Section 17
Shadow Flicker Evaluation

17.0 SHADOW FLICKER

Highland is designed and sited to avoid undue adverse shadow flicker effects, as required by Maine law 38 M.R.S. § 484(10). There are no specific regulatory limits on exposure to shadow flicker, but the Maine Department of Environmental Protection has recognized a general guideline of under 30 hours of actual flicker being reasonable. Actual and theoretical flicker are not the same, as there are many mitigating effects, such as weather, wind conditions, vegetation, and distance between receptor sites and the turbine.

The attached report demonstrates compliance with the statute, as well as the guidelines, as actual flicker (even without accounting for vegetation or the distance between the turbine and the receptors) is under 10 hours.

Appendix 17-1

Memo

To:	Jonathan Ryan Stantec Consulting Services Inc. Topsham, ME	From:	Theo Kindermans Stantec Planning and Landscape Architecture, PC Boston, MA
File:	Highland Wind Project	Date:	December 15, 2010

Reference: Shadow-Flicker Modeling
Highland Wind Project, Highland Plantation, Maine

Introduction

Highland Wind LLC (Highland Wind) is proposing the Highland Wind Project (Project), a 39 turbine wind energy generating facility located in Highland Plantation, Somerset County, Maine. In addition to the wind turbines, the Project includes a 34.5-kilovolt (kV) electrical collector system, an electrical collector substation, a 115-kV generator lead, an Operations and Maintenance (O&M) building, up to five permanent 80-meter meteorological towers, and a series of roads to construct and then access the turbines and related infrastructure.

This memorandum provides a brief explanation of the shadow-flicker phenomenon resulting from rotating turbine blades, the modeling approach employed to calculate shadow-flicker and relevant explanations and results. The site layout was provided by the Stantec Consulting Services, Inc. located in Topsham, ME, showing 39 GE 2.5xl turbines with an 85 meter high hub and a 100 meter rotor diameter for a maximum height of 135 meters. The turbine selected for the Highland Wind Project will be no taller than this machine, and thus utilizing the GE 2.5xl allows assessing the worst-case impacts.

Shadow-Flicker Background

Shadow-flicker from wind turbines results from brief reductions in light intensities caused by the rotating blades of the turbine casting shadows on receptors on the ground and stationary objects, such as a window at a residence. When the sun is obscured by clouds or storms, or when the turbine is not operating, or when the rotor of the turbine is perpendicular to the receptor, no shadows will be cast, and thus no flicker occurs.

Shadow-flicker can occur on project area receptors when the wind turbine is located near the receptor and when the turbine blades interfere with the angle of the sunlight. The most typical effect is the visibility of an intermittent light reduction on the receptor facing the wind turbine and subject to the shadow-flicker. In addition, obstacles such as terrain, trees, or buildings between the wind turbine and a potential shadow-flicker receptor can significantly reduce or eliminate shadow-flicker effects. No shadow flicker is present when the rotor of the turbine is perpendicular to the receptor.

Shadow flicker intensity is defined as the difference in brightness at a given location in the alternating presence and absence of a shadow. Shadow flicker intensities diminish with increased distance from turbine to receptor and with lower visibility weather or atmospheric conditions such as haze or fog. Closer to a turbine the shadow will appear to be darker and wider as the rotors will block out a larger portion of sunrays. The shadow line will also be more defined. Further from the turbine the shadow will be less intense or lighter, and less distinct until the point is reached at which the human eye no longer perceives any shadow flicker effect.

The spatial relationship between a wind turbine and a receptor, as well as wind direction (due to the role in the position of the turbine) are key factors related to the amount of time any location might experience shadow-flicker. Shadow-flicker time is most commonly expressed in hours per year. Shadow flicker is most pronounced at distances from the turbine of less than 1,000 ft and during sunrise and sunset when the sun's angle is lower and the resulting shadows are longer (National Academies of Science, 2007). Shadow flicker is typically present at a receptor for short periods each day. The phenomenon is more prevalent in the winter than the summer due to the sun's lower position on the horizon in winter months in North America.

The analysis provided in this report does not evaluate the flicker intensity, but rather focuses on the total amount of time (hours and minutes per year) that shadow flicker can potentially occur at receptors regardless if the shadow flicker is barely noticeable or clearly distinct. As a result, it is likely that receptors will experience less shadow-flicker impact than modeled and reported, especially those that are further away from the turbines. It is likely that marginally affected receptors may not be able to identify shadow-flicker at all as the shadows become more diffuse with increased distance.

The speed of the rotor and the number of blades determine the frequency of the flicker of the shadow. The shadow-flicker results in this memo are based on the GE 2.5xl turbine, which has a 3-blade design and a turbine hub height of 85 meters. The diameter of the rotors is 100 meters. The rotor speed for this turbine will be between 6 and 16 RPM which translates in a maximum blade frequency of approximately .8 Hz (less than 1 alternation per second).

Modeling Approach

For the shadow flicker modeling a module of the WindPRO software has been used. WindPRO is accepted by the Maine Department of Environmental Protection for use in assessing shadow flicker impact. The computer model simulates the path of the sun over the course of the year and assesses at regular intervals the possible shadow flicker across a receptor. The color coded map that was produced by the computer model, shows a very conservative estimate of the number of hours per year that shadows could be cast by the rotation of the turbine blades.

A near worst case approach has been adopted for reporting the shadow flicker results. This worst case scenario includes the following assumptions for sun and wind:

- The sun is always shining, from sunrise to sunset.
- The rotor plane is always perpendicular to the line from the turbine to the sun. This means that the wind blows either directly from or towards the sun, and that the wind direction moves with the moving of the sun.
- The turbine is always operating.
- There is no intervening vegetation, clouds or fog
- Windows are situated in direct alignment with the turbine-to-sun line of sight. Even when windows are so aligned, the analysis does not account for the difference between windows in rooms with primary use and enjoyment (e.g. living rooms) and other less frequently occupied or un-occupied rooms or garages.

The shadow-flicker model uses the following input:

- Turbine locations
- Shadow flicker receptor (residence) locations (coordinates)
- USGS 1:24,000 topographic and USGS DEM (height contours)
- Turbine rotor diameter
- Turbine hub height
- Joint wind speed and direction frequency distribution
- Sunshine hours (long term monthly reference data)

The model calculates detailed shadow flicker results at each assessed receptor location and the amount of shadow-flicker (hours per year) everywhere surrounding the project. A receptor in the model is defined as a 1 square meter located 1 meter above ground level. This omni-directional approach produces shadow-flicker results at a receptor regardless of the direction of windows and provides similar results as a model with windows on various sides of the receptor.

The sun's path with respect to each turbine location is calculated by the software to determine the cast shadow paths every minute, daily over one full year. This calculation is done through straight trigonometry; a straight line from the sun through the turbine blade to a possible receptor. The model will calculate this line, regardless of the distance between the turbine and the receptor. Any atmospheric conditions are not taken into account.

The turbine run-time and direction (seen from the receptor) are calculated from the site's long-term wind speed and direction distribution.

Output from the model includes the following information:

- Calculated shadow-flicker time at selected receptors,
- Tabulated and plotted time of day with shadow flicker at receptors,
- Tabulated time of impact from each turbine at a receptor
- Map showing turbine locations, selected shadow-flicker receptors and color-coded contour lines indicating projected shadow-flicker time (hours per year).

In addition to the model's worst case evaluation, we also evaluated the model results using data that are reflective of typical conditions at the Highland Wind Project. The data used are local meteorological information on wind speed and direction, as well as cloud cover. Other model inputs remained the same. The data came from the following sources:

- Wind speeds and direction frequency distributions were acquired from the on-site meteorological towers,
- Sunshine hours, the time between sunrise and sundown for the area, was obtained from monthly reference data for the annual number of sunny or partly sunny days experienced in Caribou (the closest reporting station for the National Oceanic and Atmospheric Administration) in 2008.

The turbine run-time and direction (seen from the receptor) are calculated from the site's long-term wind speed and direction distribution, while the actual sunshine hours add the probability of sunshine during any given period. This calculation more accurately reflects the expected shadow-flicker time, though this approach still excludes the effect of intervening vegetation. Inclusion of vegetation or obstructions would further minimize the effects of shadow-flicker.

<u>Analysis</u>

As previously stated, the shadow-flicker model assumptions applied to this project are very conservative and as such, both the worst case and meteorologically adjusted results are expected to over-predict the impacts. Additionally, many of the modeled shadow flicker hours are expected to be of very low intensity.

Of the modeled 104 receptors, 2 have the potential to receive shadow flicker. All other modeled receptors do not show any impact of shadow flicker.

The statistics of the potentially impacted receptors are outlined below:

Flicker Receptor	Total shadow flicker time per year (hours;minutes) worst case	Expected total shadow flicker time per year (hours;minutes) weather corrected	Distance to nearest WTG with impact (feet)	Surrounding vegetation
A	45:20	9:15	2,755 (6W)	Wooded
CQ	33:34	7:16	3,307 (5W)	Wooded

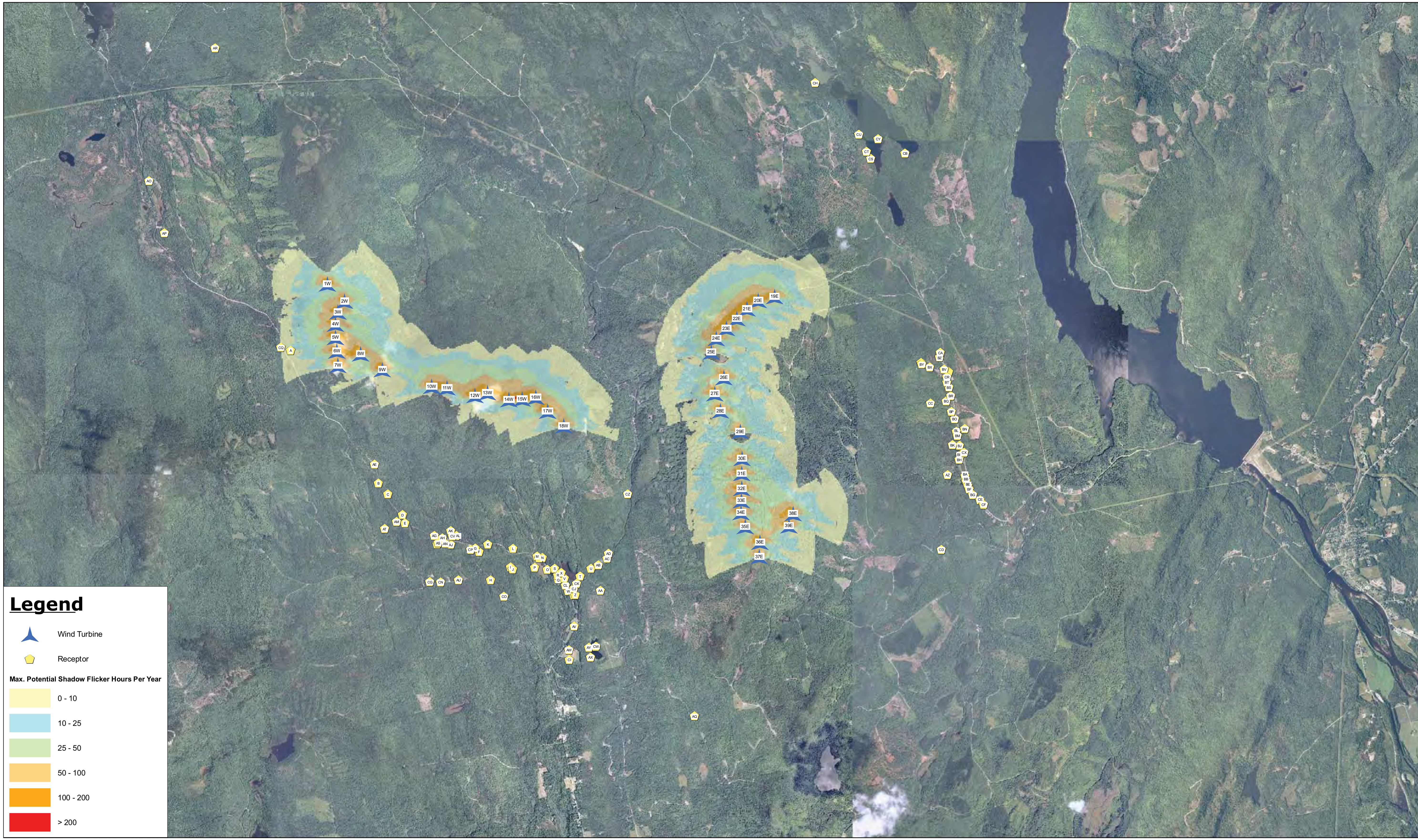
Standards

Maine statute provides that projects such as Highland Wind are subject to a requirement that they "… be designed and sited to avoid undue adverse shadow flicker effects." 38 M.R.S. § 484(10). Maine has not set any specific regulatory limits on exposure to shadow flicker. However, a general guideline of a maximum of 30 hours of *actual* calculated flicker has been recognized in the past.

The sun has to be at a very shallow angle to produce calculated shadow flicker beyond 1000 feet as previously stated. Both receptors are far beyond this distance at 2,755 and 3,307 feet respectively. At this distance the intensity of the shadow is not only greatly reduced, the possibility that vegetation in this heavily wooded area will block the changes in light intensity will be increased as well.

Conclusion

The calculated flicker effect on the 2 listed receptors is expected to be below the range of Maine's previously accepted guidelines off less than 30 hours per year. Furthermore, the area between the receptor sites and the turbine is heavily wooded. It is my opinion that potentially calculated shadow flicker will not pose an unreasonable adverse impact on the receptors identified in this report. For clarifications and more detailed analysis of expected influence at selected receptors, please do not hesitate to contact me.



Highland Wind Project
Highland PLT, Maine

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Stantec
Planning and Landscape Architecture, PC
141 Portland Street
Boston, MA 02114

Meteorologically Adjusted Shadow Flicker Study

November 2010

Data Source: Aerial from 2007 National Agriculture Imagery Program (NAIP) aerial orthoimagery

Section 18
Operational Monitoring

18.0 OPERATIONAL MONITORING

Highland Wind LLC (Highland) proposes the following operational monitoring protocol at the Highland Wind Project (Project). The purpose of these proposed monitoring protocols is 1) to assess the wildlife impacts designated herein, and 2) to detail vegetation management during the course of the Project's operational life.

Operational monitoring will include:

- Bird and bat casualty assessment;
- Bog lemming habitat assessment; and
- Vegetation Management Plan.

18.1 Bird and Bat Casualty Assessment

18.1.1 Background

The proposed protocol is to base the final assessment methodology on evolving methods associated with post-construction assessment, including the most recent assessments at Mars Hill and Stetson Mountain. It is the Applicant's intent to consult with the Maine Department of Inland Fisheries and Wildlife (MDIFW) and the U.S. Fish and Wildlife Service (USFWS) to ensure that, at the time this assessment is executed, the most current survey methodology is employed at the Project. Consultation also will help define a specific assessment schedule.

This post-construction monitoring protocol is based upon similar post-construction monitoring plans developed for other existing or proposed wind development projects in the northeast. In addition, this plan was developed in consideration of the draft guidance of the Maine Wind Power Advisory Group. This draft guidance includes contributions by several recognized experts in the field of wind energy and wildlife interaction and other state-sponsored wind-wildlife survey protocols (e.g., the Pennsylvania Game Commission's post-construction monitoring protocols). Finally, other recent studies of bird and bat fatalities at wind power projects in the United States and Europe were reviewed with regard to methods and search techniques (e.g., Arnett *et al*. 2008, Arnett 2005, Kerns and Kerlinger 2004, Barrios and Rodriguez 2004, de Lucas *et al*. 2004, Krewitt and Nitchs 2003, and Osborn *et al.* 2000). The following does not necessarily represent all post-construction monitoring methods that could be employed, but does represent the recent requirements for wind development projects in Maine. Additional surveys, if required, will be developed through consultation with MDIFW biologists.

18.1.2 Proposed Casualty Monitoring Protocol

At a minimum, Highland proposes to fund and conduct the following wildlife casualty monitoring protocols during Year 1 of operation:

1) Standardized searches during peak activity periods for birds and bats (spring migration, summer nesting and pup-rearing, late-summer swarming, and fall migration);
2) Searcher efficiency trials to estimate the percentage of carcasses found by searchers in each habitat surrounding the turbines; and
3) Carcass removal trials to estimate the length of time that carcasses remain in the field for possible detection.

These monitoring protocols are consistent with those approved for and employed at other wind development projects in Maine and in the northeast. Other survey methods also will be employed during Year 1. These methods will include documentation of casualties outside the standard search plots and monitoring of weather conditions. A more detailed work scope for these surveys will be developed in consultation with the MDIFW and USFWS between the time that construction is initiated and the first spring survey period that occurs after operation. This will allow for the incorporation of survey results from post-construction monitoring at other wind development projects in Maine, including the Mars Hill

Wind Project and the Stetson Mountain Wind Farm, and also data collected at other operating facilities in northern New England such as the Lempster Mountain Wind Project.

In addition, Highland proposes to conduct follow-up monitoring in Years 3 and 5. The scope and timing of the follow-up monitoring will be determined through consultation with the MDIFW and USFWS with consideration given to current research priorities within the industry and the region, as well as the results of the first year of monitoring at the Project; therefore, the scope and timing are not addressed in any additional detail in this document.

Year One Monitoring Protocol

Standardized Searches

Monitoring will involve regular, systematic searches by trained technicians of the area beneath each turbine and the guyed meteorological (met) towers. Plots will be searched by walking parallel transects located at regular intervals across the turbine laydown area. Initially, transects will be set at 6 to 8 meters (20 to 26 feet) apart. A searcher will walk at a rate of approximately 45 to 60 meters (148-197 feet) a minute along each transect and will search both sides of the transect for casualties. The search area will extend approximately 3 to 4 meters (10-13 feet) on each side of the transect. Depending upon whether casualties are found, it should take an average of 60 minutes to search each plot and then travel to the next. The distance between transects will be modified, if needed, based on vegetation development within the plots.

All casualties found will be documented on standardized field forms, photographed, and collected. If a state- or federally-listed species is collected, it will be reported within 24 hours of identification. The type of observation or condition of carcasses will be recorded, such as intact carcass, scavenged, or feather spot. From the location of the carcass, a bearing to the wind turbine will be recorded, and the distance to the turbine will be determined using a laser range finder.

Casualties found incidentally during normal on-site operations at the Project will also be recorded and collected. Operations personnel will be instructed on the proper handling and notification requirements for these occurrences.

Schedule and Search Effort

Monitoring will be conducted during the first full year following completion and initial operation of the Project. The need for subsequent survey efforts will be evaluated based upon the number of casualties documented during the initial year of survey, indications of correlations between casualties and weather, or indications of correlations between casualties and bird or bat activity.

Four distinct survey periods will occur. The timing of these periods will result in a total of 24 consecutive weeks of surveys. These survey periods are as follows.

- April 15 – May 31 for spring migration
- June 1 – July 14 for summer bird nesting and bat pup-rearing
- July 15 – August 15 for late-summer bat activity
- August 15 – October 15 for fall bird and bat migration

During each time period, all turbines will be searched weekly. Additionally, the cleared area under one of the met towers, which primarily lies directly underneath the guy wires, will be searched once per week.

Search Plot Sizes

Casualties from turbine strikes may be found at considerable distances from the base of the turbine. In some instances, casualties have been found at distances equal to or greater than the total height of the turbine and rotor, in the range of 300 to 400 feet (Erickson *et al*. 2004, 2003 and 2000, Johnson *et al*. 2000a and 2000b). Survey plots to cover this range could include a substantial area of forest cover (primarily recently-selection cut areas) and, in some instances, steep terrain beyond clearing needed for the individual turbines. Because the Project is considering turbines that demand different minimum turbine clearings and pads, the ultimate search extent beyond the reach of the clearing will need to be determined in consultation with the resource agencies. Further, because the cover and terrain in these forested settings are distinctly different from many of the published studies conducted at existing projects in the western United States, which are located in relatively level agricultural landscapes, the plot sizes will need be adjusted for landscapes based on best available information.

As noted in the draft Maine Audubon guidelines, conducting searches at an equivalent level of intensity to those conducted on level landscapes may simply be impractical in hilly and forested terrain. For similar reasons, Kerns *et al*. (2005) scaled down their search areas in consideration of existing site constraints. The landscape limitations on search plot sizes are somewhat offset by the fact that, in mountainous terrain, the majority of fatalities are being found much closer to the turbines than in level landscapes. For example, working at the Meyersdale project in Pennsylvania, Kerns and Kerlinger (2004) reported that the majority of bird and bat fatalities were found within approximately 30 meters (100 feet) of the turbine bases, and Kerns *et al.* (2005) reported that greater than 80 percent of bat fatalities were found within 40 meters (131 feet) of turbines at Meyersdale, Pennsylvania and Mountaineer, West Virginia.

In light of the above, the Applicant is considering tailoring the monitoring methods at the Project such that the standardized searches will focus on monitoring the cleared and leveled lay-down areas around each turbine and then applying a correction factor to account for fatalities that fall outside of the smaller search plots. The methods for calculating this correction factor will be determined through further discussions with MDIFW and USFWS and will incorporate the ongoing survey results targeting this issue at the Mars Hill Wind Farm.

<u>Search Timing and Frequency</u>

As noted above, systematic searches will be conducted weekly at all turbines and one met tower during four survey periods. These survey periods are essentially consecutive time periods ranging from four to eight weeks in length that represent different time periods in the activity and habits of birds and bats. The result will be approximately 24 weeks of consecutive casualty monitoring and a total of 1,152 individual turbine searches and 24 met tower searches.

<u>Searcher Efficiency Trials</u>

Searcher efficiency trials will be conducted in the Project search areas to estimate the percentage of avian and bat casualties that are found by searchers. The trials will consist of periodic manual placement of carcasses at the search turbines the night before searches occur. Carcasses will be placed within all available ‘search habitats’ under the turbines, including the gravel access way immediately surrounding each turbine and the restored (loamed, seeded, and mulched) portions of the lay-down areas. Searchers will not have prior notification as to when these trials will occur. Over the course of the full survey period, approximately 25 to 50 carcasses (up to 25 birds and up to 25 bats, if possible) will be placed in the search plots. The number of carcasses placed for searcher efficiency trials will be modified, if necessary, based on the number of searchers used over the course of the surveys.

The carcasses used for these trials will be obtained during earlier searches at the Project or other facilities. Trial carcasses will be marked with a small piece of black electrical tape placed around the animal’s leg. If too few carcasses are available, then substitute species similar in size to native species will be obtained. Estimates of searcher efficiency will be used to adjust for detection bias using methods similar to Kerns *et al.* (2005).

<u>Carcass Removal Trials</u>

Two carcass removal trials will be performed during the survey, one in spring and one in fall. These will be conducted independently of the searcher efficiency trials. The objective will be to estimate the percentage of bird and bat fatalities that disappear from study plots due to scavengers. Estimates of carcass removal will be used to adjust the number of carcasses found, thereby correcting for the effects of scavengers.

For each trial, a minimum of 6 carcasses, up to 25 carcasses (species composition as noted for searcher efficiency trials), will be placed near search plots. These carcasses will not be placed within search plots to avoid contamination from blowing feathers or similar effects. Carcasses will be checked on days 1, 2, 3, 4, 5, 7, 10, and 14, or until all evidence of the carcass is absent. On day 14, carcasses, feathers, or parts will be retrieved and properly discarded.

Weather Data Collection

Weather conditions will be recorded throughout the duration of the survey effort to evaluate if there are correlations between weather and the number of casualties. Weather parameters, including wind speed and wind direction, will be recorded at the on-site met towers or at the wind turbines. Temperature at or near hub height and near the ground also will be recorded. Additional measurements, including barometric pressure, relative humidity, and precipitation, will be recorded.

Reporting

A report will be provided after the full year (i.e., spring and fall) of monitoring. The report will summarize the methods and results of the post-construction avian and bat assessment surveys. For the nocturnal radar surveys, if deemed necessary, the report will include information on passage rates, mean flight direction, and flight altitude for each season. These results will be compared to the two seasons of pre-construction monitoring. For the casualty monitoring, the report will include estimates of the total number of wind turbine-related fatalities based on five components: 1) observed number of carcasses; 2) searcher efficiency expressed as the proportion of trial carcasses found by searchers; 3) removal rates expressed as the length of time a carcass remains in the study area and is available for detection by searchers; 4) factors such as the proportion of casualties likely to land or move outside the plot (e.g., forested conditions beyond the cleared area surrounding turbines); and 5) an estimate number of carcasses found by observers where cause of death could not be attributed to wind energy development, and calculations of the number of bird and bat fatalities on a per turbine per year basis or other possible measurement methods (i.e., per megawatt per year). Stantec intends to use the calculation methods are presented in Kerns *et al*. (2005).

18.2 Bog Lemming Habitat Assessment

Stantec conducted initial surveys of suitable habitats within the Project area to identify those habitats with bog lemming activity. These surveys were conducted in July of 2009 and bog lemming activity was documented in three wetlands: W011, W067, and W134 (Refer to Section 14, Appendix 14-2). Methods used to determine the presence of bog lemmings involved documenting indirect evidence, including runways and tunnels through the peat moss (*Sphagnum* spp.), browse and clippings on graminoid vegetation, and fecal pellets. Such indirect evidence indicates the presence of one of the two bog lemming species, but does not distinguish between the northern bog lemming (*Synaptomys borealis*) and southern bog lemming (*Synaptomys cooperi*). Because identification of these two species requires trapping to observe dental characteristics, all indirect evidence was conservatively presumed to reflect the presence of the northern bog lemming.

Based upon results of these surveys and the Project location, biologists from MDIFW suggested that additional surveys, both pre- and post-construction, would be appropriate at wetlands W67 and W134. The intent of these surveys would be to assess bog lemming activity before and after the Project is constructed and operational. These surveys may go beyond those initially conducted to determine species presence, but because so little is known about the northern bog lemming, such methods have not yet been developed. Through consultation with MDIFW biologists, survey methodology will be developed to assess activity level (i.e., pellet or runway counts along established transects) and to track potential changes in habitat quality (i.e., documentation of sedimentation or changes in wetland hydrology). A Project-specific work plan will be developed and surveys and reporting will follow this plan.

18.3 Vegetation Management Plan and Invasive Species Control Plan

The Project is carefully designed to utilize existing roads and clearings where possible. The electrical collector system will be buried within the shoulder of Project roads along the ridgelines, and then will occur as overhead lines that will be located in newly created corridors as these lines approach the collector substation. The electrical generator lead will be located within a newly created overland corridor for a portion of its length, but will parallel an existing Central Maine Power Company transmission line corridor for its majority.

The Project will, however, require additional vegetation clearing and soil disturbance (i.e., grading and filling). The areas of clearing and soil disturbance occur principally in relatively undeveloped forest land that is managed for timber production. Clearings for roads and turbine pads will be larger in the construction period than needed for the operational period, so much of this initially cleared area will be allowed to naturally revegetate.

Highland has prepared this Post-Construction Vegetation Maintenance Plan (VMP) and associated Invasive Species Control Plan (ISCP) to present maintenance requirements for natural resources that occur in proximity to Project components. These plans address requests from the MDIFW that Highland provide a VMP, and the US Army Corps of Engineers (Corps) Maine General Permit requirement for the inclusion of an ISPC in all Category 2 applications. These plans are intended to be used in conjunction with the Project construction drawings, which identify the locations of the natural resources where maintenance restrictions apply. The requirements of these plans apply to routine maintenance and are not intended to apply to emergency maintenance and repair actions. Regular vegetation management is only expected to be required within electrical corridors with less frequent maintenance required for turbine and met tower clearings.

The natural resources that occur within or in proximity to the Project area and are subject to this VMP are:

- Wetlands and waterbodies;
- Streams; and
- Vernal pools.

18.3.1 Typical Vegetation Maintenance Procedures

Electrical Corridors:
Highland will engage in routine management of woody vegetation within the electrical corridor. Specifically, the Applicant will practice a type of vegetation management called Integrated Vegetation Management, which uses a combination of hand-cutting and selective herbicide applications. In unusual circumstances, where typical procedures are not sufficient, mechanical mowing may be used to regain control of the vegetation.

While vegetation will be left in place to the extent practical during construction and maintenance, large trees will be removed from the new electrical corridors during the initial phase of construction and prior to the actual installation of poles. During operation, maintenance activities will entail only the selective removal of dead trees, "capable species," and "danger trees." Capable species are defined as those plant species that are capable of growing into the conductor safety zone during the typical vegetation management cycle. Because the sag of electric transmission lines between the poles varies with the distance between poles, tension on the wire, electrical load, air temperature and other variable conditions, the appropriate clearance is typically achieved by removing all capable species and topping other vegetation exceeding 8 to 10 feet tall.

Once the vegetation in an area is brought under control (usually 3-4 years following construction), maintenance generally will occur on a four-year or five-year maintenance cycle depending on growth, weather, geographic location, and corridor width. Significant branches that overhang the right-of-way (ROW) and any dead or damaged trees outside of the ROW that could contact the power lines or come within 15 feet of a conductor ("danger trees") may be removed as soon as they are identified.

The following procedures will be implemented during vegetation maintenance activities along electrical corridors. The intent of these procedures is to protect sensitive natural resources.

- Areas of significant soil disturbance will be stabilized and reseeded immediately following completion of maintenance activity in the area.
- Equipment access through wetlands or over waterbodies will be avoided as much as practicable

by utilizing existing public or private access roads, with landowner approval where required.

- Waterbodies will be protected during maintenance. Bridge mats, low ground pressure (tracked) vehicles, or other methods will be used to span waterbodies to prevent excessive rutting and disturbance.
- Construction mats or equivalent for equipment support will be used if saturated soils are present.
- Rutting or significant damage to wetland or waterbody bank vegetation, if any, will be repaired immediately following completion of maintenance activities in the area.

Turbine and Met Tower Clearings:
Vegetation maintenance within turbine and met tower clearings will occur as needed rather than on an established schedule. During construction, all woody vegetation will be removed from the clearings and each area will be graded. Maintenance inspections conducted at each structure will involve periodically checking clearings for dead trees, danger tress, and woody vegetation that could affect the safety or operation of turbines or met towers. Similar to maintenance within the electrical corridors, maintenance within these clearings will require the removal of those types of vegetation. Access for maintenance activities at the turbine and met clearings will occur from Project roads; therefore, impacts to sensitive natural resources should not occur. However, if necessary, the bullet point procedures listed above will be followed.

8.3.1.1 *Mechanical Techniques*

During routine vegetation maintenance of electrical corridors, the primary technique to control vegetation will be hand-cutting, with limited use of motorized equipment in areas that are directly accessible from public or private access roads. The procedure will be to cut all capable species and any dead or danger trees at ground level except in waterbody buffer zones (Refer to Sections 3.0 and 4.0 for stream and vernal pool standards). All large vegetation cut during routine maintenance will be removed, chipped or flailed on-site or otherwise handled in accordance with the Maine Slash Law.

Periodic maintenance in turbine and met tower clearings will be conducted principally by hand-cutting. Dead trees, danger trees, and other trees that could affect the operation or safety of these structures will be cut at ground level and will be handled in accordance with Maine Slash Law.

8.3.1.2 *Use of Herbicides*

Herbicide application within the electrical corridors will be used in conjunction with the mechanical or hand-cutting methods of vegetation maintenance. Herbicides will be applied to target species by directional spraying using a low-volume foliar application. In addition, herbicides may be applied to cut stumps and surfaces of larger trees. The direct application to individual plant species will control only the targeted woody vegetation, leaving low-growing plants such as grasses, forbs, and shrubs to persist. Selective herbicides such as those that target broad-leaved woody vegetation also will be used to minimize the impacts to non-target species. Aerial applications will not be performed. Only herbicides that are registered with and approved by the U.S. Environmental Protection Agency (EPA-approved) and the Maine Board of Pesticides Control (BPC) will be used.

Typically, the electrical corridors will receive herbicide treatment the year following construction and then again two to three years after construction to gain control of vegetation growth. When control is achieved, treatment will occur on the standard four-year to five-year cycle or as needed. By utilizing selective herbicides and application methods, dense low-growing plant communities will eventually become established, which will impede the growth of woody vegetation and thereby reduce the need for future control efforts.

Herbicide application is not anticipated for vegetation management within turbine or met tower clearings.

The following procedures will be implemented during vegetation maintenance activities utilizing herbicides.

- Herbicides will be used in strict accordance with the manufacturer's EPA-approved labeling and will not be applied directly to water or areas where surface water is present.
- Herbicides will not be applied, mixed, transferred or stored within the designated buffers, or applied within 25 feet of intermittent streams or wetlands that have water present at the surface.
- Herbicides will not be applied, mixed, transferred or stored within 250 feet of perennial streams to protect potential habitat of northern spring salamander (*Gyrinophilus porphyriticus*) and Roaring Brook mayfly (*Eperonus frisoni*).
- Herbicides will not be applied, mixed, transferred or stored within 100 feet of vernal pool depressions (whether there is standing water present or not).
- Herbicides will not be applied, mixed, transferred or stored over significant sand and gravel aquifers.
- Herbicides will not be applied, mixed, transferred or stored within 100 feet of any known private well or spring or within 100 feet of a home or other human dwelling.
- Herbicides with a low potential for mobility and low persistence in the environment will be utilized in sensitive areas such as wetlands.
- Herbicides will not be applied to any area when it is raining or when wind speed exceeds 15 miles per hour as measured on-site at the time of application.
- The foreman of every crew using herbicides will be licensed by the Maine BPC and will remain in eye contact and within earshot of all persons on his/her crew applying herbicides. At least one individual from any company applying herbicides also must hold a Commercial Master License issued by the BPC and must be in Maine during any application. Application of pesticides will be in accordance with applicable regulations promulgated under the Maine Pesticides Control Act.
- The chemicals are typically mixed in a truck-mounted tank that stays on the access roads. The application is done by personnel with backpacks who travel along the corridor by all-terrain vehicle or on foot and spot-treat target species.
- Each target tree is sprayed just enough to wet the foliage while avoiding any dripping or run-off.

The location of all streams, wetlands and vernal pools crossed by the electrical corridors will be shown on the As-Built Plan and Profile drawings. Crew leaders will be responsible for having all resources and buffers located and properly delineated on the ground for clear identification by the applicators.

18.3.2 Vegetation Maintenance within Stream Buffers

Highland has chosen to conservatively treat all perennial streams as potential habitat for the Roaring Brook mayfly, a state-listed endangered species, although this species was only documented from two of the surveyed streams within the Project area. Appendix B of Chapter 375, No Adverse Environmental Effect Standard of the Site Location Law, calls for a 100-foot buffer on Class A, AA, outstanding river segments, cold water streams or streams that contain threatened or endangered species. Accordingly, a 100-foot buffer, as measured from the top of bank on each side, will be established for all perennial streams crossed by the electrical lines. To the extent practicable, each intermittent stream will have an established 25-foot buffer, as measured from the top of bank on each side. Special procedures and restricted activities will apply within these stream buffers during construction and operational vegetation maintenance. Vegetation maintenance within stream buffers is typically conducted on a three-year or four-year cycle, depending on growth and vegetation. This section describes the restrictions related to vegetation cutting and maintenance that will apply within all standard stream buffers. The location of all streams crossed by the line also will be shown on the construction drawings with a designation as to whether the stream is perennial or intermittent. Note that the vegetation maintenance procedures and restrictions that apply to typical electrical corridor maintenance also apply within stream buffers.

No vegetation management within stream buffers is anticipated in association with turbine or met tower clearings.

18.3.2.1 *Additional Vegetation Maintenance Restrictions within Stream Buffers*

The following additional restrictions apply to vegetation maintenance within the stream buffers.

- Prior to line construction and during vegetation maintenance after construction, only capable species vegetation greater than eight feet will be removed. No other vegetation, other than dead or danger trees, will be removed.
- Under most terrain conditions, removal of capable species, dead, or danger trees will be accomplished by hand-cutting or by traveling into the buffer zone with low pressure tree harvesting equipment and mats as necessary.
- No herbicides will be used, stored, mixed or transferred between containers within the buffer areas.
- No refueling or maintenance of equipment, including chain saws, will occur within the buffer areas.
- No accumulation of slash will be left within 50 feet of the edge of any stream.

The additional restrictions on vegetation maintenance within stream buffers will allow taller vegetation to provide additional shading and reduce the warming effect of direct sunlight (insulation). Low ground cover also will remain to filter sediment in surface runoff. As a result, the buffers will continue to function in a similar manner as they did before construction. These restrictions also are intended to minimize ground disturbance and ensure that herbicides and petroleum products are not able to reach the stream via either surface runoff or groundwater transport.

18.3.3 Vegetation Maintenance at Vernal Pool Locations

All vernal pools identified within the electrical corridors will receive a 100-foot vegetation management buffer. Vernal pool locations will be shown on the construction drawings. No vegetation management within vernal pool buffers is anticipated in association with turbine or met tower clearings.

Vegetation maintenance within 100 feet of vernal pools within the electrical corridors will consist of cutting all capable species and topping other vegetation that may interfere with the 15-foot clearance between conductor and vegetation. Removal will be accomplished by hand-cutting only, with limited use of motorized equipment in areas that are directly accessible from public or private access roads or from the middle access way established during initial clearing. The use of mechanized equipment will not be allowed within the vernal pool depression. No herbicide use will be allowed within 100 feet of the pool depressions.

The following additional restrictions apply to vegetation maintenance within the vernal pool buffers:

- Prior to line construction and during vegetation maintenance after construction, only capable species vegetation greater than eight feet will be removed. No other vegetation, other than dead or danger trees, will be removed.
- Under most terrain conditions, removal of capable species, dead, or danger trees will be accomplished by hand-cutting or by traveling into the buffer zone with low pressure tree harvesting equipment and mats as necessary.
- No herbicides will be used, stored, mixed or transferred between containers within the buffer areas.
- No refueling or maintenance of equipment, including chain saws, will occur within the buffer areas.
- No accumulation of slash will be left within 50 feet of the edge of any vernal pool.
- Between April 1 and June 30, no vegetation management may occur within 100 feet of the vernal pool depression.
- Between April 1 and June 30, vegetation management in the critical terrestrial habitat from 100 to 250 feet of the vernal pool depression will be conducted using hand tools only.

18.3.4 System for Locating/Marking Restricted Areas

Prior to conducting maintenance activities along the electrical corridors, a foreman or supervisor will identify restricted areas with flagging or signage. The location of sensitive natural resource such as streams, wetlands and vernal pools that were identified during pre-construction surveys will be referenced to the nearest structure (pole) or road. Structures will be numbered at the time of construction, and in some instances, signage related to natural resources or their associated buffers will be attached to these structures. The structure numbers, sensitive natural resources and buffers will be included on the construction drawings, which will enable maintenance contractors to locate and these resources in the field. The distance and direction from the nearest structure to the sensitive area will be included with the structure number. That data will then be incorporated in this VMP. Maintenance contractors will be given the VMP prior to receiving the required environmental training.

18.3.5 Training of Maintenance Personnel

This section summarizes the environmental training that will be required for personnel with maintenance responsibilities.

18.3.5.1 *Personnel and Schedule*

Highland personnel and contractors who will be participating in vegetation maintenance activities within the electrical corridors will receive appropriate environmental training before beginning work. The level of training will be commensurate with the type of duties of the personnel. Newly hired or replacement or personnel will receive similar training prior to performing any maintenance activities.

18.3.5.2 *Content of Training Sessions*

Prior to receiving maintenance training, each participant will be required to undergo environmental training, which will require review this Post-Construction VMP. The training session will consist of a review of all protected resources and restricted areas, the respective maintenance requirements and restrictions for each, and a review of how these areas and resources can be located in the field (relative to the nearest numbered structure). Training will include familiarization with and use of the construction drawings in conjunction with the contents of this VMP, as well as basic causes and preventive and remedial measures for contamination, erosion and sedimentation of water resources. Training also will include a review of safety, clean-up, monitoring, and reporting requirements.

18.3.6 Invasive Species Control Plan

This ISCP addresses the anticipated procedures for managing invasive plant species within the proposed development area. The majority of the proposed development will occur within forested uplands, but there also will be fill and clearing impacts within wetlands. Vegetation clearing will be required for the construction of the turbines, roads, the electrical collector line, and the electrical generator lead. Those areas subject to clearing could be susceptible to colonization by invasive plant species. Invasive species are a potential threat to wetland functions, so this plan is directed towards protecting and maintaining those functions.

18.3.6.1 *Management Plan Objectives*

The overall goal of this ISCP is to preserve the functions and values of the wetlands within the Project area. While complete eradication of invasive species is not a stated goal, this ISCP is intended to limit the spread of these species as much as possible. The ISCP includes the following steps:

- Develop a baseline for future monitoring by identifying locations in the turbine areas and along roads and the electrical corridors in which invasive species presently exist;
- Provide a plan for monitoring the status of invasive species within the Project area and coordinate with the relevant agencies regarding the results of the monitoring;

- Identify appropriate strategies (e.g., mechanical cutting, herbicide application, biological control, or a combination thereof) for controlling and/or limiting the spread of invasive species within the turbine areas, along roads, and along the electrical corridors; and
- Incorporate these invasive plant species control strategies into the proposed vegetation management plan for the Project.

18.3.6.2 *Invasive Species Background*

Invasive plants are non-native species that, when introduced to an area, cause or are likely to cause environmental or economic harm. Invasive plants often lack natural predators in the area, and can therefore successfully colonize and thrive beyond their natural ranges without competition, often out-competing native plants. Generally, these species have competitive adaptations, aggressive reproductive strategies, and efficient dispersal methods. The spread of invasive plant species in both wetland and upland areas is a concern for both biological reasons (e.g., threaten global biodiversity, reduce wildlife habitat value) and cultural/economic reasons (e.g., adverse aesthetic effects, reduced recreational opportunities).

The Maine Natural Areas Program (MNAP) maintains a list of invasive plants known to be present in Maine. Table 1 below presents the invasive species with the highest likelihood of occurring within the Project area based upon MNAP's list and field surveys conducted by Stantec within the Project area.

Table 1. Invasive Plant Species with Highest Likelihood of Occurring within the Highland Project Area

Common Name	Scientific Name
Norway Maple	*Acer platanoides*
Garlic Mustard	*Alliaria petiolata*
Japanese Barberry	*Berberis thunbergii*
Oriental Bittersweet	*Celastrus orbiculatus*
Russian Olive	*Eleagnus angustifolia*
Autumn Olive	*Eleagnus umbellata*
Japanese Knotweed	*Fallopia japonica*
Glossy Buckthorn	*Frangula alnus*
Morrow's Honeysuckle	*Lonicera morrowii*
Tatarian Honeysuckle	*Lonicera tatarica*
Purple Loosestrife	*Lythrum salicaria*
Common Reed	*Phragmites australis*
Wood Bluegrass	*Poa nemoralis*
Common Buckthorn	*Rhamnus cathartica*
Multiflora Rose	*Rosa multiflora*

18.3.6.3 *Existing Conditions*

During 2008, 2009, and 2010, Stantec performed wetland delineations, vernal pool surveys, and rare, threatened, and endangered (RTE) species surveys within the Project area. The results of these surveys are provided in Section 14 of this permit application. During the course of each survey, Stantec staff recorded notes on plant species observed within the various upland and wetland communities. Generally, these notes focused on dominant plant species, but also included less common species. Invasive species would have been included if observations had occurred. Based upon these field notes, no invasive species were observed within the Project area. The general lack of invasive plant species can be attributed to the relatively undeveloped landscape within and surrounding the Project area.

18.3.6.4 *Invasive Species Monitoring Program*

Goals and Objectives

Highland is committed to performing monitoring to assess the status of invasive species within the Project area and to identify areas where invasive species control measures will be required to protect and maintain wetland functions. This monitoring program will target the invasive species identified in Table 1 and will provide recommendations that will be used to select and implement appropriate control options for each invasive species.

The objectives of the monitoring program will be to:

- Update the status of invasive species within the Project area to target those areas where control measures will be required;
- Define the types of control measures that are most appropriate for each invasive species; and
- Provide input to implement invasive species control measures.

Methods

Invasive species monitoring within the Project area will be conducted in the first year following the complete development of Project and for four years thereafter (i.e., a total of five years of annual monitoring). If densities of invasive species are found to be low during the first two years of monitoring, monitoring frequency may be reduced to every other year. The goal of the five-year monitoring effort will be to identify locations where invasive species are present so that control measures can be implemented as soon as practical. The five years of monitoring also will allow for an evaluation of the effectiveness of the control measures. After the completion of five years of monitoring and treatments, this ISCP will be integrated into the Applicant's VMP (see above). Once incorporated into the VMP, this invasive species monitoring program should occur in the year prior to routine vegetation maintenance work along the electrical corridors so that treatment recommendations can be included with the regular maintenance effort. A similar but less structured timeline would be applied to maintenance within turbine and met tower clearings. Over time, as invasive species control becomes a standard component of the VMP, monitoring and control schedules may be adjusted to respond to site-specific issues (e.g., monitoring less frequently as densities decrease, instituting treatment in consecutive years to control an aggressive population).

The Applicant will retain a qualified, independent researcher to conduct the monitoring program, which will consist of field surveys of the Project area to determine whether invasive species are present and to provide recommendations concerning control options. When locating invasive species, researchers will complete invasive species monitoring forms and take representative photographs. Any conditions that would influence the viability of a particular type of invasive control method also will be noted. Field surveys will be conducted during the growing season when plant species are most easily identifiable. The monitoring effort will be scheduled to allow time for invasive species treatments to be implemented in the same growing season.

Monitoring Report

The results of each year of invasive species monitoring will be detailed in a brief report that will include a summary of the field results, a table and map that identifies the locations of invasive species in the turbine areas, met tower clearings or in the collector line, copies of the monitoring forms, and representative photos. Comparisons will be made as to whether invasive species are becoming more or less prevalent, based on a review of the pre-construction data and on the results of the previous year's monitoring results. The monitoring report will include recommendations regarding where invasive species control measures are required, the suggested type of control strategy, and the schedule for the implementation of control measures.

During the first five years of monitoring, reports will be submitted annually. The monitoring report will be provided to the Corps and LURC by March 31 of the year following the year in which the monitoring was conducted (e.g., for monitoring conducted in the summer of 2011, the monitoring report will be submitted by March 31, 2012). If it is determined that monitoring will not be required every year, reports will only be submitted in years when monitoring has occurred. If requested, the Applicant and its contractors will be available to meet with the involved agencies to review the results of the invasive species monitoring and control program. The purpose of the meetings would be to assess the status of the program and the effectiveness of the monitoring and control methods.

Implementation of invasive species control measures will be based on the results of the monitoring and will not require approval from the regulatory agencies. The application of control measures will be performed pursuant to any standard permit and safety requirements governing such activities.

18.3.6.5 *Invasive Species Control Strategies*

Goals and Objectives

To develop an effective approach for controlling invasive species within the project area, various factors must be considered. These include:

- The characteristics and functions/values of the wetlands and uplands in the project area;
- The invasive species that are present and their density within the project area;
- Sensitive areas along the collector line ROW, including wetlands, streams, vernal pools, RTE species, wildlife habitat, sand and gravel aquifers, and visual buffers;
- Adjacent land use developments, which can affect the value of wetlands on the collector line ROW and can influence the choice of control strategies; and
- The cooperation of the landowner and the potential lack of complete land use control, depending on the conditions of the ROW easements across private properties.

As a result of these factors, it should be recognized that invasive species control measures may not be practical or highly effective in all areas along the collector line ROW. Additionally, complete eradication of invasive species is unlikely given the aggressive nature of most invasive species.

Types of Control

In general, there are three types of invasive species control methods: mechanical, chemical, and biological. These control methods may be combined to provide a more effective control strategy.

Mechanical control measures such as digging, pulling, and cutting may be effective in controlling isolated invasive plants or small stands of plants. However, such techniques may be labor-intensive and may be impractical in areas with dense infestations of invasive species such as common reed, purple loosestrife, and garlic mustard.

Chemical control (herbicides) is the most common alternative used for controlling invasive species. If used selectively and in limited areas (i.e., not in wetlands with standing water or in streams), herbicides can be successfully applied in an environmentally-sound manner. In addition, herbicide applications often provide the most cost-effective method for controlling dense infestations of invasive species.

Biological controls can be effective in controlling purple loosestrife under certain conditions but are not yet proven for the control of other species. Consultation with the Corps indicates that species such as loosestrife beetles (*Galerucella calmariensis* and *Galerucella pusilla*) may be useful in controlling purple loosestrife. At this time, purple loosestrife has not been identified within the Project area, and the use of loosestrife beetles is unlikely to be recommended for this Project.

Control of Existing Invasive Species

While no invasive species were observed in the Project area, the Applicant will be prepared to implement control methods should invasive species be detected during construction. Measures such as cleaning construction equipment and construction mats, stockpiling contaminated soil, and inspections of construction vehicles will be implemented immediately if populations of invasive species are encountered within the Project area.

Schedule for Implementation of Invasive Species Controls

Following construction, the Applicant recognizes that early treatment measures can prevent the spread of invasive species, particularly in areas where such species were not present prior to construction of the project. As a result, the Applicant will implement an aggressive invasive species control approach in the first five years immediately following the completion of construction. Particular treatment efforts will focus on preserving the functions and values of the wetlands in the Project area.

Based on the results of the monitoring program conducted in each of the first five years after construction, the Applicant will schedule invasive species treatment measures annually, as soon as practical after the field monitoring recommendations are received. The schedule for the treatment will depend on the types of controls recommended. For example, mechanical removal of certain species can be performed almost any time of the year when plant species are identifiable, while herbicide applications and biological controls require that work be done during the growing season to be most effective. Over time, the Applicant expects that the invasive species treatment program will be integrated into the overall Project VMP.

Depending on the results of the monitoring, the Applicant may contract a field biologist or wetland scientist to work with its management contractor to oversee the implementation of invasive species control measures, to recommend methods for maximizing the potential re-establishment of native vegetation, and to suggest wetland plantings to enhance habitat values. For locations where invasive species controls are implemented, monitoring performed in subsequent years will serve to assess the effectiveness of such measures.

Control Strategies

Although specific treatments will be refined based on the results of the monitoring program, it is anticipated that the most effective general approach for controlling invasive species within the Project area will likely be a combination of mechanical removal and application of herbicides in selected locations during the growing season. Repeated spot herbicide applications may be required in subsequent growing seasons in order to achieve effective control. Based on the lack of invasive species documented in the Project area, large-scale control is not anticipated.

The need for and types of chemical control of invasive species will be carefully evaluated, particularly in sensitive areas such as wetlands, streams, and vernal pools. Additionally, invasive species may be present in wetland and upland areas that are outside of the defined Project area boundaries. The Applicant has no authority to attempt to control invasive species that may be present in adjacent areas outside of the Project area.

Herbicide applications will be performed according to applicable laws and regulations put forth by the Maine BPC, Maine Department of Environmental Protection (MDEP), and the EPA. The type of herbicide(s) to be used, method of application, and schedule for application will be determined based on the locations of the targeted areas and the particular invasive species to be controlled. For additional information on herbicide application, refer to the above detailed VMP.

Similarly, the use of any biological control measures will be coordinated with MDEP and the Corps. The species used for biological control will be obtained from approved sources and released pursuant to specifications.

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Section 19
Noise Evaluation

19.0 Noise Evaluation

The Highland Wind Project (Project) is within the “expedited permitting area” as identified by the Land Use Regulation Commission (LURC) and defined by 35-A M.R.S.A. Chapter 34-A, Expedited Permitting of Grid-Scale Wind Energy Development. In accordance with the provisions of 12 M.R.S.A. § 685-B, a wind energy development within the expedited permitting area is required to meet the requirements of the Maine Department of Environmental Protection (MDEP) noise control rules. The MDEP noise control regulation thus applies in lieu of the noise regulations set forth in LURC Chapter 10 *Land Use Districts and Standards*. The Project has been sited and designed so that it has operations that meet the MDEP’s strictest noise standard of 45 decibels (dBA) nighttime and 55 dBA daytime at all protected locations.

Appendix 19-1

RSG INC.
ENVIRONMENT, ENERGY, & ACOUSTICS

Noise Impact Study for Highland Wind Project

December 2010

DATA ■ ANALYSIS ■ SOLUTIONS

Table of Contents

1.0 EXECUTIVE SUMMARY

This study evaluates the potential noise impacts of a proposed 39 turbine wind farm in Highland Plantation, Maine. The study included background sound monitoring, estimation of sound power levels from the wind turbines, and computer sound propagation modeling.

Background sound monitoring was performed at five locations throughout the project area. Monitoring locations include the homes southwest of the project area near the intersection of Long Falls Dam Road and Old County Road, residential areas east of the project area along Rowe Pond Road, and uninhabited areas north of the project area. Compliance with the Maine DEP noise standard is evaluated through the use of computer modeling. The model, based on ISO 9613-2 modeling methods, uses conservative parameters, with meteorological conditions favorable to propagation, and an assumption of hard ground in the entire project area. An analysis of construction and maintenance noise on the area is also provided.

The primary findings are as follows:

- Within one mile of any proposed turbine, there are two seasonal homes and no year-round residences. These two seasonal camps are upwind of the proposed turbines with respect to the prevailing wind. The closest protected area (full-time residence) is 5,800 feet from the nearest turbine.
- Background sound monitoring reveals that wind speeds at hub height are correlated with sound levels at the monitoring sites. Based on our correlations, the background sound levels range from 25 to 36 dB LA90 and 28 to 42 dB LAeq when the wind speed is 7 m/s at turbine hub height, depending on the location.
- The monitoring shows that the existing nighttime equivalent sound level (Leq) is below 35 dBA at all sites, requiring the project to meet a Chapter 375.10 sound limit of 45 dBA during the night and 55 dBA during the day.
- Several turbine models are being considered. For the purposes of this report, we evaluated the Siemens Model SWT 2.3-101, Siemens Model SWT 3.0-101, GE 2.5 xl, and Vestas V90 3.0. The Siemens models have a maximum electrical power output of 2.3 MW and 3.0 MW, respectively. The GE and Vestas models have maximum electrical power outputs of 2.5 MW and 3.0 MW, respectively. The sound power levels of the turbines at worst-case wind speeds range from 105 to 107 dBA.
- Modeling was conducted using ISO 9613-2 protocols as implemented by the Cadna A computer program. The manufacturer confidence interval was added to the sound power. A hard ground (G=0) assumption was used. This results in a ground attenuation factor of 3 and 4 dB added to the level, depending on the frequency, distance, and relative heights of the source and receiver.
- The results of sound propagation modeling indicate that Maine DEP noise standards are met at all protected locations for all wind turbine layouts being considered. At the two camps upwind of the turbine array, the standard is not met only when using Siemens SWT 3.0-101 turbines under normal operating modes. This can be mitigated by operating the four turbines in the southwest corner of the project near Witham

Mountain at a noise reduced operation (NRO) mode of 1 to 2 dB at night. In this case, noise levels at all protected locations and camps, comply with the Maine DEP standard.

- The levels of low frequency sound will not create perceptible building vibration or rattle.
- Other than extended concrete pours and similar events, major construction will take place during normal business hours.
- Routine maintenance and transformers will not create significant noise impacts.
- An evaluation of one year of meteorological data collected on site indicate that levels of turbulence and wind shear are not typically within ranges that are conducive to short duration repetitive sounds.

2.0 INTRODUCTION

The Highland Wind Project is a proposal to construct and operate up to 39 wind turbines in Highland Plantation, Maine. The maximum total capacity of the system would be 117 MW, with each turbine generating up to 3.0 MW.

Wind data being collected at the project met towers suggest that the area has a complex and dynamic wind regime. As a result, additional data are being collected before a final decision is made regarding the type of turbine to be used at each location. Four turbine models currently are under consideration: Siemens SWT 3.0-101 and 2.3-101, GE 2.5 xl, and Vestas V90.

This study assesses the affects of wind turbines on noise in the surrounding area. We analyzed four scenarios involving the exclusive use of each type of turbine, to determine the worst-case with respect to sound. This report includes:

1) A description of the site
2) A discussion of noise issues specific to wind turbines
3) A discussion of applicable noise limits
4) The results of background sound level monitoring
5) The results of sound propagation modeling
6) A discussion of the results
7) Summary and conclusions

3.0 SITE DESCRIPTION

The proposed turbine sites are located in Highland Plantation, a rural area in western Maine on the western edge of Somerset County. Highland Plantation is approximately 70 miles north of Augusta and 30 miles north of Madison.

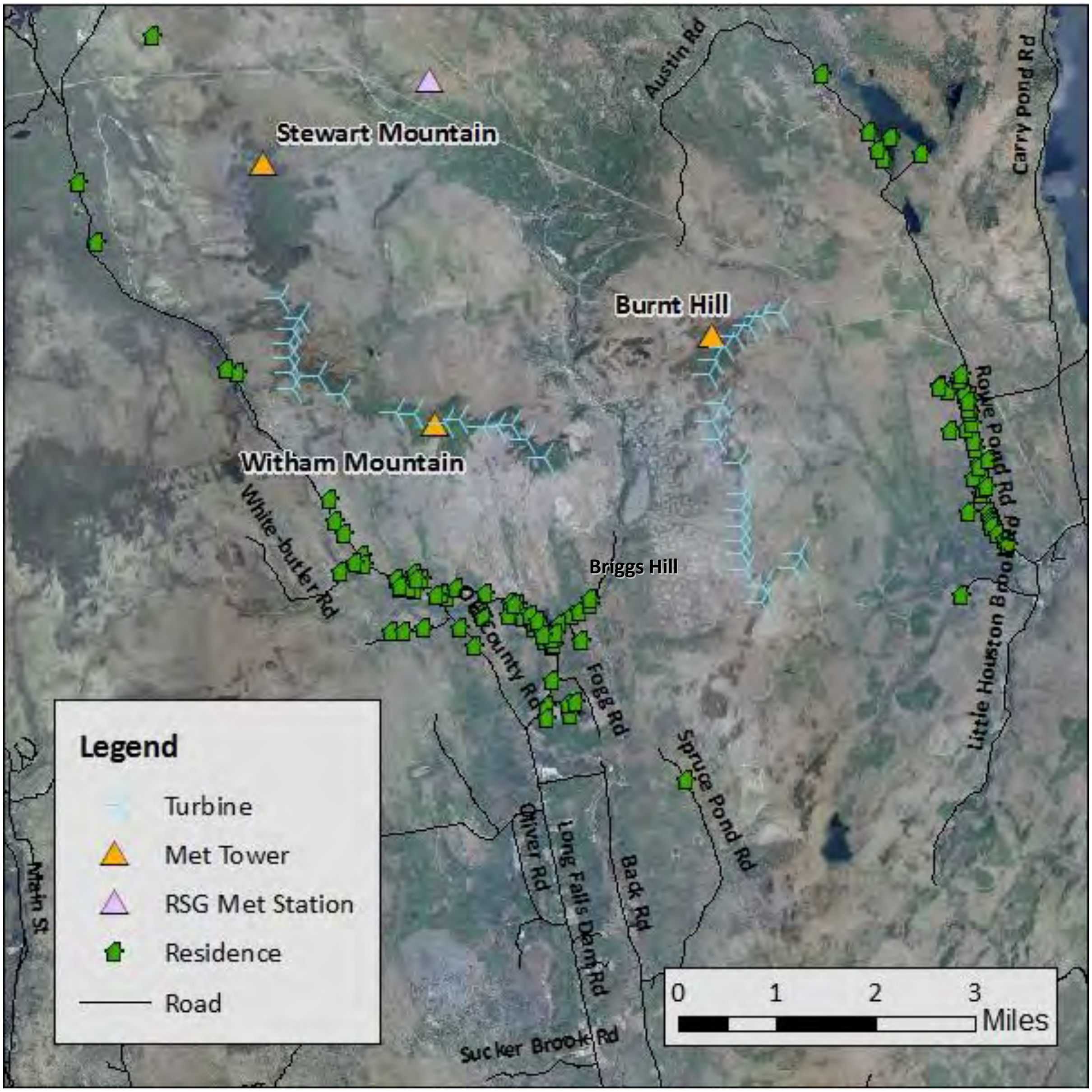
Located to the east of the Bigelow Mountain Range, the project area is forested and especially mountainous. The turbines would be constructed in two strings: a western string running northwestsoutheast between Witham Mountain and Bald Mountain, and an eastern string running north-south between Burnt Hill and Briggs Hill.

Highland Plantation is a rural township with low population density. Two seasonal camps are located within one mile and an additional 67 homes are located within two miles of the proposed turbines. The closest full-time residence is about 5,800 feet from the nearest turbine. There are no schools, hospitals, centers of worship, or other protected locations as defined in Chapter 375 noise regulations (see Section 5.0) within this two-mile radius.

The majority of the project area is uninhabited, though frequented by hunters in the fall. The Appalachian Trail summits Little Bigelow Mountain at a distance of approximately 6 miles from the closest wind turbine. At its closest point, near the tip of Flagstaff Lake, the Trail is 3.6 miles away.

Figure 1 displays the project area, including proposed turbine locations, residences, and the project's three long-term pre-development met towers (there are two additional met towers that do not have long-term data and are not used in our analysis). In addition, the figure shows the location of a 1.5 meter high anemometer to the north of the project area, placed during RSG's sound monitoring period.

Figure 1: Project Area Map



4.0 DESCRIPTION OF TERMS

Sound can be measured in many different ways. Perhaps the simplest way is to take an instantaneous measurement, which gives the sound pressure level at an exact moment in time. As an example, a sound level reading could be 62 dB, but a second later it could be 57 dB. In most environments, sound pressure levels change constantly. For this reason, it makes sense to describe noise and sound in terms of time.

The most common way to describe sound over time is by using various statistics. Take, as an example, the sound levels measured over time shown in Figure 2. Instantaneous measurements are shown as a ragged grey line. The sound levels that occur over this time can be described verbally, but it is much easier to describe the recorded levels statistically. This is done using a variety of “levels” which are described below.

4.1 Equivalent average sound level - Leq

One of the most common terms used to describe noise levels is the equivalent sound level (Leq). The Leq is the average of the root mean squared sound pressure over an entire monitoring period and expressed as a decibel. The monitoring period could be for any amount of time. It could be one second ($Leq_{1\text{-sec}}$), one hour ($Leq_{(1)}$), or 24 hours ($Leq_{(24)}$). As an example, the Maine DEP, in their Chapter 375.10 noise standard, uses an Leq with an averaging time of 1-hour. Since Leq describes the average pressure, loud and infrequent noises have a greater effect on the resulting level than quieter and more frequent noises. For example, in Figure 2, the median sound level is about 47 dBA, but the equivalent average sound level (Leq) is 53 dBA. Because it tends to weight the higher sound levels and is representative of sound that takes place over time, the Leq is the most commonly used descriptor in noise standards and regulations.

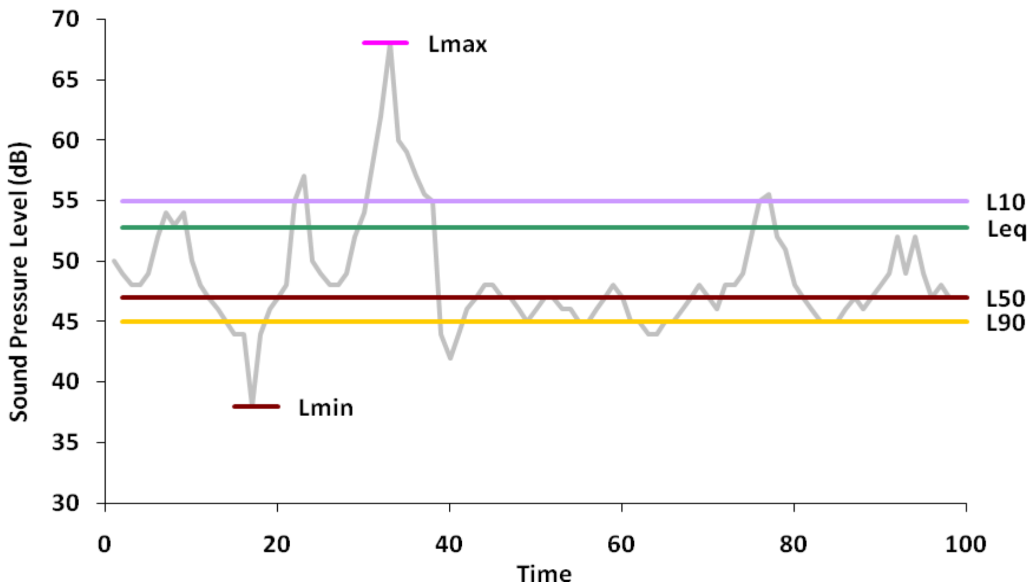
4.2 Percentile sound level - Ln

Ln is the sound level exceeded *n* percent of the time. This type of statistical sound level, also shown in Figure 2, gives information about the distribution of sound levels over time. For example, the L10 is the sound level that is exceeded 10 percent of the time, while the L90 is the sound level exceeded 90% of the time. The L50 is exceeded half the time. The L90 is a residual base level which most of the sound exceeds, while the L10 is representative of the peaks and higher, but less frequent, levels. When one is trying to measure a continuous sound, like a wind turbine, the L90 is often used to filter out other short-term environmental sounds that increase the level, such as dogs barking, vehicle passbys, wind gusts, and talking. That residual sound, or L90, is then the sound that is occurring in the absence of these noises.

4.3 Minimum and Maximum level – Lmin and Lmax

The absolute minimum and absolute maximum sound levels are often used as environmental noise descriptors. These are represented by Lmin and Lmax, respectively.

Figure 2: Example of Sound Measurement over Time and Descriptive Statistics



5.0 NOISE STANDARD

Highland Plantation falls under the planning and zoning jurisdiction of the Maine Land Use Regulation Commission (LURC), which oversees the state's townships, plantations, and unorganized areas. Highland Plantation has been deemed an "expedited permitting area", meaning that the wind energy project must conform to the Maine Department of Environmental Protection (DEP)'s state noise standards. No additional restrictions are in place.

The DEP has set out its regulations for noise in Control of Noise, Chapter 375.10, established in 1989. These standards apply to "Protected Locations" and to project property lines, whichever are farther from the source. A protected location is an accessible parcel of land containing a full-time residence, house of worship, school, library, nursing home, or certain park lands. Here, the closest protected location is over one mile from the nearest turbine.[1]

Generally speaking, the standard for protected locations that are not predominantly commercial, industrial, or transportion is an hourly sound level limits of 60 dBA in the daytime (7am to 7pm) and 50 dBA (7pm to 7am) ($LAeq_{(1)}$). However, in areas with existing hourly sound levels below 45 dBA during the day and 35 dBA during the night, the hourly sound level limit is lowered to of 55 dBA during the day. During the night, the "quiet area" standard depends on whether the protected location is at or within 500 feet of a full time dwelling. Within 500 feet of the dwelling (or the property line, whichever is closer), the nighttime standard is 45 dBA. Outside of this area, the nighttime standard is 55 dBA.

In this case, the nighttime Leq is below 35 dBA, thus the project is subject to, and will be designed to meet, the quiet-area criteria of 55 dBA during the day and 45 dBA during the night ($LAeq_{(1)}$).

[1] There are camps that are closer than one mile. The closest full time residence is about 5,800 feet from the nearest turbine.

The DEP standards apply various penalties to the overall sound levels which exceed certain tonal and short duration repetitive sound criteria. Given the nature of the turbines proposed for this location, which is discussed in further detail in Section 8.0, these penalties are not expected to be applied.

Typically, as part of a permit for a wind farm in Maine, post-construction monitoring is required to assess compliance with the applicable noise standard. For a wind farm, sound levels are generally monitored at night to minimize other background sounds. The data collected include information to determine the overall sound level, the spectral content (to assess any tonal penalties), and 1/8 or 1/10 second sound levels (to assess any penalties for short-duration repetitive sounds.)

6.0 EXISTING NOISE ENVIRONMENT

By conducting background sound monitoring during pre-construction, we establish a baseline noise level to compare the project with, identify any anomalous noise sources in the area that need to be considered during post-construction monitoring, establish the basis for masking calculations, and determine whether this site falls into a "quiet area" definition as established by regulation.

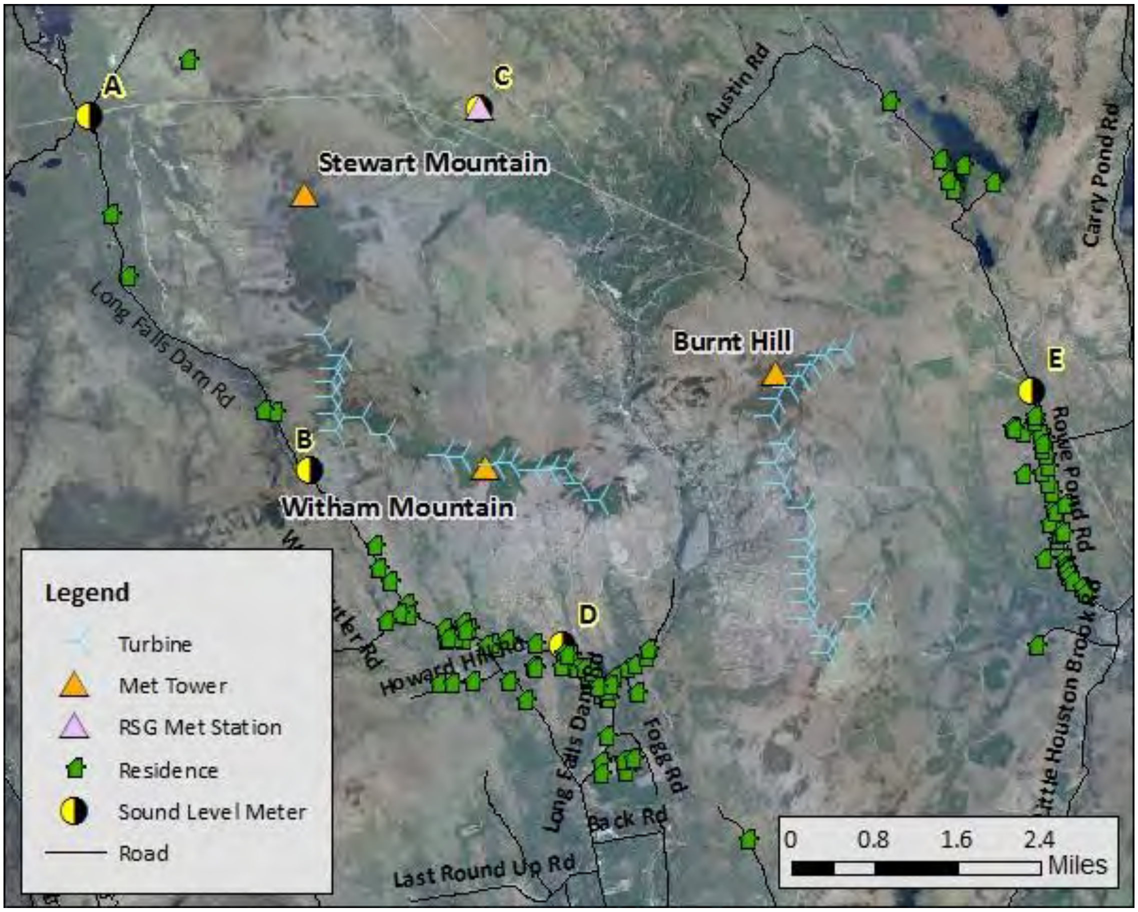
With respect to their contribution to the background sound, we can identify several distinct soundscape areas around the project. They include:

1) The homes southwest of the project area near the intersection of Long Falls Dam Road and Old County Road
2) Residential areas east of the project area along Rowe Pond Road
3) Uninhabited areas north of the project area

Sound level meters were installed around these areas to determine ambient sound levels under a variety of weather conditions. These are shown in Figure 3 and described in detail below.

The main noise sources in and around the project area include traffic, birds, insects, wind, and timber harvesting. Closer to major roadways, traffic noise was also observed.

Figure 3: Sound Monitoring Locations



6.1 Background sound monitoring

To determine ambient sound levels in the area, RSG conducted sound level monitoring for five locations in the representative areas around the project (see Figure 3). The monitoring was conducted from 8 October to 16 October, 2009.

All sites were monitored with ANSI Type 1 Cesva SC310 sound level meters set to log 1/3 octave band sound levels every second or ANSI Type 2 Rion NL-22 sound level meters set to log equivalent average sound levels every 10 seconds. Each sound level meter was calibrated before and after the measurements and fitted with seven-inch diameter windscreens. The windscreens reduce the self-noise created by wind passing over the meter's microphone. Each microphone was placed approximately 1.4 meters above the ground. In each case, the ground was considered "soft", that is, it was suitable for the growth of vegetation. Table 1 shows the specifics of each measurement position and Table 2 displays summarized results from the background sound monitoring.

Table 2 displays four different sound levels: the Leq, L90, L50, and L10. As defined in Section 3, the Leq is the equivalent average sound level. This measure weights louder sound levels more than quieter levels because it is based on a logarithm of the squared sound pressure. The L90, L50, and L10 are the sound levels exceeded 90%, 50%, and 10% of the time, respectively.[2] In this table, "daytime" refers to the period between 7am and 7pm and "nighttime" refers to the period between 7pm and 7am. This is in accordance with the Maine DEP regulations outlined in Section 5.0 of this report. The values given for each statistic correspond to the average daytime or nighttime sound levels throughout the entire monitoring period.

As shown in Table 2, the nighttime Leq is below 35 dBA at each location, subjecting the entire study area to a Chapter 375.10 nighttime noise limit of 45 dBA, and daytime noise limit of 55 dBA.

Table 1: Background Sound Monitoring Summary

Monitor	Meter	Start Time	End Time	Elevation (m)
A	Rion NL22	10/8/09 11:00 AM	10/16/09 9:50 AM	179
B	Cesva SC310	10/8/09 11:20 AM	10/9/09 12:10 AM	362
C	Rion NL22	10/8/09 12:00 PM	10/16/09 9:10 AM	454
D	Rion NL22	10/8/09 1:00 PM	10/16/09 10:10 AM	358
E	Rion NL22	10/8/09 2:00 PM	10/16/09 11:00 AM	350

Table 2: Background Monitoring Results Summary (dBA)

	Daytime				Nighttime			
	Leq	L90	L50	L10	Leq	L90	L50	L10
Monitor A	41	29	32	41	30	25	26	31
Monitor B	42	38	40	44	30	28	29	32
Monitor C	35	29	32	37	28	25	27	30
Monitor D	45	37	40	46	39	36	37	39
Monitor E	38	29	33	39	30	25	27	31

Each monitoring location and sound level readings are shown in greater detail in the figures that follow, and pictures are displayed in Appendix D. Supplementary sound modeling results are provided in Appendix C.

[2] In this case, the Ln represents the percentile based on continuous 1-second equivalent average levels in the case of Monitor B and 10-second equivalent average levels at all other stations.

Monitor A was installed near the project's northwestern limits. As shown in Figure 4, the site is located in a transmission line right-of-way approximately 380 feet east of East Flagstaff Road and 130 feet west of Long Falls Dam Road. The sound monitoring results are shown in Figure 5, which displays the 10-minute Leq and L90 throughout the monitoring period.

Figure 4: Monitor A Location

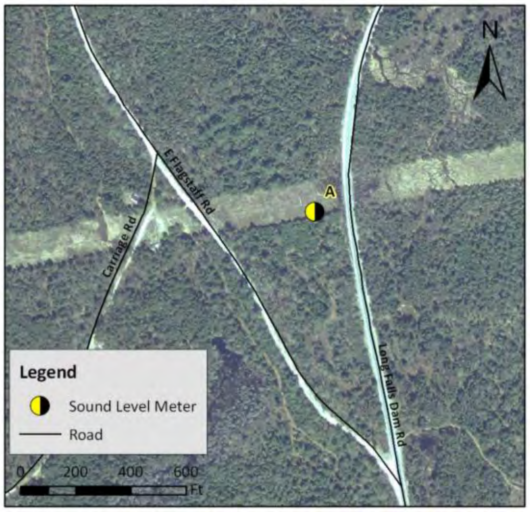
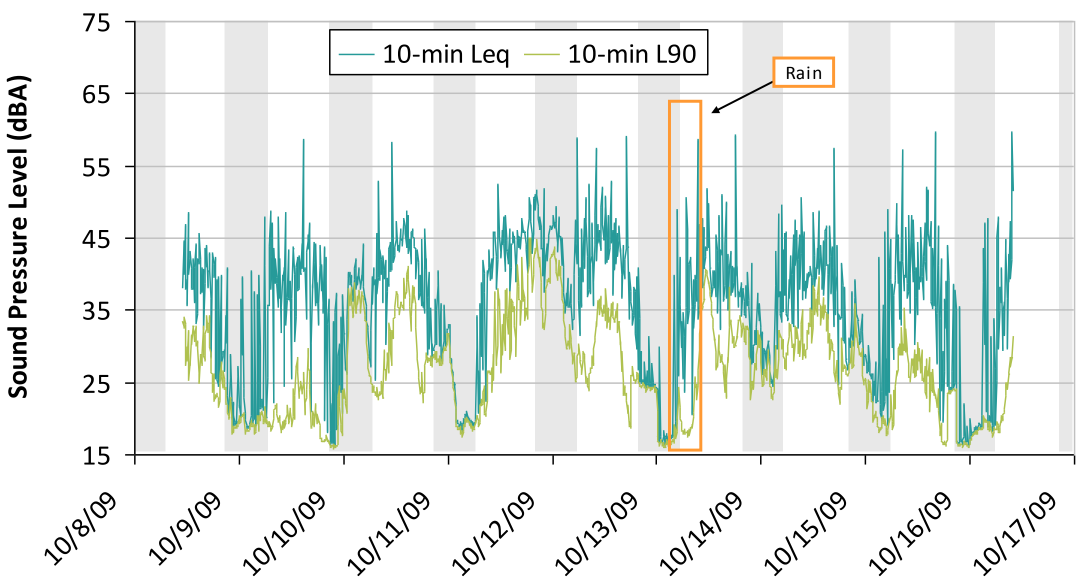


Figure 5: Sound Pressure Levels (dBA) for Monitor A



Monitor B, shown in Figure 6, was located 460 feet along a private road branching off of Long Falls Dam Road at the south end of the western string of turbines. The monitor was installed 0.46 miles from the nearest wind turbine. Monitor B experienced a power failure on 9 October; available data is shown in Figure 7.

Figure 6: Monitor B Location

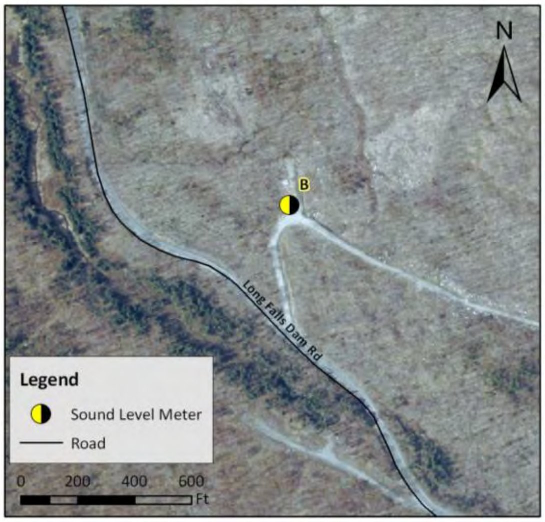
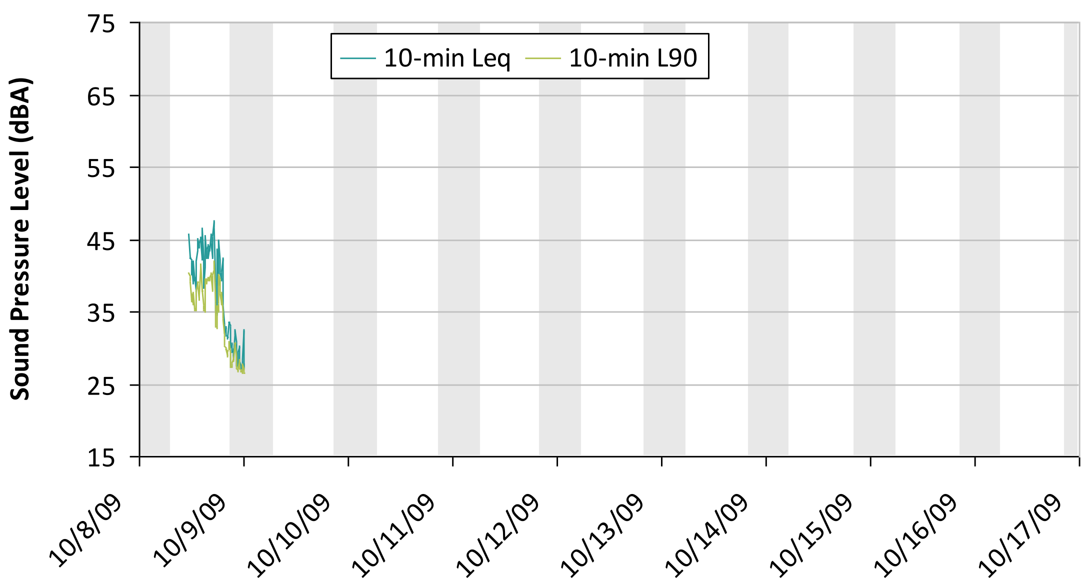


Figure 7: Sound Pressure Levels (dBA) for Monitor B



Monitor C, shown in Figure 8, was located north of the western string of wind turbines, about 35 feet north of a private access road. Figure 9 displays sound monitoring results for the site.

Figure 8: Monitor C Location

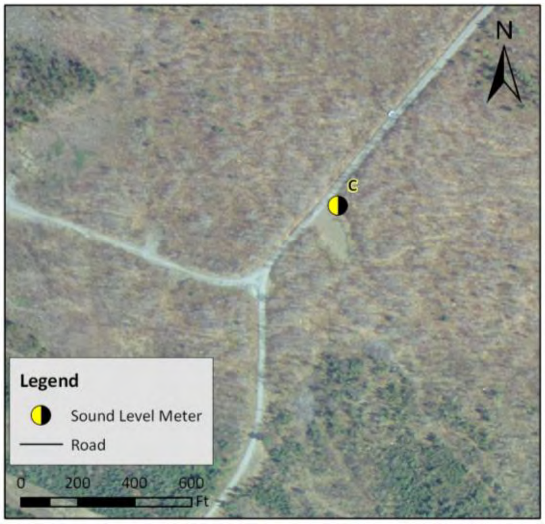
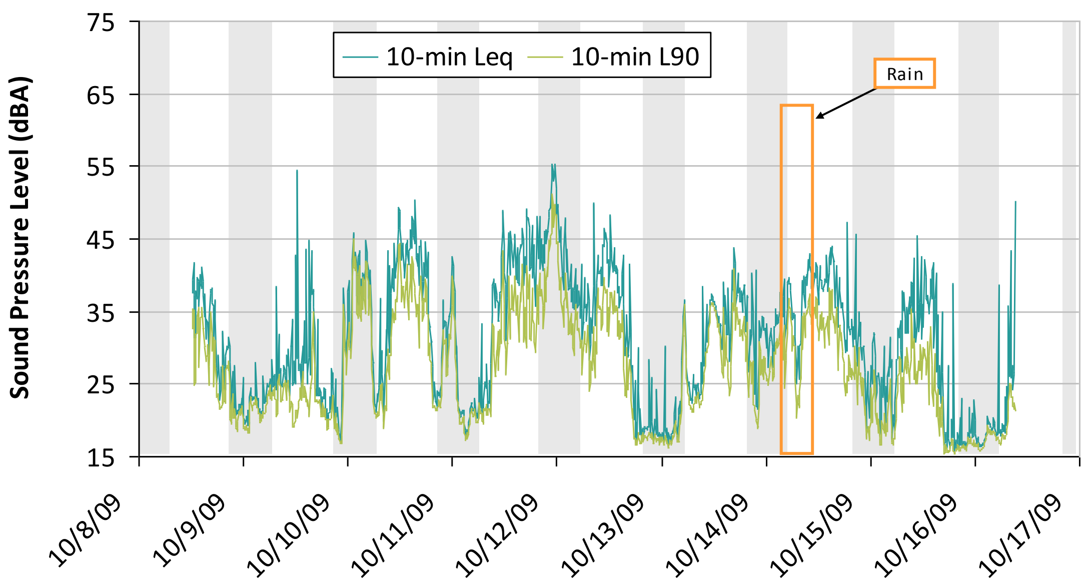


Figure 9: Sound Pressure Levels (dBA) for Monitor C



Monitor D, shown in Figure 10, was located on a private road south of the project area, approximately 320 feet northeast of Long Falls Dam Road. The monitor was installed 390 feet from the nearest residential structure.

Figure 11 displays sound monitoring results for the site.

Monitor D exhibited significantly higher sound levels than the other monitored sites, particularly at night. Sound recording files captured during the period indicate that the private road is regularly and sometimes frequently used by timber-harvesting trucks. This is a typical event for the project area.

Figure 10: Monitor D Location

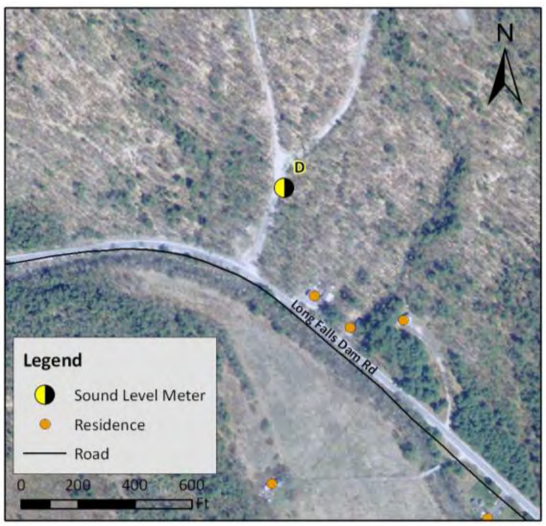
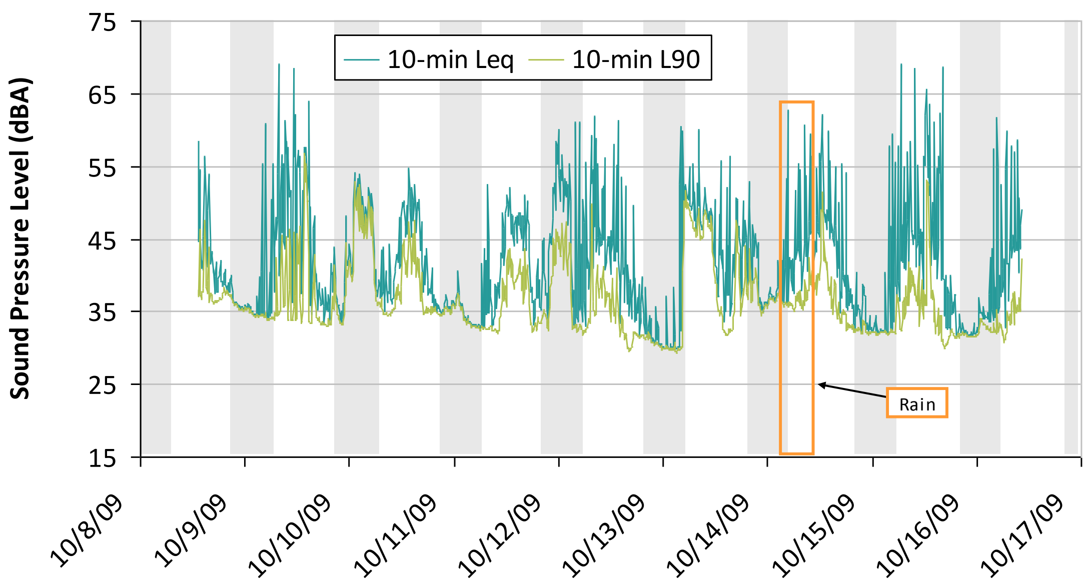


Figure 11: Sound Pressure Levels (dBA) for Monitor D



Monitor E, shown in Figure 12, was located to the east of the project area, approximately 60 feet west of Rowe Pond Road. The monitor was installed 1,250 feet from the nearest residential structure. Figure 13 displays sound monitoring results for the site.

Figure 12: Monitor E Location

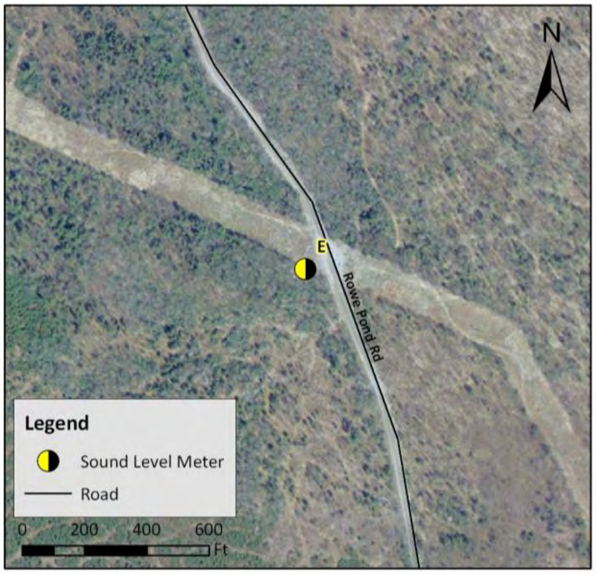
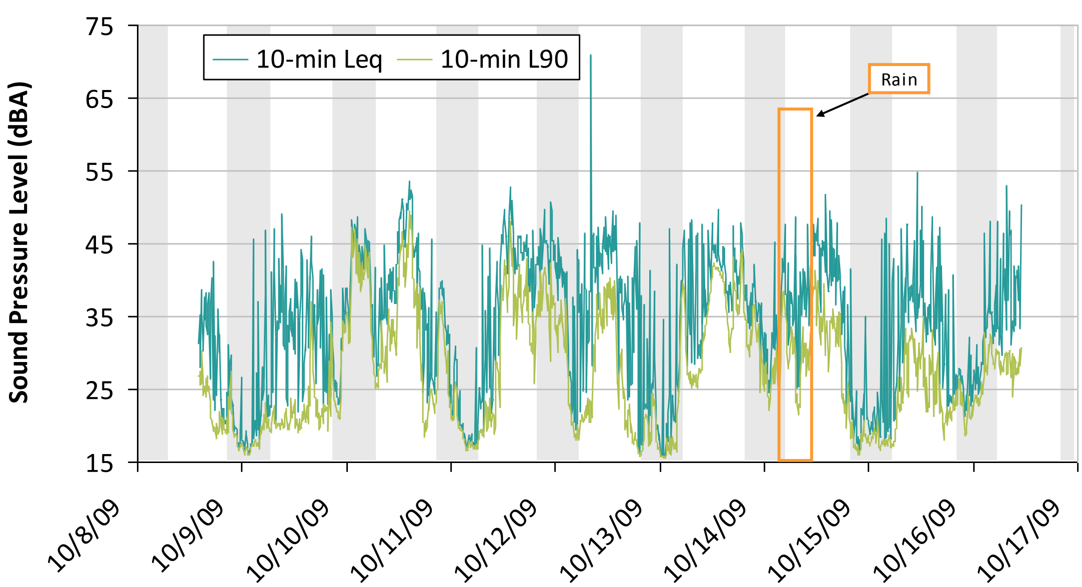


Figure 13: Sound Pressure Levels (dBA) for Monitor E



7.0 METEOROLOGICAL DATA

Meteorology affects many aspects of a wind farm with respect to noise. Some of these factors include:

- Wind and rain during pre-and post-construction sound monitoring tend to increase recorded levels due to the rustling impacts on vegetation and the ground
- Depending on the difference in wind speeds between the turbine height and the ground, wind noise at ground level can mask turbine sounds at higher speeds.
- Very high winds during monitoring can introduce false noise created by localized pressure fluctuations around the microphone
- The level of wind at the ridge is directly related to the sound emissions of the wind turbines
- High wind shear combined with turbulence can create a higher probability of high amplitude modulation from the wind turbine, potentially leading to short-duration repetitive sounds.

Some of these issues are addressed below.

7.1 Weather events during sound monitoring

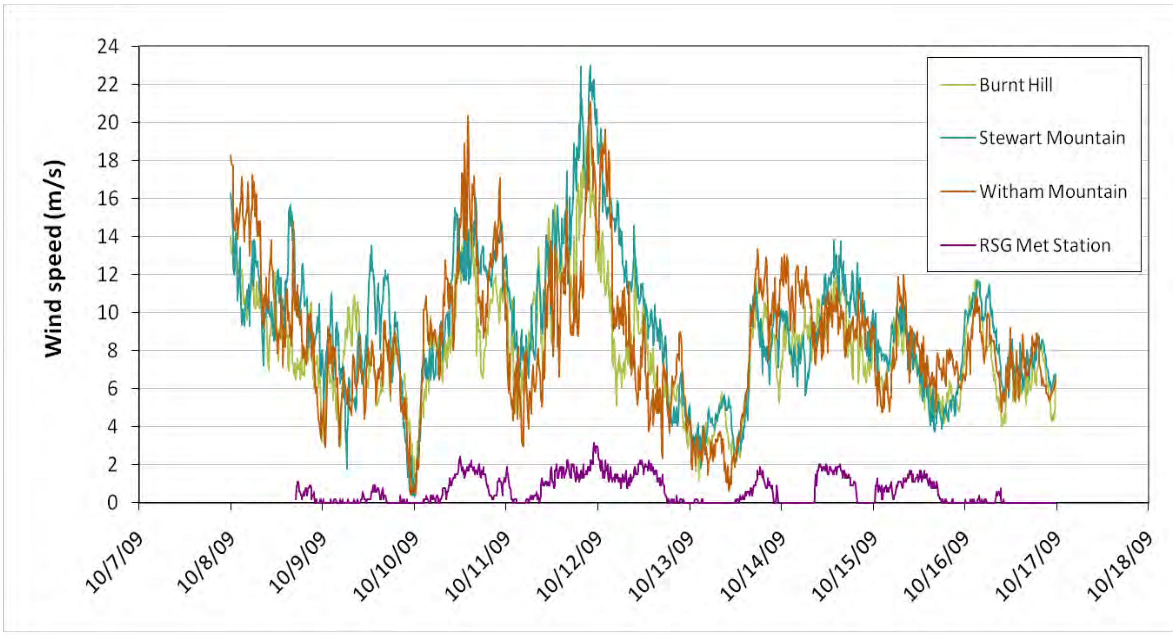
RSG installed a ground-level meteorological station near the sound level meter at Location C (See Figure 1). The RSG met station recorded temperature, relative humidity, wind speed, gust speed, and wind direction throughout the monitoring period.

During the monitoring period, the average temperature was 48˚F, ranging from a low of 15˚F to a high of 81˚F. The average relative humidity was 64%, ranging from a high of 93% to a low of 22%. On 13 October, 0.23 inches of rain fell between the hours of 5:30 and 9:30am.

7.2 Wind speeds vs monitored sound levels

During the monitoring period (10/08/2009-10/16/2009), three long-term project met towers collected 10-minute average wind speeds at various anemometer heights. The towers were located on Stewart Mountain (elevation of 745 m), Witham Mountain (elevation of 665 m), and Burnt Hill (elevation of 645 m) (see Figure 1), and an anemometer at 1.5 meters high was included in RSG's met station. The project met towers each had several anemometers at heights varying from 10 meters to 60 meters above ground. From this data, we were able to determine the wind shear for each interval and then extrapolate the wind speed at a relative elevation of 80 meters, which is one of the turbine hub heights. Figure 14 shows wind speeds at 80 meters during the monitoring period for each of the project met towers, as well as the wind speed at the ground-level RSG met station.

Figure 14: Wind Speed (10-min Averages) at Long-Term Project Met Towers (80m Height) and RSG Met Station (1m Height)



Wind speeds and sound pressure levels are typically correlated. Figure 15 through Figure 24 depict the relationship between wind speed and "daytime" and "nighttime" 10-min Leq and L90 at each monitoring station. These periods do not correspond with the 7:00am-7:00pm timeframe used by the DEP to regulate noise levels. Here, "day" refers to the period that ranges from one hour before sunrise until one hour after sunset (from about 5:45am until 7:00pm during the monitoring period). This relates to the periods that most affect atmospheric stability, an important consideration in sound propagation.

Figure 15: Daytime and Nighttime Leq Values for Monitor A

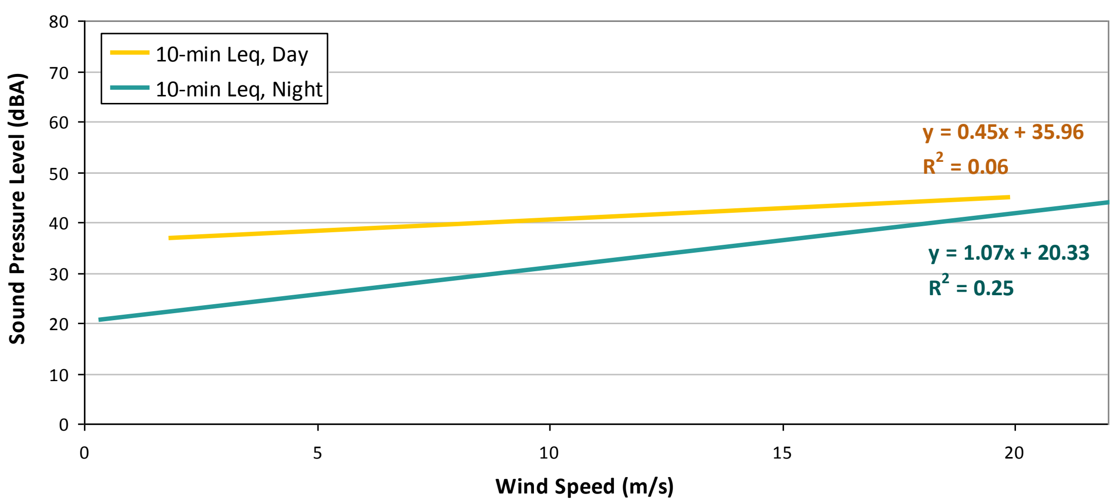


Figure 16: Daytime and Nighttime L90 Values for Monitor A

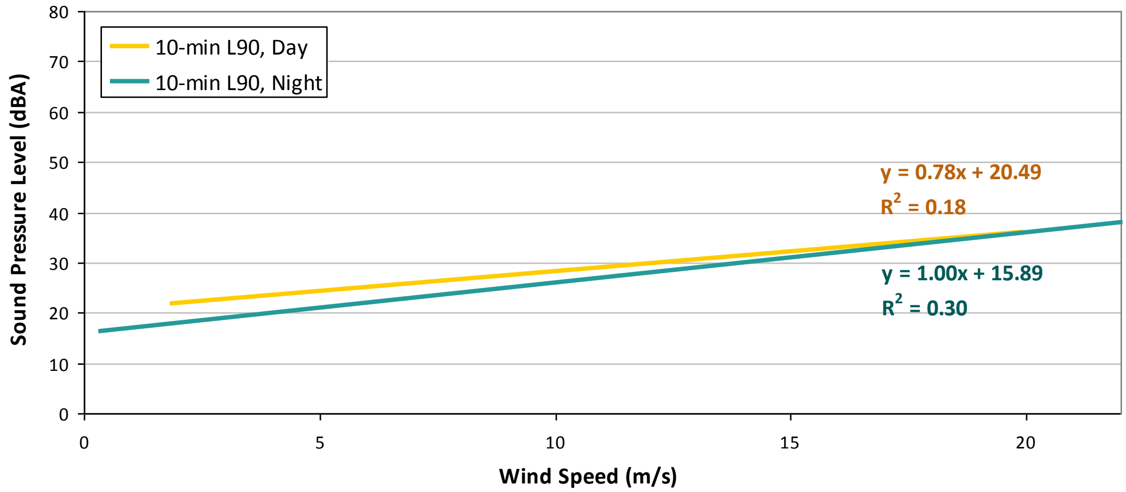

80
70
60
50
40
30
20
10
0
10-min L90, Day
10-min L90, Night
y = 0.78x + 20.49
R^2 = 0.18
y = 1.00x + 15.89
R^2 = 0.30
Sound Pressure Level (dBA)
0
5
10
15
20
Wind Speed (m/s)

Figure 17: Daytime and Nighttime Leq Values for Monitor B

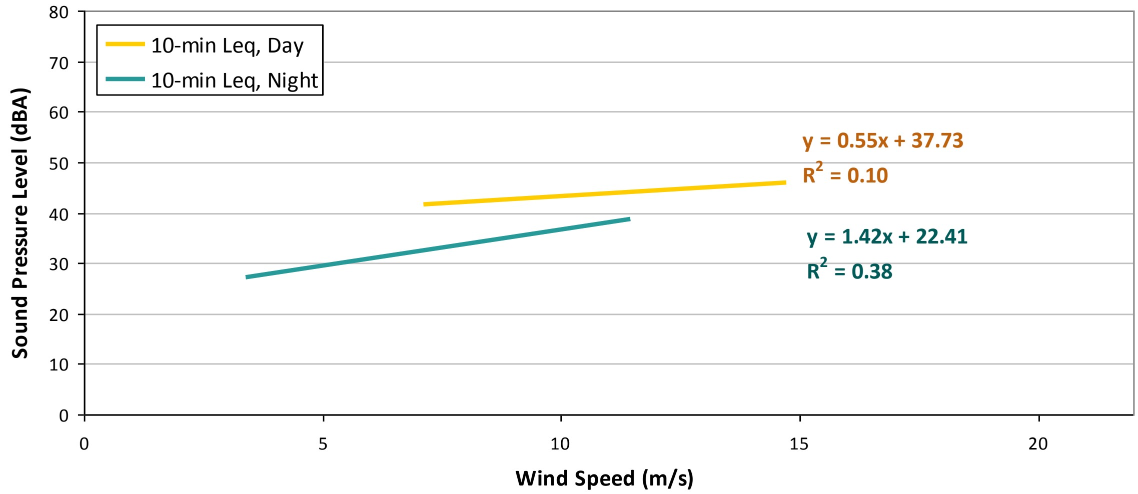


Figure 18: Daytime and Nighttime L90 Values for Monitor B

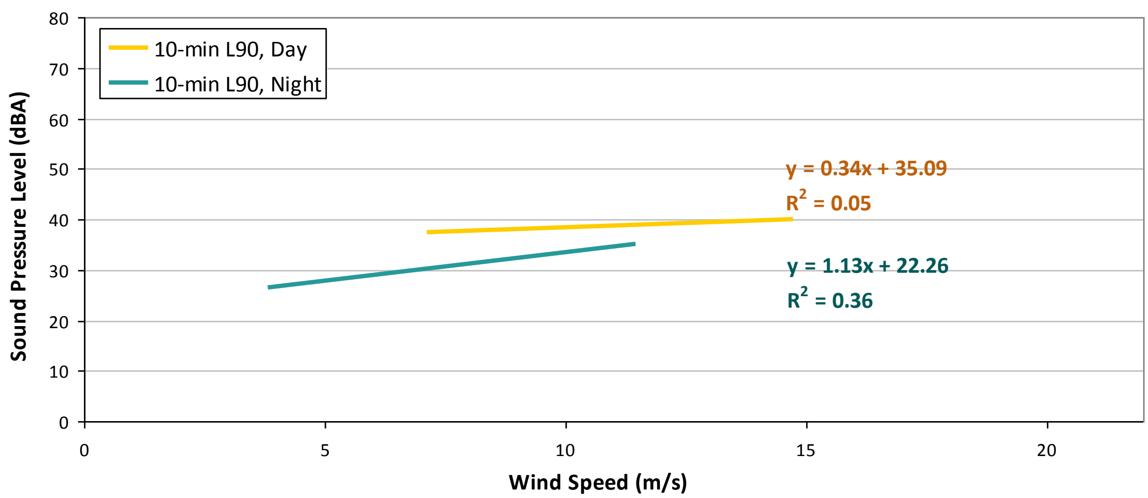


Figure 19: Daytime and Nighttime Leq Values for Monitor C

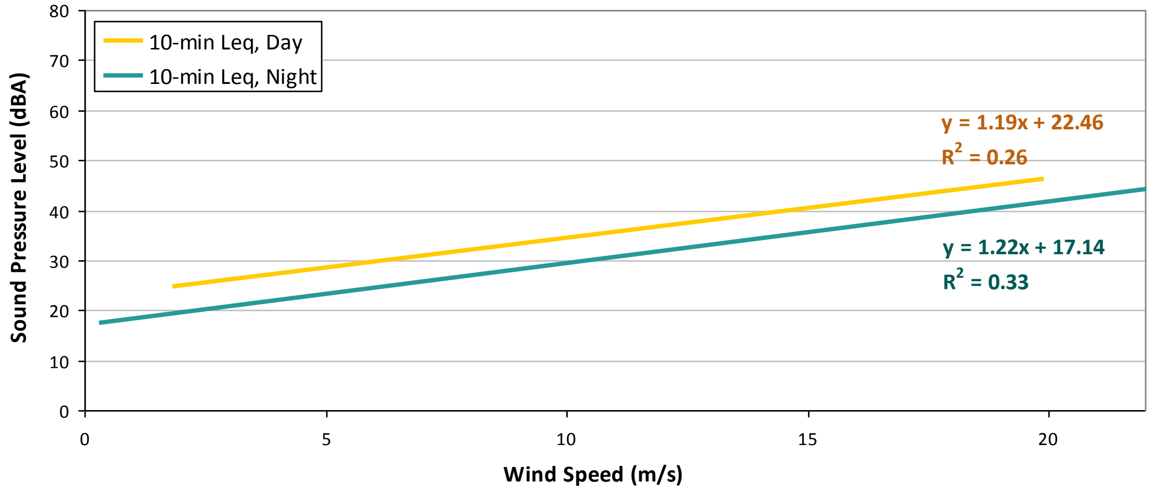


Figure 20: Daytime and Nighttime L90 Values for Monitor C

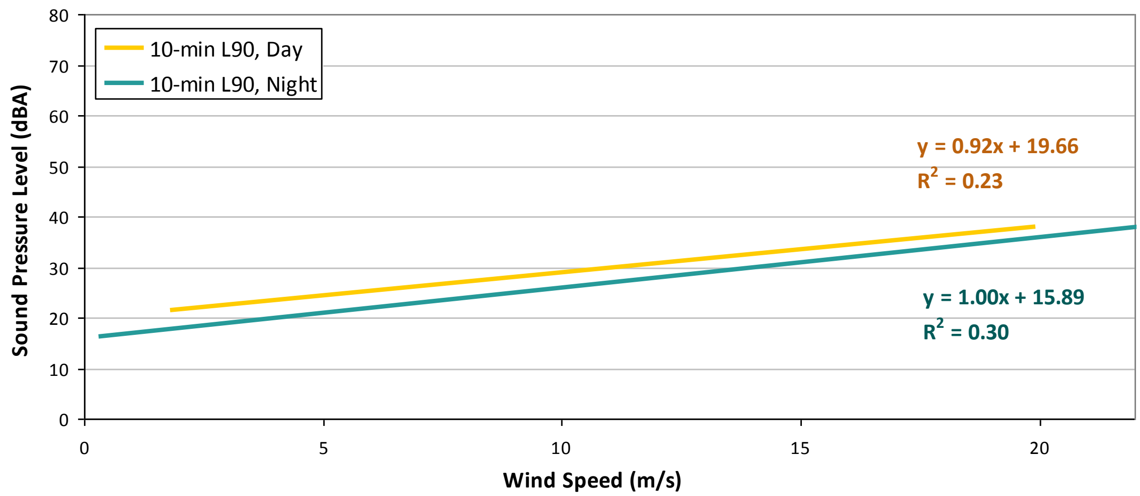


Figure 21: Daytime and Nighttime Leq Values for Monitor D

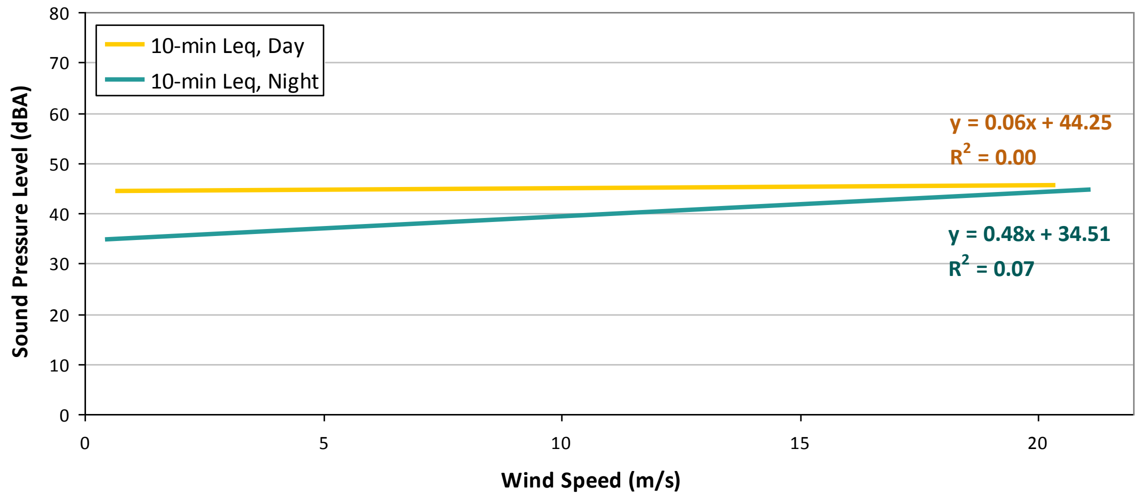


Figure 22: Daytime and Nighttime L90 Values for Monitor D

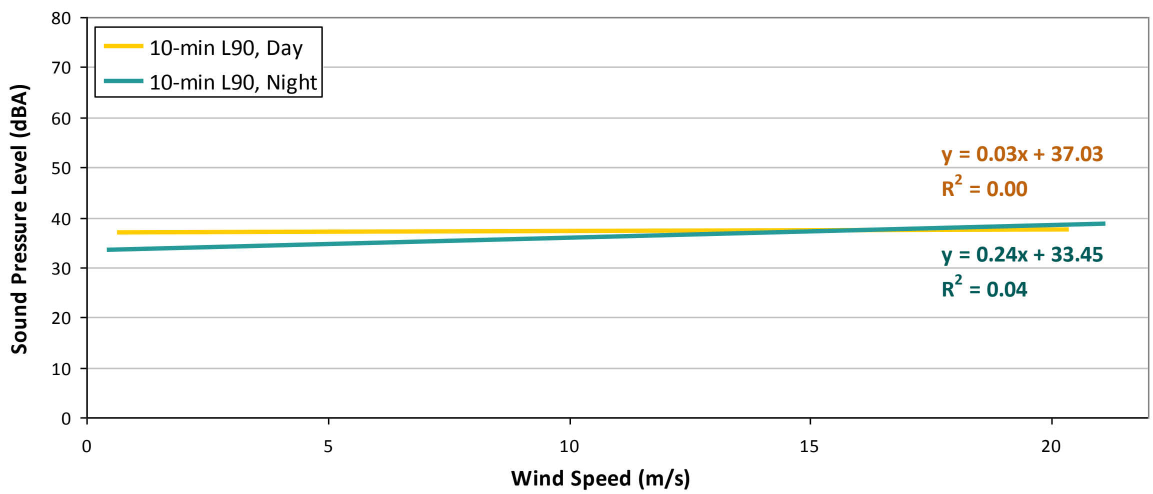


Figure 23: Daytime and Nighttime Leq Values for Monitor E

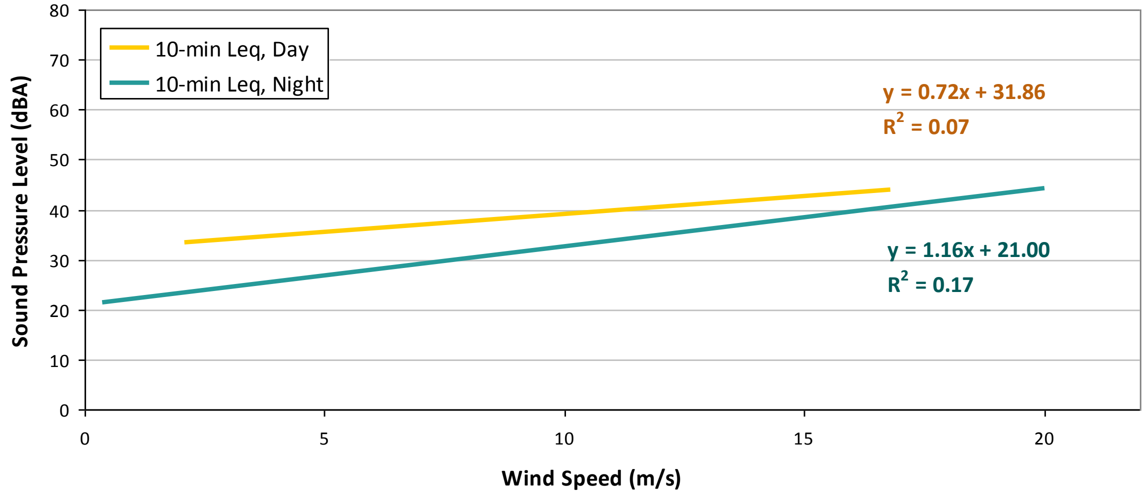
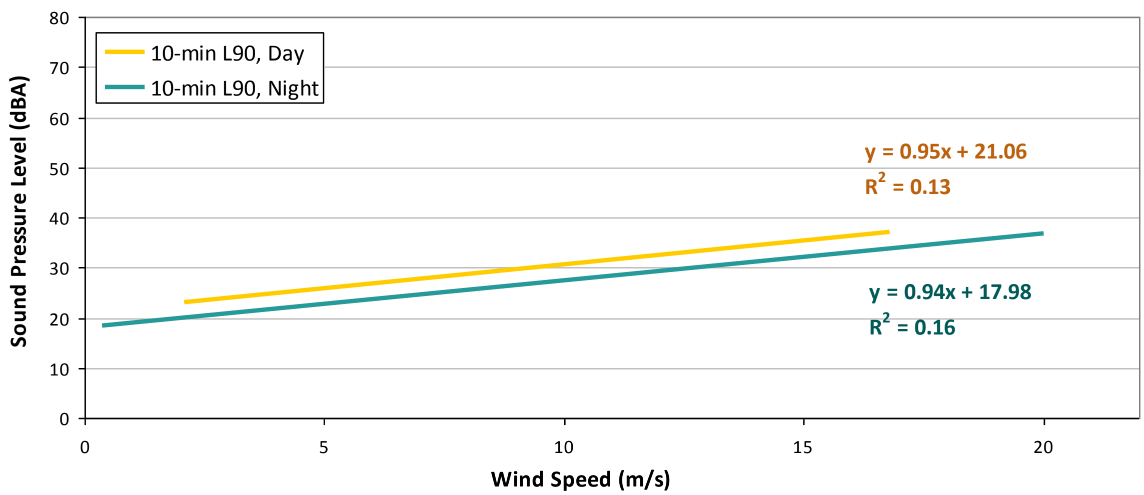


Figure 24: Daytime and Nighttime L90 Values for Monitor E



7.3 Turbulence and wind shear

Turbulence of the wind is one factor that affects the sound generated by a wind turbine. Wind shear, which measured as the change of wind speed by height can also be a factor. As an example, during times of high wind shear, the wind speed aloft can be high enough to turn the rotor blades, but low enough on the ground such that there is little or no rustling of vegetation. In such cases, the wind turbine sound can be more noticeable. In addition, such high wind shear conditions can lead to higher amplitude modulation, which, in turn, can lead to events of short-duration repetitive sounds. At this time, however, there are no models that accurately predict the level of amplitude modulation under specific meteorological conditions.

To assess the existing turbulence and wind shear conditions, one year of meteorological data from Witham Mountain was evaluated. Figure 25 shows turbulence intensity as a function of wind speed at 58 meters. As shown, turbulence intensity decreases with wind speed. At the wind speed that generates the most sound from the turbine (above 7 m/s), turbulence intensity averages about 0.12 and is generally below 0.2, which indicates that there will not be significant periods of high turbulence that would affect the overall noise level at downwind receivers. As shown in Figure 26, periods of higher turbulence tend to occur during the middle part of the day. Nighttime turbulence intensity is lower.

Figure 25: Turbulence Intensity[3] by Wind Speed with Lower and Upper 90th Percentile – 58 meter anemometer height

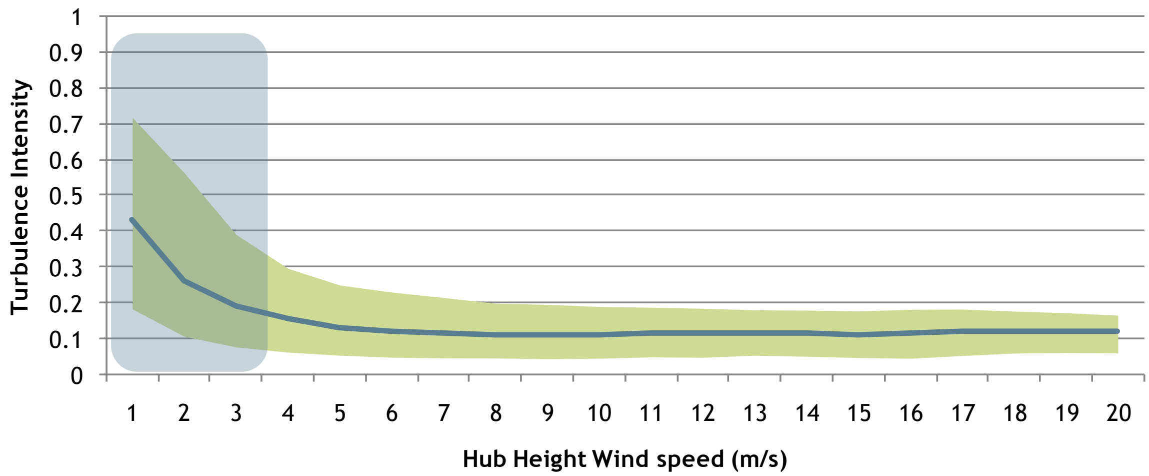
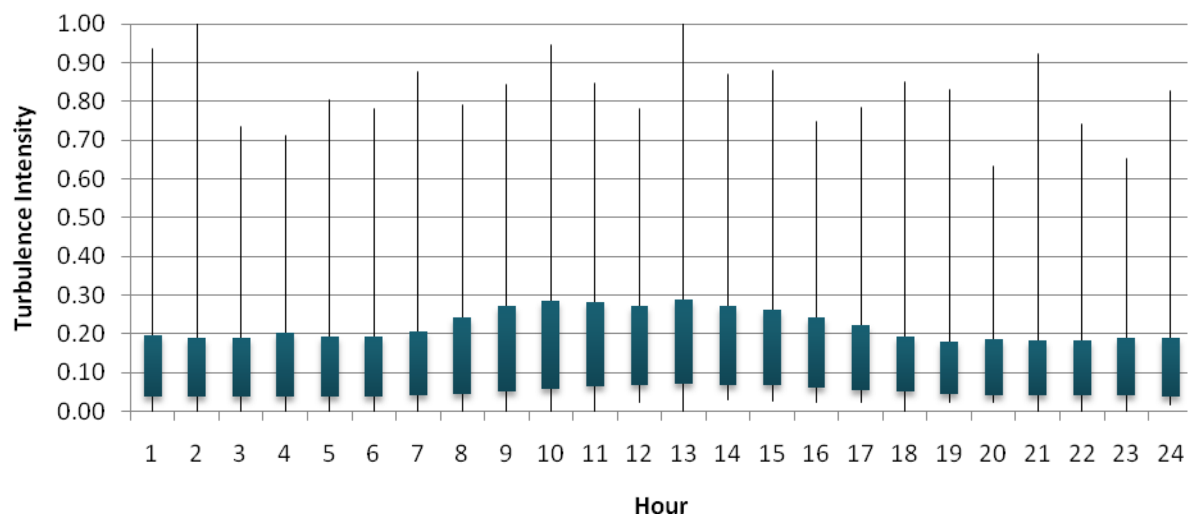


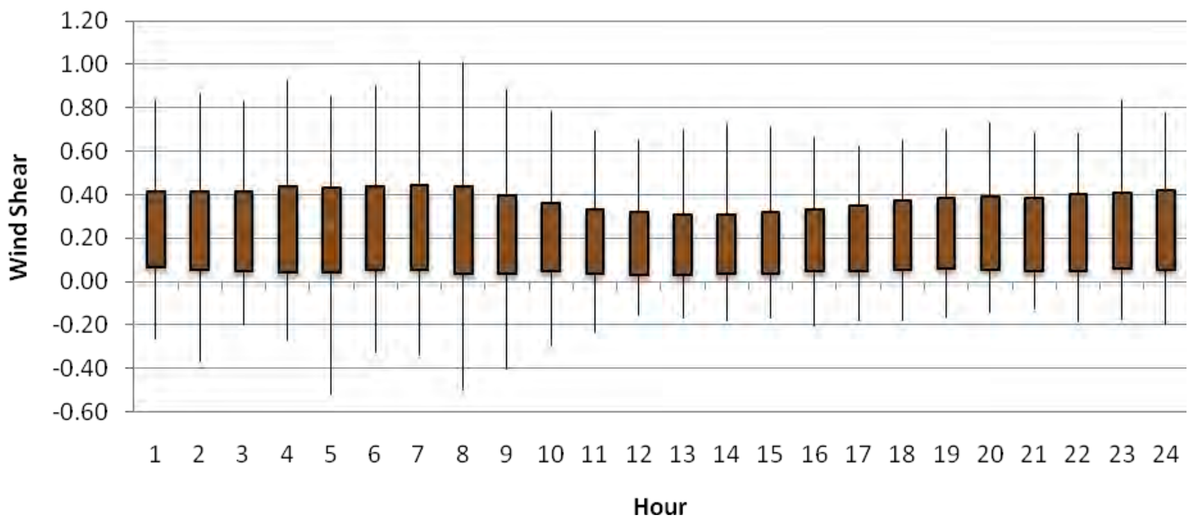
Figure 26: Turbulence Intensity by Hour with Upper and Lower 95th Percentile Box, and Min and Max Lines



[3] Turbulence Intensity, as shown here, is the standard deviation of wind speed over a ten-minute period divided by the average wind speed over that period.

The logarithmic profile wind shear exponent is a measure of the amount of wind shear for a given time. The higher the exponent, the greater the difference between winds near the ground and winds aloft. *Figure 27* shows the wind shear by time of day. As indicated, there is a greater range of wind shear at night, but overall, there is no indication of a prevalence of high nighttime wind shear leading to short-duration repetitive sounds.

Figure 27: WindshearExponent by Hour, with Upper and Lower 90th Percentile Box and Upper and Lower 99% Percentile Lines



8.0 MANUFACTURER SOUND EMISSIONS ESTIMATES

Sound emissions from a wind turbine are measured as sound *power*. This is different from the sound *pressure* that one measures on a sound level meter. Sound power is the acoustical energy emitted by an object, and sound pressure is the measured change in pressure caused by acoustic waves at an observer location. While both pressure and power levels are often reported in decibels (dB or dBA), and thus often confused, they have different underlying units and meaning. The sound power from a source is not regulated by the Chapter 375.10 standards, but it is used in the calculation of the sound pressure level, which is regulated.

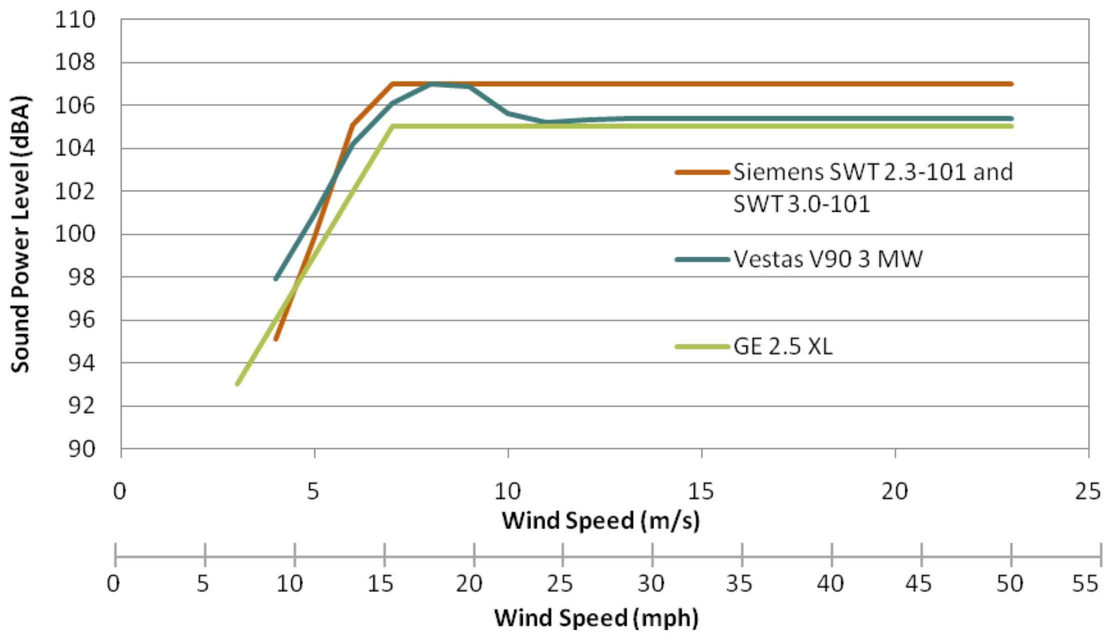
A manufacturer of a wind turbine must test its turbines and report their sound emissions using two international standards:

1) International Electrotechnical Commission standard IEC 61400-11:2002(E), "Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques"
2) International Electrotechnical Commission standard IEC 61400-14:2005(E), "Wind Turbine Generator Systems – Part 14: Declaration of Apparent Sound Power Level and Tonality Values"

These standards describe a procedure for measuring and reporting sound power levels from a turbine, by wind speed and frequency. They also provide the tonal audibility level and the confidence interval around the measurements.

The wind farm will select a turbine of equivalent or less sound level to the following turbine models: Siemens Model SWT 2.3-101, Siemens Model SWT 3.0-101, GE 2.5 xl, and Vestas V90 3.0. The Siemens models have a maximum electrical power output of 2.3 MW or 3.0 MW respectively and the "-101" in the model name refers to the rotor diameter in meters. The GE and Vestas models have maximum electrical power outputs of 2.5 MW and 3.0 MW, respectively.

Figure 28: Comparison of sound power level at hub height with respect to wind speed



The maximum sound power levels from the Siemens units are both 107 dBA, at the worst-case wind speed. According to the manufacturer, these levels are guaranteed with a 95% confidence level of ±1.5 dB. The maximum sound power occurs at a 7 m/s wind speed, measured at a 10-meter height. This translates into an approximate sound pressure level of 52 dBA, at 130 m away from the turbine base.[4] The maximum tonal audibility level as measured by the IEC 61400-11 methodology is 0 dB. This is an indication that these turbines will not create tonal sounds, as defined by Chapter 375.10.G.24.

The maximum sound power level from the GE 2.5 xl unit is 104.2 dBA, with an 95% confidence level of 1.8 dB at a worst-case sound wind speed of 8 m/s wind speed measured at a 10-meter height. This translates into an approximate sound pressure level of 49 dBA at about 130 meters from the turbine base with an 85 m hub height. The maximum tonal audibility level as measured by the IEC 61400-11 methodology is less than 4 dB. While this turbine has a higher tonality than the Siemens, it is not at a level that would be defined as tonal sound by the Maine standard.

The maximum sound power level from the Vestas V90 unit is 107 dBA at worst-case wind speed. According to the manufacturer, this level is guaranteed and we use an assumed 95% confidence level of ±2 dB. The maximum sound power occurs at 8 m/s wind speed, measured at a 10-meter height. This translates into an approximate sound pressure level of 53 dBA at about 130 meters from the turbine base with an 80 m hub height. The maximum tonal audibility level as measured by the IEC 61400-11 methodology is 1 dB, indicating that it would not generate tonal sound as defined in the standard.

[4] This distance is the reference distance (R_o) stipulated by IEC TS61400-11 for wind turbine noise measurements and is calculated by R_o= H + D/2, where H is the hub height and D is the diameter of the blades.

9.0 SOUND FROM WIND TURBINES – SPECIAL ISSUES

Wind turbines are special sound generators in that their sound emissions are often masked by noise from the wind moving through trees and other vegetation, and their sound level is highly dependent on meteorological conditions. In addition, wind turbines generate low frequency sound which tends to propagate better than higher frequency sound. These aspects are discussed below.

9.1 Meteorology

Meteorological conditions can significantly affect sound propagation. The two most important conditions to consider are wind shear and temperature lapse. Wind shear is the difference in wind speeds by elevation and temperature lapse rate is the temperature gradient by elevation. In conditions with high wind shear (large gradient), sound levels upwind from the source tend to decrease and sound levels downwind tend to increase. With temperature lapse, when ground surface temperatures are higher than that aloft, sound levels on the ground will decrease. The opposite is true when ground temperatures are lower than those aloft (an inversion condition).

As a substitute for these conditions, we often use “stability class”. Stability classes range from A to G, where A is a highly unstable condition (high solar radiation and high winds) and F or G are very stable (clear night, no wind, strong temperature inversion).

In general terms, sound propagates best under stable conditions with a strong inversion. This occurs during the night and is characterized by low winds.[5] As a result, worst-case conditions for wind turbines tend to be under moderate nighttime inversions. In areas with strong nighttime wind gradients, it is possible to have impacts with greater stability conditions.

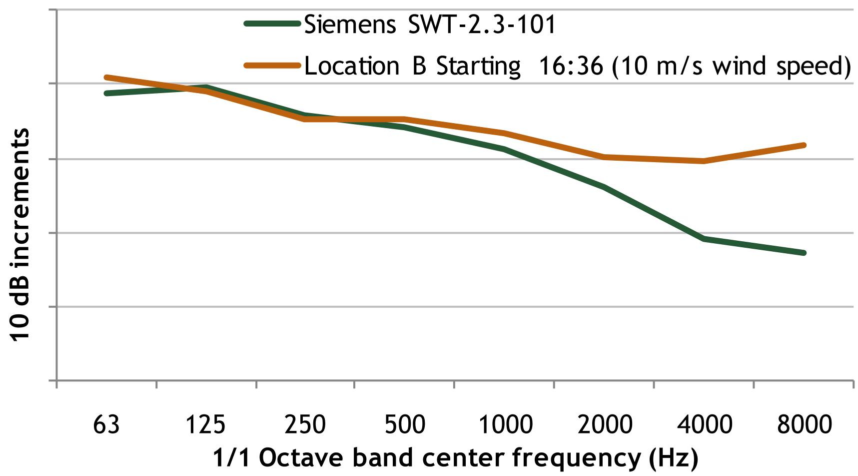
Higher wind shear can also create greater amplitude modulation, as the winds hitting the top of the rotor are higher than that at the bottom. As demonstrated in Section 7.3, very high wind shear is not prevalent in this area.

9.2 Masking

As mentioned above, sound levels from wind turbines are a function of wind speed. Background sound is also a function of wind speed, i.e., the stronger the winds, the louder the resulting background sound. This effect is amplified in areas covered by trees and other vegetation. The sound from a wind turbine can often be masked by wind noise at downwind receivers because the frequency spectrum from wind is very similar to the frequency spectra from a wind turbine. Figure 29 compares the sound spectrum measured at Monitor C during a 10 m/s wind event to a Siemens SWT 2.3-101 turbine. As shown, the shapes of the spectra are very similar at the lower frequencies. At higher frequencies, the sounds from the masking wind noise are higher than the wind turbine. As a result, the masking of turbine noise is possible at higher wind speeds.

[5] The amount of propagation is highly dependent on surface conditions and the frequency of the sound. Under some circumstances highly stable conditions can show lower sound levels.

Figure 29: Comparison of Frequency Spectra from Wind at Monitor C and a Siemens SWT 2.3-101 Wind Turbine



It is important to note that while winds may be blowing at turbine height, there may be little to no wind at ground level. This is especially true during low-level jets or strong wind gradients, which can occur at night.

To investigate this, we used the correlation of wind speed at the long-term project met towers with sound levels from Figures 15 through 24. We found that in each case, sound levels at the measurement locations were correlated with wind speed at the nearest tower (Figure 30 and Figure 31 for the overall periods). Therefore, in this case, we would expect some masking of wind turbine sound especially at higher ridgeline wind speeds.

Figure 30: Background Sound Pressure Levels by 80-Meter Wind Speed, 10-min Leq

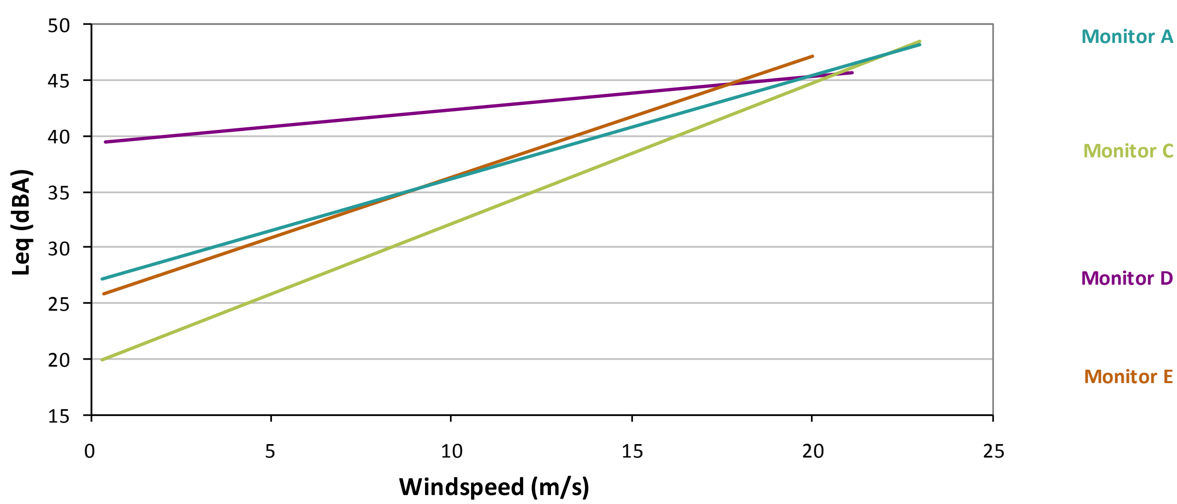
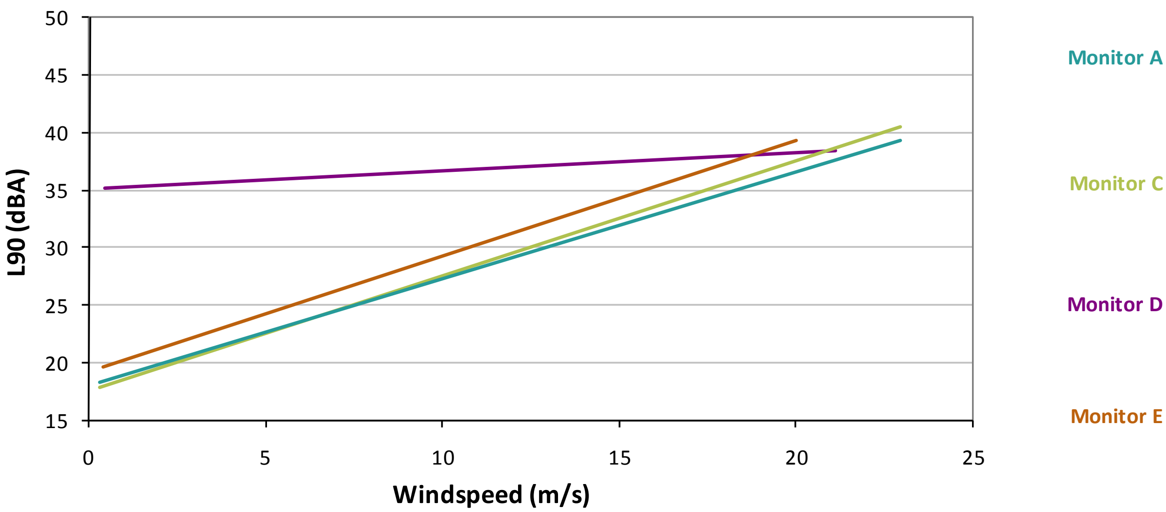


Figure 31: Background Sound Pressure Levels by 80-Meter Wind Speed, 10-min L90



9.3 Infrasound and low frequency sound

Infrasound is sound pressure fluctuations at frequencies below about 20 Hz. Sound below this frequency is generally not audible. Low frequency sound is in the audible range of human hearing, that is, above 20 Hz, but below 100 to 200 Hz depending on the definition. At very high sound levels, infrasound can cause health effects and rattle light-weight building partitions.

In a wind turbine, low frequency sound is primarily generated by the generator and mechanical components. Much of the mechanical noise has been reduced in modern wind turbines through improved sound insulation at the hub. Low frequency sound can also be generated at higher wind speeds when the inflow air is very turbulent. However, at these wind speeds, low frequency sound from the wind turbine blades is often masked by wind noise at the downwind receivers.

Overall, modern wind turbines, with the hub upwind of the tower, do not create levels of audible infrasound or levels of infrasound that induce vibration and rattle inside buildings. A 2005 survey of all known published measurable results of infrasound from wind turbines concluded that "wind turbines of contemporary design with an upwind rotor generate very faint infrasound with a level far below the level of perception even at a rather short distance … infrasound from such upwind turbines can be neglected when evaluating the environment effects of wind turbines."[6]

In a more recent study of turbines at an operating wind farm, researchers from Epsilon Associates found that, "Outdoor measurements of Siemens SWT 2.3-93 wind turbines under high output and relatively low ground wind speed (which minimized effects of wind noise) at 1000 feet indicate that infrasound is inaudible to the most sensitive people (more than 20 dB lower than the median thresholds of hearing)."[7]

[6] Jakobsen, Jorgen. "Infrasound Emission from Wind Turbines". Journal of Low Frequency Noise, Vibration and Active Control 24(3): 145

[7] O'Neal, Robert D. et al. "A Study of Lower Frequency Noise and Infrasound from Wind Turbines." Guidelines and Criteria: Epsilon Associates. 2433/reports/LFN_Report_07_28_2009: ES-1, July 2009.

To address the impacts of low frequency sound, our modeling took into account nighttime inversions and differential atmospheric absorption of low and high frequency sound. The results are found in Section 10.2.2.

10.0 Sound Modeling

10.1 Modeling software

Modeling was completed for the project using Cadna A acoustical modeling software. Made by Datakustik GmbH, Cadna A is an internationally accepted acoustical model, used by many other noise control professionals in the United States and abroad. The software has a high level of reliability and follows methods specified by the International Standards Organization in their ISO 9613-2 standard, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation." The ISO standard states,

> "This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level … under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation … or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night."

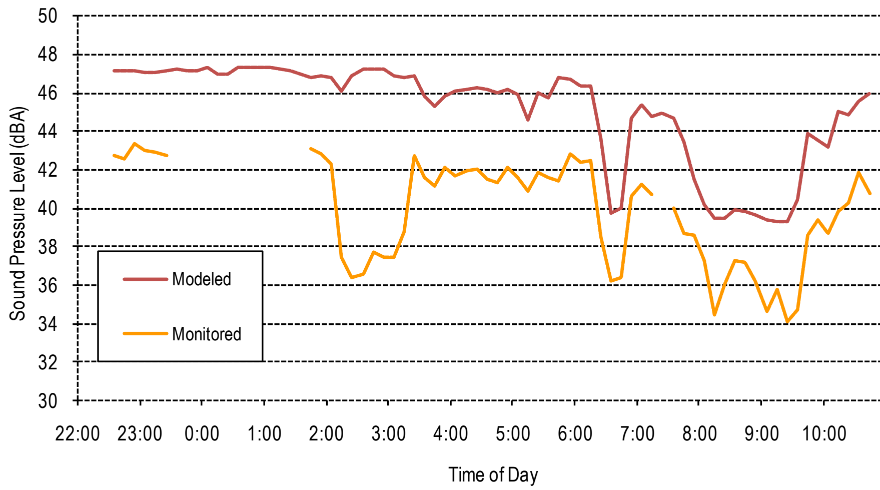
The model takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain.

While standard modeling methodology takes into account moderate nighttime inversions and moderate wind speeds, there may be meteorological conditions that result in higher levels of sound from the turbines. In particular, much higher wind speeds can account for greater downwind propagation. Adjustments can be made to take into account the more extreme conditions. For this study, we modeled the sound propagation in accordance with ISO 9613-2 with spectral ground attenuation and non-porous hard ground (G=0), which has been found to yield conservative results using standard modeling parameters.[8] In addition, we added the manufacturer 95% confidence interval to the sound power. This ranged from +1.5 dB for the Siemens turbines to +2.0 dB from the Vestas turbines.

Use of hard ground creates a ground attenuation factor which adds 3 to 4 dB to the model sound pressure level, depending on the heights of the source and receiver, the frequency of the sound, and the propagation distance. The combination of using hard ground (+3 to 4 dB) and adding the manufacturer confidence interval (1.5 to 2.0 dB) to the results will tend to overestimate the actual field conditions. As an example, a comparison of monitored versus modeled results using these factors for a wind farm studied in Reference 8 is shown in Figure 32. As indicated, the model consistently overestimated monitored results on the order of 3 to 5 dB.

[8] Duncan, E., and Kaliski, K., "Improving Sound Propagation Modeling for Wind Power Projects," Acoustics 08, 2008, Paris, France.

Figure 32: Monitored sound levels over a night compared to modeled sound levels using hard ground (G=0) and 2 dB added to the overall sound power



In this case, a 10 meter by 10 meter grid of receivers was set up in the model covering 78 square miles around the site. This accounts for a total of about 2,020,000 modeled receivers. A receiver is a point above the ground at which the computer model calculates a sound level. In addition, discrete receivers were placed at 103 residences within a 2.5-mile radius of the proposed wind turbines. Details of the modeling input assumptions are provided in Appendix A.

In summary, the model is based upon conditions favorable to noise propagation and makes the following conservative assumptions:

- Ground is hard or non-porous
- There is no noise shielding from buildings or trees
- Wind is omnidirectional from each source so that all receivers are downwind from the wind turbines
- Receiver height is set to four meters, approximately the level of a second-storey window
- Wind turbines are operating at their maximum sound power levels, plus the 95% confidence interval which accounts for the margin of uncertainty
- Wind turbines are modeled as point sources at hub height.

10.2 Modeling results

10.2.1 Wind Turbine Layout Scenarios

Four turbine models are currently under consideration for the project area: Siemens SWT 3.0-101, Siemens SWT 2.3-101, GE 2.5 xl, and Vestas V90. Turbines selected for the project will have acoustical output that is no greater than what is modeled here.

We modeled five scenarios, each involving the exclusive use of one of the four turbine models. Figure 33 shows the turbines used for each scenario.

Figure 33: Modeled Turbine Scenarios

Scenario	Turbine Type
1	Vestas V90
2	Siemens SWT 3.0-101
3	GE 2.5 xl
4	Siemens SWT 2.3-101
5	Siemens SWT 3.0-101 NRO

10.2.1 Overall results

We modeled each of the above four scenarios. The highest sound pressure levels occur with Scenario 2, which uses Siemens SWT 3.0-101 wind turbines. The results for this scenario are shown in Figure 34. Within the figure, green house symbols represent residences. The lines emanating from the wind turbines are color-coded noise isolines, where red represents the highest sound level and light blue represents the lowest.

Modeling results show that one-hour sound pressure levels are at or below 45 dBA at all residences within 2.5 miles of the wind turbines in the worst case scenario, when all the turbines are operating at the maximum-rated sound power. In addition, we investigated sound pressure levels at a 500-foot distance from residences, as per DEP regulations. For all camps and residences within 2.5-miles of the wind turbines, sound pressure levels are 47 dBA or less at a distance of 500 ft from the residential structure. Aside from two camps upwind of the project, the maximum one-hour sound levels at residences are below 41 dBA.

To attain a modeled sound level at or below 45 dBA with the Siemens 101 3.0 MW scenario, the four turbines at the elbow of Witham Mountain must go into a nighttime noise reduction mode of 1 to 2 dB (Figure 35). When a turbine is in noise reduced operation (NRO), the rotor is slowed to reduce the tip speed, reducing noise. The turbine is placed in an NRO mode automatically when meteorological and turbine operating conditions are predicted to yield high noise levels. Since the rotor speed is reduced, the power output is also reduced. Generally, NRO should only be necessary when winds are in the direction from the turbines to camps to the east, but this can be confirmed during post-construction sound monitoring. With NRO modes at these four wind turbines, the sound levels within 500 feet of both camps are at or below 45 dBA.

Appendices A and B show detailed results for all scenarios, including the sound pressure levels at each receiver, the sound power levels from each wind turbine, and a map of the overall modeled sound pressure levels.

Figure 34: A-weighted Overall Modeled Sound Pressure Levels (dBA) from the Highland Wind Project at Maximum-Rated Sound Power, Scenario 2 (Siemens SWT 3.0-101)

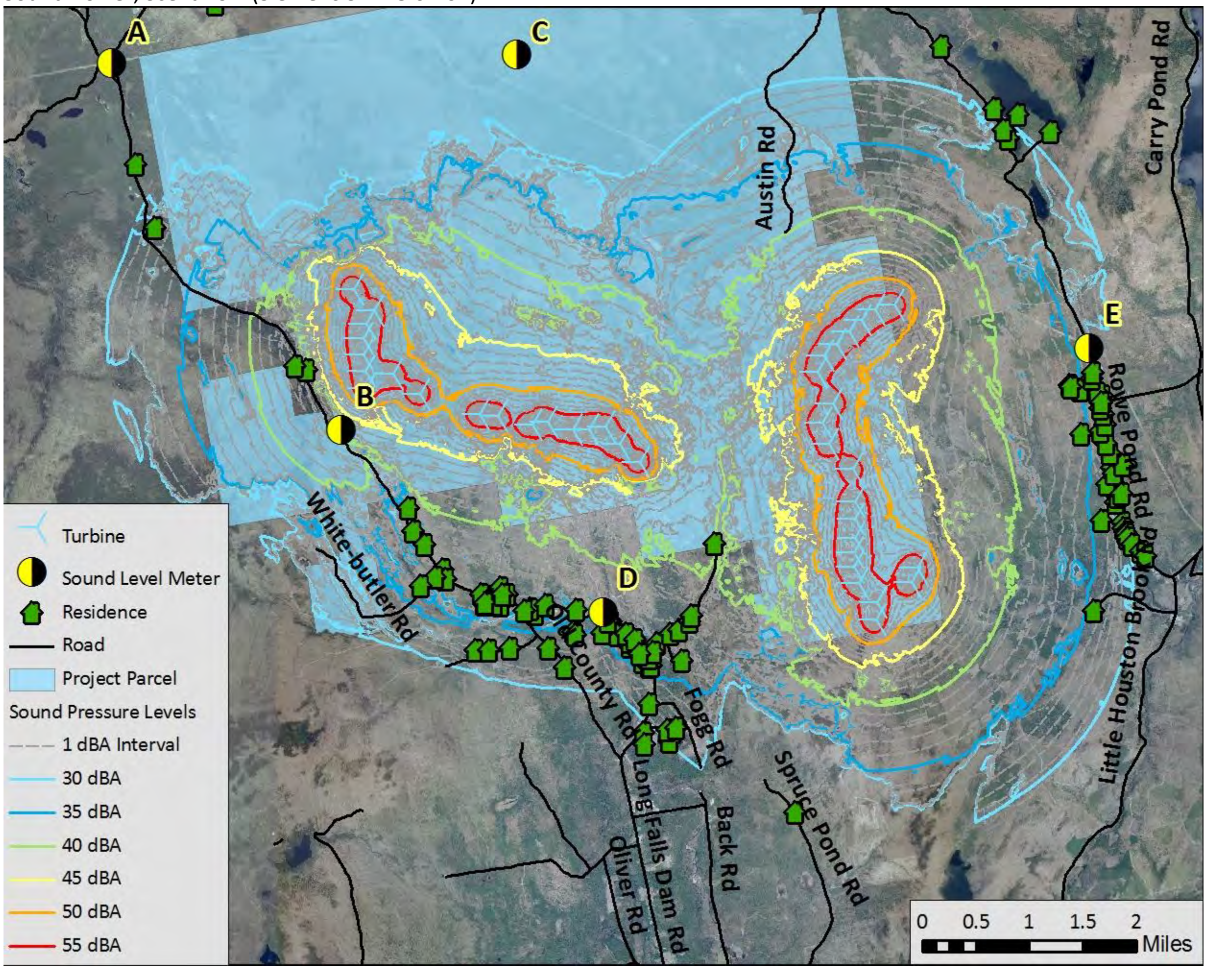
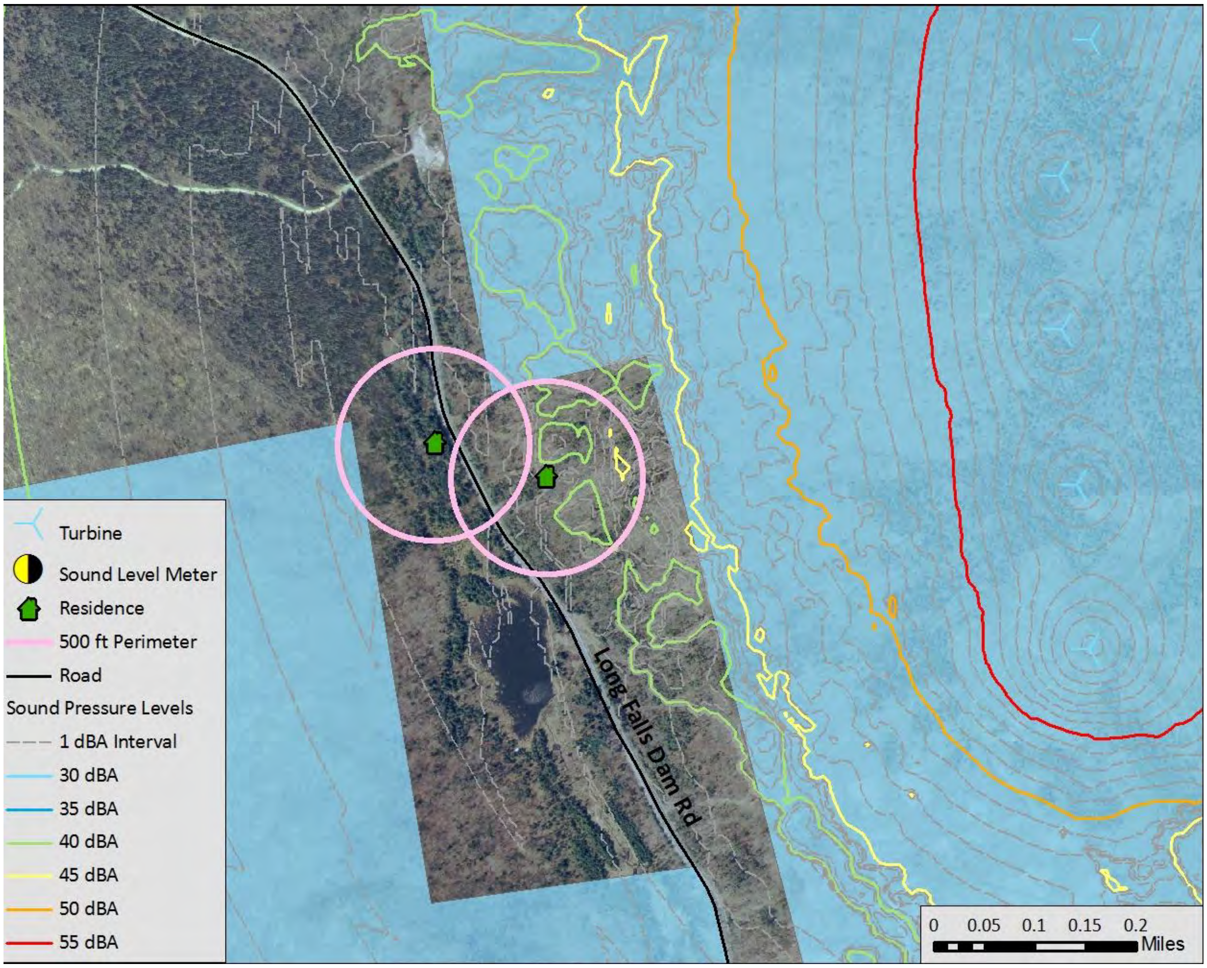


Figure 35: Sound pressure levels around the two camps southwest of Witham Mountain when the Siemens SWT 3.0-101 wind turbines are in noise reduced operation



10.2.2 Low frequency sound

Of all the residences in Scenario 1 (Siemens 101 3.0 MW), the highest sound level at a frequency of 63 Hz is 49 dB. This modeled value is well below the interior sound level of 70 dB that is likely to create moderately perceptible building vibrations at these frequencies[9]. Levels at lower frequencies (16 Hz and 31.5 Hz) can also cause building vibration; however, the turbine manufacturer does not have turbine emissions data for these lower frequencies.

For the Vestas V90, the worst-case low-frequency sound levels are 47 dB at 31.5 Hz and 50 dB at 63 Hz. These are substantially below the thresholds for moderately perceptible building vibrations.

[9] ANSI/ASA S12.2-2008, “Criteria for Evaluating Room Noise”

11.0 OTHER NOISE SOURCES

There will be several minor noise sources at the site. These include:

1) Transformers –There may be a transformer at the base of each turbine. Transformer noise emissions are subject to NEMA TR-1 standards. The transformers at the base of the turbines are not likely to be audible outside of the project area. A 34.5 to 115 kV step-up transformer is proposed for this project inside of the wind turbine project area. The transformer is rated at 84/112/140 MVA and 200/450 kV BIL, for which the NEMA TR-1 standard is approximately 80 dBA ONAN (fans off) and 83 dBA ONAF (fans on). According to the calculations of equation 3 of IEEE Standard 1127-1998 (R2004), the sound pressure level at the nearest home approximately 2,700 feet away, would be 23 dBA. This is below the nighttime L90 for all of the background monitoring stations (see Table 2). As a result, transformer sound levels are expected to be insignificant.

2) Transmission lines – The transmission lines associated with the project are 115 kV and 34.5 kV. The voltage of these lines is too low to generate any significant corona noise and will likely be inaudible next to the lines.

3) Maintenance and operations –The site will be accessed via a pickup truck or off-road vehicle. This level of increased traffic will not create any adverse sound impacts. There is also a possibility for cranes to be used at the site occasionally for repairs and maintenance.

12.0 CONSTRUCTION IMPACTS

The construction of the turbines will take place primarily on the ridge line. While there may be activity closer to residences for road construction and utility work, such work will be of a relatively short duration.

The equipment used for the construction will be varied. Some of the louder pieces of equipment are shown in Table 4 along with the approximate maximum sound pressure levels at 50 feet (15.2 m) and 2,755 feet (745 m). The closest non-participating residence is about 2,755 feet from the nearest proposed turbine. Sound levels at this distance are likely to be lower due to the presence of vegetation between the construction areas and the nearest residences.

Figure 31: Maximum sound levels from various construction equipment

Equipment	Sound Pressure Level at 50 feet (dBA)	Sound Pressure Level at 2755 feet (dBA)[10]
M-250 Liftcrane	82.5	44
2250 S3 Liftcrane	78	39
Excavator	83	46
Dump truck being loaded	86	51
Dump truck at 25 mph accelerating	76	38
Tractor trailer at 25 mph accelerating	80	43
Concrete truck	81	42
Bulldozer	85	45
Rock drill	100	56
Loader	80	39
Backhoe	80	41
Chipper	96	60

Blasting may be required. However, the amount of blasting will be limited. Blasts will be warned as per federal and/or state requirements. Blasts will be designed by a licensed blasting company and charges and delays will be set such that Bureau of Mines standards for vibration and airblast will be complied with.

Construction will take place over approximately nine months. Major construction work, such as clearing for the access roads, will occur primarily during the day, however, minor construction work may extend earlier or later.

Due to the setbacks involved and the limited duration of the activities, construction noise should not pose undue quality of life concerns. This is particularly true, given that the project area is presently used for timber harvesting, and many of the sound sources common with harvesting operations are similar to construction machinery.

13.0 SUMMARY AND CONCLUSIONS

The Highland Wind Project proposes to construct and operate up to 39 wind turbines in Highland Plantation, Maine. This report evaluated potential noise impacts of the project and concluded the following:

1) Within one mile of any turbine, there are only two seasonal homes and no year-round residences. These two seasonal camps are upwind of the prevailing wind direction. The closest protected area (full time residence) is 5,800 feet from the nearest turbine.

2) Background sound monitoring reveals that wind speeds at hub height are highly correlated with sound levels. Based on our correlations, as shown in Figure 30 and Figure 31, the background sound levels range from 25 to 36 dB LA90 and 28 to 42 dB LAeq when the wind speed is 7 m/s at hub height.

[10] Assumes hard ground around construction site, and ISO 9614-2 propagation with no vegetation reduction. Actual sound levels will likely be lower given the prevalence of dense vegetation and soft ground around the site.

3) The noise standard applied to the project is based on Chapter 375.10 of DEP regulations. Since the nighttime Leq is below 35 dBA at all monitoring sites, the noise standard for this project would be 45 dBA during the night and 55 dBA during the day.

4) Compliance with the Maine DEP noise standard was evaluated through the use of computer modeling. The model used conservative parameters based on meteorological conditions favorable to propagation, an assumption of hard ground in the entire project area, and the addition of the manufacturer confidence interval to the turbine sound power levels. Using an assumption of hard ground results in a ground attenuation factor that increases overall sound level by 3 to 4 dB.

5) The results of the modeling indicate that Maine DEP noise standards are met at all protected areas and camps for all wind turbine layouts being considered for the project, except at two camps when using the Siemens SWT 3.0-101 under normal operating modes.

6) If the Siemens SWT 3.0-101 or a turbine with similar sound output is used, then a nighttime noise reduction mode of 1 to 2 dB will need to be applied to four turbines in the southwest of the project in order to meet the nighttime noise limit at the two closest camps.

7) Other than at the two camps mentioned, sound levels are at or below 40 dBA under all scenarios.

8) The levels of low frequency sound will not create perceptible building vibration.

9) While it is not possible at this time to model levels of short-duration repetitive sounds from wind turbines, the measured turbulence and wind shear show that the site characteristics are not conducive to common occurrences this phenomenon.

10) Other than extended concrete pours and similar events, major construction will take place during normal business hours.

11) Routine maintenance and transformers will not create significant noise impacts.

Overall, the project has been shown to meet the strictest Maine DEP noise standard of 45 dBA at a distance of 500 feet from residential structures for all turbine models except the Siemens SWT 3.0-101. Were this turbine model chosen, a nighttime NRO model of 1 to 2 dB may be required for the four closest turbines to the camps in the southwest of the project, especially during winds from the east. With this NRO mode in place, modeled sound pressure levels do not exceed 45 dBA at any home, or within 500 feet of any home.

APPENDIX A

Receiver and Source Data from Sound Modeling Results

Figure A1: Modeled Sound Levels at Residences for Each Scenario

Receiver ID	Type	Modeled Scenarios					Relative Height (m)	Coordinates UTM NAD 83 Z19		
		1	2	3	4	5		X (m)	Y (m)	Z* (m)
1	Camp	38	42	39	42	42	4	411370	4993156	456
16	Residence	30	35	32	35	35	4	412969	4990742	337
17	Residence	33	37	35	37	37	4	413136	4990541	316
18	Residence	33	37	35	37	37	4	413406	4990166	280
19	Residence	33	37	35	37	37	4	413450	4990017	266
23	Residence	32	36	34	36	36	4	414793	4989494	204
24	Residence	32	36	34	36	36	4	414726	4989562	202
25	Residence	30	34	32	34	34	4	415004	4988982	199
26	Residence	31	35	33	35	35	4	415367	4989217	205
27	Residence	31	35	32	35	35	4	415405	4989177	210
28	Residence	32	37	34	37	37	4	414953	4989629	204
29	Residence	31	35	33	35	35	4	415413	4989553	190
30	Residence	32	36	34	36	36	4	415847	4989413	170
31	Residence	33	37	35	37	37	4	415942	4989387	172
32	Residence	32	36	34	36	36	4	416033	4989173	164
33	Residence	31	36	33	36	36	4	415802	4989211	168
34	Residence	32	36	33	36	36	4	416229	4988999	159
35	Residence	32	36	34	36	36	4	416223	4989072	160
36	Residence	32	37	34	37	37	4	416169	4989191	164
37	Residence	33	37	35	37	37	4	416631	4989049	159
38	Residence	33	38	35	38	38	4	416827	4989191	161
39	Residence	32	36	34	36	36	4	416345	4989011	159
40	Residence	31	36	33	36	36	4	416411	4988782	159
42	Residence	32	37	34	37	37	4	416290	4989112	159
43	Residence	31	35	33	35	35	4	416515	4988705	157
44	Residence	31	35	33	35	35	4	416539	4988715	157
47	Residence	32	37	34	37	37	4	416996	4988793	154
48	Residence	34	38	36	38	38	4	416962	4989254	159
4	Residence	34	39	36	39	39	4	417120	4989374	160
6	Residence	34	39	36	39	39	4	417147	4989465	165
53	Residence	33	37	35	37	37	4	412897	4991082	391
54	Residence	32	37	34	37	37	4	414031	4989635	234
55	Residence	33	37	35	37	37	4	413982	4989789	235
56	Residence	33	37	34	37	37	4	414129	4989741	224
57	Residence	32	37	34	37	37	4	414125	4989680	224
58	Residence	32	36	34	36	36	4	414281	4989626	214

Receiver ID	Type	Modeled Scenarios					Relative Height (m)	Coordinates UTM NAD 83 Z19		
		1	2	3	4	5		X	Y	Z*
								(m)	(m)	(m)
59	Residence	33	37	35	37	37	4	414281	4989879	215
60	Residence	33	37	35	37	37	4	414383	4989788	209
61	Residence	33	37	35	37	37	4	413295	4990043	268
66	Residence	32	36	34	36	36	4	414180	4989646	219
68	Residence	19	23	21	23	23	4	408798	4996235	391
69	Residence	27	32	30	32	32	4	409082	4995285	404
73	Residence	18	22	20	22	22	4	418703	4986509	208
74	Residence	0	0	0	0	0	4	409999	4998650	516
75	Residence	32	37	34	37	37	4	414051	4989659	232
77	Residence	32	37	34	37	37	4	413079	4989912	249
100	Residence	30	34	31	34	34	4	414421	4988980	196
79	Residence	28	32	30	32	32	4	416519	4988141	154
101	Residence	22	26	24	26	26	4	416424	4987711	150
80	Residence	26	30	28	30	30	4	416819	4987579	152
81	Residence	26	31	28	31	31	4	416787	4987757	153
82	Residence	30	34	32	34	34	4	423304	4990894	287
83	Residence	25	29	27	29	29	4	423620	4990871	275
84	Residence	25	29	27	29	29	4	423638	4990778	270
85	Residence	25	29	27	29	29	4	423662	4990727	267
86	Residence	25	29	27	29	29	4	423694	4990653	263
87	Residence	25	29	27	29	29	4	423675	4990695	266
88	Residence	25	29	27	29	29	4	423696	4990631	262
102	Residence	25	29	27	29	29	4	423763	4990531	256
89	Residence	19	24	22	24	24	4	423517	4991174	290
90	Residence	17	21	19	21	21	4	423542	4991261	287
103	Residence	17	21	19	21	21	4	423523	4991424	293
91	Residence	24	29	27	29	29	4	423392	4991436	307
104	Residence	20	25	23	25	25	4	423465	4991683	305
106	Residence	22	26	24	26	26	4	423483	4991606	303
108	Residence	20	25	22	25	25	4	423617	4991729	292
109	Residence	20	25	22	25	25	4	423429	4991909	315
110	Residence	27	31	29	31	31	4	423374	4992045	324
112	Residence	28	32	30	32	32	4	423281	4992232	331
113	Residence	27	31	29	31	31	4	423361	4992329	333
114	Residence	24	29	26	29	29	4	423329	4992489	338
115	Residence	26	31	29	31	31	4	423293	4992574	341
116	Residence	24	28	27	28	28	4	423321	4992763	341
117	Residence	22	27	25	27	27	4	423240	4992813	348

Receiver ID	Type	Modeled Scenarios					Relative Height (m)	Coordinates UTM NAD 83 Z19		
		1	2	3	4	5		X (m)	Y (m)	Z* (m)
92	Residence	32	36	34	36	36	4	422821	4992932	347
93	Residence	31	35	33	35	35	4	422979	4992849	355
94	Residence	32	36	34	36	36	4	422836	4992903	347
95	Residence	28	33	30	33	33	4	423155	4993032	359
96	Residence	22	27	24	27	27	4	423169	4993113	352
118	Residence	14	18	16	18	18	4	422531	4996734	379
97	Residence	31	36	33	36	36	4	422994	4992194	328
98	Residence	30	35	32	35	35	4	423190	4989534	252
119	Residence	23	27	25	27	27	4	423893	4990436	246
120	Residence	23	27	25	27	27	4	423960	4990356	244
121	Residence	29	34	31	34	34	4	413899	4988948	214
123	Residence	19	23	21	23	23	4	420897	4998015	379
1000	Residence	19	23	21	23	23	4	416435	4987533	149
1001	Residence	32	36	34	36	36	4	416514	4988831	158
1002	Residence	32	36	34	36	36	4	416566	4988918	159
1003	Residence	32	36	34	36	36	4	416366	4988888	159
1004	Residence	32	36	34	36	36	4	415886	4989379	167
1007	Residence	29	33	31	33	33	4	414098	4988945	209
1009	Residence	29	33	31	33	33	4	415244	4988685	208
1010	Residence	32	36	34	36	36	4	414641	4989536	200
1011	Camp	41	44	42	44	44	4	411193	4993208	434
1013	Residence	24	29	26	29	29	4	423293	4992674	343
1014	Residence	23	28	25	28	28	4	421907	4996638	379
1016	Residence	26	31	28	31	31	4	421829	4996767	379
1017	Residence	25	29	27	29	29	4	421690	4997080	379
124	Residence	33	37	35	37	37	4	414312	4989782	213
125	Residence	27	32	29	32	32	4	416913	4987777	152
126	Residence	15	19	17	19	19	4	423605	4991299	285
127	Residence	24	29	26	29	29	4	422043	4996996	379
1018	Camp	36	40	38	40	40	4	417491	4990545	178

**Z represents elevation plus the relative receiver height (1.5m)*

Figure A2: Modeled Turbine Source Inputs

Turbine Model	Lw (dBA)	Correction (dB)	Relative Height (m)
GE 2.5 XL	104.2	1.8	85
Vestas V90	107	2.0	80
Siemens SWT 2.3-101	107	1.5	80
Siemens SWT 3.0-101	107	1.5	80
Siemens 3.0 NRO 4W and 7W	107	0.5	80
Siemens 3.0 NRO 5W and 6W	107	-0.5	80

Figure A3: Modeled Turbine Source Locations

Turbine ID	Coordinates UTM NAD 83 Z19		
	X	Y	Z
	(m)	(m)	(m)
1W	412037	4994362	766
2W	412353	4994046	750
3W	412231	4993849	712
4W	412182	4993632	713
5W	412185	4993388	719
6W	412210	4993142	735
7W	412229	4992881	738
8W	412641	4993092	749
9W	413038	4992802	713
10W	413933	4992497	684
11W	414210	4992472	751
12W	414719	4992333	755
13W	414950	4992383	727
14W	415336	4992260	710
15W	415576	4992268	700
16W	415821	4992302	695
17W	416038	4992049	677
18W	416333	4991779	700
19E	420159	4994132	629
20E	419865	4994060	642
21E	419662	4993907	679
22E	419476	4993731	717
23E	419287	4993553	750
24E	419103	4993370	755
25E	419010	4993123	763
26E	419240	4992659	667

27E	419072	4992369	633
28E	419178	4992053	645
29E	419538	4991677	655
30E	419569	4991189	585
31E	419562	4990916	585
32E	419563	4990642	597
33E	419555	4990424	620
34E	419553	4990207	661
35E	419626	4989951	684
36E	419897	4989668	638
37E	419882	4989405	639
38E	420497	4990189	559
39E	420420	4989966	580

Figure A4: Modeled Turbine (GE SLE) Sound Power Spectrum (dBA)

Turbine Model	Octave Band Frequency (Hz)								dBA
	63	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	
Siemens SWT 3.0-101	82	94	100	104	100	93	82	78	107
Siemens SWT 2.3-101	84	94	98	102	102	98	91	87	107
GE 2.5 xl	86	92	99	99	98	94	86	70	104
Vestas V90, 3 MW	83	92	94	97	100	102	101	97	107

Figure A5: Modeling Parameters

Parameter	Setting
Ground Absorption	ISO 9613-2 Spectral, G=0
Atmospheric Absorption	Based on 10 Degrees Celsius, 70 % Relative Humidity
Reflections	None
Search Radius	4000 m from each source (2.6 miles)
Receiver Height	4 m (approximately 13 feet) for residences, 1.5 meters for grid
Contour Interval	5.0 m (16.4 ft) from USGS digital elevation model

Figure A6: Map Showing the Receivers to the South of the Project with their IDs Labeled.

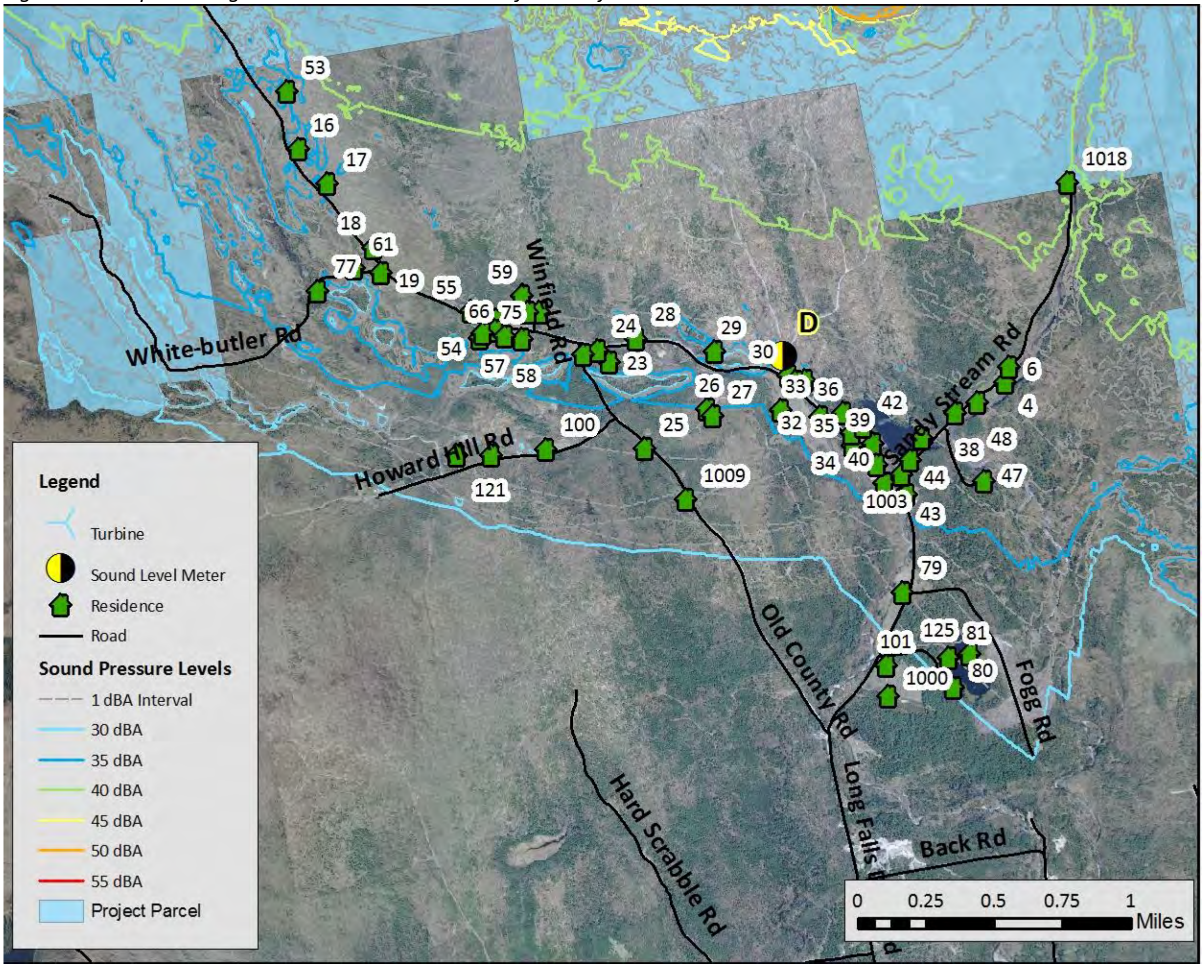
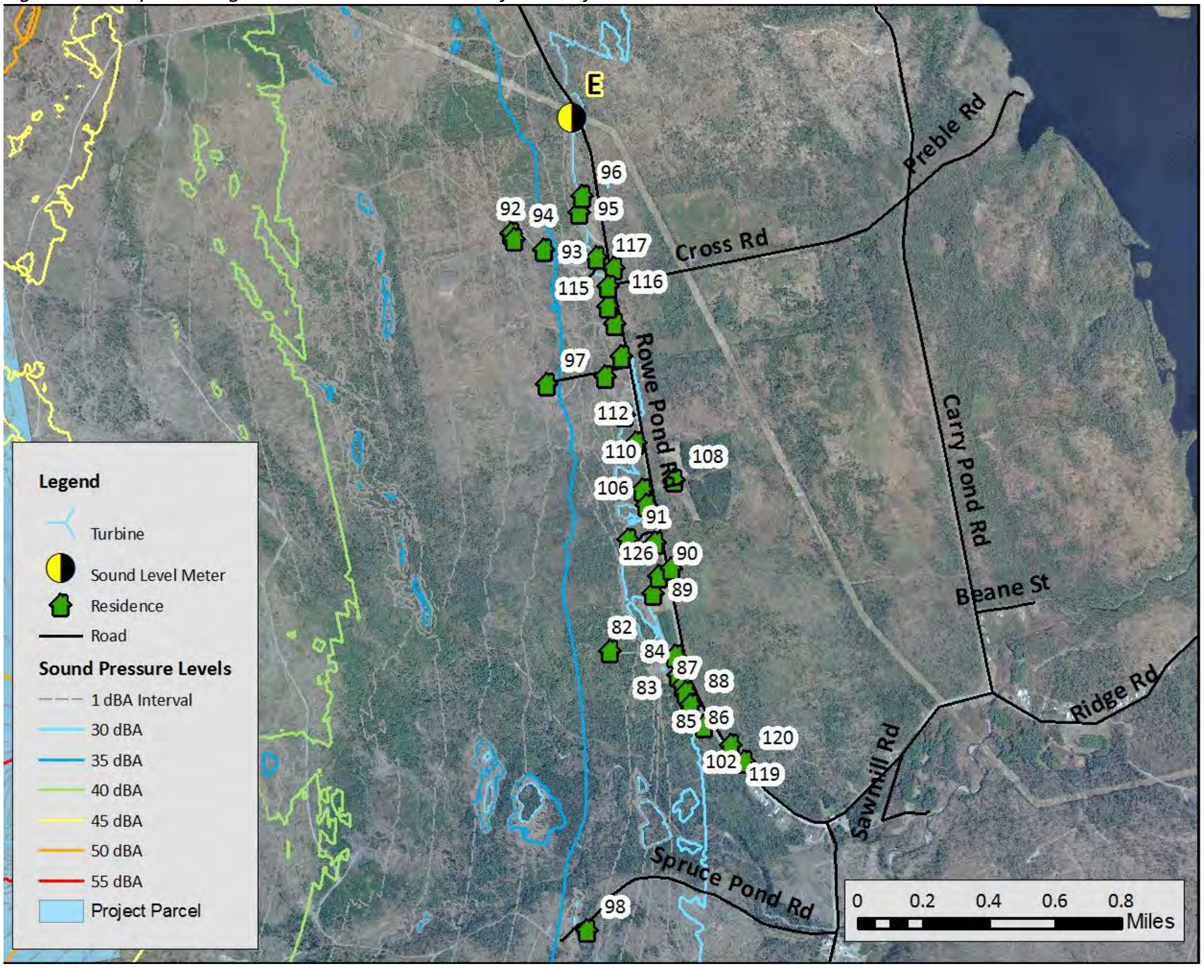


Figure A7: Map Showing the Receivers to the East of the Project with their IDs labeled.



APPENDIX B

Sound Level Maps for Each Turbine Scenario

Figure B11: A-weighted Overall Modeled Sound Pressure Levels (dBA) from the Highland Wind Project at Maximum-Rated Sound Power, Scenario 1 (Vestas V90)

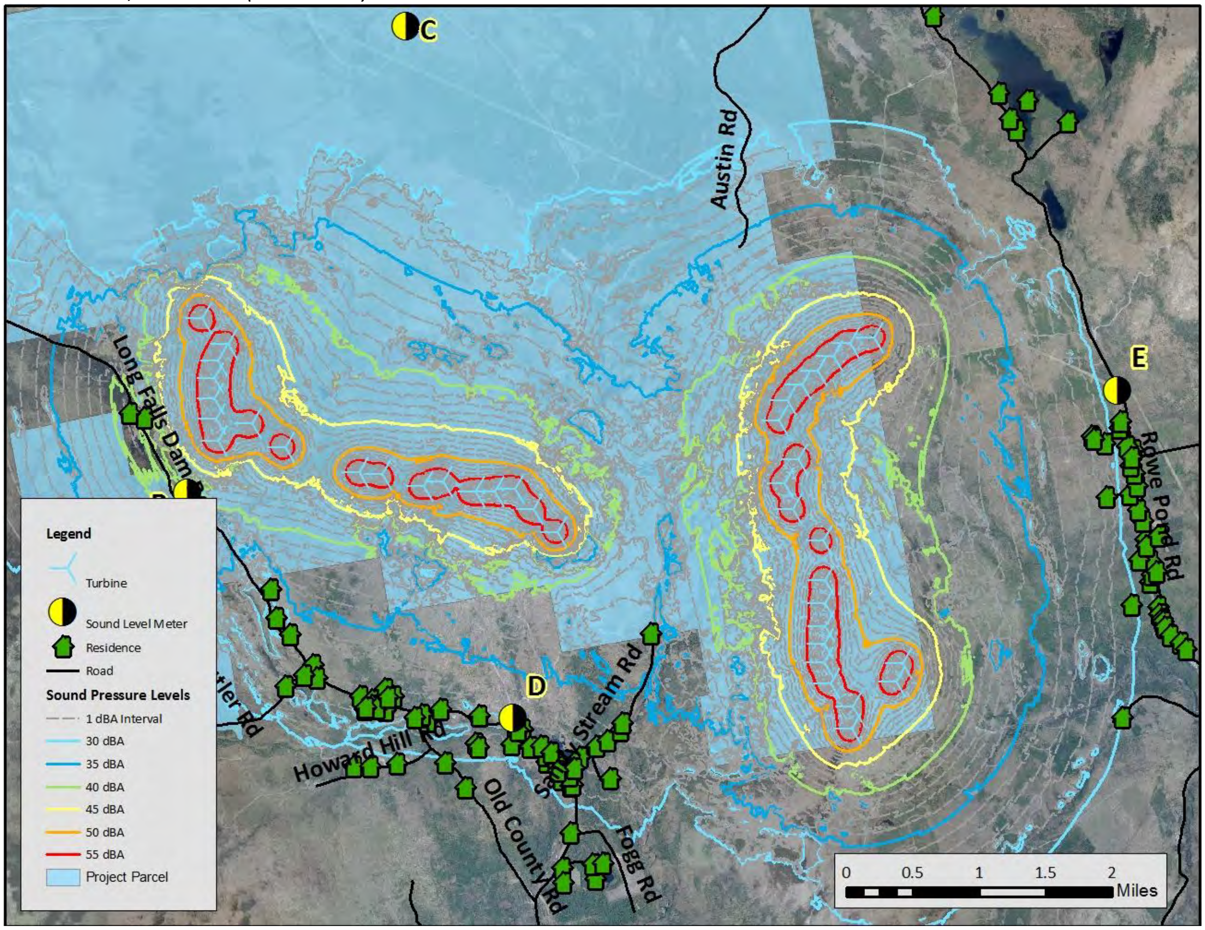


Figure B22: A-weighted Overall Modeled Sound Pressure Levels (dBA) from the Highland Wind Project at Maximum-Rated Sound Power, Scenario 2 (Siemens 3.0-101)

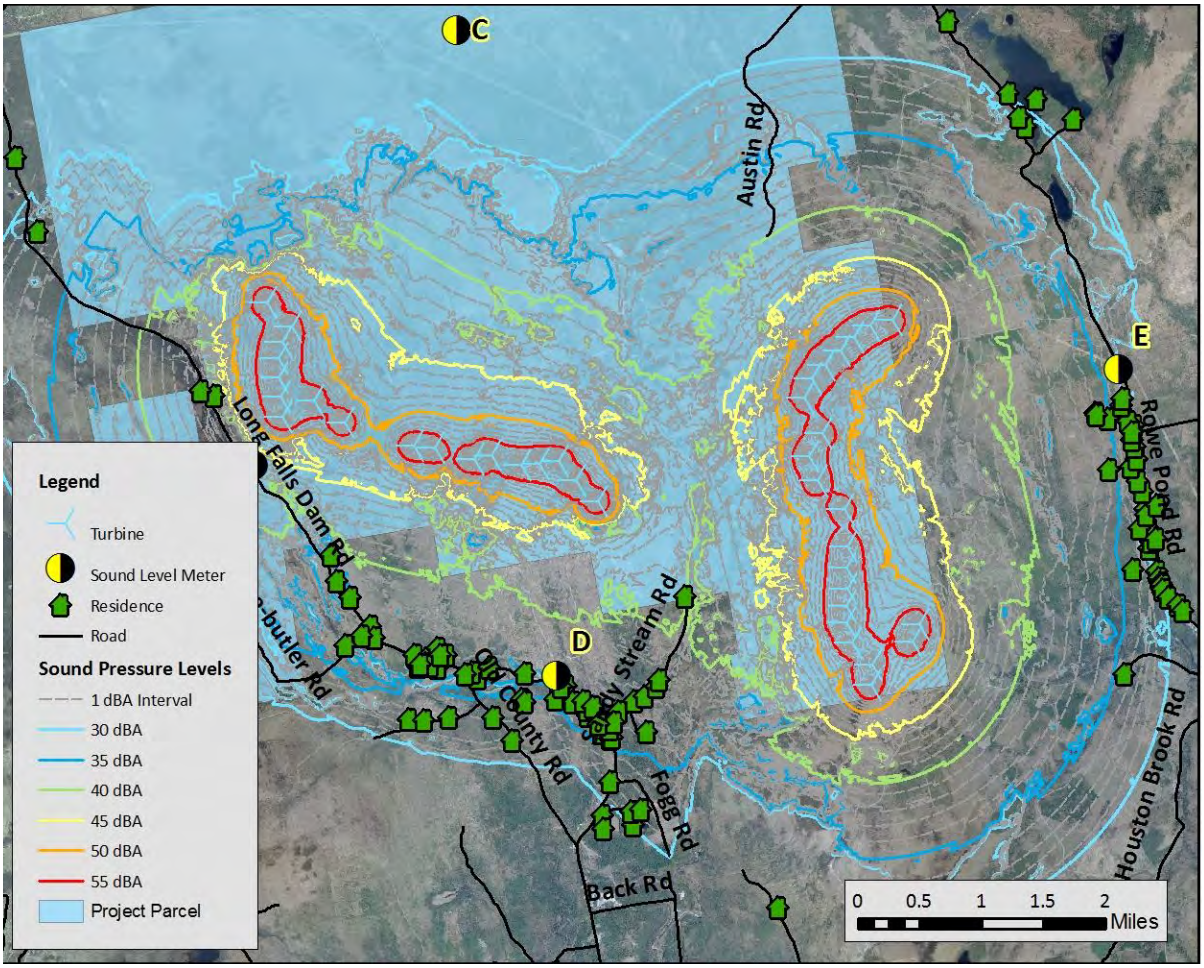


Figure B33: A-weighted Overall Modeled Sound Pressure Levels (dBA) from the Highland Wind Project at Maximum-Rated Sound Power, Scenario 3 (GE 2.5xl)

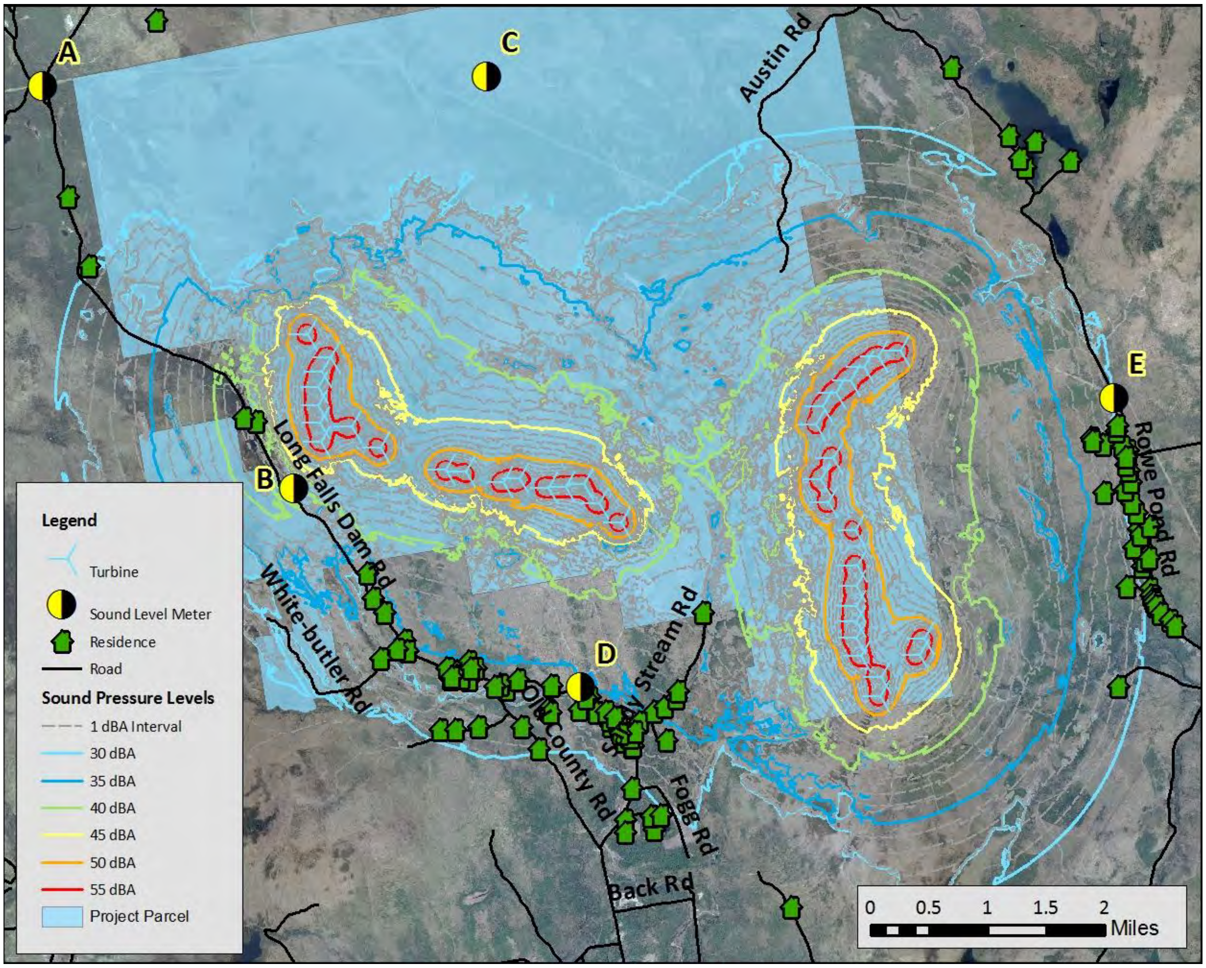


Figure B44: A-weighted Overall Modeled Sound Pressure Levels (dBA) from the Highland Wind Project at Maximum-Rated Sound Power, Scenario 4 (Siemens 2.3-101)

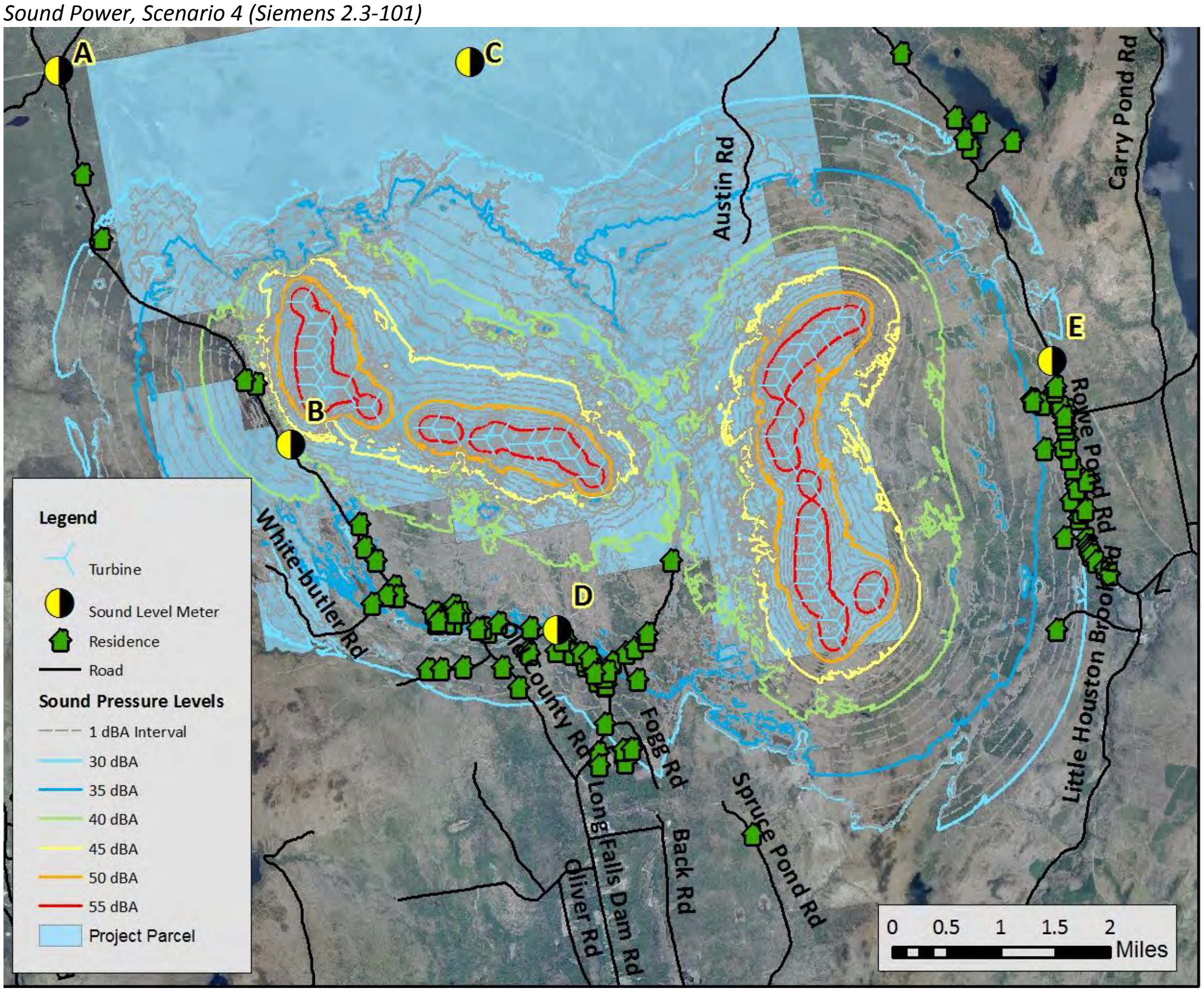
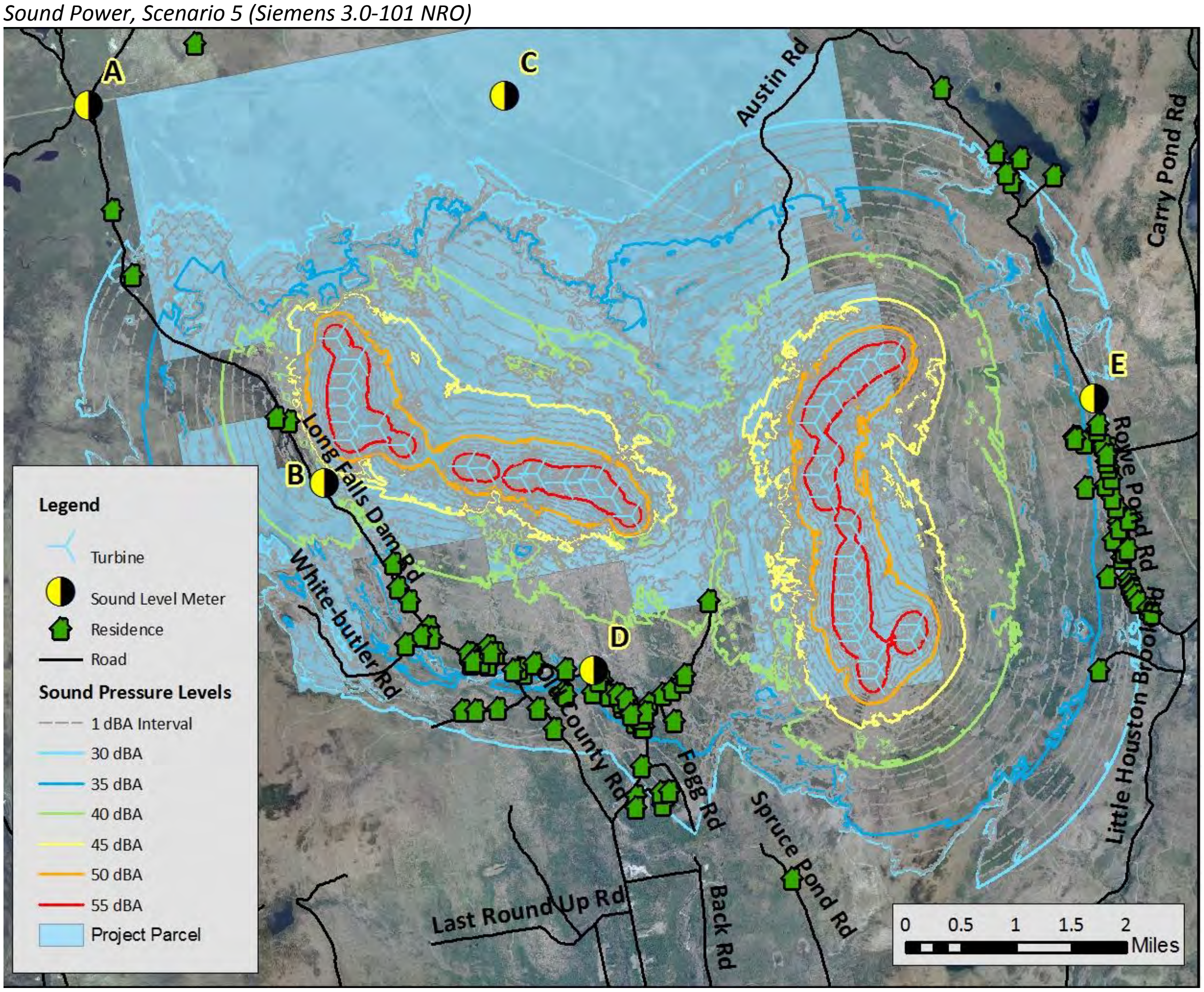


Figure B55: A-weighted Overall Modeled Sound Pressure Levels (dBA) from the Highland Wind Project at Maximum-Rated Sound Power, Scenario 5 (Siemens 3.0-101 NRO)



APPENDIX C

Supplementary Sound Monitoring Results

Figure C1: Daytime and Nighttime Leqs for Monitor A

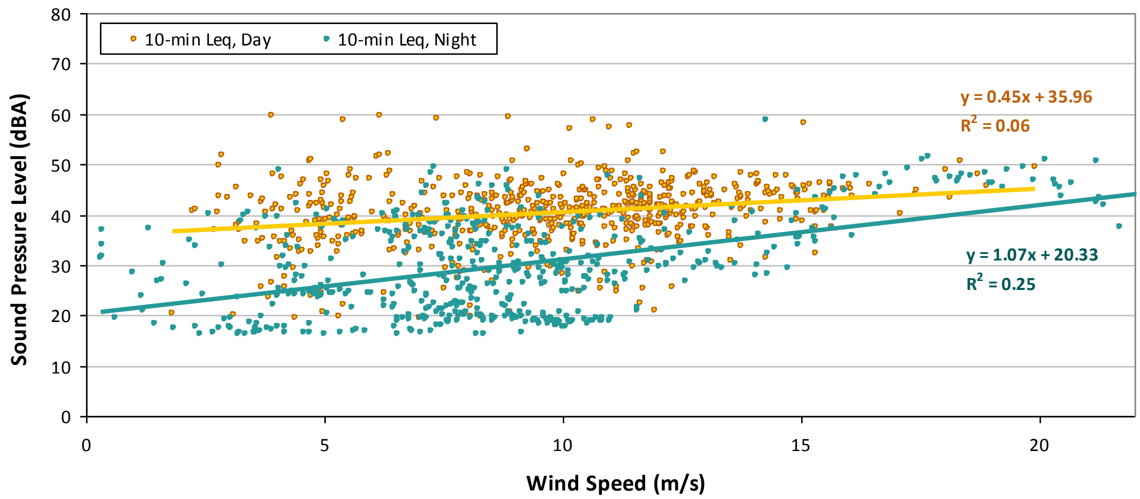


Figure C2: Daytime and Nighttime L90s for Monitor A

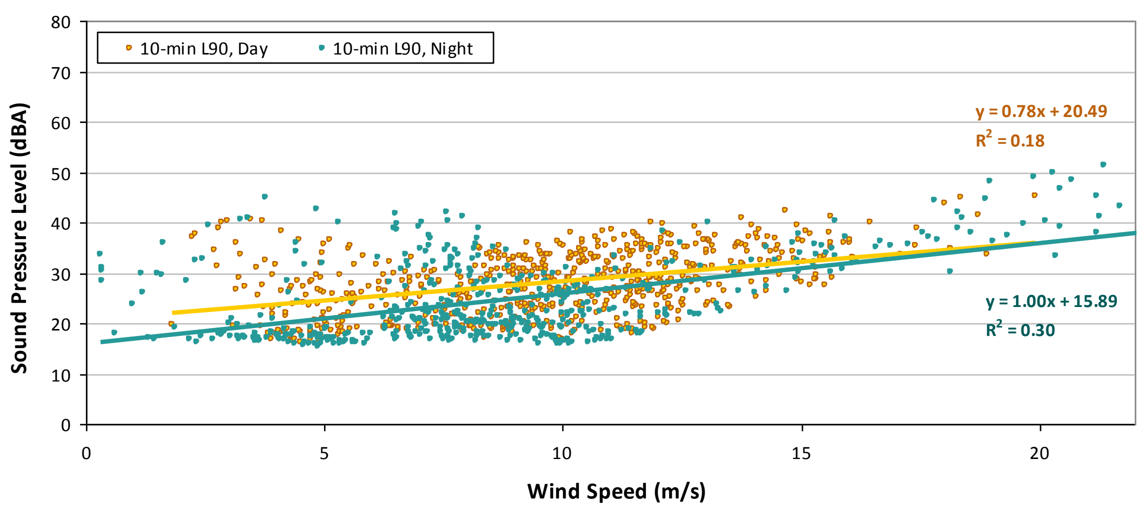


Figure C3: Daytime and Nighttime Leqs for Monitor C

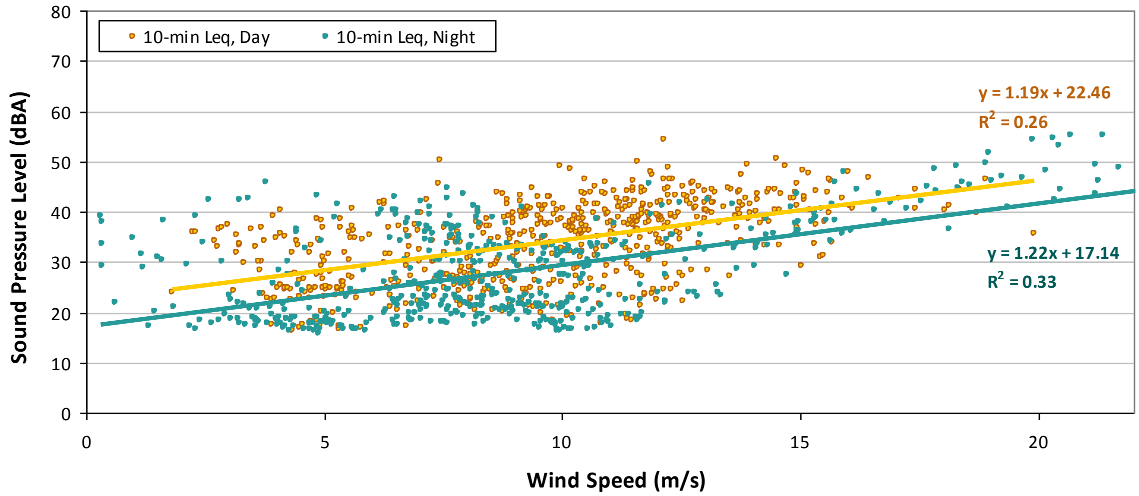


Figure C4: Daytime and Nighttime L90s for Monitor C

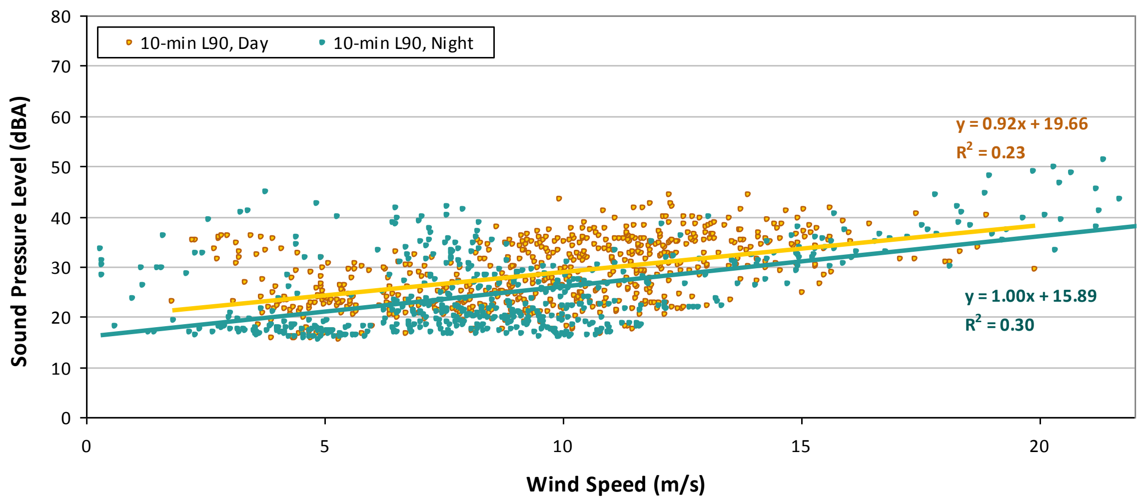


Figure C5: Daytime and Nighttime Leqs for Monitor D

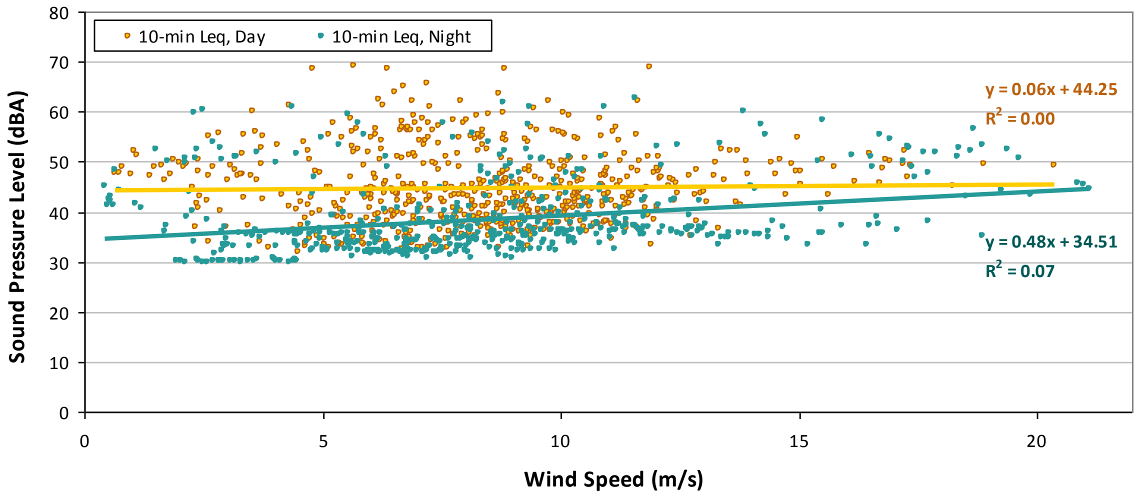


Figure C6: Daytime and Nighttime L90s for Monitor D

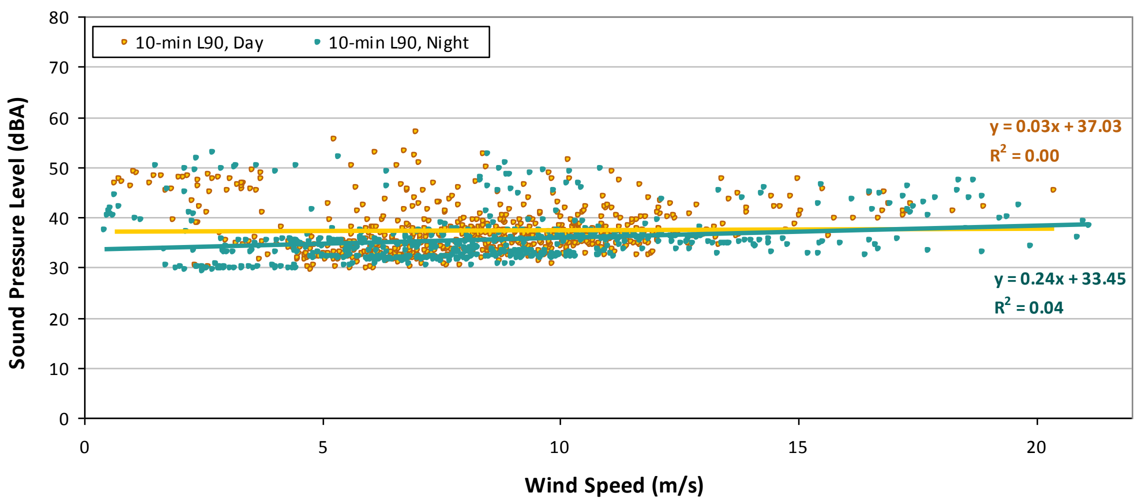


Figure C7: Daytime and Nighttime Leqs for Monitor E

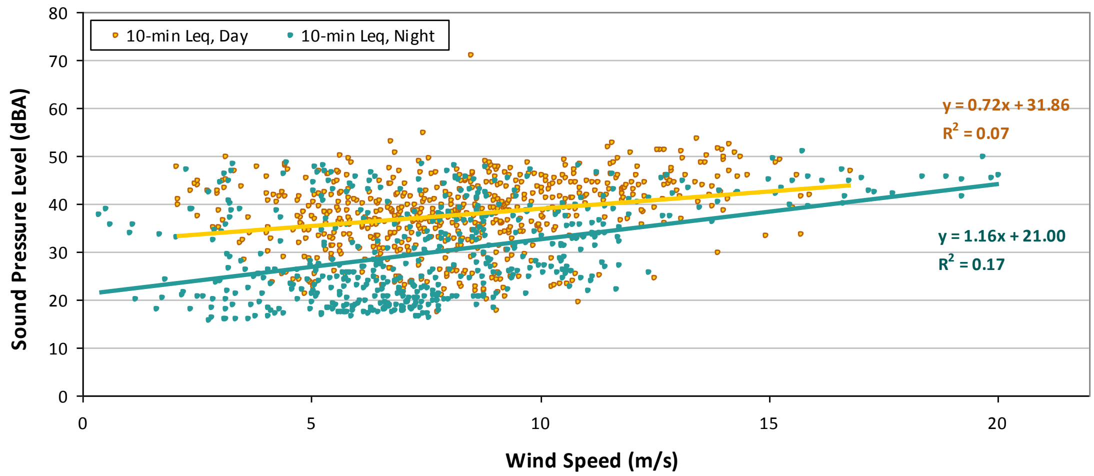
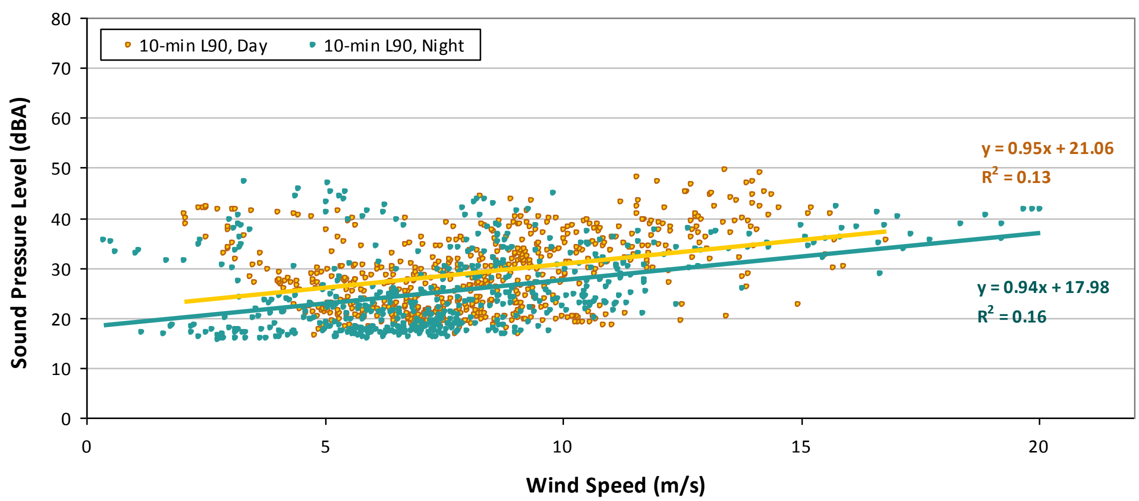


Figure C8: Daytime and Nighttime L90s for Monitor E



APPENDIX D

Site Photographs

Figure E1: View from Monitor A Looking East

Figure E2: Monitor B

Figure E3: View from Monitor B Looking Southwest

Figure E4: Monitor C

Figure E5: Monitor D

Figure E6: Monitor E

Appendix 19-2

Highland Wind Project Wind Turbine Sound Compliance and Assessment Plan

February 2011

The purpose of this plan is to demonstrate compliance with 06-096 CMR 375.10 requirements through a post-construction sound monitoring assessment.

The Highland project is unique, in that only two camps and no year-round residences lie within one mile of the project. According to meteorological data from Stewart Mountain, these two camps are upwind of the project and winds from the project towards the camps are rare (Figures 1 and 2).

This protocol for monitoring post-construction sound levels for the Highland project is based on that submitted for Record Hill Wind Project, with exceptions to account for its unique configuration. The monitoring will occur as a single test.

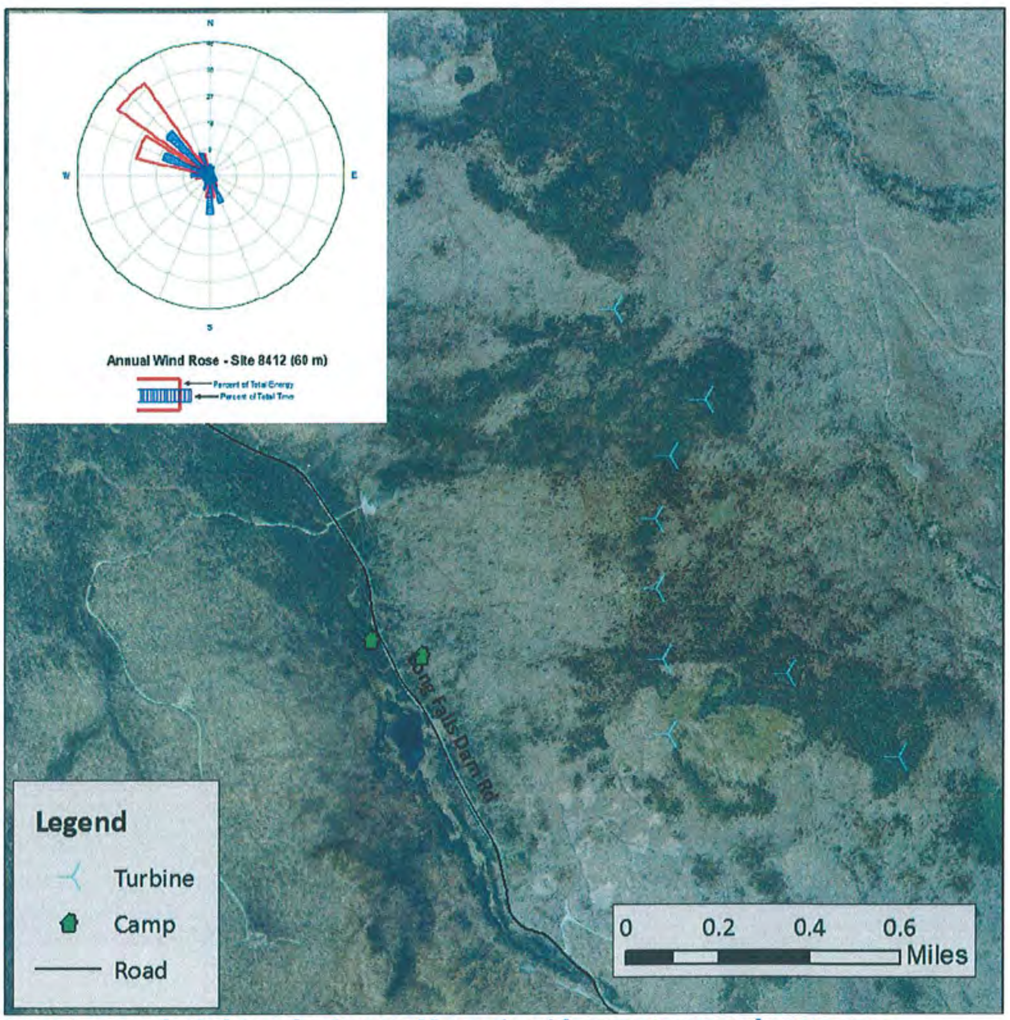


Figure 1: Annual wind rose for Stewart Mountain with respect to two closest camps

PROTOCOL

a. Monitoring will include one or more sites representative of protected locations within one mile of the nearest operating wind turbine. To the extent possible, given landowner permissions, protected locations closest to the wind turbines will be used. Selection of monitoring locations will require concurrence from Maine DEP. Additional locations outside of one mile may be considered if complaints are filed prior to conducting the field tests.

b. Compliance will be demonstrated when the required operating/test conditions and sound level limits per 06-096 CMR Chapter 375.10 have been met for twelve 10-minute measurement intervals at each representative monitoring location.

c. Compliance will also be demonstrated and analyses of either short duration repetitive or tonal sound will not be required when the total of all sound for each of the twelve, 10-minute measurement results are equal or greater than 5 dBA below the applicable DEP noise limit for each representative monitoring position even with wind speeds equal or less than 6 mph. When the total of all sound for each of the twelve, 10-minute measurement results are equal or greater than 10 dBA below the applicable DEP noise limit for any representative monitoring position, short duration repetitive and tonal sound analyses will not be required for that position.

d. Measurements will be obtained during weather conditions when wind turbine sound is most clearly noticeable. To the extent reasonably possible, measurements will be conducted when the measurement location is downwind of the development and maximum surface (10 meter) wind speeds are less than or equal to 6 mph with concurrent turbine hub-elevation wind speeds sufficient to generate the maximum continuous rated sound power from the five nearest wind turbines to the measurement location. These conditions generally occur during inversion periods usually between 11pm-5am and can also occur earlier in the evening around sunset. A downwind location is defined as within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines. It is recognized that downwind conditions at some sites is not possible given the rarity of such winds. As such, if downwind winds of sufficient speed to operate the wind turbines at maximum sound power occur less than 5% of the year, then the measurements may be taken when the wind direction is within 45° of the prevailing wind direction. Extraneous sounds could potentially or do complicate routine operation compliance assessment. If Highland must adjust for such sounds, background ambient sound level measurements used in the pre-construction assessment or additional post-construction monitoring will be used. If background ambient sound level measurements are proposed, locations will be determined with concurrence from the DEP and as further described below.

e. Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow or other extraneous ambient noise sources that affect the ability to demonstrate compliance will be excluded from reported data. The intent is to obtain measurements that meet the specified criteria for the entire 10-minute interval.

f. Maine DEP concurrence on meteorological site selection is required. To the extent reasonably possible, meteorological measurements of wind speed and direction will be collected using anemometers at a 10-meter height above ground and at the center of large unobstructed areas that are generally correlated with sound level measurement locations. Locations that cannot meet these criteria due to the lack of large unobstructed areas in the general vicinity of the compliance monitoring positions can be utilized with DEP concurrence and could require adjustments to reflect the actual conditions found at the protected locations selected for measurements. Results will be reported, based on 1-second integration intervals, and be reported synchronously with hub level and sound level measurements at 10 minute intervals. The wind speed average and maximum will be reported from surface stations. Individual 1-second wind gusts greater than 6 mph during any 10-minute measurement interval do not necessarily prevent the use of sound measurements taken during those intervals from being used to demonstrate compliance with the DEP noise limits.

g. Sound level parameters reported for each 10-minute measurement period will include A-weighted equivalent sound level, 10/90% exceedance levels and ten 1-minute 1/3 octave band linear equivalent sound levels (dB). Short duration repetitive events will be characterized by event duration and amplitude. Event frequency is defined as the average event frequency +/- 1 standard deviation and amplitude is defined as the peak event amplitude minus the average minima sound levels immediately before and after the event, as measured at an interval of 125 ms or less, A-weighted and fast time response (i.e. 125 milliseconds). For each 10-minute measurement period, short duration repetitive sound events will be reported as the percentage of intervals of the blade passage frequency with modulation amplitudes greater than 6 dBA.

h. Compliance data collected in accordance with the assessment methods outlined above for representative locations selected in accordance with this protocol will be submitted to the Department for review and approval prior to the end of the first year of facility operation. Compliance data for each location will be gathered and submitted to the Department at the earliest possible opportunity after the commencement of operation, with consideration for the required weather, operations, and seasonal constraints.

Section 20
Public Safety

20.0 PUBLIC SAFETY

Section 3455 of the Maine Wind Energy Act requires the relevant siting authority to consider the recommendation of a professional, licensed engineer as well as any setback recommended by the manufacturer of the generating facilities in determining a sufficient public safety-related setback for a proposed project. These required setbacks apply across the entire project layout. This section also allows the siting authority to require the applicant to provide this information as part of its application.

Subsequent guidance from the Land Use Regulation Commission (LURC) and the Maine Department of Environmental Protection states that the applicant's obligation is fulfilled by providing documentation that the turbine design meets accepted safety standards and has appropriate safety controls. To our knowledge, all commercially manufactured utility-scale turbines meet these standards, including each of those turbines currently under consideration for this Project. Attached at Appendix 20-2 are the safety certifications for three of the four turbines currently under consideration; for the Siemens 3.0, a memo is provided to describe its safety features and the schedule for obtaining a certification. Highland further commits to providing LURC with appropriate safety information on the selected turbine technology upon final selection, which will include adequate internal safety measures to address overspeed braking, fire control, and other safety concerns.

LURC's application guidance documents recommend a minimum setback from property lines, roads, or other structures equal to the local setback requirements or 1.5 times the maximum turbine blade height, whichever is greater. The Project has been sited with setbacks of more than five times the turbine height from structures and public roads, and only one turbine is sited with setbacks from the property line of less than 1.5 times the maximum turbine height. Turbine 19E is located approximately 200 feet from the eastern property line, as shown on Sheet C-301 of the civil plans (Exhibit 1). A waiver of the public safety setback from the abutting land owner, Plum Creek Timberlands, LP, is attached in Appendix 20-1.

In addition to public safety setbacks related to the turbines themselves, consistent with 12 M.R.S.A. §685,B(4-B), adequate provision for safety of the public has been provided with respect to general public use of the private property on which the project is proposed to be located. The private landowner of the underlying parcel has a policy of open land use for recreation. These uses largely will be allowed to continue during and after construction of the project, however, some areas will be closed to during construction for safety and security reasons. After construction is completed, access will be allowed to resume, however signage will likely be placed at access points to alert users to potential risks in traveling throughout the project area. In addition, signs to regulate the vehicle speed and use will be installed along project roads and those roads that intersect with project roads.

Appendix 20-1

R. Paul Hossain, P.E.
Director – Natural Resources
Plum Creek Timberlands, LP
One Concourse Parkway, Suite 755
Atlanta, GA 30328
770-829-6316 (office)
770-375-5724 (mobile)
Paul.Hossain@plumcreek.com

Plum Creek

March 3, 2010

Mr. Tom Colgan
Highland Wind LLC
c/o Wagner Forest Management Ltd.
PO Box 160
Lyme, NH 03768

Dear Tom,

The proposed Highland Wind LLC wind project in Highland Plantation, Maine abuts property owned by Plum Creek Timberlands in the towns of Pleasant Ridge Plantation and Lexington Plantation.

In your proposed project, we note turbine #E27 is approximately 221 feet from the common boundary of Highland Plantation and our land in Pleasant Ridge Plantation.

We have do not object to the setback distances being less than the distance recommended by LURC.

Please call with additional questions or clarifications.

Sincerely,

R. Paul Hossain, P.E.
Director – Natural Resources

Appendix 20-2

DET NORSKE VERITAS

TYPE CERTIFICATE

SWT-2.3-101

IEC TC-218901-0	**2009-11-04**
Type Certificate number	**Date of issue**

Manufacturer:
Siemens Wind Power A/S
Borupvej 16
DK - 7330 Brande

Valid until: 2014-10-30

This certificate attests compliance with IEC 61400-1 ed. 3: 2005 concerning the design and manufacture. The conformity evaluation was carried out according to IEC WT 01: 2001 "IEC system for conformity testing and certification of wind turbines - Rules and procedures."

Reference documents:

Design Evaluation Conformity Statement:	IEC DE-218901-0
Type Test Conformity Statement:	IEC TT-218901-0
Manufacturing Conformity Statement:	IEC MC-218901-0
Type Characteristics Measurement Conformity Statement(s):	IEC TM-218901-0
Final Evaluation Report:	PD-642189-1240749-22

Wind Turbine specification:
IEC WT class: 2 B. For further information see Appendix 1 of this Certificate.

Date: 2009-11-04		**Date: 2009-11-04**
Tove Feld	PRODUCTS	**Bente Vestergaard**
Management Representative	RvA C257	**Project Manager**
Det Norske Veritas, Danmark A/S		**Det Norske Veritas, Danmark A/S**

APPENDIX 1 - WIND TURBINE TYPE SPECIFICATION

General:

IEC WT class acc. to IEC 61400-1 ed. 3: 2005:	II B
Rotor diameter:	100.6 m
Rated power:	2300 kW
Rated wind speed V_r:	12 m/s
Hub height(s):	80 m
Operating wind speed range V_{in}-V_{out}:	4 m/s – 25 m/s
Design life time:	20 years
Low noise option/modified power curve:	May be used, which gives lower energy production

Wind conditions:

V_{ref} (hub height):	42.5 m/s
V_{ave} (hub height):	8.5 m/s
I_{ref} (V_{hub}=15 m/s) acc. to IEC 61400-1 ed. 3: 2005:	14 %
Mean flow inclination:	8°

Electrical network conditions:

Normal supply voltage and range:	690 V ±10%
Normal supply frequency and range:	50/60 Hz ±1%
Voltage imbalance:	1%
Maximum duration of electrical power network outages:	No limits when requirements in manuals are followed
Number of annual electrical network outages:	Maximum 1000 per year

Other environmental conditions (where taken into account):

Air density:	1.225 kg/m^3
Normal and extreme temperature ranges:	Normal: -10°C to +40°C Extreme: -20°C to +50°C
Relative humidity:	100%
Solar radiation:	1000 W/m^2
Salinity:	Present
Description of lightning protection system:	Designed according to IEC 61024-1 and IEC 61312-1

Main components:

Blade type:	Siemens Wind Power, B49-00
Gear box type:	Winergy PEAB 4456.2 or Winergy PEAB 4456.5 or Hansen EH851AQ21
Generator type:	ABB AMA 500L4A
Tower type:	Tubular/Conical steel tower
Service lift:	Not present
Crane:	HMF 262 T2

Statement of Compliance for the

A-Design Assessment

Registration-No.
44 220 10196537-DA-GL, Rev. 0

Name and address of customer	**GE Energy GmbH** Holsterfeld 16 48499 Salzbergen GERMANY
Wind Turbine	**GE 2.5xl, 60 Hz, hh 85 m** **LM 48.7 P / GE 48.7**

with the characteristic data given in the attached "Annex to Design Assessment" has been assessed by TÜV NORD concerning the design.

Assessed acc. to	**WTGS Class IEC IIB / IIIA**

The design approval is based on the indicated documents as follows:

TÜV NORD	Report No. 8000 196 537/1 E	Load assumptions IEC 61400-1, (1999) WTGS Class IIB/IIIA	Rev.0	dated Jan. 2010
TÜV NORD	Report No. 8000 196 537/2 E	Safety system and manuals	Rev.0	dated Jan. 2010
TÜV NORD	Report No. 8000 196 537/3 E	Rotor blades LM 48.7 P and GE 48.7	Rev.0	dated Jan. 2010
TÜV NORD	Report No. 8000 196 537/4 E	Machinery components	Rev.0	dated Feb. 2010
TÜV NORD	Report No. 8000 196 537/5 E	Electrical systems	Rev.0	dated Jan. 2010
TÜV NORD	Report No. 8000 196 537/6 E	Tubular steel tower hh 85 m NAMTS	Rev.0	dated Jan. 2010
TÜV NORD	Report No. 8000 196 537/9 E	Commissioning	Rev.0	dated Jan. 2010
TÜV NORD	Report No. 8000 196 537/12 E	Nacelle cover and spinner	Rev.0	dated Jan. 2010

Normative references: **Certification scheme:**
Germanischer Lloyd WindEnergie GmbH "Guideline for the Certification of Wind Turbines", Edition 2003 with Supplement 2004
in combination with
IEC 61400-1 "Wind turbine generator systems - part 1: Safety requirements", Second Edition, 1999-02.

Getr

TÜV NORD

Any change in the design is to be approved by TÜV NORD. Without approval this Statement loses its validity.

Please also pay attention to the information stated overleaf

TÜV NORD CERT GmbH
Certification Body for
Wind Turbines

Dipl.-Ing. Werner Petruschke

Deutscher Akkreditierungs Rat
DAR
DAP-ZE-2016.80

Essen, 04th February 2010

Langemarckstraße 20 • 45141 Essen • Fon +49 (0)40 8557-2417 • Fax +49 (0)40 8557-2552

Annex to A-Design Assessment

No. 44 220 10196537-DA-GL, Rev. 0

TÜV NORD

Principle technical turbine data of the GE 2.5xl, 50/60 Hz, hh 85 m

Main data	Type	Horizontal axis wind turbine with variable rotor speed
	Rotor diameter	100 m
	Power regulation	Independent electromechanical pitch system for each blade
	Rated power	2500 kW
	Hub height	85 m
	Rated rotational speed	14.05 rpm
	Operating range rotational speed	3.83 ... 15.61 rpm
	Cut-in wind speed	3.0 m/s
	Rated wind speed	12.0 m/s
	Cut-out-wind speed (10 min mean)	25 m/s
	Extreme wind speed (50-year-wind)	42.5 m/s (IEC IIB) 37.5 m/s (IEC IIIA)
	Annual average wind speed	8.5 m/s (IEC IIB) 7.5 m/s (IE
	Design life time	20 years
	IEC 61400-1, class	**IIB and IIIA**
Nacelle	Manufacturer	GE Energy
	Drawing No.	115W1980
Nacelle cover	Manufacturer	Jupiter Plast
	Drawing No.	102W3918 102W3921 115W1941 115W6941 115W6508 115W6566
Spinner	Manufacturer	GE Energy
	Drawing No.	114W4337 102W1378 102W2271
Rotor	Cone angle	3°
	Tilt	4°
	Blade pitch angle	Variable
	Orientation	Upwind
Blade	Type	LM 48.7 P
	Material	Glass fibre reinforced polyester
	Blade length	48.7 m
	Number of Blades	3
	Manufacturer	LM Glasfib er
	Drawing No.	DR-02557 Eng change Id.: 21351

Annex to A-Design Assessment

No. 44 220 10196537-DA-GL, Rev. 0

TÜV NORD

	<u>alternative:</u>	
	Type	GE 48.7
	Material	Glass fibre reinforced epoxy
	Blade length	48.7
	Number of blades	3
	Manufacturer	GE Energy
	Drawing No.	103W1687
Pitch gear	Manufacturer	s.me.i
	Type	RES1300GR3S
	<u>alternative:</u>	
	Manufacturer	Liebherr
	Type	DAT300/484
Hub	Type	Cast
	Material	EN-GJS-400-18U-LT
	Drawing No.	115 W 6058
Main shaft	Type	Forged
	Material	34CrNiMo6
	Drawing No.	115W1655
Main bearing front	Design	Tapered roller bearing
	Type	808471A
	Manufacturer	F.A.G
	<u>*alternative*</u>:	
	Design	Tapered roller bearing
	Type	F-572912.TR2
	Manufacturer	F.A.G
Main bearing rear	Design	Cylindrical roller bearing
	Type	F-808599.NU30/710
	Manufacturer	F.A.G
Gearbox	Manufacturer	Winergy
	Type	PFZB 3494.0
	Ratio	1:117.249
	<u>alternative:</u>	
	Manufacturer	Bosch-Rexroth
	Type	GPV 530 D
	Ratio	1:117.315
Mechanical brakes	No of callipers	1
	Position	High speed shaft of main gear
	Manufacturer	Svendborg Brakes
	Type	BSAK 3000-MS 40 S-100
Flex Coupling	Manufacturer	ATEC
	Type	ARW-4 KRZK 520-4

Lehr

	alternative:	
	Manufacturer	KTR
	Type	RADEX-N220 NANA 4 spec.
Generator	Manufacturer	ABB
	Type	AMG 0500LN08 AAM (Permanent magnet synchronous generator)
	Rated Power	2640 kW
	Rated speed	1650 rpm
	Isolation class	F
	Degree of protection	IP 55
Transformer	Manufacturer	Hainan Jinpan Electric
	Type	dry type cast resin
	Drawing No.	manufacture: 3TO1620700 GE: 10745099P345
	Rated power	2.300/2.800 kVA
	Rated voltage LV	0.69 kV
	Rated voltage HV	34.5kW
Medium Voltage Switchgear	Manufacturer	Schneider
	Type	DVCAS
	Rated voltage	38 kV
Converter	Manufacturer	GE
	Drawing No.	151X1227CA41AA01 151X1227MZ04AA54
Main frame	Type	Cast
	Material	EN-GJS-400-18U-LT
	Drawing No.	115W2170, 3 sheets 115W2171, 2 sheets
Yaw system	Type	Active, 4 yaw drives 5 active hydraulic brakes with ball bearing
	Manufacturer	Liebherr
	Type	Ball Bearing Slewing Ring
	Drawing No.	KUD 748VA802-000
	alternative:	
	Manufacturer	Rothe Erde
	Type	Ball Bearing Slewing Ring
	Drawing No.	061.60.2791.100.68.1512
Generator frame	Type	Weldment
	Material	S355 J2G3
	Drawing No.	115W6543 115W6544
Yaw gear	Manufacturer	s.me.i
	Type	RES 6000 GR4-KT
	Drawing No.	908050 (50 Hz) 908060 (60 Hz)

Annex to A-Design Assessment

No. 44 220 10196537-DA-GL, Rev. 0

Yaw brake	Manufacturer Type	Svendborg Brakes BSAB 120
Tower	Design Length Drawing No.	Tubular steel tower with 4 sections 80.86 m 123W1169
Control and safety system	Manufacturer	GE Energy

End of Annex

TÜV NORD CERT GmbH
Certification Body for
Wind Turbines

Dipl.-Ing. Werner Petruschke

Deutscher Akkreditierungs Rat
DAR
DAP-ZE-2016.80

Essen, 04th February 2010

Langemarckstraße 20 • 45141 Essen • Fon +49 (0)40 8557-2417 • Fax +49 (0)40 8557-2552

DET NORSKE VERITAS

TYPE CERTIFICATE

Vestas V90 3MW

IEC TC-205703-6	**2009-06-07**
Type Certificate number	**Date of issue**

Manufacturer:
Vestas Wind Systems A/S
Alsvej 21
DK-8900 Randers

Valid until: 2014-06-07

This certificate attests compliance with IEC 61400-1 ed. 3: 2005 concerning the design and manufacture. The conformity evaluation was carried out according to IEC WT 01: 2001 "IEC system for conformity testing and certification of wind turbines - Rules and procedures."

Reference documents:

Design Evaluation Conformity Statement:	IEC DE-205703-6
Type Test Conformity Statement:	IEC TT-205703-5
Manufacturing Conformity Statement:	IEC MC-205703-5
Type Characteristics Measurement Conformity Statement(s):	IEC TM-205703-4
Final Evaluation Report:	WTDK-2554 rev.2

Wind Turbine specification:

IEC WT class: S. For further information see Appendix 1 of this Certificate.

Date: 2009-06-07	**Date: 2009-06-07**
Christer Eriksson	**Torben Søndergaard**
Management Representative	**Project Manager**
Det Norske Veritas, Danmark A/S	**Det Norske Veritas, Danmark A/S**

PRODUCTS
RvA C257

DET NORSKE VERITAS, DANMARK A/S

APPENDIX 1 - WIND TURBINE TYPE SPECIFICATION

General:

IEC WT class acc. to IEC 61400-1:2005:	S (IEC WT class 1A/2A except for temperature range)
Rotor diameter:	90 m
Rated power:	3000 kW
Rated wind speed V_r:	13.4 m/s
Hub heights, Standard version:	65m, 75m, 79.8m, 80 m (IEC 1A, 50Hz / 60Hz) 105m (IEC 2A, 50Hz / 60Hz)
Hub heights, LT version:	75m, 79.8m, 80m (IEC 1A, 50 Hz / 60 Hz)
Operating wind speed range V_{in}-V_{out}:	4 – 25 m/s
Design life time:	20 years

Wind conditions:

	1A	2A
V_{ref} (hub height)	50 m/s	42.5 m/s
V_{e50} (hub height)	70 m/s	59.5 m/s
V_{ave} (hub height):	10 m/s	8.5 m/s
I_{ref} at V_{hub} = 15 m/s:	0.16	0.16

Electrical network conditions:

Normal supply voltage and range:	6-33 kV (50 Hz) 10-34.5 (60 Hz)
Normal supply frequency and converter types:	50 Hz VCS 60 Hz VCRS

Other environmental conditions (where taken into account):

Air density:	1.225 kg/m^3	
Normal ambient temperature range:	Standard version:	-20°C to 40°C
	LT version:	-30°C to 40°C
	(however maximum air density according to IEC 61400-1 Ed.3 at wind speed above 10m/s: 1.34 kg/m^3)	
Extreme ambient temperatures range:	Standard version:	-40°C to 50°C
	LT version:	-40°C to 50°C

Main components:

Blade type:	Vestas 44m blade
Gear box alternatives:	Hansen EF901EE55-K1, i=104.6 (50 Hz) Hansen EF901EE55-K1, i=109.0 (60 Hz)
Main bearing alternatives:	SKF: BT2-8125 C/HA1
Generator alternatives:	Leroy Somer G54-10/4P: Mk 6 (50 Hz VCS) Leroy Somer G54-9/4P: Mk 7 (60 Hz VCRS)

	Weier DVSGM 560/4L: V5 (50 Hz VCS)
	Weier DVSGM 560/4L: V6 (60 Hz VCRS)
Transformer alternatives:	Siemens AG 4GB6580-9KA
	SGB DTTHIL 2500/30
Yaw gear	SOM PG 1604 R=1391/1
Tower type:	Tubular steel tower
Crane and service load	Integrated, 800kg
Service Lift	Avanti, type Shark, max working load 240 kg
Controller	VMP 6000

Siemens SWT-3.0-101 Safety Narrative
Abigail Krich
February 7, 2011

The SWT-3.0-101 turbine is a 3-bladed, horizontal-axis, upwind, variable-speed, pitch-regulated turbines. It has the same rotor diameter (101m) as the 2.3-101 (101m) and the same blade design. The SWT-3.0-101 is designed to Class IA wind conditions.

The speed and power output is controlled primarily by an active, hydraulic pitch regulation system. The blades are mounted on pitch bearings and can be feathered 80 degrees for shutdown purposes. Each blade has its own independent pitching mechanism capable of feathering the blade under any operating condition. The independent pitch mechanism on each of the blades provides for redundancy.

The wind turbine operates automatically. It is self-starting when the wind speed reaches an average about 3 to 5 m/s (about 7 - 11 mph). The output increases approximately linearly with the wind speed until the wind speed reaches 11 to 12 m/s (about 26 mph). At this point, the power is regulated at rated power.

If the average wind speed exceeds the maximum operational limit of 25 m/s the wind turbine will shut down automatically by feathering of blades. The aerodynamic brakes are redundant due to the ability to brake with one blade. When the average wind speed drops back below 20 m/s the systems reset automatically, and the wind turbine is restarted when wind speeds drop to 18 m/s.

The mechanical disc brake is fitted to the generator rear end and has three hydraulic calipers.

The rotor hub is sufficiently large to provide a comfortable working environment for two service technicians during maintenance of blade roots and pitch bearings from inside the structure.

The SWT-3.0-101 wind turbine is mounted on a cylindrical or tapered tubular steel tower. The tower has internal ascent and direct access to the yaw system and nacelle. It is equipped with platforms and internal electric lighting.

In addition to the Siemens WebWPS SCADA system, the SWT-3.0-101 wind turbine is equipped with the unique Siemens TCM condition monitoring system. This system monitors the vibration level of the main components and compares the actual vibration spectra with a set of established reference spectra.

The SWT-3.0-101 turbine is presently undergoing DNV Type Certification review. An interim Type B Certification is expected to be available in March 2011. A final Type Certificate is expected to be available by November 2011.

Section 21
Tangible Benefits

21.0 TANGIBLE BENEFITS

35-A MRSA §3454 requires an applicant for a grid-scale wind energy project to provide energy and emissions-related "tangible benefits"[1] and, as a subset of tangible benefits, a community benefits package.[2] 35-A MRSA §3454(1) sets forth certain documentation regarding tangible benefits that an applicant must include in any permit application; this information is set forth below.

In addition, pursuant to the statutory language contained in 35-A MRSA §3454(1) that states that "the applicant may submit the information required under paragraph D ["a description of the community benefits package..."] as an addendum to the permit application during the period in which the application is pending," Highland Wind hereby notifies the Land Use Regulation Commission (LURC) that it intends to submit supplemental information regarding paragraph D of 35-A MRSA §3454(1), including proposed implementing legal documents (e.g., document extinguishing right to development wind power on Stewart Mountain) at an appropriate later date during the period in which the application is pending but sufficiently in advance of any hearing before LURC so that the staff, Commission and other parties to this proceeding are fully aware of this information and can review it prior to any pre-filed testimony deadline.

21.1 Documentation Required

An expedited wind energy development permit, pursuant to 35-A MRSA §3454 (1) must provide documentation of tangible benefits as follows:

"A. Estimated jobs to be created statewide and in the host community or communities, as a result of construction, maintenance and operations of the project;

B. Estimated annual generation of wind energy;

C. Projected property tax payments;

---

[1] "Tangible benefits," as defined by the Act, means "environmental or economic improvements or benefits to residents of this State attributable to the construction, operation and maintenance of an expedited wind energy development, including but not limited to:

- Property tax payments resulting from the development;
- Other payments to a host community, including, but not limited to, payments under a community benefit agreement;
- Construction-related employment;
- Local purchase of materials;
- Employment in operations and maintenance;
- Reduced property taxes;
- Reduced electrical rates;
- Land or natural resource conservation;
- Performance of construction, operations and maintenance activities by trained, qualified and licensed workers in accordance with Title 32, chapter 17 and other applicable laws [note: this items refers to the use of licensed electricians on the project]; or
- Other comparable benefits, with particular attention to assurance of such benefits to the host community or communities to the extent practicable and affected neighborhood communities." (35-A M.R.S.A. §3451 (10))

[2] The community benefits element of tangible benefits must be a package that is valued at no less than $4,000 per year per wind turbine, averaged over a 20-year period. This value is in addition to the property tax obligations of the wind energy development. The community benefits package must consist of any of the following:

"A. Payments, not including property tax payments, to the host community or communities, including, but not limited to, payments under community benefit agreements;

"B. Payments that reduce energy costs in the host community or communities; and

"C. Any donations for land or natural resource conservation." (35-A M.R.S.A. §3451 (1-C))

A "community benefit agreement," referred to in A. in the definition above, is an optional agreement between the developer and the host community that allows payments from the developer to be used for any public purpose specified in the agreement. (35-A M.R.S.A. §3451 (1-B). As described in this Section 20.2, Highland Wind's community benefits package, which is valued at $4,000 per year per wind turbine, focuses on reducing energy costs and reliance on fossil fuel combustion in the host community, and on land conservation, neither of which requires a separate community benefit agreement.

D. A description of the community benefits package, including but not limited to community benefit agreement payments....; and

E. Any other tangible benefits to be provided by the project."

21.2 Tangible Benefits Provided

The Highland Wind project will provide the following tangible benefits, which are presented in the order (A through E) listed in the statute.

A. *Jobs Created:* Engineering, design, permitting and construction are estimated to occur over a 6-year period. According to an analysis by University of Southern Maine economist Charles Colgan (attached hereto as Appendix 21-1), over this planning and construction period, employment in Maine associated with the project will peak at more than 330 jobs during the primary construction year and, during the non- peak years, will average about 36 jobs per year. Highland Plantation is at the boundary of what the economic model refers to as the Kennebec and Western Maine regions, and most of the jobs will be within these regions, including all of the peak construction year jobs. Following construction, an estimated 8 permanent jobs will be created to operate and maintain the project. These employees will be located in a facility to be built in Highland Plantation.

The Wind Energy Act includes use of licensed electricians in the construction and maintenance of the project as a specific type of tangible benefit. Based on comparable projects in Maine, it is projected that the construction of the Highland Wind project will utilize about 80 licensed electricians for the construction of collector lines and the project's substation.

B. *Estimated Annual Generation of Wind Energy:* Highland Wind's 39 turbines will have an installed capacity of between 90 and 117 megawatts, which represents 4.5 percent to 6 percent of the statewide goal of 2000 megawatts of installed wind power capacity by 2015. Actual production is projected at 306,000 to 350,000 megawatts/hour/year (MW/hr/yr), which represents the electricity requirements of 41,000 to 47,000 Maine homes.

C. *Projected Property Tax Payments:* The cost of developing Highland Wind is estimated at between $210 million and $247 million. Assuming that assessed value for purposes of property taxation is approximately 80 percent of project cost, the local assessed value of Highland Plantation will increase in the first full year of valuation by between $168 million and $198 million. This represents a 20- to 24-fold increase in the Plantation's existing (2010) assessed value of about $8.3 million and will have a dramatic, beneficial effect on the local property tax rate.

In most other wind power projects in Maine, the community or county and developer have established tax increment finance districts (1) to shelter the increase in assessed value from losses under school aid and municipal revenue sharing formulas and increases in the local share of county taxes and (2) to return a portion of new property taxes to the developer to help finance the project. State law does not allow tax increment financing in plantations, and in any case the developers of Highland Wind have not in the past sought so-called "credit enhancement agreements" to subsidize their projects. As a result, Highland Plantation will see a large benefit in property taxes but, through state and county redistribution formulas, state and county taxpayers also will share in some of these benefits.

State valuations, which are used to "equalize" tax calculations statewide, typically are two years behind local valuations, and the tax shifts relating to school aid, revenue sharing, and county taxes also take two years to "catch up" and to be reflected in the local budget. Initially, therefore, based on Highland Plantation's 2010 budget, it is estimated that Highland Wind will pay to Highland Plantation property taxes of between $118,000 and $119,000 per year, depending on actual project costs. This will be the great majority of all property taxes paid in the plantation.

Once state valuations catch up and Highland Plantation's 2010 budget is adjusted to account for losses in school aid and municipal revenue sharing and the Plantation's increased share of county taxes, it is estimated that Highland Wind will pay to Highland Plantation property taxes of between $469,000 and $526,000 per year.[1]

[1] The local budget can vary dramatically from year to year, depending largely on the number of students of school age. Highland Wind's property taxes would vary accordingly.

Again, this will be the great majority of all property taxes paid in Highland Plantation. Collectively, if the Plantation's 2010 budget stayed the same as in 2010, all other Highland Plantation taxpayers would see their contributions to the expenses of the Plantation drop from $123,900 per year to about $23,000. Over time, the analysis assumes that Highland Wind's facilities will depreciate in value at about three percent per year.

As a result:

- Highland Plantation will see its mill rate drop from a little under $15 per thousand dollars of assessed value (as of 2010) to an estimate of between $2.92 and $3.05 per thousand, based on its 2010 budget but accounting for shifts that will occur once state valuations are updated.[2] The impact on a property in Highland Plantation that is assessed at $90,000 will be to reduce its property taxes from about $1,348 per year to between $262 and $275, a savings of nearly $1,100 per year.[3]
- Somerset County will see, on average, over the first several years the project is on line once state valuation is updated, an estimated increase of between $303,000 and $354,000 per year in the share of taxes paid by Highland Plantation,[4] reducing the county tax shares of other municipalities in Somerset County by a like amount.
- Municipalities around the state will have an additional estimated $11,000 in state aid to education[5] and an additional estimated $8,800 in municipal revenue sharing to share among themselves as a result of the redistribution of aid under these formulas.

Property tax calculations are presented in Appendix 21-2.

D. *Community Benefits Package:* As mentioned earlier, under the Wind Energy Act a grid-scale wind energy development must provide at least $4,000 of community benefits, as defined in the law, for each turbine over 20 years. Highland Wind's project has 39 turbines. Therefore, at $4,000 per wind turbine per year for 20 years, the required value of its community benefits package is $3,120,000, or an average of $156,000 per year, above and beyond property tax payments resulting from the project. The community benefits package outlined below meets this requirement. Because Highland Wind is not using a tax increment financing approach that would have the effect of greatly reducing tax payments to the host community, LURC should be aware that Highland Plantation and its residents -- as the host community -- will be receiving very significant tax benefits, as set forth in Section C, above, in addition to the community benefits outlined below.

Highland Wind's community benefits package will include the following elements:

- **<u>For Highland Plantation and its residents:</u>**

  A. Highland Wind will provide to Highland Plantation and its residents twenty annual payments in the amount of $104,000 per year, or two-thirds of the community benefits package value as currently proposed. With the single exception set forth in the subsequent paragraph, the obligation on Highland Wind to begin paying to Highland Plantation this $104,000 annual payment begins on the first date that ISO-New England verifies that Highland Wind is continuously delivering power into the grid (hereinafter "triggering date").

  Highland Plantation has requested of Highland Wind, and Highland Wind has agreed, to provide an immediate pre-permitting one-time advance payment to Highland Plantation in an amount up to $15,000, to allow the Plantation to defray the reasonably anticipated technical and legal costs of the application review by the Plantation.

This application review fee will be paid immediately by Highland Wind to the Plantation upon the acceptance of this application as complete for processing. Highland Wind understands that this application review fee is non-

[2] This assumes the 2010 budget holds steady. If the Plantation were to use the increased valuation to meet additional local needs or take on new expenses, the tax rate would vary accordingly.
[3] Due to the large amount of value added into a community with a very small population and budget, the impacts on individual taxpayers are very sensitive. Projections can fluctuate widely with changes in the assumptions on which the analysis is based, including, for example, assumptions about valuation method and assessed value ratio.
[4] Actual impacts on county taxes and state subsidies will vary based on a variety of factors, including, among other things, taxable value increases in other communities, state statutes governing education subsidies and revenue sharing, and other added taxable value in Highland Plantation.
[5] This amount can change from year to year based on the number of school-aged children in Highland Plantation.

refundable, regardless of the outcome of this permitting proceeding, and respectfully requests that the Commission credit this advance payment toward partial fulfillment of Highland Wind's first-year community benefit payment obligation, in recognition of the fact that the request for this advance funding was made by the host community and that the pre-permitting, advance nature of it was necessitated by the host community's desire to use these funds to defray the costs of its review of Highland Wind's application at the outset of this proceeding.

Under this disbursement schedule, over 20 years Highland residents and the Plantation would receive $2,080,000 in total annual payments, including the funds provided for application review.

In the alternative, and at the request of Highland Plantation, Highland Wind is prepared to make the entire 20-year value, minus the up-front application review fee as described above, available to Highland Plantation and its residents as a single, lump-sum payment due at the triggering date, with the lump-sum amount calculated as a net present value of this twenty- year income stream.[6]

B. All payments owed to Highland Plantation and its residents would be distributed by Highland Wind to an agreed-upon third-party escrow/disbursal agent and placed in a segregated, separately invested and administered Highland Plantation Fund (HPF).

C. Disbursements from the HPF will occur in the sequence set forth below. The first three categories of disbursement, consistent with 35-A MRSA §3451 (1-C) (B), will "reduce energy costs in the host community." The fourth category of disbursement will be made consistent with 35-A MRSA §3451 (1-C) (A), "payments, not including property tax payments, to the host community...".

- <u>First, to reduce energy costs to the residents of Highland Plantation</u>, annual payment directly to all existing Highland Plantation households as of January 1, 2011 (year-round and seasonal) for 20 years for day-to-day electrical use, as follows:

  Each year-round and seasonal resident is entitled, no later than February 15 of the year following payment of electrical expenses for the preceding year, to submit an invoice with electrical bills to the agent for direct and immediate reimbursement from the HPF as follows:

  -- Year-round residents would receive a lump sum payment equal to the value of 500 kilowatt-hours (KWh) per month of the energy generation portion of the price charged on Central Maine Power Company (CMP) bills to customers for the preceding May through November and 750 KWh per month of the energy generation price charged on CMP bills to customers for the preceding January through April and December; and

  -- Seasonal residents would receive a lump sum payment equal to the cost actually incurred by those seasonal residents for their energy generation costs up to 500 KWh incurred per month for May-November.

  -- The escrow/disbursal agent will verify qualifying expense, and disburse funds directly from HPF to the Highland Plantation household presenting the invoice. Because these benefits are tied to the residence, any subsequent owner of the residence is eligible for the remaining benefit.

- <u>Second, to reduce energy costs to the residents of Highland Plantation and reduce their reliance on fossil fuel combustion,</u> a one-time payment of up to $6,000 directly to all full-time residences as of January 1, 2011, in which the owner of the residence installs fossil fuel reduction measures for their homes, as follows:

  -- Each full-time residence is entitled to receive a one-time grant of up to $6,000 for reimbursements from the HPF for expenses incurred for installation of home weatherization,

[6] By way of example only, if the net present value of $2,080,000 paid out over twenty years were to be calculated today using the applicable OMB discount rate, the lump-sum payment owed to Highland Plantation and its residents would equal $1,364,624.

solar heating or hot water, electrical thermal storage units and/or other fossil-fuel reduction measures. The grant can be for capital equipment and installation, including wiring and other costs to insure functionality of equipment. Grants are awarded for installations occurring in the first three full calendar years following occurrence of the triggering date, with the first calendar year counted as beginning on the next January 1 to occur following the triggering date. So long as installation is accomplished within these three calendar years, all installation expenditures does not have occur at one time; each full-time residence would have an account from which up to $6000 is available. Invoices for expenses incurred for previous year must be submitted to agent by February 15 of the year following expenditure, with all invoices submitted no later than by February 15 of year 4.

-- The escrow/disbursal agent will verify qualifying expense, and disburse funds directly from

HPF to the Highland Plantation household presenting the invoice. Because these benefits are tied to the residence, any subsequent owner of the residence is eligible for the remaining benefit.

- <u>Third, to reduce energy costs to the residents of Highland Plantation and reduce their reliance on fossil fuel combustion</u>, an annual payment for up to 20 years directly to all full-time residences who have installed thermo-heat storage units, as follows:

  -- Each full-time residence that has installed in their home an electro-thermal heat storage unit (ETS) and a separate electrical meter that can measure and control off-peak power delivery, along with the wiring required to measure and direct electrical energy to that ETS, is entitled to receive a payment, on an annual basis, in an amount equal to the total monetary value of the difference, for the previous calendar year, between (1) the total off-peak KWh energy cost charged to the residence on its monthly CMP bill for the energy (not delivery) costs for off-peak energy used by the ETS, up to a total of 22,000 KWh of electricity, and (2) what the total off-peak KWh energy cost would have been had the residence been charged at a rate of $0.02 KWh for the same amount of energy.

  For instance, should the actual energy rate charged by CMP for the year have been $0.05 KWh, then:

  1. A qualifying residence that used 20,000 KWh of energy in that year for powering the ETS would be entitled to a monetary payment of $600 (20,000 KWh times $0.03); or

  2. A qualifying residence that used 25,000 KWh of energy in that year for powering the ETS would be entitled to a monetary payment of $660 (capped limit of 22,000 KWh times $0.03).

  -- The qualifying residence is responsible for the CMP delivery charges for this electricity.

  -- No later than February 15 of the year following payment of electrical expenses for the ETS for the preceding year, the residence would submit an invoice to the agent with electrical bills showing the amount of the separate ETS metered electricity for the previous year, for direct and immediate reimbursement from the HPF. The escrow/disbursal agent will verify qualifying expense, and disburse funds directly from HPF to the Highland Plantation household presenting the invoice. Because these benefits are tied to the residence, any subsequent owner of the residence is eligible for the remaining benefit.

  -- Regardless of when during the 20-year disbursement period a household first installed an ETS system and began receiving annual payments pursuant to this provision, all payments, and all obligations to make payments, shall cease following the final annual disbursement made in Year 21, as described below.

- <u>Fourth, to assist Highland Plantation for other municipal costs that it incurs</u>, all residual payments remaining after the above-discussed three reimbursements will be distributed to Highland

Plantation, as follows. (The presentation that follows assumes that Highland Plantation chooses to receive annual payments of $104,000 and not a one-time lump-sum payment or other agreed upon payment schedule.)

-- On triggering event day, Highland Wind will deposit $208,000 (two annual payments of $104,000) into the HPF. The next annual payment of $104,000 (# 3 of 20) will be due on 2nd anniversary of triggering event, and annually thereafter until all 20 payments have been made.

-- On April 15 of Year 3, the assessors of Highland Plantation will receive from the escrow/disbursal agent all of what remains of the first three payments made by Highland Wind to the HPF, after all payouts for the first, second, and third direct disbursements to Highland Plantation residents, as stated above, have been made on or about February 15 of that year and all preceding years, which it is free to use for any lawful purpose.

-- On April 15 of Year 5 and annually thereafter through Year 20, the assessors of Highland Plantation will receive the remainder of preceding year's annual payment, less all payouts to Highland Plantation residents made on or about February 15 of that year.

-- On April 15 in Year 21, all residual monies remaining in the HPF, plus accumulated interest, will be distributed in a lump-sum amount to the assessors of Highland Plantation.

- **For the Maine Department of Conservation, Bureau of Parks and Lands:** Highland Wind will provide $1,040,000 to the Maine Department of Conservation, Bureau of Parks and Lands (BPL) over a twenty year period, as a "donation for land or natural resource conservation" pursuant to 35-A MRSA §3451 (1-C) (C). This land or natural resource conservation will be comprised of two elements:

A. Permanent protection for Stewart Mountain from the development of wind turbines. On or before the triggering date, Highland Wind shall execute or cause to be executed a legally sufficient document that will extinguish in perpetuity all rights of any current or future landowner to site wind turbines on the land comprising approximately 572 acres on Stewart Mountain that was previously proposed by Highland Wind as the location for eight wind turbines. The current fair market value lost for extinguishing these wind turbine development rights is $253,000.

B. Payments for Additional Bigelow Preserve Viewshed Protection. Highland Wind will make twenty annual payments of $39,350 to BPL, to be used for protecting the viewshed from trails in the Bigelow Preserve. Over 20 years, BPL will receive $787,000 in total annual payments. The initial annual payment from Highland Wind is due on the triggering date. In the alternative, and at the request of BPL, Highland Wind is prepared to make the entire 20-year value of these twenty payments available to BPL as a single, lump-sum payment due at the triggering date, with the lump-sum amount calculated as a net present value of this twenty-year income stream.

All payments owed to BPL would be distributed by Highland Wind to an agreed-upon third-party escrow/disbursal agent and placed in a segregated, separately invested and administered Bigelow Preserve Scenic Viewshed Fund. (Viewshed Fund). BPL will be granted the authority to use the monies in the Viewshed Fund to acquire in fee or easement properties that it deems to be valuable for protecting the viewshed from trails in the Bigelow Preserve. At BPL's choosing, a modest percentage of these funds (e.g., 10-20%) could be used for viewshed trail maintenance activities in the Preserve.

E. ***Other Tangible Benefits:***

1. Reduction in air pollutants: An installed wind power capacity of 90 to 117 megawatts (MW) that produces 306,000 – 350,000 MW/hr/yr translates into an avoidance of a significant tonnage of green house gases each year that would otherwise be emitted by fossil fuel plants generating the same amount of electricity.
2. Energy price stability: Grid-scale wind projects typically enter into long-term supply contracts with electric power brokers. While usually there are escalators in the annual prices allowed for wind power in these contracts, the rate of inflation is relatively low. By comparison, prices for fossil fuels, including oil and natural gas, are projected to increase significantly over the next 25 years. According to the Energy Information Administration, the "reference" projection is for the price of oil

to increase by 89 percent in real dollars by 2035 (after accounting for inflation), with a "high" projection showing an increase of 198 percent - nearly a tripling of prices. Natural gas prices are projected to double over this period of time[7] If fossil fuel prices do rise as expected – and as of December 2010, the per barrel price of oil was following the "high" forecast projection – wind power capacity installed now will contribute to more stability in electricity prices in the future.

3. Wind-for-oil: Highland Wind aims to demonstrate at two different scales how wind power produced in Maine can reduce reliance on fossil fuels that are imported from out of state and allow for higher use of wind energy produced in Maine to the benefit of Maine customers. It will do so by providing direct assistance and incentives to use ETS units that can capture energy produced during off-peak hours and convert it to thermal energy for use during the day when demand for energy is high. Off-peak hours are those times of day or night when electric power is generally in surplus and therefore less expensive on wholesale exchanges. With the use of smart meters that control the time of day that energy is used, wind energy can be captured in the home or business during those off-peak hours for later use; thus it can both be a less expensive source of fuel and reduce dependence on fossil fuel combustion. Because institutional systems are not yet in place in Maine to price off-peak energy at low cost, Highland Wind will provide the means to do so on a demonstration basis.

    - At the residential scale, the community benefits package described earlier includes grants to residents of Highland Plantation to reduce reliance on fossil fuels. Residents may choose to use the grant for ETS units in their homes, and if they do, they will be entitled to a special reimbursement for off-peak use over 20 years, as described in Section D, Community Benefits Package, above, under the third category of disbursements from the proposed Highland Plantation Fund. This simulates an off-peak pricing system that can help drive use of wind power for heating.

    - At the institutional scale, Highland Wind and the University of Maine are entering into a Memorandum of Understanding, under which Highland Wind will provide ETS units that will be housed in a future expansion of the University of Maine's Offshore Wind Laboratory as a pilot project to demonstrate the efficient and effective use of wind generated power for space heating of buildings. The intent is not only to provide this indigenous, "green" source of space heating at the Laboratory, but also to (1) enable other interested members of the public to be able to visit and learn about the use of this technology, and (2) make the ETS units and their output available for data gathering and research purposes.

The monetary value of this tangible benefit to Highland Plantation residents who choose to install ETS units in their homes is discussed under community benefits. The capital value of the units to be placed at the University is $40,000. The potential benefit of demonstrating the viability of replacing fossil fuels for heating in Maine with renewable energy such as wind is much more far-reaching.

[7] Energy Information Administration, "Annual Energy Outlook 2010 with Projections to 2035," viewed on the Internet at http://www.eia.gov/oiaf/aeo/index.html.

Appendix 21-1 – Tangible Benefits
The Economic Impacts of the Proposed Highland Wind Development in Highland Plantation, Somerset County, Maine

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December 2010

Introduction

Independence Wind Inc. proposes to build a 39 turbine wind power project in Highland Plantation, Somerset County. Independence Wind asked the Maine Center for Business and Economic Research (MCBER) at the University of Southern Maine to conduct an analysis of the impacts on the local, regional, and Maine economies. This report provides the results of that analysis.

To conduct the analysis, MCBER uses the econometric models developed by Regional Economic Models Inc. (REMI) of Amherst, MA and maintained by MCBER. These models are widely used to conduct this type of analysis, and have been used by MCBER to conduct several studies of wind power projects in Maine.

The models cover seven regions with Maine comprised of single or multiple county regions. For this analysis, the relevant regions for the project itself are:

Kennebec (Kennebec and Somerset Counties)

Western Maine (Androscoggin, Franklin, and Oxford Counties)

In addition, parts of the project planning and design work are done in Cumberland County and in Penobscot County (which is included in the Eastern region along with Piscataquis, Hancock, and Washington counties).

In the analysis, a base forecast of each of the regional economies is compared with an alternative forecast that includes the economic activity associated with the Independence Wind proposal. The differences between the two forecasts are the “impacts” of the project.

Input Assumptions

The following information reflects the inputs to the REMI model. These inputs were provided to MCBER by Independence Wind and are based on estimates of expenditures from other similar wind power projects constructed in Maine. The affected sectors are:

- Construction

  Construction expenditures are estimated at $48.95 million. This covers the costs of road, site preparation, and building construction plus installation of the towers and turbines. It excludes expenditures on the turbines and other electrical equipment that are not manufactured in Maine.

  The location of Highland Plantation at the border between Somerset and Franklin counties requires that some assumptions be made about the division of expenditures as these two counties lie in different regions within the REMI model. For this purpose the construction expenditures are assumed to be 65% in Somerset County and 35% in Franklin County.

  The project is assumed to begin construction in 2012 and to continue for 3 years. 10% of construction activity is assumed to be in 2012, 85% in 2013, and 5% in 2014.

- Equipment Rental & Leasing

  The construction of wind power projects is different than typical construction projects in that there are significant requirements for use of specialized equipment such as cranes and transporters. Expenditures for these types of equipment are not adequately represented in the industry average data used in the model, so an estimated $3 million is added to the Equipment and Rental & Leasing industry to reflect this aspect of wind power project construction.

  The expenditures for equipment rental may be made to the prime construction contractor or to firms specializing in this field. Equipment provided by prime contractors would normally be included in the construction industry expenditures. Discussions with Reed & Reed, the construction company with the most experience building wind power projects in Maine, confirmed both the estimated amounts and the desirability of analyzing these expenditures as part of the equipment rental industry to reflect the particular circumstances of wind power construction.

Expenditures in this industry are assumed to be distributed across regions and the construction period in the same proportions as for the construction industry noted above.

- Accommodations and Food Services

  The construction of wind power projects in remote areas of Maine requires a combination of locally hired employees and employees with specific technical skills that are usually not available in the nearby area. Non-local employees will be housed in local hotels and will utilize local restaurants while they are working on the project.

  Total expenditures on food and accommodations are estimated at $400,000, distributed half between Franklin and Somerset counties, and to be distributed across the construction period in the same proportions as construction expenditures noted above.

- Professional and Technical Services

  The category “Professional and Technical Services” encompasses a variety of activities, including engineering, planning, meteorology, environmental analysis, and legal services. Total expenditures in this category are estimated at $7.9 million. These expenditures will primarily be made to firms outside of Somerset and Franklin counties.

  Engineering services ($900,000) include civil, geotechnical, architectural, and related services. These are assumed to be occur equally in 2011 and 2012 and to be made in Cumberland County (50%), Kennebec, and Penobscot counties (25% each).

Other permitting costs are estimated to occur in 2009, 2010, and 2011 (30% in 2009 and 2012 and 40% in 2011). Table 1 shows the assumed split among the regions for these years:

	2009	2010	2011
Cumberland	65%	65%	50%
Kennebec-Somerset	25%	25%	40%
Eastern Maine	10%	10%	10%

Table 1: Distribution of permitting costs by region

Table 2 on the following page shows the summary of inputs to the model by region, sector, and year.

		2009	**2010**	**2011**	**2012**	**2013**	**2014**	**Total**
Western Maine	Construction				1,713,250	14,562,625	856,625	17,132,500
	Equipment Leasing				105,000	892,500	52,500	1,050,000
	Accommodations				13,334	113,339	6,667	133,340
	Food				6,666	56,661	3,333	66,660
	Sub Total				*1,838,250*	*15,625,125*	*919,125*	18,382,500
Kennebec-Somerset	Construction				3,181,750	27,044,875	1,590,875	31,817,500
	Equipment Leasing				195,000	1,657,500	97,500	1,950,000
	Accommodations				13,334	113,339	6,667	133,340
	Food				6,666	56,661	3,333	66,660
	Prof & Tech	1,365,000	1,820,000	1,050,000				
	Sub Total	*1,365,000*	*1,820,000*	*1,050,000*	*3,396,750*	*28,872,375*	*1,698,375*	38,202,500
Cumberland	Prof & Tech	525,000	700,000	840,000				2,065,000
Eastern Maine	Prof & Tech	210,000	280,000	210,000				700,000
TOTAL		**2,100,000**	**2,800,000**	**2,100,000**	**5,235,000**	**44,497,500**	**2,617,500**	**59,350,000**

Table 2: In-state expenditures by region

RESULTS

Table 3 shows employment estimates in the Kennebec and Western regions based on the inputs described above, while Table 4 shows the personal income and wage & salary totals for each for the entire project period.

EMPLOYMENT	2009	2010	2011	2012	2013	2014
Kennebec-Western Regions	23	30	17	43	332	26
Rest of Maine	9	12	23	0	0	0
Total Maine	36	36	40	43	332	26

Table 3: Summary of construction period employment

	Personal Income	Wages & Salaries
Kennebec-Somerset	$11,490,000	$11,070,000
Androscoggin-Franklin-Oxford	$5,160,000	$4,640,000
Cumberland	$1,410,000	$620,000
Eastern	$2,040,000	$330,000
TOTAL	$20,100,000	$16,660,000

Table 4: Personal Income and Wages & Salaries 2009-2014 Totals

Major findings include:

- The project results in an average of about 100 jobs per year across the five years of project planning and construction, with residual employment continuing into a sixth year. During the peak year of construction, 2013, more than 330 jobs are created in the Franklin-Somerset regions and jobs will average about 36 jobs in the non-peak years.
- “Jobs” includes both direct jobs, which is employment directly engaged by the project developer and its contractors/subcontractors, and the indirect or “multiplier” employment. For this project, the multiplier is about 1.3, meaning that each direct job in the construction and professional-technical services industries supports .3 jobs in other industries.
- Because of the specialized nature of the construction project, most employees will come from outside the Franklin-Somerset region and will reside in the local area temporarily. However, most of the employees will come from within Maine.
- The communities of Bingham, Carrabassett Valley, Kingfield, Madison, and Skowhegan will receive most of the primary impacts from spending by employees during the construction period.

- Personal income in the Kennebec-Western Maine regions will increase by $16.6 million over the course of the project, of which $15.7 million will be in wages and salaries.[10]

- Statewide, personal income will increase by $20 million, of which $16.7 million is wages and salaries.

It should be noted that the jobs reported here are a combination of "new" jobs that would not exist but for this project and "supported" jobs, which already exist. Expenditures for the project provide revenues to various organizations that is translated into wages and salaries for these "supported jobs".

After the construction period is complete, about 8 employees will be required for operations of the wind power project.   These employees will be located in a facility to be built in Highland Plantation. The majority of these employees will reside in Franklin and Somerset counties, although the exact distribution cannot be estimated at this time. These employees will spend money in the two counties, supporting jobs in the retail, service, and other industries.

During the operating period, it will be necessary to periodically undertake maintenance, including periodic replacement, on the towers and turbines. Because of the nature of wind power, these maintenance and replacement activities will resemble the construction period in terms of the number of workers required and the need to deploy equipment such as cranes. Neither the timing nor the extent of these activities can be accurately predicted at this time, but whenever they occur they will result in employment increases of 50-100 jobs, roughly distributed in the same industries as the construction period.

[10] In addition to wages and salaries, personal income includes "other labor payments" such as benefits and income to business proprietors.

Appendix 21-2 – Tangible Benefits
Property Tax Calculations

<u>Highland Plantation</u>

$247mm Project Cost

$197.6mm Additional Taxable Value

Mil Rate Projection: No Project

State Valuation 2010	**9,050,000**
Local Taxable Valuation 2010	**8,272,533**
Municipal Appropriations 2010	**198,371**
Municipal Tax Levy 2010	**123,923**
Mil Rate 2010	**14.98**

Calendar Year	Project Year	Municipal Valuation	Mil Rate
2010	Base	8,272,533	14.98
2011	1	8,272,533	14.98
2012	2	8,272,533	14.98
2013	3	8,272,533	14.98
2014	4	8,272,533	14.98
2015	5	8,272,533	14.98
2016	6	8,272,533	14.98
2017	7	8,272,533	14.98
2018	8	8,272,533	14.98
2019	9	8,272,533	14.98
2020	10	8,272,533	14.98

<u>Highland Plantation</u>

$247mm Project Cost

$197.60mm Additional Taxable Value

Projected Tax Impacts on $60k and $90K Parcels

		$60k Parcel			$90k Parcel			
Calendar Year	Project Year	Taxes w/out project	Taxes w/ project	Tax Savings w/ Project	Taxes w/out project	Taxes w/ project	Tax Savings w/ Project	% Tax Savings
2010	Base	$899	$899	$0	$1,348	$1,348	$0	
2011	1	$899	$899	$0	$1,348	$1,348	$0	
2012	2	$899	$36	$863	$1,348	$54	$1,294	95.98%
2013	3	$899	$37	$862	$1,348	$56	$1,292	95.86%
2014	4	$899	$38	$860	$1,348	$58	$1,291	95.73%
2015	5	$899	$175	$724	$1,348	$262	$1,086	80.54%
2016	6	$899	$170	$729	$1,348	$255	$1,093	81.08%
2017	7	$899	$172	$727	$1,348	$258	$1,091	80.90%
2018	8	$899	$173	$726	$1,348	$260	$1,088	80.72%
2019	9	$899	$175	$724	$1,348	$262	$1,086	80.53%
2020	10	$899	$177	$722	$1,348	$265	$1,083	80.34%
			total	$6,936		total	$10,404	
			average	$630.53		average	$945.80	

<u>Highland Plantation</u>

$247mm Project Cost

$197.6mm Additional Taxable Value

Projected Tax Shifts

	Calendar Year	Project Year	Education Aid Shift	County Tax Shift	Revenue Sharing Shift	Total Projected Revenue Losses
	2010	Base	0	0	0	0
	2011	1	0	0	0	0
in service	2012	2	$0	$0	$0	$0
	2013	3	$0	$0	$0	$0
	2014	4	$11,444	$403,587	$8,802	$423,832
	2015	5	$11,444	$372,496	$8,794	$392,734
	2016	6	$11,444	$361,677	$8,785	$381,906
	2017	7	$11,444	$351,162	$8,767	$371,373
	2018	8	$11,444	$340,943	$8,758	$361,144
	2019	9	$11,444	$331,012	$8,748	$351,204
	2020	10	$11,444	$321,362	$8,738	$341,545

<u>Highland Plantation</u>

$247mm Project Cost

$197.60mm Additional Taxable Value

Projected Mil Rate with New Project

	Calendar Year	Project Year	New Muni Valuation with project	New Budget With Offset for Tax Shifts	Projected Mil Rate $/1000	Company's Projected Taxes
	2010	Base	$8,272,533	$123,923	14.98006	$0
	2011	1	$8,272,533	$123,923	14.98006	$0
in service	2012	2	$205,872,533	$123,923	0.60194	$118,943
	2013	3	$199,696,357	$123,923	0.62056	$118,943
	2014	4	$193,705,466	$123,923	0.63975	$118,943
	2015	5	$187,894,302	$547,755	2.91523	$525,699
	2016	6	$182,257,473	$516,657	2.83476	$495,850
	2017	7	$176,789,749	$505,829	2.86119	$485,455
	2018	8	$171,486,057	$495,305	2.88831	$475,353
	2019	9	$166,341,475	$485,077	2.91615	$465,534
	2020	10	$161,351,231	$475,137	2.94474	$455,992

Assumptions:

1 The in service/construction complete date will be on or before 4/1/2012.

2 80% of Project Costs will be recognized as tangible taxable property.

3 The Plantation's budget will remain relatively constant except for increases to make up for projected tax shifts due to project.

4 The State Valuation process used for county taxes, school funding and state revenue sharing typically takes two years to capture new value.

5 The community's school budget appropriations will remain relatively constant.

6 The cost approach to valuation currently in use for valuing commercial wind generation facilities by Maine Revenue Services (MRS) recognizes annual depreciation. Based on MRS methods applied to date, commercial wind generation facilities have an expected service life of 20 years, which correlates to a %5 rate of depreciation each year. The model uses a more conservative depreciation rate of 3% per year. It is expected that the valuation of commercial wind generation facilities will, within the next five years, also include an income approach to valuation similar to the method of valuation for hydro electric facilities, with the result that the assessed value will eventually stabilize over the balance of the facility's operating life.

7 These projections are based on the most current state revenue sharing projections, the most current county budget and education funding information, and the assumption that there will continue to be available revenues to fund schools and provide revenue sharing distributions. Changes in the valuation of sister county communities, rankings for state valuation purposes and changes in local appropriations will have marked and potentially dramatic impacts on these projections.

Highland Plantation

$210mm Project Cost
$168mm Additional Taxable Value

Mil Rate Projection: No Project

State Valuation 2010	9,050,000
Local Taxable Valuation 2010	8,272,533
Municipal Appropriations 2010	198,371
Municipal Tax Levy 2010	123,923
Mil Rate 2010	14.98

Calendar Year	Project Year	Municipal Valuation	Mil Rate
2010	Base	8,272,533	14.98
2011	1	8,272,533	14.98
2012	2	8,272,533	14.98
2013	3	8,272,533	14.98
2014	4	8,272,533	14.98
2015	5	8,272,533	14.98
2016	6	8,272,533	14.98
2017	7	8,272,533	14.98
2018	8	8,272,533	14.98
2019	9	8,272,533	14.98
2020	10	8,272,533	14.98

Highland Plantation

$210mm Project Cost
$168mm Additional Taxable Value

Projected Tax Impacts on $60k and $90K Parcels

		$60k Parcel			$90k Parcel			
Calendar Year	Project Year	Taxes w/out project	Taxes w/ project	Tax Savings w/ Project	Taxes w/out project	Taxes w/ project	Tax Savings w/ Project	% Tax Savings
2010	Base	$899	$899	$0	$1,348	$1,348	$0	
2011	1	$899	$899	$0	$1,348	$1,348	$0	
2012	2	$899	$42	$857	$1,348	$63	$1,285	95.31%
2013	3	$899	$43	$855	$1,348	$65	$1,283	95.16%
2014	4	$899	$45	$854	$1,348	$67	$1,281	95.01%
2015	5	$899	$183	$715	$1,348	$275	$1,073	79.59%
2016	6	$899	$178	$721	$1,348	$267	$1,082	80.22%
2017	7	$899	$180	$719	$1,348	$269	$1,079	80.02%
2018	8	$899	$181	$717	$1,348	$272	$1,076	79.81%
2019	9	$899	$183	$715	$1,348	$275	$1,073	79.60%
2020	10	$899	$185	$713	$1,348	$278	$1,070	79.38%
			total	$6,868		total	$10,302	
			average	$624.34		average	$936.51	

Highland Plantation

$210mm Project Cost
$168mm Additional Taxable Value

Projected Tax Shifts

	Calendar Year	Project Year	Education Aid Shift	County Tax Shift	Revenue Sharing Shift	Total Projected Revenue Losses
	$2,010	Base	$0	$0	$0	$0
	$2,011	$1	$0	$0	$0	$0
in service	$2,012	$2	$0	$0	$0	$0
	$2,013	$3	$0	$0	$0	$0
	$2,014	$4	$11,444	$347,777	$8,755	$367,975
	$2,015	$5	$11,444	$318,259	$8,745	$338,448
	$2,016	$6	$11,444	$308,971	$8,735	$329,150
	$2,017	$7	$11,444	$299,946	$8,725	$320,115
	$2,018	$8	$11,444	$291,178	$8,714	$311,336
	$2,019	$9	$11,444	$282,660	$8,703	$302,807
	$2,020	$10	$11,444	$274,385	$8,692	$294,520

Highland Plantation

$210mm Project Cost
$168mm Additional Taxable Value

Projected Mil Rate with New Project

	Calendar Year	Project Year	New Muni Valuation with project	New Budget With Offset for Tax Shifts	Projected Mil Rate $/1000	Company's Projected Taxes
	2010	Base	$8,272,533	$123,923	14.98006	$0
	2011	1	$8,272,533	$123,923	14.98006	$0
in service	2012	2	$176,272,533	$123,923	0.70302	$118,107
	2013	3	$170,984,357	$123,923	0.72476	$118,107
	2014	4	$165,854,826	$123,923	0.74718	$118,107
	2015	5	$160,879,182	$491,898	3.05756	$468,813
	2016	6	$156,052,806	$462,371	2.96291	$440,672
	2017	7	$151,371,222	$453,073	2.99312	$431,810
	2018	8	$146,830,085	$444,038	3.02416	$423,199
	2019	9	$142,425,183	$435,259	3.05605	$414,832
	2020	10	$138,152,427	$426,730	3.08883	$406,703

Assumptions:

1. The in service/construction complete date will be on or before 4/1/2012.
2. 80% of Project Costs will be recognized as tangible taxable property.
3. The Plantation's budget will remain relatively constant except for increases to make up for projected tax shifts due to project.
4. The State Valuation process used for county taxes, school funding and state revenue sharing typically takes two years to capture new value.
5. The community's school budget appropriations will remain relatively constant.
6. The cost approach to valuation currently in use for valuing commercial wind generation facilities by Maine Revenue Services (MRS) recognizes annual depreciation. Based on MRS methods applied to date, commercial wind generation facilities have an expected service life of 20 years, which correlates to a %5 rate of depreciation each year. The model uses a more conservative depreciation rate of 3% per year. It is expected that the valuation of commercial wind generation facilities will, within the next five years, also include an income approach to valuation similar to the method of valuation for hydro electric facilities, with the result that the assessed value will eventually stabilize over the balance of the facility's operating life.
7. These projections are based on the most current state revenue sharing projections, the most current county budget and education funding information, and the assumption that there will continue to be available revenues to fund schools and provide revenue sharing distributions. Changes in the valuation of sister county communities, rankings for state valuation purposes and changes in local appropriations will have marked and potentially dramatic impacts on these projections.

Section 22
Decommissioning Plan

22.0 DECOMISSIONING PLAN

22.1 Anticipated Life of Wind Turbines

Megawatt-scale wind turbines are designed and certified by independent agencies for a minimum expected operational life of 20 years. Turbines such as the machines being considered here meet these criteria and are expected to last for at least 20 years.

It is in Highland's long-term financial interests to maximize the operational lifespan of the wind turbine generators, and thus Highland plans to employ a proactive maintenance regime to ensure turbines are in good repair for at least the full 20 years of expected life. As the wind turbines approach the anticipated end of life, it is expected that technological advances will economically drive the replacement of existing turbines with newer models.

22.2 Trigger for Implementing Decommissioning Plan

Decommissioning will follow the standards of the Land Use Regulation Commission (LURC) in effect at the time of this application. These standards are based on a rebuttable presumption that decommissioning is required if no electricity is generated for a period of 12 continuous months. Under these standards, the project owner may rebut these presumptions by providing evidence that although the Project has not generated electricity for a continuous period of 12 months, it should not be considered abandoned. Such evidence may include delays surrounding long lead time for spare part procurement, or a *force majeure* event that interrupts the generation of electricity. As used here, a "force majeure" event means instances such as fire, earthquake, flood, tornado, or other acts of God and natural disasters; strikes or labor disputes; war; any law, order, proclamation, regulation, ordinance, action, demand or requirement of any government agency; suspension of operations of all or a portion of the Project for routine maintenance, overhaul, upgrade, or reconditioning; or any other act or condition beyond the reasonable control of the project owner.

22.3 Description of Work Required – Wind Turbines

If triggered, decommissioning will involve the following specific work. All wind turbines and associated foundations will be removed to a depth of 24 inches below grade. In addition buildings, cabling, electrical components, and other facilities, will be removed unless the Project owner or land owner proposes another use for these facilities. All earth disturbed during decommissioning will be graded and re-seeded, unless the landowner of the affected land requests otherwise in writing.

Based on a work plan developed by an experienced contractor, the turbines will be dismantled in the reverse of the erection sequence. A large (i.e., +/- 400-ton) crane will be brought to the site and assembled, along with various support cranes and equipment. On a particular tower site, the work sequence will most likely proceed as follows:

- Install erosion control measures as required;
- Assemble and stage crane on pad at turbine;
- Disconnect electrical connections;
- Remove rotor and block on ground;
- Disassemble rotor;
- Remove nacelle and set on ground;
- Remove turbine tower sections and stage on ground;
- Remove electrical down tower assembly;
- Remove turbine components from site to appropriate facilities;
- Remove foundation;
- Backfill foundation;
- Remove electrical collector system; and
- Rehabilitate disturbed areas.

The turbines will be dismantled using standard Best Management Practices. Critical lift plans will be developed specifically for each major turbine component. The components will be removed from the site and transported to appropriate facilities for reconditioning, salvage, recycling, or disposal. Depending upon the ultimate destination, some components may need to be disassembled on-site to maximize reuse or ensure compliance with applicable disposal regulations.

22.4 Description of Work Required – Other Components

Decommissioning of the non-turbine aspects of the Project will follow LURC permitting guidelines. Currently, these provisions call for foundations, anchor bolts, rebar, conduit, and other subsurface components to be removed to a minimum of 24 inches below grade. Items not known to be harmful to the environment buried greater than 24 inches below grade may be left in place, at the project owner's sole discretion. Once removal is complete, the excavation will be backfilled with material of quality comparable to the immediate surrounding area. The disturbed soils of the site will be rehabilitated, including appropriately grading and re-seeding the area, unless the landowner of the affected land requests otherwise in writing.

The Project collector system, substation, and interconnection facilities will be removed and salvaged, recycled, or repurposed to the maximum amount economically practical, providing that applicable regulations are followed. Any other components will be hauled to approved disposal sites. Any trenches or holes that remain after removal will be backfilled, and the surface areas will be rehabilitated. Construction pads will be rehabilitated and re-seeded. Road improvements and stream crossings will not be removed. Improvements to town and county roads that were not removed after construction at the request of the town or county will remain in place.

Disturbed areas will be reseeded with native species to promote re-vegetation of the area. Restoration will include, as reasonably required, leveling, terracing, mulching, and other necessary steps to prevent soil erosion to ensure establishment of suitable grasses and forbs and to control noxious weeds and pests.

22.5 Estimate of Decommissioning Costs

The Total Estimated Decommissioning Cost will be $1,212,186. A detailed breakout of this cost can be found below in Table 22-1.

Table 22-1. Total Estimated Decommissioning Costs

	Decommissioning Cost	Salvage Value	Net Cost
Turbines & Project Management	$ 4,890,600	$ 4,200,114	$ 690,486
Buildings	$ 42,500	$ -	$ 42,500
Substation	$ 425,000	$ 250,000	$ 175,000
Collection Lines	$ 2,028,000	$ 1,723,800	$ 1,270,000
Total	**$ 7,386,100**	**$ 6,173,914**	**$ 1,212,186**

22.6 Ensuring Decommissioning and Site Restoration Funds

The following funding plan is consistent with LURC's requirements of previously permitted projects, and Highland's understanding of how LURC interprets the decommissioning requirement. Highland recognizes that previously permitted wind projects have provided for decommissioning funds to be established over the first portion of the project's life, with funds fully established at least five years prior to the expected end of useful economic life of the Project, and therefore proposes a similar mechanism. Highland is aware that some project opponents have challenged LURC's interpretation of this requirement, but makes this submission, in good faith, based on the understanding that LURC has found such a mechanism to be compliant with the decommissioning requirement.

On or prior to December 31 of the year in which the project commences commercial operations, the Project will reserve an amount equal to $80,815 (1/15 of the total). For each subsequent year through and including the 7th calendar year of operations $80,815 will also be reserved for site restoration and decommissioning. On or prior to December 31 of the 15th calendar year of operations the estimated cost of decommissioning (less salvage value) will be reassessed and the Project will reserve an amount equal to this updated decommissioning cost estimate(less the amounts reserved in prior years) for decommissioning and site restoration.

The decommissioning fund will be held in the form of a performance bond, surety bond, letter of credit, parental guaranty or other acceptable form of financial assurance. The project owner commits to working with LURC to determine a mutually acceptable form no later than six months prior to the fund's establishment. Funds reserved for decommissioning and site restoration may be drawn upon by the Project for actual decommissioning and site restoration activities. Upon complete decommissioning of the site, any remaining balance of the Decommissioning Fund shall be returned to the Project.

Please also refer to Sections 7.7 and 7.8 of the Ground Lease located in Appendix 5-1 of this Application for Highland's independent obligations to the landowner to properly decommission this project.

Section 23
Other Required Permits and Notifications

23.0 OTHER REQUIRED PERMITS AND NOTIFICATIONS

This Project will require completion of the following notices and additional approvals and permits.

Permit/Notification	**Received**
Federal Aviation Administration Notice of Proposed Construction or Alteration–Off Airport: Determination of No Hazard for Turbine Lighting Plan	
Maine Department of Environmental Protection (MDEP) Notice of Intent for a Construction General Permit	
Forest Operation Notification	
Maine Department of Transportation (MDOT) road opening permit	
MDOT and/or Pleasant Ridge road crossing permit for overhead lines	
U.S. Army Corps of Engineers Clean Water Act license	
MDEP NOI Stormwater General Permit	
DHHS/DEH Plumber/Septic Approval and Cert. of Occupancy	
CMP’s 241 Line Upgrade – pending before PUC	