2000 and 2005) and The Netherlands (2007) by Eja Pederson and other authors (Waye, Lassman, etc.). There have been several papers about these studies, including a summary written by Janssen et al (2011) that included a combined dose response curve. The Pederson studies were performed by sending self-reporting surveys to respondents living in and around wind farms and comparing responses from these surveys to modeled sound levels at those residences. A total of 1,830 people responded to these surveys.

The Janssen dose-response curves show that for sound at 45 dBA L_{eq} (calculated outdoors), there is an annoyance rate of approximately 12 percent for residents outdoors and 5 percent for residents indoors. The highly annoyed rate is 5 percent outdoors and 2 percent indoors for this sound level. Note that sound levels were calculated using the equations of the Swedish Environmental Protection Agency and assumes that receptors are always downwind of the source. A common finding among the various studies is that annoyance was lower among residents who benefited economically from the wind turbines. Annoyance also increases with age, visibility of the turbines from the residence, and noise sensitivity.

Health Canada studied health indicators among populations exposed to wind turbine sound (Michaud, 2015). Just as with Pedersen's studies, self-reporting surveys were distributed to participants (1,238 in total). Correlations were found between wind turbine modeled sound levels and annoyance towards noise, shadow-flicker, turbine visibility, blinking lights, and vibration. Although C-weighted sound levels were calculated for the study, A-weighted levels were primarily assessed, due to the high correlation between A-weighted and C-weighted levels (R2=0.88). The rate of highly annoyed residents due to wind turbine noise was found to be approximately three percent at sound levels between 40 and 46 dBA. This sound level assumes wind turbines emissions at an 8 m/s wind speed measured at a height of 10 meters. Also note, that the Health Canada study assumed a ground absorption factor of G=0.7 with no uncertainty factor added to the wind turbine sound power, so levels modeled by Health Canada will be about 3 dB lower than the equivalent scenario modeled in this report.

A Japanese study also looked at the relative annoyance of residents surrounding wind farms, compared with the $L_{eq,n}$, or average of the A-weighted 10-minute sound levels from each hour over the night with the wind turbine(s) at their rated capacity (Kuwano et al., 2014).The $L_{eq,n}$ measured by the study is lower, on average, than the sound level downwind with the 10 meter wind speed at 8 m/s, due to the directionality of turbines. Due to differences in wind farm layouts (single turbine, grid layout, ridgeline layout, etc.), this difference was not readily determined. The authors estimated that, on average, the $L_{eq,n}$ will be about 6 dB less than the L_{dn}. Using this assumption, the authors found that wind turbine noise is between 6 and 9 dB more annoying than road traffic noise. The study found that between 41 and 45 dB $L_{eq,n}$ approximately 14 percent of respondents were extremely annoyed and 19 percent were moderately annoyed (Yano et al., 2013). Other findings included that visual disturbance was well correlated with wind turbine noise disturbance, and that insomnia, though low in incidence overall, was more prevalent near wind turbine sites. Insomnia was also found to be related to visual disturbance. Wind turbine noise was also found to have an effect on sleep disturbance for a small portion of respondents, when audible.

Response in the Infrasound Frequency Range

Infrasound is generally defined as the portion of the frequency spectrum below 20 Hz. Low-frequency sound is generally considered in the frequency range from 20 Hz to 200 Hz.

Measurements of infrasound at distances from wind turbines typical of their nearest residential neighbors have consistently found that infrasound levels are below published audible human perception limits. O'Neal et al. (2011) measured sound from wind projects that used the GE 1.5 sle and Siemens SWT 2.3-93 model wind turbines. They found that at typical receptor distances away from a wind turbine, more than 1,000 feet away, wind turbine sound is typically audible starting at 50 Hz.

Tachibana et al. (2014) measured sound levels from 34 wind projects around Japan over a three-year period. They found that infrasound levels were "much lower than the criterion curve" proposed by Moorehouse et al. (2009). RSG et al. (2016) studied infrasound levels at two wind turbine projects in the northeastern U.S. Both indoor and outdoor measurements were made. Comparisons between turbine-on periods and adjacent turbine shutdown periods indicated the presence of wind-turbine-generated infrasound, but well below ISO 389-7 (ISO, 2013) and Wattanabe et al (1990) perception limits. In their review of several wind turbine measurement studies (including O'Neal et al. (2011) and Tachibana et al. (2014)), McCunney et al. (2014) did not find evidence of audible or perceptible infrasound levels at typical residential distances from wind projects.

Authors Salt and Huller (2010), Pierpont (2009), and Schomer et al. (2015) have theorized that infrasound from wind farms can be perceived by humans and cause adverse reactions, even when it is below measured audibility thresholds. Some of these theories have focused on the human vestibular system, hypothesizing that sub-audible infrasound could stimulate the vestibular system, upsetting the human body's manner of determining balance and causing symptoms such as dizziness, nausea, and headaches, along with disruptions in sleep. In response, McCunney et al. (2014) and Leventhall (2013) contend that there has been no demonstration that humans can perceive sub-audible infrasound, citing the relative insensitivity of the inner ear (where the vestibular system is located) to airborne sound and the presence of other low to moderate magnitude infrasound sources in the body and the environment.

Yokoyama et al. (2013) conducted laboratory experiments with subjects exposed to synthesized infrasound from wind turbines. In one experiment, he filtered synthesized wind turbine sound to eliminate high frequency sound at ten different cutoff frequencies from 10 Hz to 125 Hz. The results indicate that when all sound above 20 Hz was filtered out, none of the respondents could hear or sense the wind turbine sound. In a second experiment correlating the subject response of wind turbine sound to different frequency weighting schemes, they found that the subjective loudness of wind turbine sound was best described by the A-weighted sound level rather than other weightings that focused on low-frequency sound or infrasound.

Hansen et al. (2015) compared subject response to infrasound and "sham" infrasound. In one case, recordings of wind turbine noise, filtered to exclude sound above 53 Hz, were presented to subjects with the infrasonic content present, with only the infrasonic content present, and with the infrasonic content removed. Results showed that adverse response to the sound, was determined by the low frequency, not infrasonic content of the sound. A study by Walker and Celano (2015) found that feelings of nausea and annoyance were more correlated with audible range blade swish than infrasonic components.

Research by Tonin, et al. (2015) found that response to infrasound was more determined by information the subject had received than the presence of infrasound in a sound signal.

(ii) Evaluation of Potential for Complaints/Annoyance

Annoyance Based on Health Canada Study

Future noise modeling results of 935 Sensitive Sound Receptors was evaluated using the results from the Health Canada Study on wind turbine noise annoyance along with adjustments to sound levels to compensate for differences in sound propagation modeling methods with the current report (Table 19-10). Results show, of 935 receptors, 22 receptors will be highly annoyed due to wind turbine noise. This corresponds to approximately 2.3% of the receptors located in the sound level range analyzed; however, it does not include all sources modeled.

Table 19-10. Estimated Highly Annoyed Receptors

Sound Pressure Level (1-hour L_{eq} - dBA)	Number of Receptors At Sound Pressure Level	Percent Highly Annoyed Indoors	Percent Highly Annoyed Outdoors	Receptors Highly Annoyed Indoors	Receptors Highly Annoyed Outdoors
30	61	0.8	0.7	0.5	0.4
31	68	0.9	0.9	0.6	0.6
32	95	1.1	1.1	1.0	1.1
33	104	1.3	1.4	1.3	1.5
34	145	1.5	1.7	2.2	2.5
35	95	1.8	2.2	1.7	2.0
36	70	2.1	2.6	1.4	1.8
37	36	2.4	3.2	0.9	1.1
38	39	2.8	3.8	1.1	1.5
39	30	3.3	4.6	1.0	1.4
40	42	3.8	5.5	1.6	2.3
41	34	4.4	6.5	1.5	2.2
42	51	5.0	7.7	2.6	3.9
43	18	5.8	9.0	1.0	1.6
44	26	6.7	10.6	1.7	2.7
45	21	7.6	12.3	1.6	2.6
46	0	8.7	14.2	0.0	0.0
47	0	9.9	16.4	0.0	0.0
48	0	11.3	18.8	0.0	0.0
49	0	12.8	21.5	0.0	0.0
50	0	14.4	24.5	0.0	0.0
Total	935			22	29

(4) Potential for Sound-Induced Vibration and Annoyance

A discussion of the potential for sound induced vibration and annoyance resulting from the operating Facility is provided above in 19(e)(4). The potential for the Facility to result in perceptible vibrations was evaluated against ANSI S12.2 low frequency criteria to prevent “clearly perceptible” and “moderately perceptible” vibration and rattles in lightweight wall and ceiling structures. The Facility was also evaluated against annoyance criteria outlined in ANSI S12.9 Part 4 Annex D, which establishes a standard for minimal annoyance due to vibrations resulting from low frequency noise and infrasound. Table 19-8, above in 19(e)(4) shows the modeled (and for infrasound, extrapolated) sound pressure levels for each of the following full octave band center frequencies: 16 Hz, 31.5 Hz, 63 Hz. The Facility will fall below thresholds for clearly perceptible vibration and rattles, moderately perceptible vibration and rattles, and annoyance from vibration and rattles at the worst-case non-participant Therefore, the Facility is not expected to result in perceptible vibration or rattles or annoyance from vibration and rattles.

(5) Potential for Ground-borne Transmitted Vibrations to be Perceptible

Ground-borne vibration has not been a primary research topic for wind turbines, although some residents near wind farms have asserted that sound from wind farms has seemed to be transmitted through the ground. As a result, there have been studies on this topic.

Research studying the amplitude of vibration due to wind farms show magnitudes below the threshold of perception and health impacts, even at distances far less than typical receiver distances. For example, Botha (2013) found magnitudes of less than 0.01 millimeters per second (mm/s) or 0.00001 meters per second at a distance of 92 meters. For comparison, the ANSI S2.71 thresholds for perception are 0.0001 meters per second or less for all frequencies. The ANSI thresholds are based upon the thresholds of perception for the most sensitive humans.

(6) Potential for Interference Technological, Industrial, or Medical Activities that are Sensitive to Sound

The influence of ground-borne vibration on seismic measurement stations that are used for earthquake detection and nuclear weapon test monitoring has been the focus of ground-borne vibration research. Seismic stations are orders of magnitude more sensitive than humans are to vibration. They are so sensitive that even in environments far from high levels of development, some ground-borne vibration will always be sensed. As a result, the question is not whether the installation can sense vibration, but rather how much vibration can be produced without harming the usefulness of the monitoring station. Table 19-11 shows the closest seismological stations to the Facility. The closest distance between a Facility turbine and a seismological station is 128 kilometers. This is well outside of recommended distances (Styles et al., 2005; Fiori et al., 2009).

Table 19-11. Closest Seismological Stations to Baron Winds

Location	Longitude (degrees)	Latitude (degrees)	Distance (km)
Binghamton, New York	-75.99	42.20	128
Effingham, Ontario	-79.31	43.09	158

Location	Longitude (degrees)	Latitude (degrees)	Distance (km)
Standing Stone, Pennsylvania	-77.89	40364	195
Erie, Pennsylvania	-79.99	42.12	199
Kingston, Ontario	-76.49	44.23	209
Sadowa, Ontario	-79.14	44.77	282
Williamsburg, Ontario	-75.28	45.00	331
Lake Ozonia, New York	-74.58	44.62	334
Ottawa, Ontario	-75.77	45.36	347

In addition, the Applicant is unaware of any highly sensitive medical equipment that could be affected by infrasound or noise-induced vibration in the vicinity of the Facility.

(7) Potential for Structural Damage

The potential for structural damage due to vibration during construction is minimize, as no blasting is proposed.

(l) Post-construction Noise Evaluation Studies

The Applicant proposes post-construction sound monitoring to take place in the first year of operations and is attached in Appendix AA. Two sound monitoring tests will take place within the first 13 months of Facility operation, with the first test to be completed within the first seven months of operation to assess compliance with the permitted noise limits established in the Article 10 Certificate and Town wind laws. Two monitoring periods will be included, one with leaf-on conditions and the other with leaf-off conditions. Monitoring locations will be set up at four of the locations at which pre-construction sound level monitoring was conducted (Henkle Hollow, Dye Road, Haskinville, and Rose Road).

Up to three additional sound monitoring locations will be identified for monitoring, representing areas where complaints were received during the first full year of operations. These additional areas will be selected based on the type of complaint, whether the complaint was due to a continuing operational issue or a non-recurring event, the modeled sound level, and the cooperation of the landowner.

Additional detail regarding the equipment setup, data collection, data analysis, and reporting are included in Appendix AA.

(m) Operational Controls and Mitigation Measures to Address Reasonable Complaints

The Applicant takes seriously any complaints that it receives from members of the public. In addition to the Complaint Resolution Plan for the Facility, which is attached as Appendix T, a Sound Monitoring and Compliance Protocol, including a complaint resolution plan specific to wind turbine noise has been developed by the Applicant and is included in Appendix AA. This plan serves as the complaint-handling procedure for the life of the Facility. Should a resident feel the Facility is creating noise levels above those specified in the local ordinances, the resident may issue a formal complaint. Complaints will be able to be made in person, via phone, or by writing. The contact information for complaints will be posted with the Town Clerk of each town in which the Facility is located. The Applicant will contact the individual within two business days of the complaint The Applicant will implement a comprehensive response for all registered, reasonable complaints, which will include community engagement, gathering information, response to the complaint, a follow up after the response has been issued, and further action if the complainant believes that the issue continues to exist.

Due to the inherent size of wind turbines, typical noise control measures to be installed post-construction, such as barriers or mufflers, are impractical or would destroy the utility of the wind turbines. In-spite of this, some post-construction mitigation measures for noise are available. Post-construction operational controls that could be utilized to reduce noise, should noise levels exceed those established in local laws, include NROs. NROs are usually accomplished by modifications in the pitch of the turbine blades, slowing the rotor speed of the turbines. This rotor speed reduction reduces aerodynamic noises produced by the turbine. In addition, some turbine models are available with serrated trailing edges, which help smooth the airflow in the wakes of the blade. The serrated edges help reduce turbulence and therefore noise emissions. Depending on the turbine, this may or may not be available post-construction. NROs were modeled in the PNIA assessment of noise impacts for several turbines, in order to bring the Facility in line with design goals. However, selection of NROs for the final Facility will ultimately depend on which turbine model is selected and the number of turbines constructed.

(n) Input Parameters, Assumptions, and Data Used for Modeling

Specific modeling parameters are included as Appendix B of the PNIA prepared by RSG. GIS files containing modeled topography, modeled turbine and substation locations, Sensitive Sound Receptors, and all external boundary lines identified by Parcel ID number are being provided to DPS under separate cover in digital format.

(o) Noise Level Comparisons and Impact Estimates

A list of with complete information of all references cited in the PNIA and a glossary of terms are included in Appendix F and G of the PNIA, respectively.

(1) Comparison of Existing Noise versus Future Noise Levels

Future noise levels of the Facility will be in compliance at all receptors with ordinances established by local laws, noise levels recommended by WHO guidelines (45 dBA L_{8h}, the Facility design goal), and both the noise level threshold and the increase in noise recommended by NYSDEC. Table 19-9 above in 19(h) lists standards applicable to the Facility and compliance with them. Ambient and future sound pressure levels under a variety of conditions and assumptions were modeled for every Sensitive Sound Receptors, and are included in Appendix C of the PNIA.

No applicable annoyance/complaint thresholds or guidelines are specifically established. However, an analysis for annoyance and complaints is provided in 19(k)(3)(ii).

(2) Impact Estimates

Table 19-12 shows the mitigated short- and long-term monitoring results and the sound levels that these receptors will experience as a result of Facility operation. None of the non-participating receptors will experience sound levels over 45 dBA and approximately 82% of the non-participating receptors will experience $L_{night,\ outside}$ sound levels of less than 30 dBA.

Table 19-12. Number of Non-Participating Receptors in Different Sound Ranges for Different Metrics

Sound Level Range	Non-participating Receptors in Each Sound Level Range		
	L_{1h}	L_{8h}	$L_{night,outside}$
<30 dBA	593 (40%)	631 (43%)	1,212 (82%)
30 – 35 dBA	477 (32%)	461 (31%)	179 (12%)
35 – 40 dBA	249 (17%)	245 (16%)	91 (6%)
40 – 45 dBA	163 (11%)	145 (10%)	0 (0%)
>45 dBA	0 (0%)	0 (0%)	0 (0%)
Total	1,482 (100%)	1,482 (100%)	1,482 (0%)

As described above in 19(d), all of the non-participating Sensitive Sound Receptors are modeled to be in compliance with the 45 dBA L_{8h} nighttime impact threshold design goal for the Facility.

Despite being in compliance with applicable ordinances and standards, the Facility may cause some potential for complaints. According to the analysis of potential for annoyance based on the data derived from a Health Canada Study (Michaud et al., 2016 and Old and Kaliski, 2017), 22 receptors may be highly annoyed indoors, and about 29 receptors may be highly annoyed outdoors. Table 19 of the PNIA (Appendix Z) includes the breakdown of receptors that will be highly annoyed for different sound level pressures.

As stated above, the Applicant takes seriously any complaints that it receives from members of the public. There is a Complaint Resolution Plan for the Facility, which is attached as Appendix T. This plan serves as the complaint-handling procedure applicable during both Facility construction and operation. Should a resident feel the Facility is creating noise levels above those specified in the local ordinances, the resident may issue a formal complaint. Complaints will be able to be made in person at the Facility's O&M building, via phone, or by writing. The Applicant will implement a comprehensive response for all registered, reasonable complaints, which will include community engagement, gathering information, response to the complaint, a follow up after the response has been issued, and further action if the complainant believes that the issue continues to exist.

Based on the results of the PNIA, which shows adherence of the Facility to appropriate noise guidelines and Town noise ordinances, potential adverse impacts due to sound from the construction and operation of the proposed Facility have minimized to the greatest extent practicable.

REFERENCES

American National Standards Institute (ANSI). 2002. *American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools*. ANSI/ASA S12.60-2002, Acoustical Society of America.

American National Standards Institute (ANSI). 2008. *American National Standard Criteria for Evaluating Room Noise*. ANSI/ASA S12.2-2008, Acoustical Society of America.

Botha, P. *Ground Vibration, Infrasound and Low Frequency Noise Measurements form a Modern Wind Turbine*. Acta Acustica United with Acustica 99(2013): 537-544.

Bowdler, D., Bullmore, A., Davis, B., Hayes, M., Jiggins, M., and Leventhall, G. 2009. *Prediction and Assessment of Wind Turbine Noise: Agreement about Relevant Factors for Noise Assessment from Wind Energy Projects*. Acoustics Bulletin 34(2): 35-37.

Duncan, E., and Kaliski, K.. 2008. *Improving Sound Propagation Modeling for Wind Power Projects*. Acoustics ’08. Paris, France.

Evans, T., and J. Cooper. *Comparison of Predicted and Measured Wind Farm Noise Levels and Implications for Assessments of New Wind Farms*. April 2012. Acoustics Australia 40(1).

Fiori, I. et al. *A Study of the Seismic Disturbance Produced by the Wind Park Near the Gravitational Wave Detector GEO-600.* Third International Meeting on Wind Turbine Noise. Aalborg, Denmark 17-19 June, 2009.

Hansen, K., B. Walker, B. Zajamsek, C. Hansen. 2015. *Perception and Annoyance of Low Frequency Noise Versus Infrasound in the Context of Wind Turbine Noise*. *6th International meeting on Wind Turbine Noise*. Glasgow, Scotland: 20-23 April 2015.

International Standards Organization (ISO). 2013. *Acoustics -- Reference Zero for the Calibration of Audiometric Equipment -- Part 7: Reference Threshold of Hearing Under Free-Field and Diffuse-Field Listening Conditions.* ISO 389-7:2005, last reviewed 2013

Janssen, S., H. Vos, A.R. Eisses, and E. Pedersen. 2011. *A Comparison Between Exposure-Response Relationships for Wind Turbine Annoyance and Annoyance Due to Other Noise Sources*. *Journal of the. Acoustical Society of* America 130(6):3746-3753.

Kuwano, S., T. Yano, T. Kageyama, and H. Tachibana. 2014. *Social Survey on Wind Turbine Noise in Japan*. Noise Control Engineering Journal 62(6):503-520.

Leventhall, G. 2013. *Infrasound and the Ear*. Fifth International Conference on Wind Turbine Noise. Denver, Colorado: 28-30 August 2013.

McCunney, R., Mundt, K.A., Colby, W.D., Dobie, R., Kaliski, K., Blais, M.B. 2014. *Wind Turbines and Health: A Critical Review of the Scientific Literature*. Journal of Occupational and Environmental Medicine 56(11) pp. e108-e130.

Michaud, D. 2015. *Wind Turbine Noise and Health Study: Summary of Results*. 6th International Meeting on Wind Turbine Noise. Glasgow, Scotland: 20-23 April 2015.

Michaud, David, et al. 2016. *Exposure to Wind Turbine Noise: Perceptual Responses and Reported Health Effects*. J. Acoust. Soc. Am. 139(3). March 2016. pp. 1443-1454.

Moorehouse, A., D.C. Waddington, and M.D. Adams. 2009. *A Procedure for the Assessment of Low Frequency Noise Complaints*." Journal of the Acoustical Society of America 126 (3):1131-1141.

NYSDEC. 2000. *Assessing and Mitigating Noise Impacts*. Program Policy. Issued October 6, 2000; revised February 2, 2001.

Occupational Safety and Health Administration. Undated. *Occupational Noise Exposure*. Available at: https://www.osha.gov/SLTC/noisehearingconservation/. (Accessed March 18, 2016).

O'Neal, R.D., R.D. Hellweg, and R.M. 2011. Lampeter. *Low Frequency Noise and Infrasound from Wind Turbines*. Noise Control Engineering J. 59(2):135-157.

Old, I., Kaliski, K., 2017. *Wind turbine noise dose response – Comparison of recent studies*. Proceedings of the 7th International Conference of Wind Turbine Noise, May 2017.

Pedersen, E. and Waye, K. 2004. *Perception and annoyance due to wind turbine noise - a dose-response relation*. Journal of the Acoustical Society of America. 116(6). pp. 3460-3470.

Pedersen, E. and Waye, K. 2008. *Wind turbines-low level noise sources interfering with restoration?* Environ. Res. Lett. 3 (January-March 2008).

Pedersen, E., et al. 2008. *Response to wind turbine noise in the Netherlands*. Acoustics 2008. Paris, France. 29 June – 4 July 2008.

Pedersen, E. and Pernilla, L. 2008. *The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines*. Journal of Environmental Psychology. 28. pp. 379-389

Pierpont, N. 2009. *Wind Turbine Syndrome: A Report on a Natural Experiment*. K-Selected Books: Santa Fe, New Mexico. November 2009.

Renewable UK. 2013. *Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect.* December 2013.

RSG, et al. 2016. *Massachusetts Study on Wind Turbine Acoustics*. Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection.

Salt, A., and Huller, T. 2010. *Responses of the Ear to Low-Frequency Sounds, Infrasound, and Wind Turbines*. Hearing Research 268(1-2):12-21.

Schomer, P., J. Erdreich, P. Pamidighantam, J. Boyle. 2015. *A Theory to Explain Some Physiological Effects of the Infrasonic Emissions at Some Wind Farm Sites*. Journal of the Acoustical Society of America 137(3): 1357-1365.

Styles, P. et al. *Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Wind Farms.* Keele University. 18 July 2005.

Tachibana, H., H. Yano, A. Fukushima, A. Sueoka. 2014. *Nationwide Field Measurements of Wind Turbine Noise in Japan*. Institute of Noise Control Engineering Journal 62(2): 90-101.

Tonin, R., and J. Brett. 2015, *Response to Simulated Wind Farm Infrasound Including Effect of Expectation*. *6th International Meeting on Wind Turbine Noise*. Glasgow, Scotland: 20-23 April 2015.

United States Environmental Protection Agency (USEPA). 1978. *Protective Noise Levels*. Condensed Version of EPA Levels Document. November 1978. EPA 550/9-79-100.

Walker, B., and J. Celano. 2015. *Progress Report on Synthesis of Wind Turbine Noise and Infrasound*. 6th International Meeting on Wind Turbine Noise. Glasgow, Scotland: 20-23 April 2015.

Watanabe, T., and H. Moller. 1990. *Low Frequency Hearing Thresholds in Pressure Field and in Free Field*. Journal of Low Frequency Noise and Vibration 9(3):106-115.

World Health Organization (WHO). 1999. *Guidelines for Community Noise*.

Yano, T., S., Kuwano, T. Kageyama, S. Sueoka, and H. Tachibana. *Dose-Response Relationships for Wind Turbine Noise in Japan.* Internoise 2013. Innsbruck, Austria: 15-18 September 2013.

Yokoyama, S., S. Sakamoto, S. Tsujimura, and H. Tachibana. 2013. *Loudness Evaluation of General Environmental Noise Containing Low Frequency Components*. Proceedings of InterNoise2013, 2013.