Hessler Associates, Inc.
Consultants in Engineering Acoustics

3862 Clifton Manor Place
Suite B
Haymarket, Virginia 20169 USA
Phone: 703-753-1602
Fax: 703-753-1522
Website: www.hesslernoise.com

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ENVIRONMENTAL SOUND SURVEY AND NOISE IMPACT ASSESSMENT

ARKWRIGHT SUMMIT WIND FARM

TOWN OF ARKWRIGHT
CHAUTAUQUA COUNTY, NY

PREPARED FOR:

Environmental Design & Research
SYRACUSE, NY

Prepared by:

David M. Hessler, P.E., INCE
Principal Consultant
Hessler Associates, Inc.

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1.0 INTRODUCTION

Hessler Associates, Inc. has been retained by Environmental Design & Research (EDR) on behalf of Arkwright Summit Wind Farm, LLC to evaluate potential noise impacts from the proposed Arkwright Summit Wind Farm on residents in the vicinity of the project area, which is located in the Town of Arkwright in Chautauqua County, NY. Current plans call for the installation of 36 wind turbines each with a nominal electrical output of 2.2 MW. The specific turbine type currently envisioned for the project is the Vestas V110-2.2 MW.

The study essentially consisted of two phases: background sound level surveys under both winter and summer conditions and a computer modeling analysis of future turbine sound levels. The field surveys of existing sound levels at the site were necessary to determine how much natural masking noise there might be - as a function of wind speed - at the nearest residences to the project. The relevance of this is that high levels of background noise due to wind-induced natural sounds, such as tree rustle, would reduce or preclude the audibility of the wind farm, while low levels of natural noise would permit operational noise from the turbines to be more readily perceptible. For a broadband noise source the audibility of and potential impact from the new noise is a function of how much, if at all, it exceeds the pre-existing background level. Measurements were made during both summer and winter conditions to quantify any possible seasonal differences in environmental sound levels.

In the second phase of the project an analytical noise model of the project was developed to predict the sound level contours associated with the project over the site area and thereby determine if any nearby residents might be able to discern the turbines above the pre-existing background level and, if so, what the impact might be.

In addition to local regulatory noise limits, the primary basis for evaluating potential project noise impacts is the Program Policy *Assessing and Mitigating Noise Impacts* issued by the New York State Department of Environmental Conservation (NYSDEC), Feb. 2001. This assessment procedure looks at potential noise impacts in relative rather than absolute terms by comparing expected future sound levels (developed from modeling) to the pre-existing level of background sound (determined from field measurements). The procedure essentially defines a cumulative increase in overall sound level of 6 dBA as the threshold between no appreciable effect and a potentially adverse impact.

Apart from these state and local metrics a further assessment of the expected impact is also discussed based on the CNR, or modified Composite Noise Rating, method and field research studies specifically on wind turbine noise in the professional literature.

1.1 EXECUTIVE SUMMARY

Field surveys of existing sound levels under both wintertime and summertime conditions within the Arkwright Summit Wind Farm project area indicate that background sound levels are highly variable and dependent on wind speed, particularly during the winter. Noises from roadways and other man-made sources are relatively insignificant over most of the site and existing sound levels are largely dominated by natural sources.

A regression analysis of sound levels vs. wind speed shows that the average, or "typical" background sound level increases with wind speed and ranges from about 41 to 50 dBA, irrespective of season, over the range of wind speeds where turbine noise is variable; i.e. from about 4 m/s (measured at a standard elevation of 10 m) to 11 m/s when the turbine rotor reaches maximum rotational speed and sound output becomes constant. The near-minimum (L90) sound level increases from 32 to 47 dBA over the same wind speed range during winter conditions and from 36 to 46 in the summer. A fairly uniform sound level was found to exist at all 5 monitoring stations used for the warm weather survey and at 7 of the 8 positions used for the winter survey. Consequently, the average sound levels from all positions, neglecting the one anomalous winter position, reasonably characterize the site-wide sound level.

A comparison, as a function of wind speed, between the background sound levels and the variable sound power level of Vestas V110-2.2 MW turbine currently planned for the project indicates that the maximum potential for an adverse impact from noise occurs at intermediate wind speeds of 6, 9 and 10 m/s, depending on season and the measurement metric. At these wind speeds the greatest differential generally exists between the turbine sound level and the amount of masking background noise available to obscure project noise. This analysis showed that the "typical" (Leq) background sound level likely to exist throughout the site area in the winter under these critical design conditions (a moderate 6 m/s wind) was **44 dBA** and the "conservative", near-minimum (L90) sound level, was **37 dBA**. In the summertime the point of maximum possible project audibility occurred during higher wind speeds of 9 and 10 m/s – essentially when the turbines would be producing the maximum sound emissions. Under these design conditions the "typical" background sound level was **47 dBA** and the "conservative" L90 level was **43 dBA**. By definition L90 sound levels only occur 10% of the time, so these lower, conservative levels do not represent the permanent background sound level, but rather momentarily low levels.

In the New York State Department of Environmental Conservation's Program Policy *Assessing and Mitigating Noise Impacts* a cumulative increase in total sound level up to 6 dBA is characterized as having "potential for adverse noise impact only in cases where the most sensitive of receptors are present" and is suggested as a threshold for determining what areas might be adversely impacted by a new noise source and what areas should see "no appreciable effect". Using the design background levels discussed above as a baseline the thresholds for a potentially adverse noise impact would be as follows:

Table 1.1.1 *Critical Design Levels and NYSDEC Impact Thresholds*

Season and Type of Impact	**Measured Critical Background Level and Wind Speed**	**Impact Threshold - Project-only Sound Level, dBA** (5 dBA above Background Level[1])	**Cumulative Sound Level with Project Operating, dBA** (6 dBA above Background Level)
Typical Impact Based on Leq Wintertime	44 dBA, 6 m/s	**49**	50
Conservative Impact Based on L90 Wintertime	37 dBA, 6 m/s	**42**	43
Typical Impact Based on Leq Summertime	47 dBA, 10 m/s	**52**	53
Conservative Impact Based on L90 Summertime	43 dBA, 9 m/s	**48**	49

A "Second Level" modeling study, carried out per the NYSDEC guidelines, showed that the region where noise impacts might occur (i.e. where an increase of 6 dBA or more is predicted) does not encompass any homes under most conditions. It is only during conservative wintertime conditions, when the background level is essentially at a minimum, that several of the closest residences may temporarily experience an increase of about 6 dBA. Under these circumstances it should be noted that residents are less likely to be sensitive to outdoor sound because they generally spend more time indoors during windy wintertime conditions. Under most normal

[1] Because decibels addition is logarithmic a project sound level that is 5 dBA above the background level would lead to a total sound level that is 6 dBA above the original value. For example, 44 + 49 = 50 dBA, or 6 dBA above the original level of 44 dBA.

conditions in both the winter and summer, however, the sound emissions from the project would be less, if not significantly less, perceptible.

An additional independent analysis of the potential project noise impact based on the modified CNR method was also carried out. This approach evaluates the frequency content of the background and project sound levels and considers other factors such as the temporal characteristics of the noise source and any character content. This analysis essentially confirmed the findings of the modeling analysis using the NYSDEC guidance and indicated that "no reaction" was likely under most circumstances and that "sporadic complaints" could be possible under conservative wintertime conditions if a very low background sound level is assumed.

Although these analyses suggest that the sound emissions from the project may be perceptible at times during the winter, it should be noted that the modeling is conservative in a number of important respects:

- The L90 background level that is assumed in the "conservative" analyses represents the quietest lulls between wind gusts, farm equipment, cars passing by, dogs barking, etc. As such, this level quantifies a very low value for environmental masking noise. The survey data shows that most of the time a substantially higher background sound level will exist.

- The noise model assumes that the wind is blowing simultaneously from all directions and that the turbine sound level experienced at any given point is the sound level that would occur downwind from all turbines in the project.

- The ground surface is assumed to have a fairly low absorptivity – normally wooded areas (which cover most of the site) and farm fields are highly absorptive.

- The predicted sound levels occur *outside*. Sound levels inside of any dwelling will be 10 to 20 dBA lower. This reduction generally puts the project sound level inside any home below the sleep disturbance threshold of 30 dBA published by the World Health Organization[1]

These conservative assumptions are intended to over-estimate project sound levels under most normal conditions so that some allowance or buffer exists to cover the intermittent occurrence of certain atmospheric conditions that allow turbine noise to be more readily perceived, such as during stable atmospheric conditions that sometimes develop in the evening or at night.

In any case, the modeling analysis shows that full compliance with the local town law relating to wind energy facilities is expected. The maximum allowable sound level of 50 dBA is predicted to occur well short of any residence or potentially sensitive receptor.

Although concerns are often raised with respect to low frequency noise emissions from wind turbines, no adverse impact of any kind related to low frequency noise is expected from this project. An extensive and impartial governmental study recently completed by Health Canada shows no relationship between various health symptoms and exposure to the sound emissions from wind turbines. Other studies suggest a psychosomatic origin to the very real health issues that have inexplicably occurred at some wind project sites.

Unavoidable noise impacts may occur during the construction phase of the project. Construction noise, sounding similar to that of distant farming equipment, is anticipated to be sporadically audible at most homes within the immediate project vicinity on a temporary basis. The maximum magnitude of construction noise at the nearest homes to individual turbine locations is not expected to exceed 54 to 61 dBA depending on the particular activity. Somewhat higher levels are possible where road building or trenching activities occur fairly close to homes.

2.0 BACKGROUND SOUND LEVEL SURVEYS

2.1 OBJECTIVE AND MEASUREMENT QUANTITIES

The purpose of the surveys was to determine what minimum environmental sound levels are consistently present and available at the nearest potentially sensitive receptors to mask or obscure potential noise from the project under wintertime, leaf-off conditions (when environmental sound levels are typically at a minimum) and during summertime conditions when the trees are fully leafed out. A number of statistical sound levels were measured in consecutive 10 minute intervals over the entire survey. Of these, the average (Leq) and residual (L90) levels are the most meaningful.

The average, or equivalent energy sound level (Leq), is literally the average sound level over each measurement interval. This is the "typical" sound level most likely to be observed at any given moment.

The L90 statistical sound level, on the other hand, is commonly used to conservatively quantify the near-minimum background sound level. The L90 is the sound level exceeded during 90% of the measurement interval and has the quality of filtering out sporadic, short-duration noise events, like a car passing by, thereby capturing the quiet lulls between such events. It is this consistently present background level that forms a "conservative" basis for evaluating the audibility of a new source.

An additional factor that is important in establishing the minimum background sound level available to mask potential wind turbine noise is the natural sound generated by the wind itself. Wind turbines only operate and produce noise when the wind exceeds a minimum cut-in speed of roughly 4 m/s (measured at a standard reference elevation of 10 m). Turbine sound levels increase with wind speed up to about 8 m/s when the sound produced essentially reaches a maximum and no longer increases with wind speed. Consequently, at moderate to high speeds the level of natural masking noise is normally relatively high due to tree, crop or grass rustle while the turbine sound level no longer increases thus reducing the perceptibility of the turbines. In order to quantify the wind-dependency of the background sound level, wind speed was measured over the entire sound level survey period at a meteorological (met) tower near the center of the site for later correlation to the sound data.

2.2 SITE DESCRIPTION AND MEASUREMENT POSITIONS

The proposed turbines in the Arkwright Summit Wind Project are spread out over an area of very roughly 20 square miles within the Town of Arkwright, NY. The site area is rural in nature and can be characterized as consisting of numerous scattered residences, mainly along the principal roads, interspersed with several farms of various sizes. Turbines are planned in the largely uninhabited areas between local roads.

The site topography is moderately hilly. In terms of vegetation, the area is a mix of open fields and wooded areas - with wooded areas much more prevalent. Most of the homes are either near wooded areas or have some trees immediately around the house.

Background sound level measurement locations were chosen to evenly cover and represent the entire area as shown in **Graphic A**. Five positions were used for the summertime survey and an additional 3 locations (making 8 altogether) were used for the more critical wintertime survey. The specific positions are listed below along with photographs of some of the locations. As will be noted from the pictures, a variety of settings were deliberately chosen to see if background sound levels were uniform or variable over the site area. For example, some positions are in open fields, some in wooded areas, some near homes, and some in remote areas.

Position 1 – 9351 Center Road
The monitor was attached to a fencepost adjacent to a pasture behind the home and near a barn.

Figure 2.2.1 *Position 1 Looking Northwest*

Position 2 – 9682 Livermore Road
The meter was attached to a post in the rear yard of the house near the barn.

Figure 2.2.2 *Position 2 Looking Northwest*

Position 3 – Meadows Road near Scout Camp
The meter was attached to a tree in a wooded area between a cleared utility right of way and a nearby Boy Scout Camp.

Figure 2.2.3 *Position 3 Looking Northeast toward Scout Camp (clearing barely visible just beyond the woods)*

Position 4 – 8193 Farrington Hollow Road
The monitor was attached to a utility pole in the middle of a large, open alfalfa field.

Figure 2.2.4 *Position 4 Looking Southeast towards House*

Position 5 – 2934 Route 83
The meter was attached to a tree in the front yard of the house. This measurement position was set back from Route 83 by roughly 150 feet.

Figure 2.2.5 *Position 5 Looking North towards House*

Position 6 – 2383 Route 83 (Supplemental wintertime survey location)
The monitor was attached to a tree in the rear yard of the house about 100 feet back from Route 83.

Position 7 – 3053 Straight Road (Supplemental wintertime survey location)
The monitor was attached to a utility pole in the front yard of the house.

Position 8 – 2910 Straight Road (Supplemental wintertime survey location)
The monitor was attached to a utility pole along Center Road (near its junction with Straight Road) in a large, open pasture.

2.3 INSTRUMENTATION AND DURATION OF SURVEYS

Rion NL Series sound level meters (NL-06, NL-22, and NL-32) ANSI Type 1 and 2 sound level meters were used at locations except Position 1 where a Norsonic 118, ANSI Type 1, 1/3 octave band analyzer was used to record frequency content. Each meter was enclosed in a watertight case. The Rion monitors were fitted with a 12" microphone boom. A Norsonic Model 1212 environmental microphone protection kit was used at Position 1 for the summertime survey only – in the winter survey a boom and large windscreen, as on all other meters, was used.

The microphones were protected from wind-induced self-noise by oversized 180 mm (7") diameter foam windscreens (ACO Model WS7-80T). The microphones were also situated at a fairly low elevation of about 1 m above grade so that they were exposed to relatively low wind speeds. As illustrated later in Figure 2.7.1 wind speed normally diminishes rapidly close to the ground, theoretically going to zero at the surface. At a height of 1 m the microphones were typically exposed to relatively innocuous wind speeds of about 3 or 4 m/s during the wind conditions of greatest interest (6 to 8 m/s as measured at the IEC standard height of 10 m above grade). In any event, self-generated wind noise affects only the extreme lower frequencies and, except in very high wind conditions, has little or no influence on the measured A-weighted level (the quantity sought in the survey) since the lower frequencies are heavily suppressed before the spectrum is summed to give an overall A-weighted level. Consequently, the measured values are considered valid and free of any significant self-generated contamination.

Two surveys were carried out for the project to evaluate possible seasonal differences in background sound levels: one during leaf-on, summertime conditions from September 9 to 25, 2007 and another during wintertime conditions with trees bare from November 29 to December 12, 2007. Altogether, on-site measurements were made for a period of approximately one month.

All equipment was field calibrated at the beginning of the survey and again at the end of each survey. The observed calibration drift of all the instruments was less than +/- 0.4 dB in both instances.

2.4 Weather Conditions – Summer and Winter Surveys

Weather conditions during the summertime survey in September were characterized by low to moderate wind speeds and little precipitation. The only significant rain (about 0.30 inch each time) fell on September 11 and 14. Wind speeds at the IEC normalization elevation of 10 m above grade were mostly under 8 m/s but two periods of higher winds, up to 10 m/s, were captured during the survey.

The general conditions of temperature, barometric pressure and wind for the summer survey period are shown in the chart below (Figure 2.4.1) as observed at Dunkirk, NY, a few miles northwest of the site area.

The first survey was carried out under warm-weather, leaf-on conditions. Summertime environmental sound levels tend to be somewhat higher than during the winter because leaves rustle in the wind and, more importantly, insects, such as crickets or cicadas, commonly elevate nighttime sound levels.

Weather conditions during the winter survey in late November and early December were characterized by several periods of high wind speeds and several snowfalls. Wind speeds ranging from 0 to 14 m/s (at 10 m) were observed over the survey period.

A partial chart of the general conditions of temperature, barometric pressure and wind for the winter survey period are shown Figure 2.4.2.

The second survey was carried out under cold-weather, leaf-off conditions when the lowest environmental sound levels typically occur because there is less wind-generated sound from trees and vegetation and no insects are active.

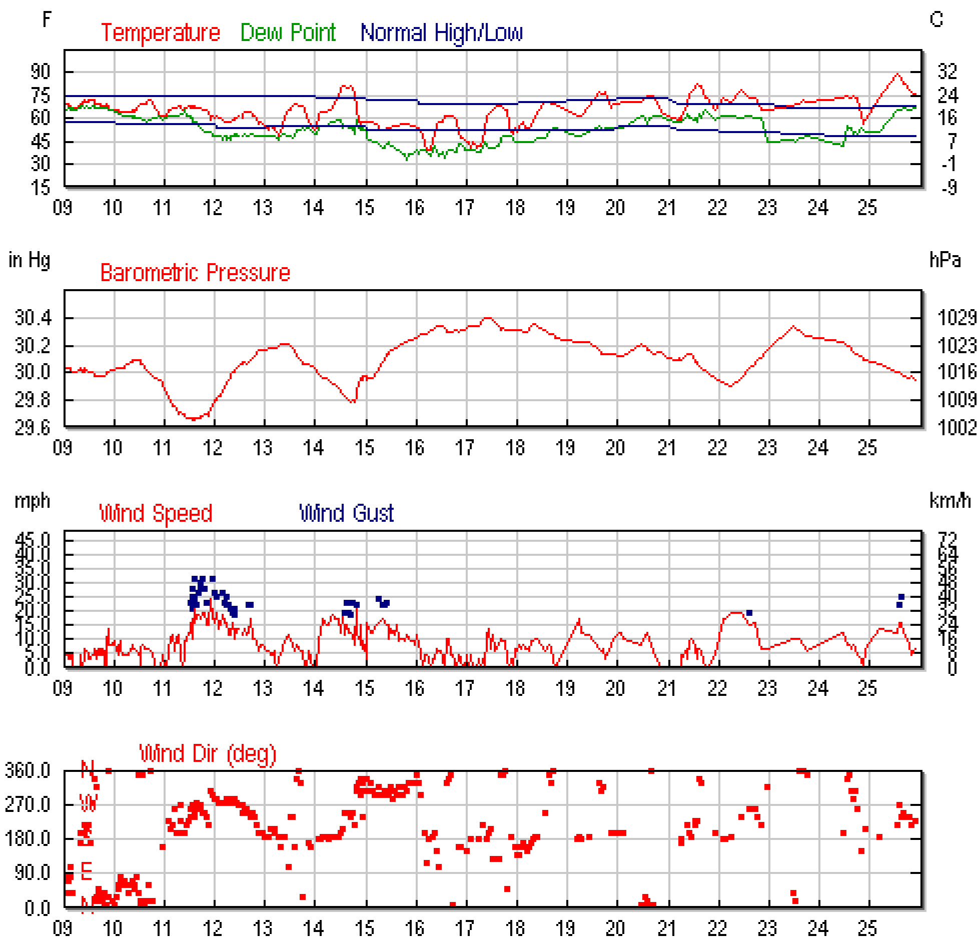
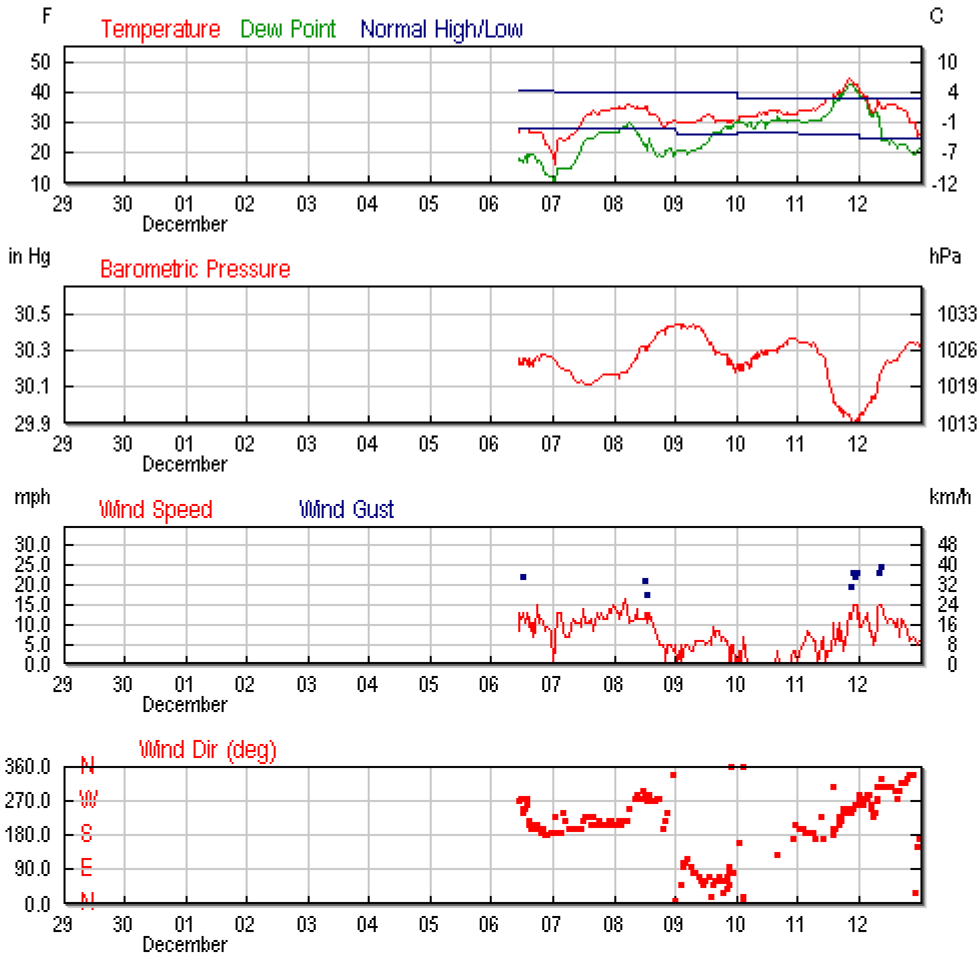


Figure 2.4.1 *General Weather Data for the Summertime Survey Period as Observed in Dunkirk, NY*



2.4.2 *General Weather Data for the Wintertime Survey Period as Observed in Dunkirk, NY (Partial)*

The wind speed at the site itself was measured by a central met tower just off of Center Road. Figure 2.4.3, shows the 10 minute average wind speeds measured by the mast top (49 m) anemometer of Tower 991 during the summer survey. Also shown is the normalized average wind speed per IEC Standard 61400-11 [Ref. 1], Equation 7, at the standard height of 10 m. A roughness length of 0.05 was used, which is associated with "farmland with some vegetation". The wind speed at this elevation is important because the turbine sound power levels are expressed as a function of wind speed at this standard height.

A similar plot of wind speed vs. time for the winter survey is shown in Figure 2.4.4.

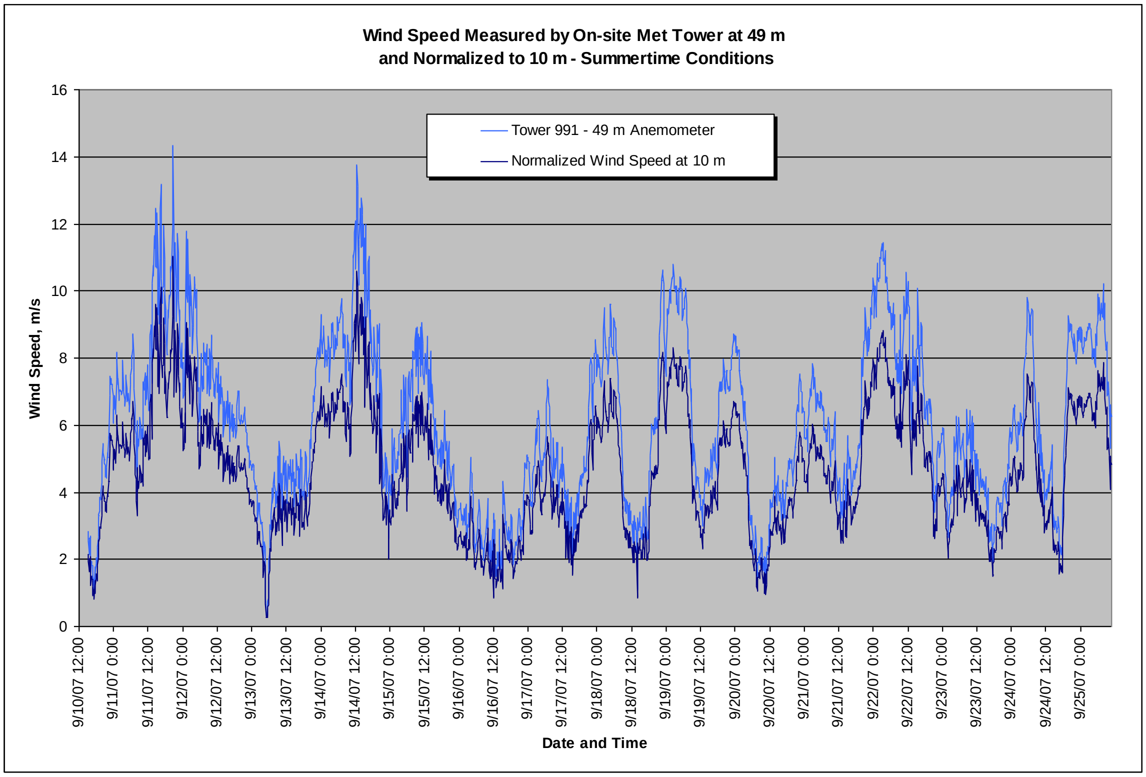


Figure 2.4.3 *Measured Wind Speeds at Site during Summer Sound Survey Period*

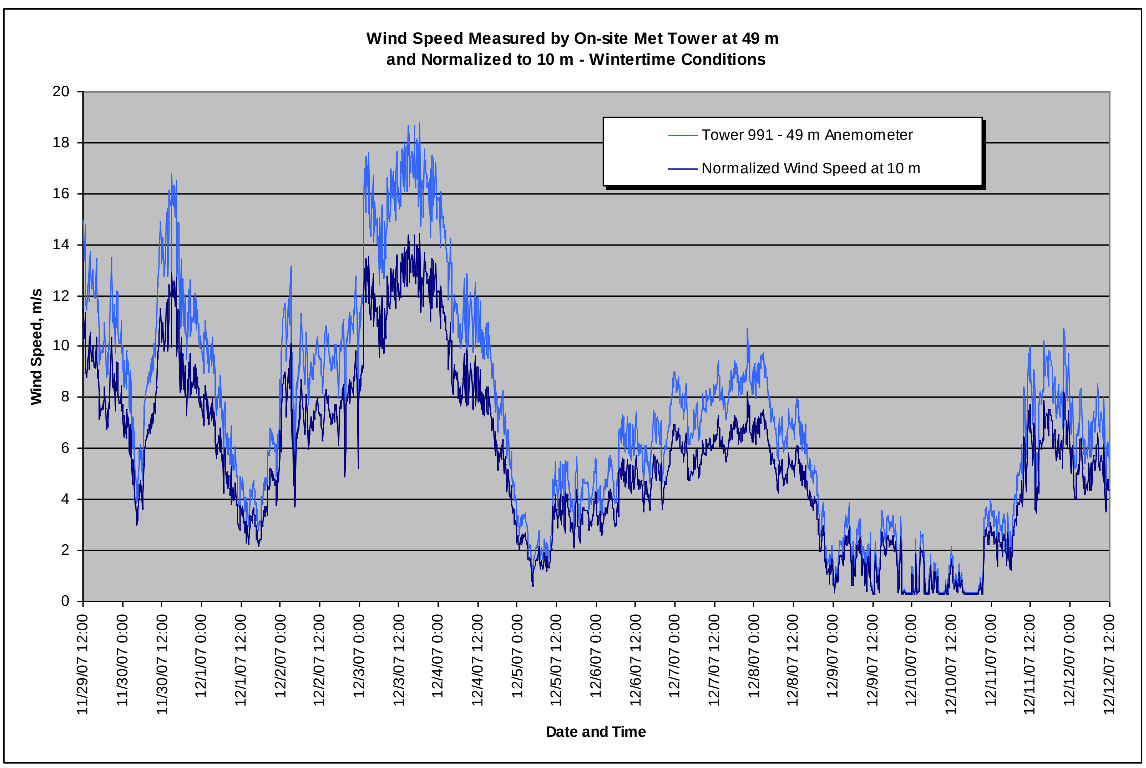


Figure 2.4.4 *Measured Wind Speeds at Site during Winter Sound Survey Period*

2.5 Overall Results – Summer Survey

As discussed above in Section 2.1, the L90, or residual, sound level is a conservative measure of background sound levels in the sense that it filters out short-duration, sporadic noise events that cannot be relied upon to provide consistent and continual masking noise to obscure potential turbine noise. This level represents the quiet, momentary lulls between all relatively short duration events, such as cars passing by or tractor activity in a neighboring field. As such, it is a "conservative" measure of the background level with regard to evaluating potential impacts from a new source.

The L90 sound levels over consecutive 10 minute increments for all 5 summertime positions are plotted below for the survey period.

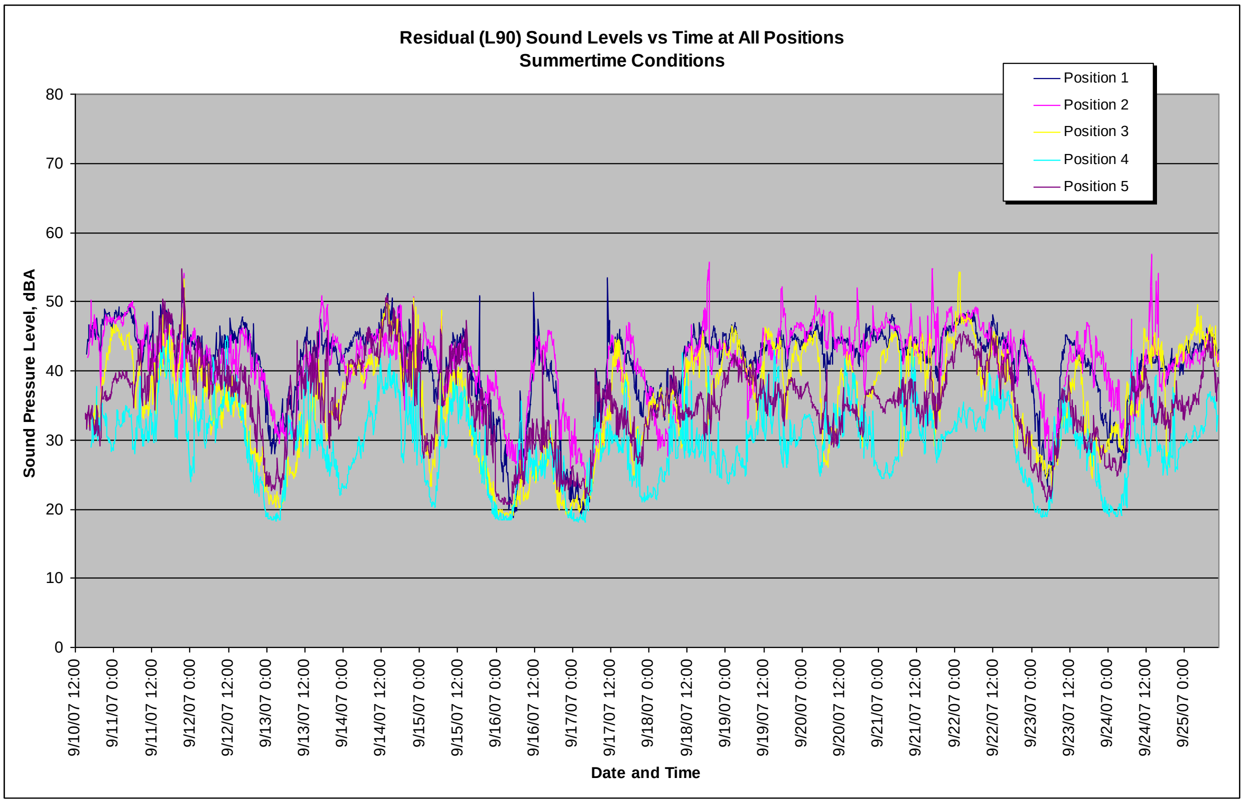


Figure 2.5.1 *10 minute L90 Sound Levels at All Monitoring Positions*

This plot shows that sound levels over the site area are of the same general order of magnitude but that some local variation is present. Experience with many other summertime field surveys indicates that most of the local variation apparent here is a common occurrence likely due to the prevalence and activity level of various insects or birds near each monitoring station. Because insect and bird noise is generally confined to the higher frequencies it plays a fairly minor role in masking mid-frequency wind turbine noise so the scatter in the data is not as substantive or important as it might at first seem. Consequently, the average sound level over all five positions, plotted in Figure 2.5.2 below, is considered a reasonably fair and representative measure of the site-wide L90 sound level and will be taken as the "conservative" design level.

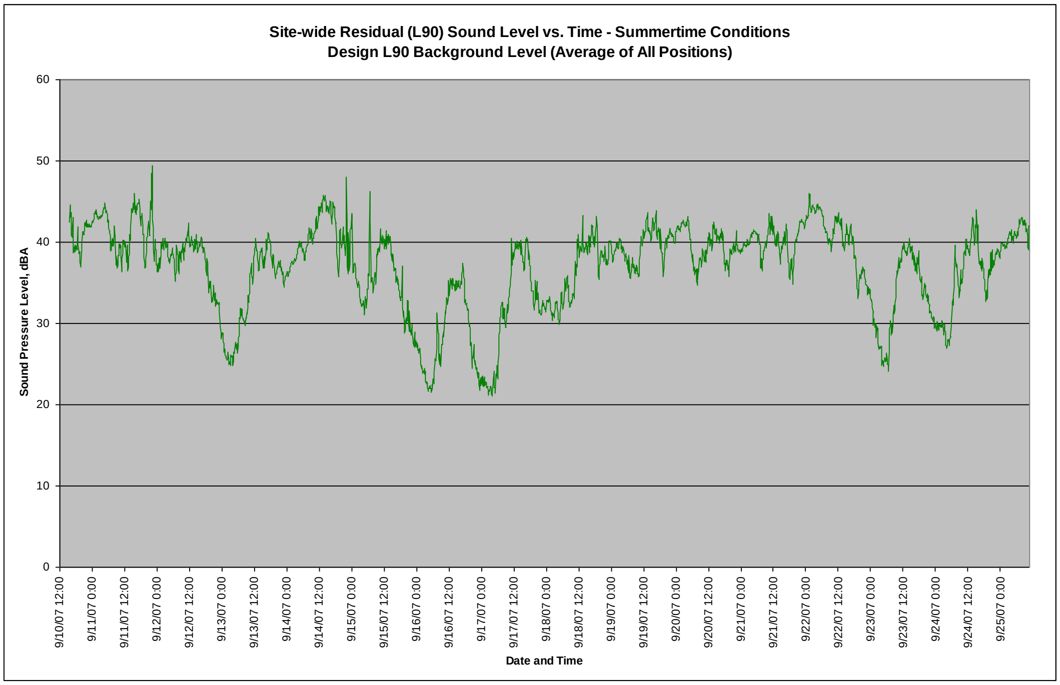


Figure 2.5.2 *Average L90 Sound Level – Design "Conservative" Background Sound Level*

The average L90 design sound level is plotted against the average wind speed at 10 m in Figure 2.5.3 below.

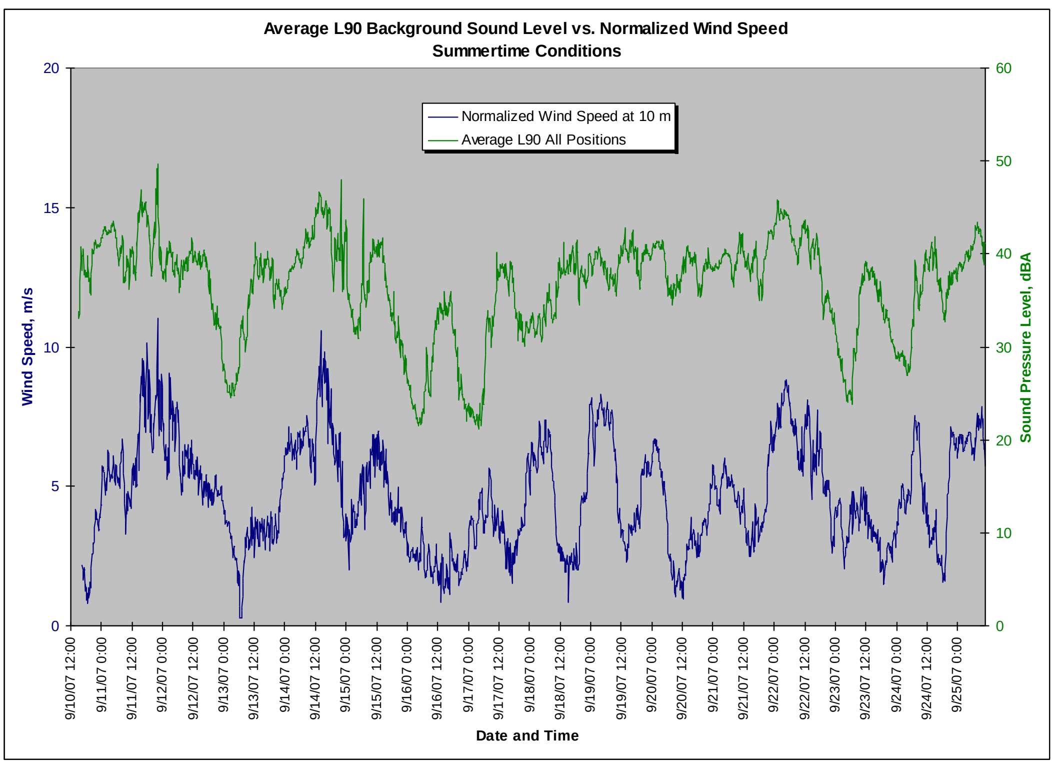


Figure 2.5.3 *Background L90 Sound Levels and Wind Speed*

This plot shows that there is only a somewhat vague correlation between sound and wind, which is not surprising because any such correlation is diluted in direct proportion to the prevalence of sounds that are independent of wind speed, such as birds or insects. Nevertheless, the sound peaks do match up well with the periods of maximum wind when tree rustle normally becomes the dominant sound in the environment.

The sound levels discussed so far are all residual, or L90, levels that capture the near minimum sound level that occurred during each 10 minute interval. As such this level can be considered a "conservative" design level for evaluating potential impacts, since it essentially represents the lowest level of masking sound. By definition, however, the L90 level occurs only a small fraction of the time (10% of the time) and is not a long-term or continuous phenomenon. The average, or Leq, level, on the other hand, is the "typical" sound level that might be heard at any given moment.

Figure 2.5.4 below shows the Leq(10 min) sound levels measured at all five monitoring stations. In this instance, sound levels at each position generally intertwine and the level at any one point is not appreciably or consistently different from that at the others. Consequently, the average of all five levels, plotted in Figure 2.5.5, is considered a valid representation of the site-wide Leq, or "typical" sound level. Averaging largely eliminates the sporadic noise spikes that are caused by local noise events.

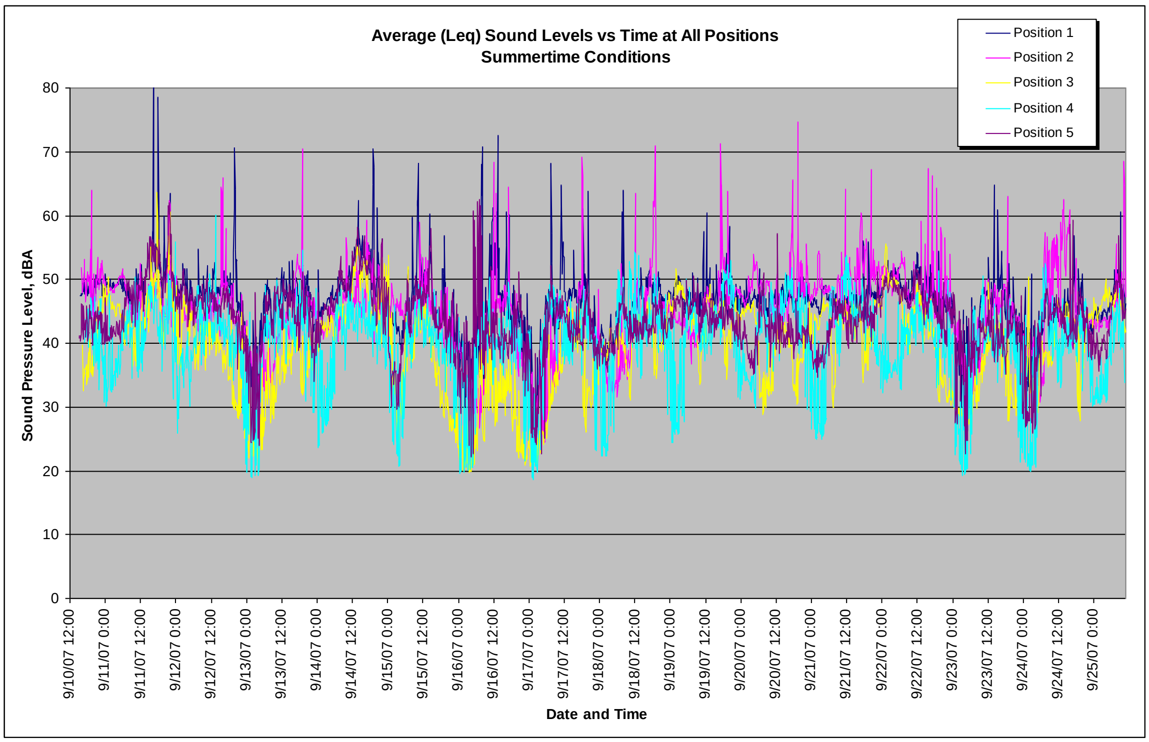


Figure 2.5.4 *10 minute Leq Sound Levels at All Monitoring Positions*

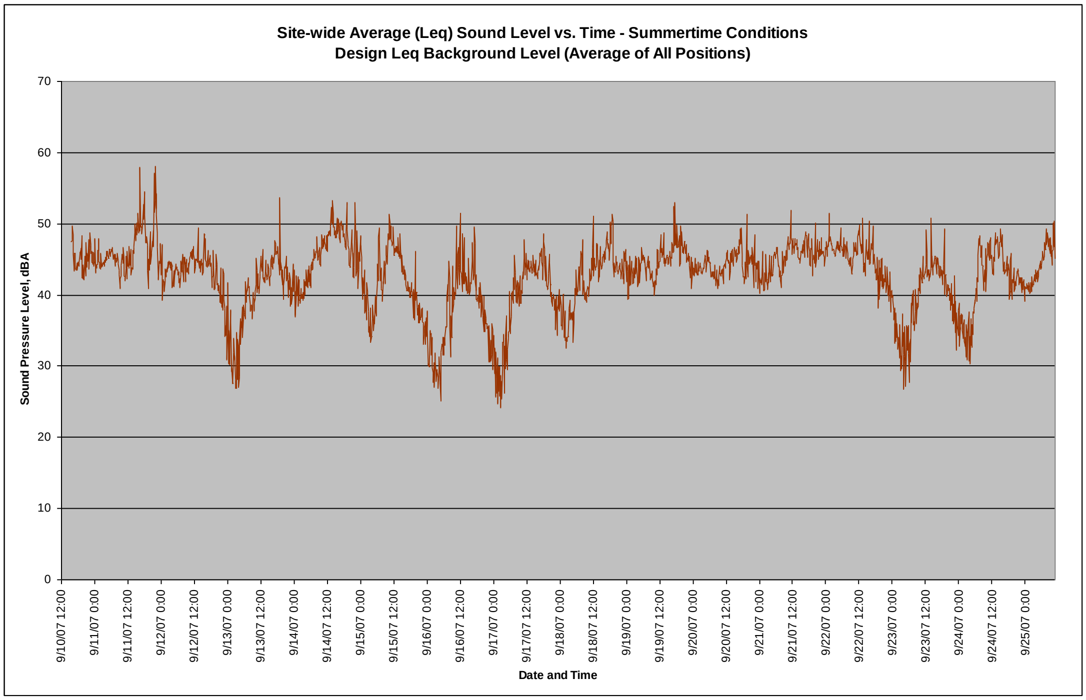


Figure 2.5.5 *Average Leq Sound Level at All Monitoring Positions*

The correlation between the Leq level and wind speed is plotted in Figure 3.5.6.

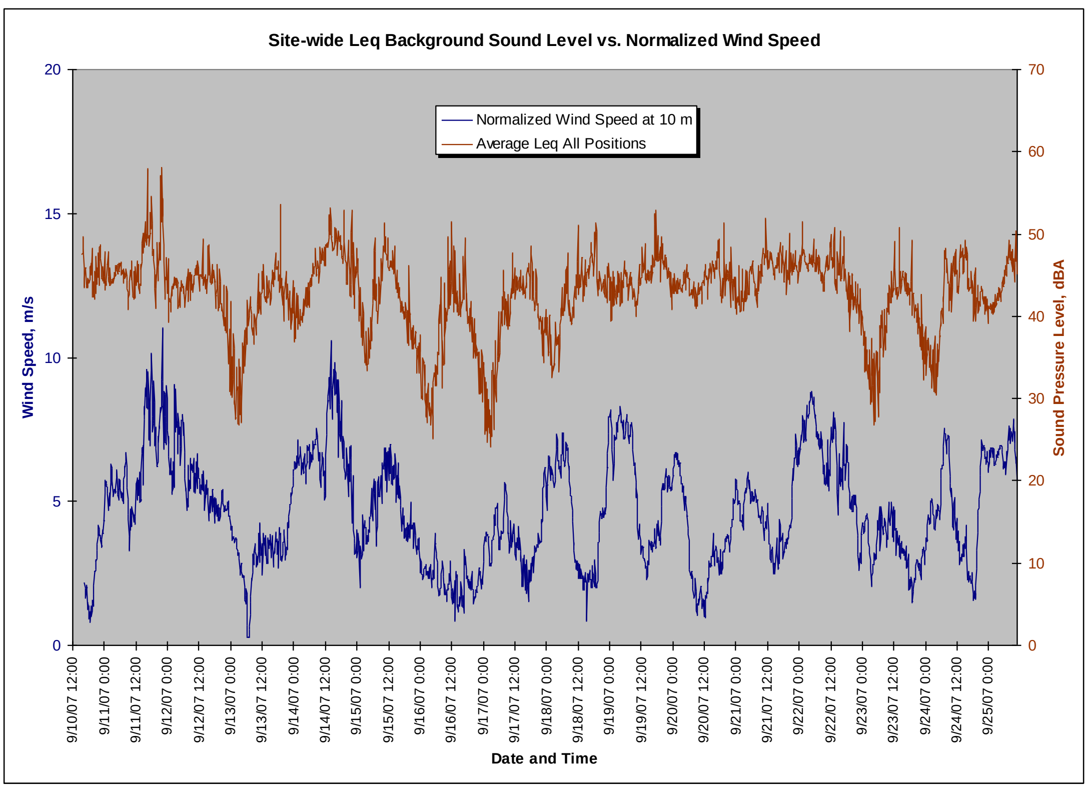


Figure 2.5.6 *Background Leq Sound Levels and Wind Speed*

In addition to the L90 and Leq results, the Town of Arkwright Local Law (discussed in Section 3.1.1 below) requires that the L10 statistical level be measured before and after construction of the project because the permissible project sound level can exceed 50 dBA (L10) if the pre-existing background level is already higher than 48 dBA. The specific language is as follows:

> If the ambient sound level exceeds 48 dBA, the standard shall be ambient dBA plus 5 dBA. Independent certification shall be provided before and after construction demonstrating compliance with this requirement.

The approximate, site-wide L10 sound level, derived from averaging the results from each position, is plotted below along with the concurrent wind speed.

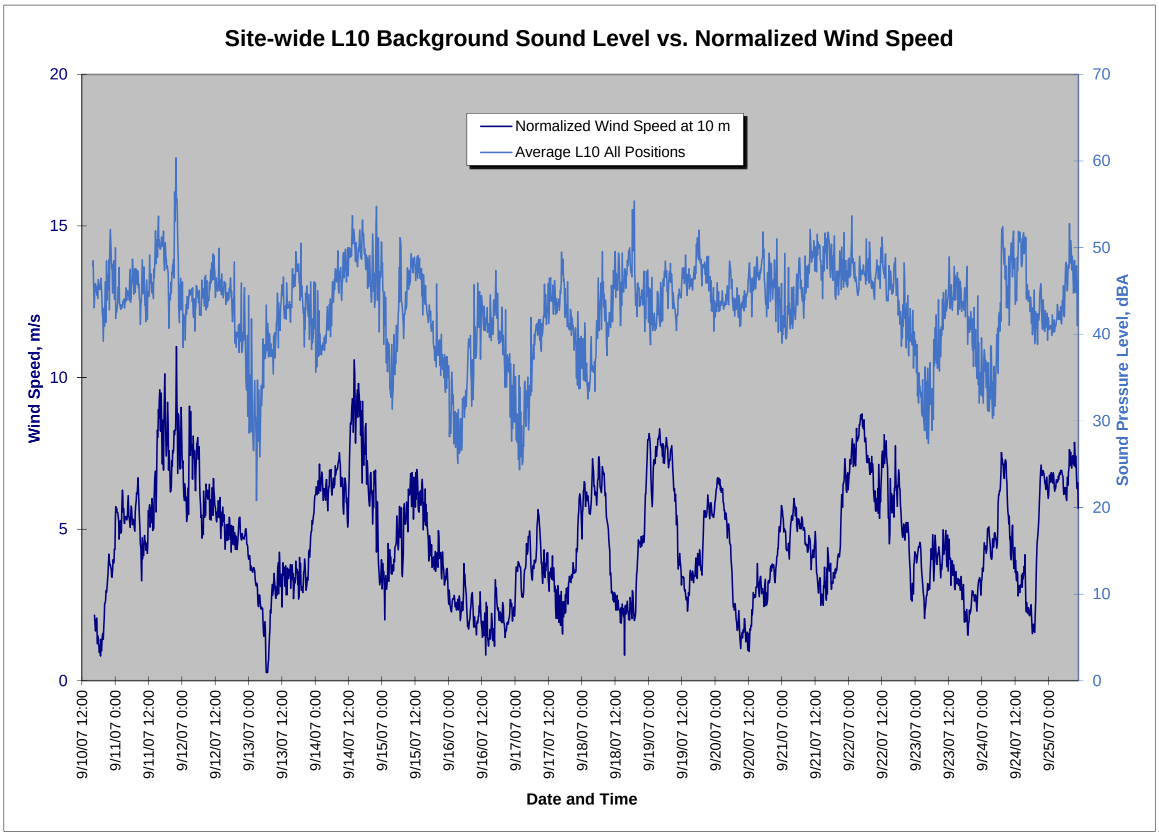


Figure 2.5.7 *Background L10 Sound Levels and Wind Speed*

As with the other measures, the background L10 sound level is not a single number but typically ranges from about 30 to 53 dBA. Figure 2.5.7 shows that this sound level is not particularly driven by, or related to, the wind speed except perhaps during the two high wind periods on 9/12 and 9/14. The regression analysis below confirms this lack of correlation with an extremely low R^2 value of less than 0.1.

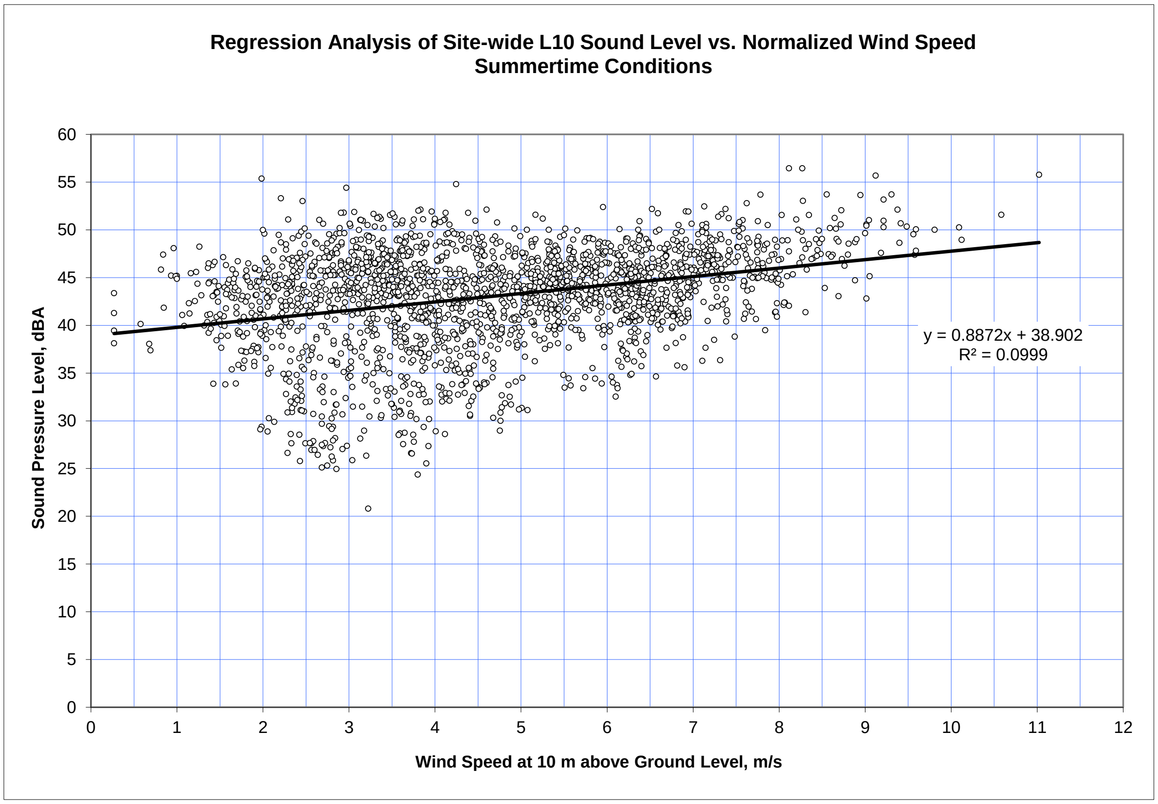


Figure 2.5.8 *Background L10 Sound Levels and Wind Speed*

This result is not surprising because the L10 sound level is normally driven by man-made or natural sounds that are usually considered interference or contamination, such as car passes, planes flying over, bird activity, nighttime insects, farm equipment, etc. – things that are typically louder than natural wind-induced sounds and, at the same time, unrelated to wind. Figure 2.5.8 demonstrates that the background sound level is, in fact, over the Town noise limit of 50 dBA some of the time and that this overage can occur under virtually any wind condition.

2.6 OVERALL RESULTS – WINTER SURVEY

The L90 sound levels over consecutive 10 minute increments for all 8 wintertime positions are plotted below in Figure 2.6.1 for the November/December survey period. Three additional measurement positions were added for the winter survey, since measurements taken during leaf-off, cold weather conditions are typically lower than in summer, less prone to contamination and therefore of more importance to the impact assessment.

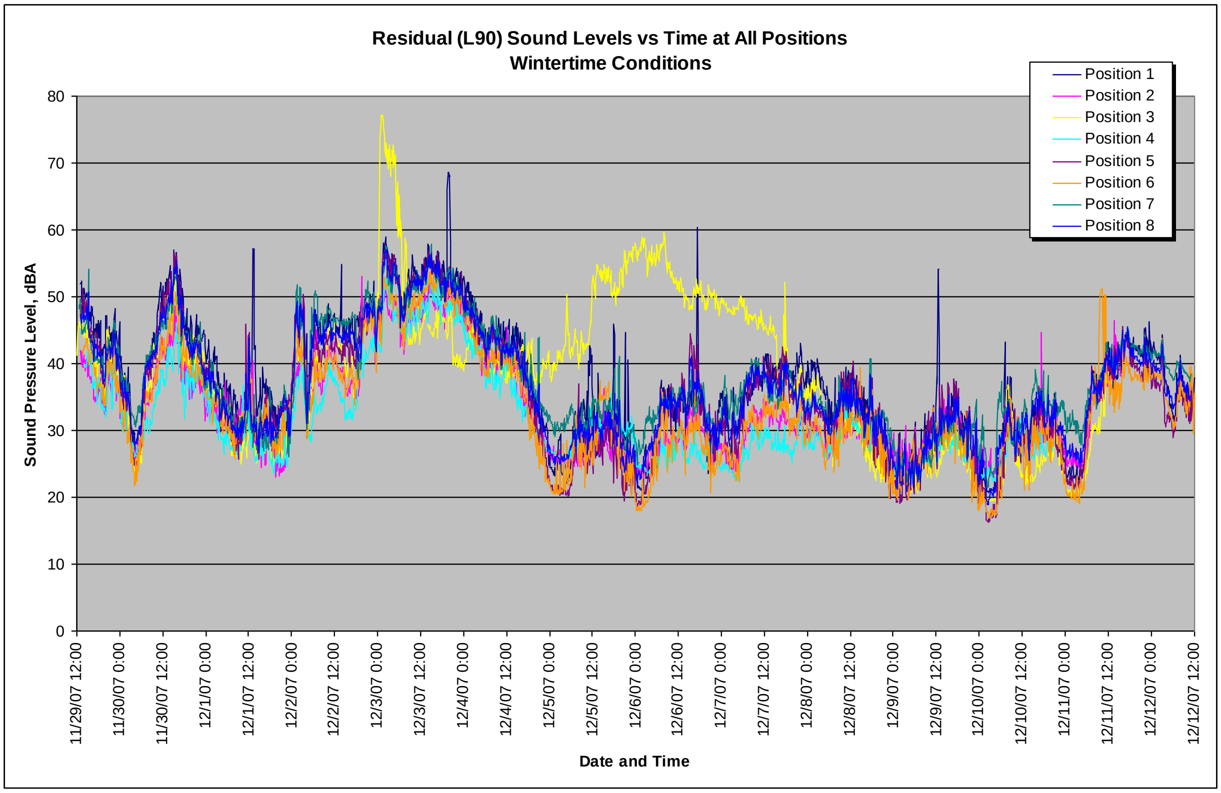


Figure 2.6.1 *10 minute L90 Sound Levels at All Monitoring Positions*

Apart from the anomalously high levels measured part of the time at Position 3, this plot shows that L90 sound levels measured during cold-weather conditions are much more tightly grouped than in the warm weather survey and all closely follow each other even though many of the positions were miles apart. It is not known why unusually high sound levels were observed for a period of several days (only) at Position 3, which is in a remote wooded area. Because of this inexplicable behavior the data measured at this position has been ignored for the entire survey period. The average level excluding Position 3, plotted below, is considered a reasonable indication of the site-wide L90 sound level during winter conditions.

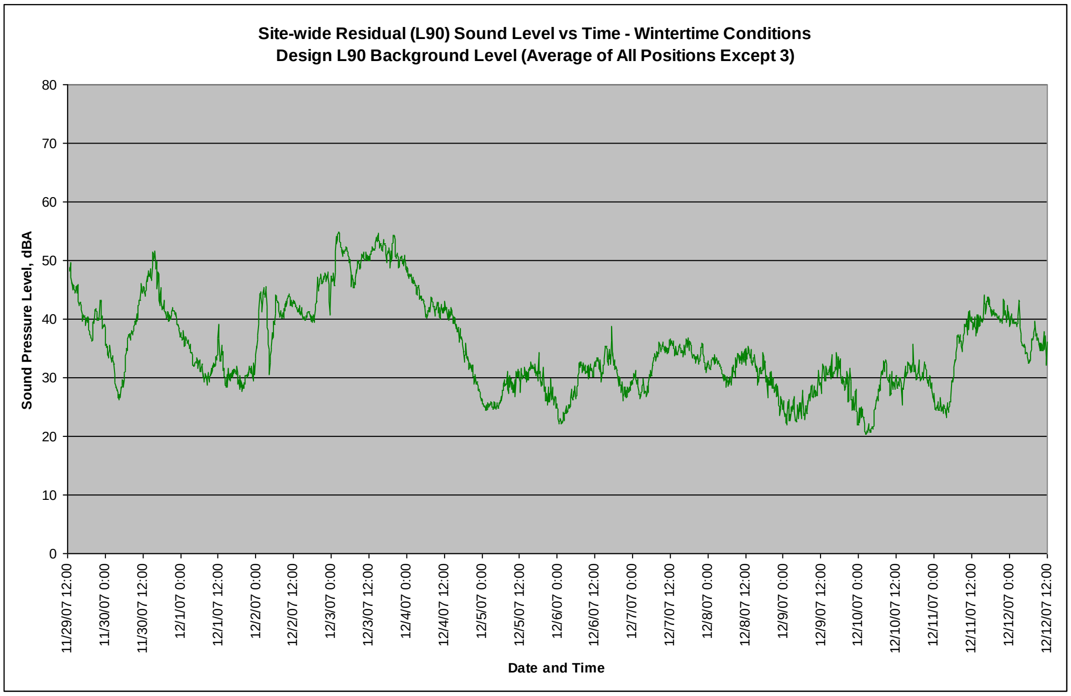


Figure 2.6.2 *Average L90 Sound Level – Design "Conservative" Background Sound Level*

This average L90 design sound level is plotted against the average wind speed at 10 m in Figure 2.6.3 below.

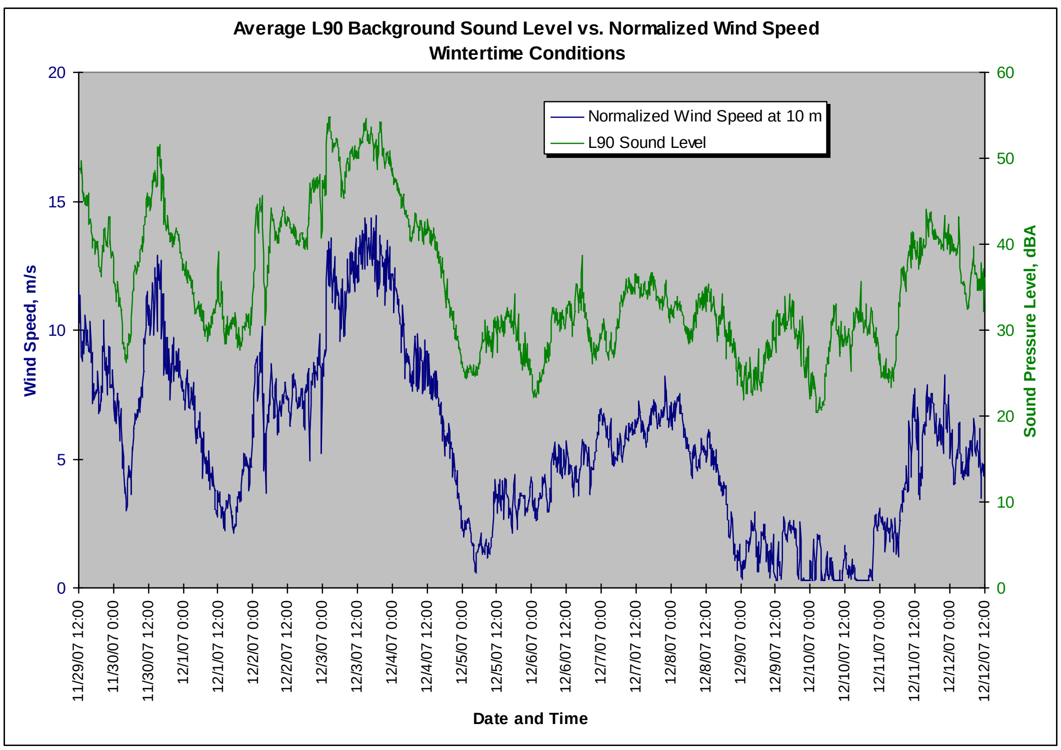


Figure 2.6.3 *Background L90 Sound Levels and Wind Speed*

As opposed to the rather vague correlation between the summer sound levels and wind speed, the winter data show that there is a clear and definite connection between the L90 ambient sound level and wind speed, which is to be expected, since summertime insect activity (a noise source unrelated to wind) is absent.

Figure 2.6.4 below shows the Leq(10 min) sound levels measured at all 8 winter monitoring stations.

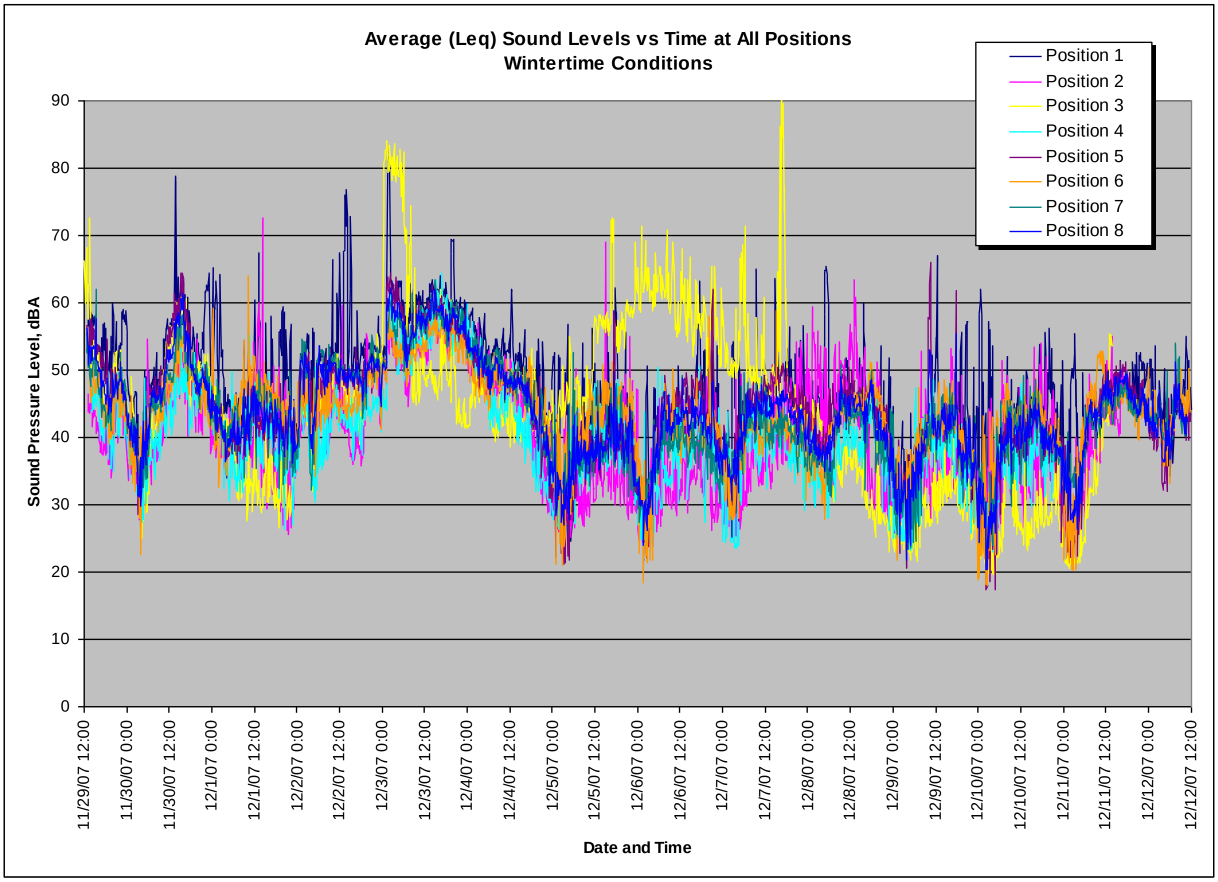


Figure 2.6.4 *10 minute Leq Sound Levels at All Monitoring Positions*

While there is more scatter in the Leq levels, they are still consistent in the sense that no one position - except Position 3 - is substantially different from the rest of the locations. Consequently, the average of the remaining 7 positions (again excluding Position 3), plotted in Figure 2.6.5, is considered a reasonably good representation of the site-wide Leq, or "typical" sound level for wintertime conditions.

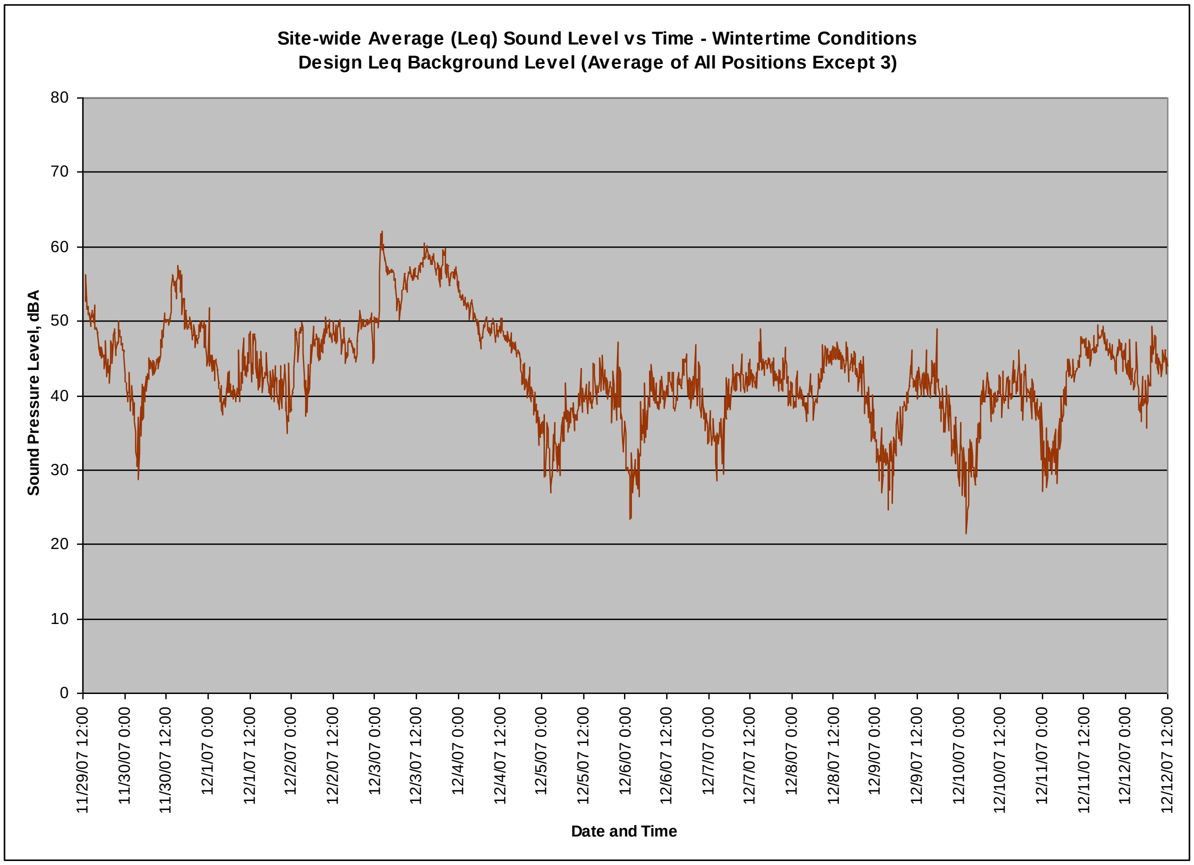


Figure 2.6.5 *Average Leq Sound Level at All Monitoring Positions*

The correlation between the Leq level and wind speed is plotted in Figure 2.6.6. As with the L90 levels, the site-wide, design Leq exhibits a close correlation between sound and wind speed.

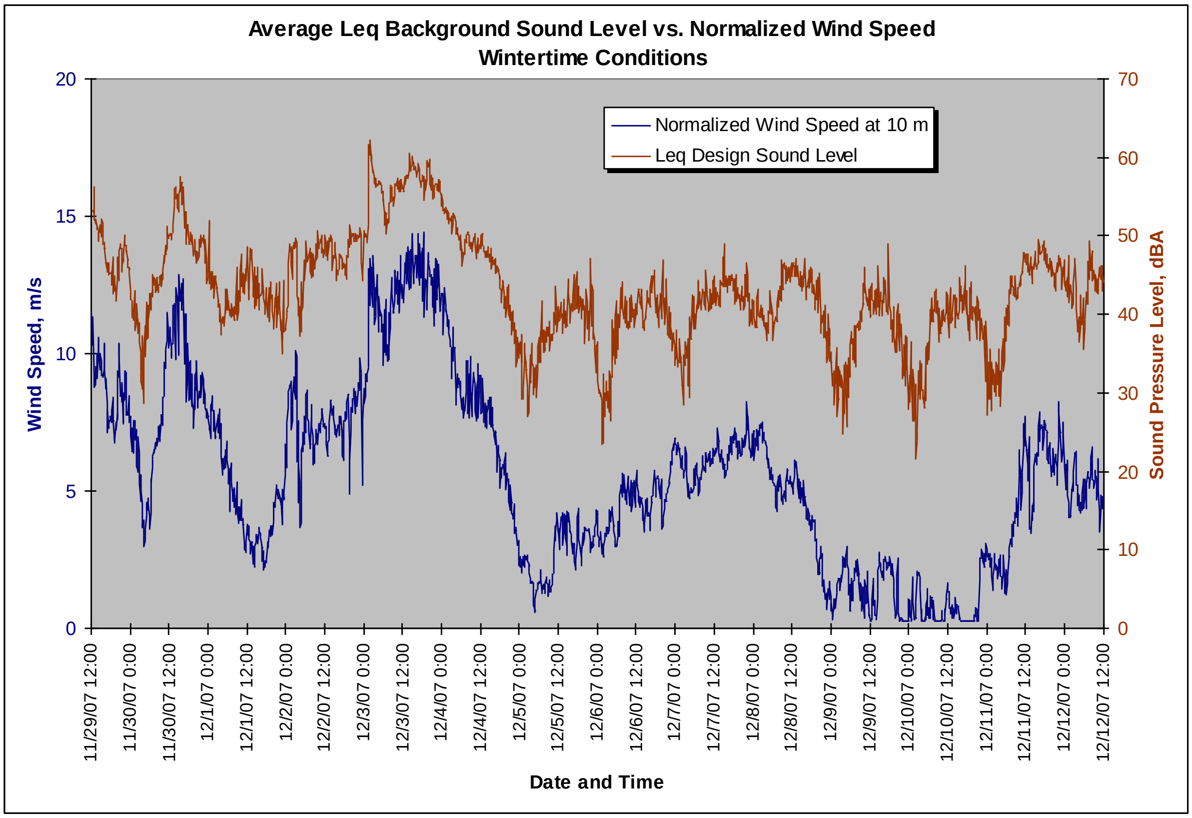


Figure 2.6.6 *Background Leq Sound Levels and Wind Speed*

The average site-wide L10 sound level vs. wind speed for wintertime conditions is shown below.

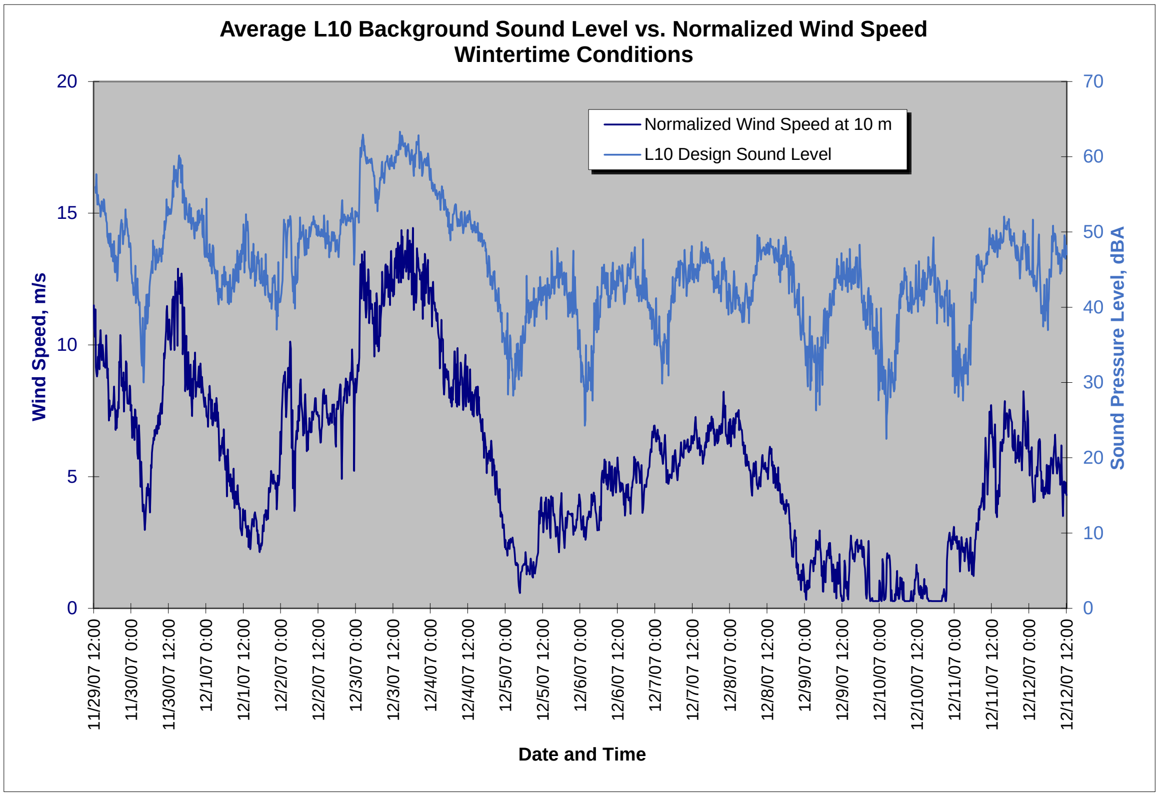


Figure 2.6.7 *Background L10 Sound Levels and Wind Speed*

In contrast to the summertime L10 results there is more of a correlation between the L10 sound level and wind speed in the winter when contamination from insects and tree rustle is diminished. The regression plot below shows that the background level is essentially always above 50 dBA when wind speed exceeds about 8 m/s (measured at a height of 10 m).

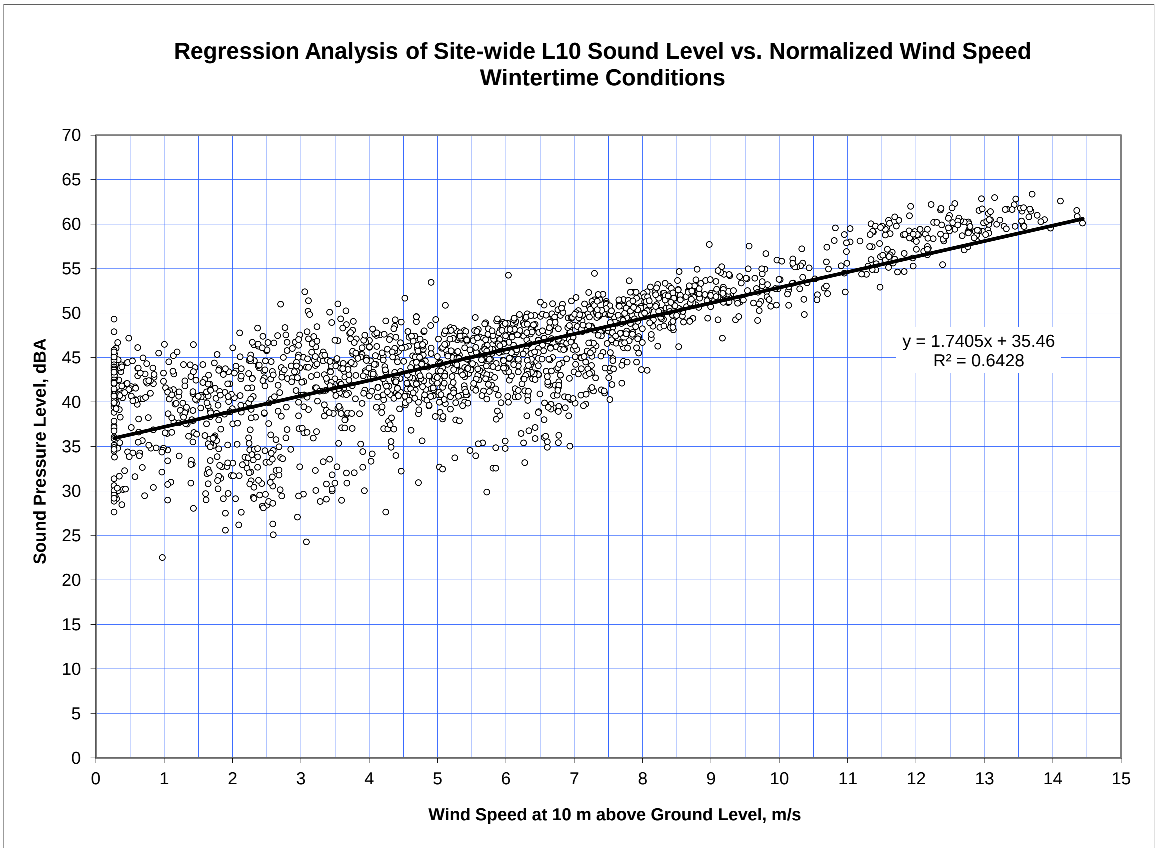


Figure 2.6.8 *Background L10 Sound Levels as a Function of Wind Speed*

2.7 WIND SPEED AS A FUNCTION OF ELEVATION

Below about 100 m, wind speed varies with elevation above the ground due to friction with the ground surface and obstacles, such as trees, structures and terrain. Because this surface roughness varies from place to place measurements of wind turbine sound power levels and concurrent wind speeds carried out in accordance with IEC Standard 61400-11[2] are normalized to and reported at a reference height of 10 m. This enables the nominal sound level of different makes and models of wind turbines to be compared on a more or less uniform basis.

The conversion from wind speed at one elevation to the related speed at another elevation is calculated from an empirically derived formula in the standard (Equation (7), Section 8), which describes a logarithmic profile. A generic example is shown below, in Figure 2.7.1, for a case where wind speed is normalized to 6 m/s at 10 m.

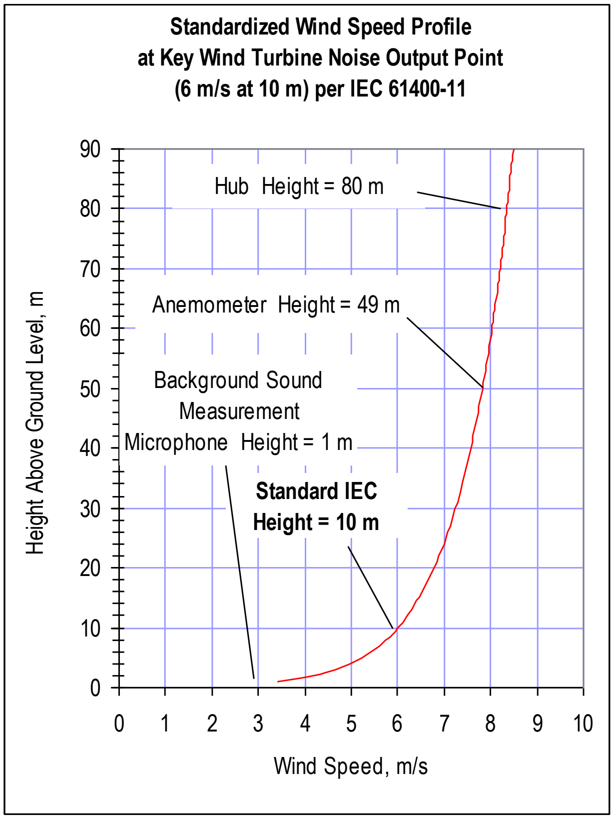


Figure 2.7.1

In this example, a standardized wind speed of 6 m/s at the reference height of 10 m would correspond to a wind speed of just under 8 m/s at a typical anemometer height of 49 m and a speed of about 8.3 m/s at a typical turbine hub height of 80 m - and about 8.5 m/s at the 95 m hub height that is relevant to this project.

This plot illustrates that near the surface the wind speed typically drops off rapidly - so measuring background levels with the microphones at a height of about 1 m exposes them to relatively low wind speeds and minimizes the probability of contamination from self-generated noise (wind blowing over the microphone).

2.8 SOUND LEVELS AS A FUNCTION OF WIND SPEED

From the data collected over the two surveys it is possible to determine the A-weighted sound levels that are likely to occur in each season over the wind speed range of interest – generally from 3 to 11 m/s (at 10 m). This range is important with respect to wind turbine sound emissions because turbine sound power levels are variable from cut in around 3 or 4 m/s, where they are minimal, up to about the 8 to 11 m/s range when the rotor first reaches maximum speed and where noise levels are generally maximum. Beyond this point wind turbine sound levels essentially remain constant and no longer increase with wind speed.

The first regression plot below, Figures 2.8.1, quantifies the relationship between wind speed and the L90, or “conservative” sound level during the leaf-off, cold weather conditions. The second plot, Figure 2.8.2, shows the correlation between the wintertime Leq, or “typical” sound level and wind speed.

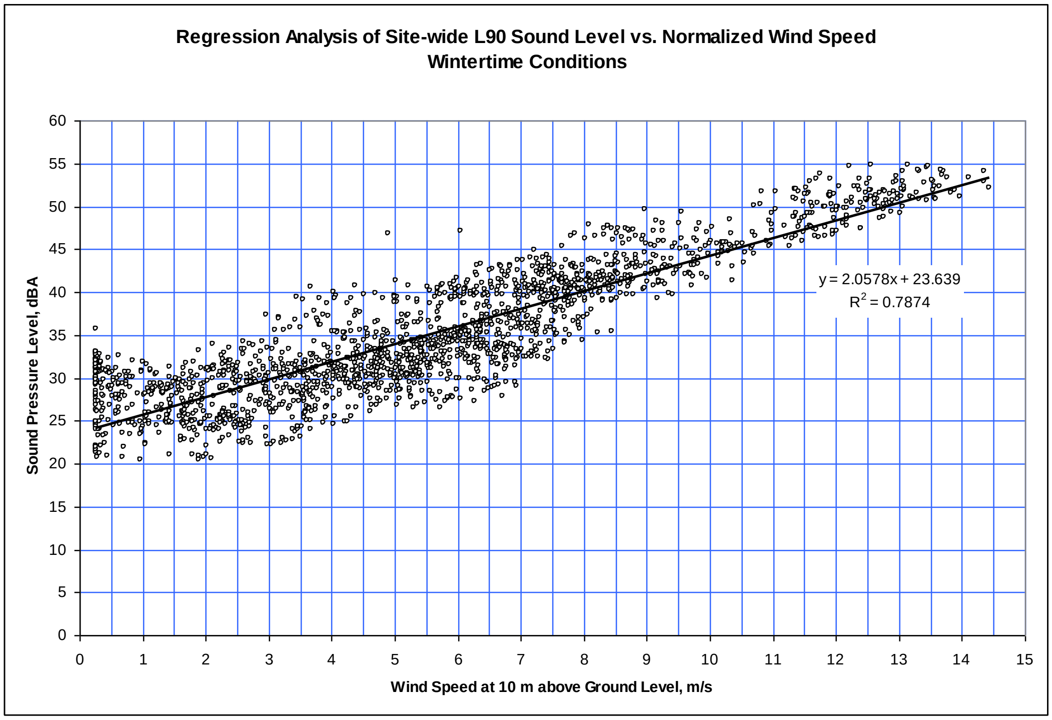


Figure 2.8.1

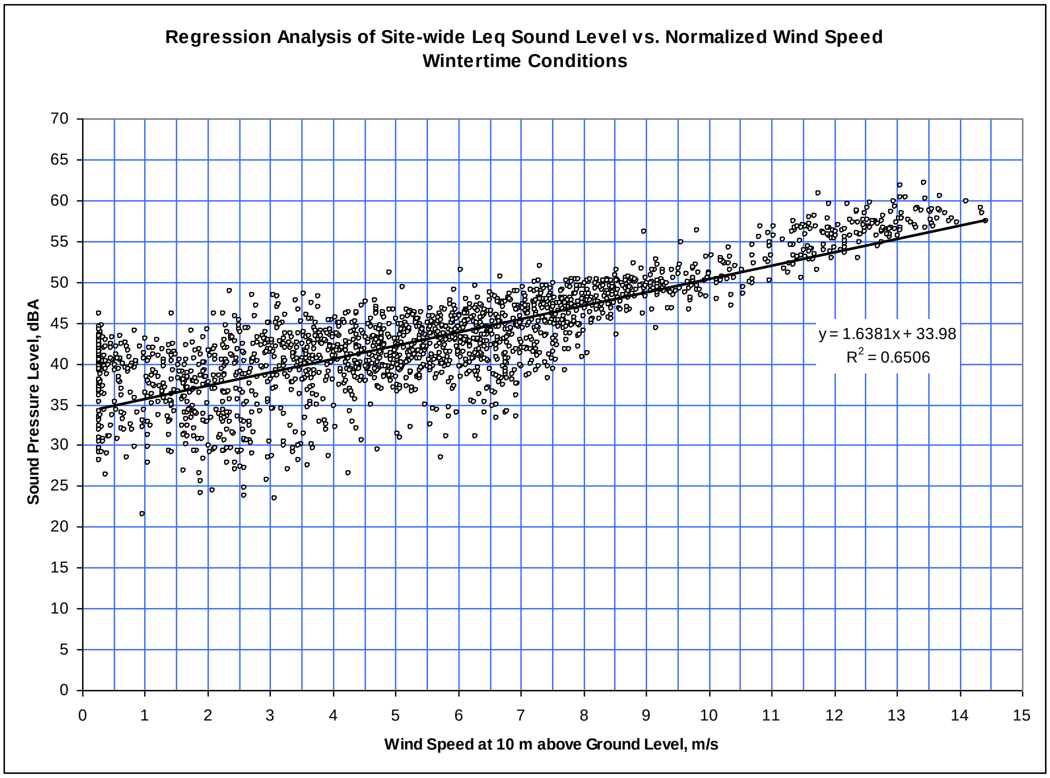


Figure 2.8.2

The regression charts for summertime L90 and Leq sound levels are shown below.

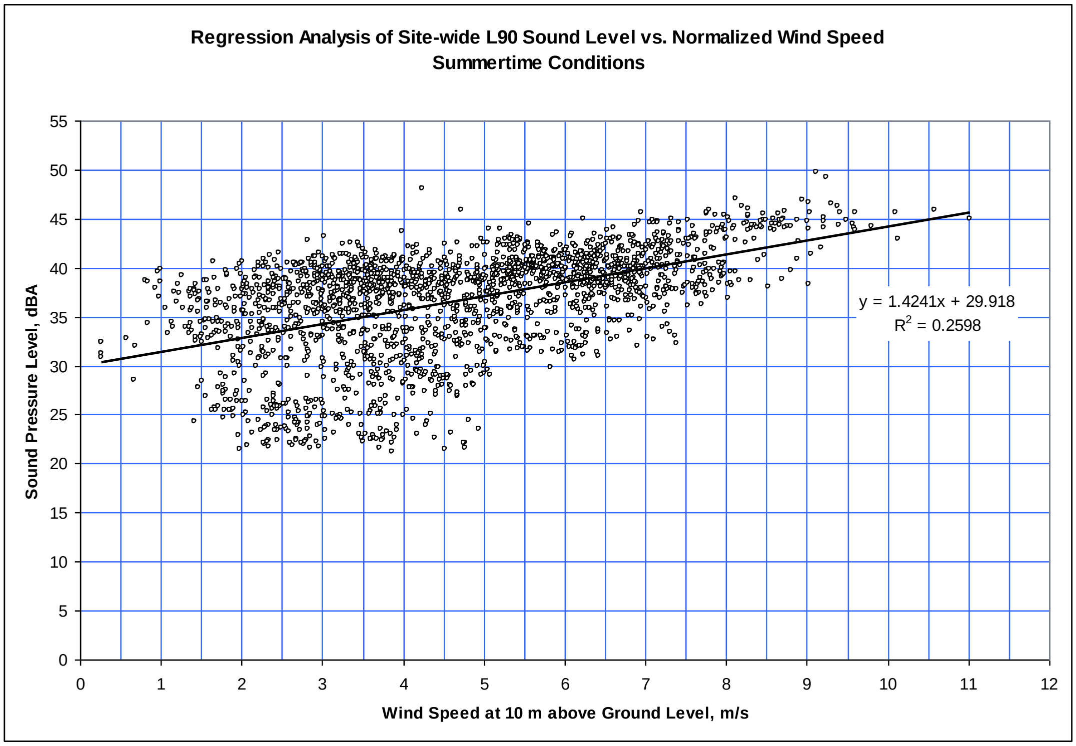


Figure 2.8.3

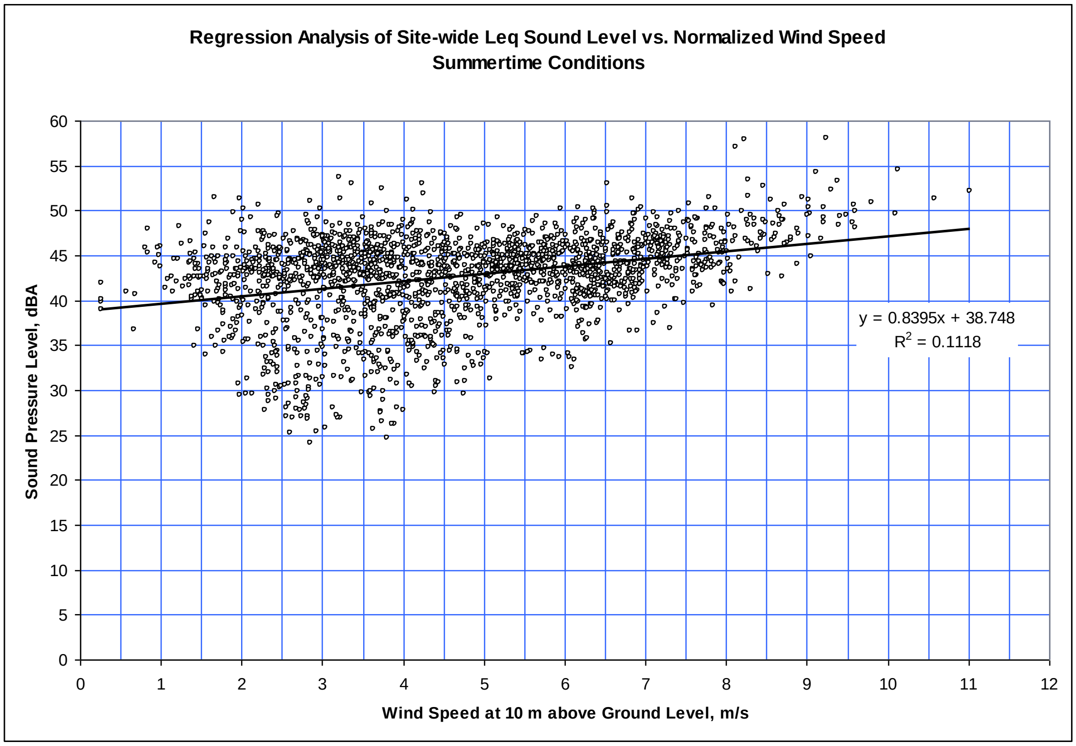


Figure 2.8.4

In general, there is a significantly tighter correlation between the winter sound levels and wind speed as opposed to the summer levels, as evidenced by the R^2 values of the trend lines, but in all cases it can be seen that environmental sound levels increase with wind speed. It would therefore be incorrect to associate a low background level, such as might occur on a calm night, with a project-on sound level that would only occur during moderately windy or very windy conditions. The maximum data scatter tends to occur at low wind speeds – below the turbine cut-in speed of about 3.5 m/s – essentially because sound levels are not driven by the wind during calm conditions. Higher correlation, i.e. R^2 values, would certainly occur if only the data above a minimum wind speed of 3.5 m/s were considered.

From the regression charts above the following typical and conservative mean background sound levels can be expected at integer wind speeds ranging from 4 to 11 m/s during cold and warm season conditions. The L10 levels, which are relevant to the Town noise regulations, are also summarized.

Table 2.8.1 *Mean Measured L90, Leq and L10 Background Sound Levels as a Function of Wind Speed during Winter and Summer Conditions*

Integer Wind Speed at Standardized Hgt. of 10 m, m/s	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Conservative L90 Sound Level **Winter**, dBA	32	34	37	38	40	42	44	47
Typical Leq Sound Level **Winter**, dBA	41	42	44	45	47	49	50	52
Average **L10** Sound Level **Winter**, dBA	43	44	47	48	49	51	53	52
Conservative L90 Sound Level **Summer**, dBA	36	37	39	40	41	43	44	46
Typical Leq Sound Level **Summer**, dBA	42	43	44	45	45	46	47	48
Average **L10** Sound Level **Summer**, dBA	43	43	45	45	46	47	48	49

At higher wind speeds the summer and winter levels aren't all that different with the warm weather levels being just slightly higher. At lower wind speeds there is a more pronounced difference in seasonal level but only in terms of the "conservative" L90 levels.

3.0 PROJECT NOISE MODELING AND IMPACT ASSESSMENT

3.1 ASSESSMENT CRITERIA

There are several metrics against which to compare the predicted noise from the project and thereby determine if any adverse environmental impacts might result from it. The first of these measures is a local regulatory noise limit; the second is a set of noise assessment guidelines published by the New York State Department of Environmental Conservation (NYSDEC); and a third approach (modified CNR) looks at the frequency content of both the masking and project sound levels to estimate community reaction.

3.1.1 REGULATORY NOISE LIMITS

The Town of Arkwright has established a local ordinance specifically relating to wind energy facilities (Local Law No. 2 of 2007) that limits noise from any wind energy conversion system (WECS) to **50 dBA** measured in terms of the L10 statistical level at "the nearest residence existing at the time of completing the SEQRA review of the application" (Section 662.A). In addition,

> If the ambient sound level exceeds 48 dBA, the standard shall be ambient dBA plus 5 dBA. Independent certification shall be provided before and after construction demonstrating compliance with this requirement.
>
> In the event audible noise due to WECS operation contains a steady pure tone, such as a whine, screech or hum, the standards for audible noise set forth in subparagraph 1) of this subsection shall be reduced by five (5) dBA. A pure tone is defined to exist if the one third (1/3) octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels of the two (2) contiguous bands by:
>
> 5 dB for center frequencies of 500 Hz or above
> 8 dB for center frequencies between 160 and 500 Hz
> 15 dB for center frequencies less than or equal to 125 Hz
>
> In the event the ambient noise level (exclusive of the development in question) exceeds the applicable standard given above, the applicable standard shall be adjusted so as to equal the ambient noise level.

It is important to note that the 50 dBA noise limit is expressed as the L10 statistical level. The L10 is the sound level during any given measurement interval that is exceeded only 10% of the time; i.e. 90% of the time the actual sound level is quieter than this value and 10% of the time it is louder. As such, the L10 captures the near-maximum level occurring during the measurement, which, from a practical standpoint, usually consists of contaminating events like cars passing by, wind gusts in trees or nearby farm equipment. In almost all cases an L10 level is, by definition, significantly higher than the average, or Leq, level and much higher than the L90, which captures the near minimum level during the measurement by largely excluding such contaminating events. The relevance of this is that any L10 measurements of actual turbine operation taken over any period longer than a few seconds are likely to be erroneously skewed to the high side by extraneous noise events that are unrelated to project operation. Because the L10 sound level will almost certainly be dominated by short-duration contaminating environmental noises rather than the largely steady underlying sound emissions associated with the project, the likely outcome of any compliance measurements will be that the L10 sound level is essentially the same whether the project is operating or not, ostensibly indicating that the project has no appreciable effect on the environment.

The L10 background levels reported for summertime and wintertime conditions in Sections 2.5 and 2.6 above suggest that the pre-existing L10 sound level already randomly exceeds the 50 dBA limit roughly about 10% of the time during the summer irrespective of the wind conditions and, in the winter, is over 50 dBA whenever the wind speed exceeds about 8 m/s (at 10 m). These results suggest that the permissible project sound level will be higher than 50 dBA at times because of the clause, quoted above, allowing the project sound level to exceed the background by 5 dBA if the background is higher than 48 dBA.

A minimum setback of 1200 ft. from all residences is also required in the law.

There are no other overarching state or federal noise regulations that are known to apply to the project.

3.1.2 NYSDEC GUIDELINES

In the Program Policy *Assessing and Mitigating Noise Impacts* published by the New York State Department of Environmental Conservation (2001) a methodology is described for evaluating potential community impacts from any new noise source. The method is fundamentally based on the perceptibility of the new source above the existing background sound level.

It is a well-established fact - for a new broadband, atonal noise source with a frequency spectrum similar to that of the background - that a cumulative increase in the total sound level of about 5 or 6 dBA at a given point of interest is required before the new sound begins to be clearly perceptible or noticeable to most people. Cumulative increases of between 3 and 5 dBA for a source of this kind are generally regarded as negligible or hardly audible. Lower sound levels from the new source are "buried" in the existing background sound level and become progressively less perceptible. The specific language relating to these perceptibility thresholds in the NYSDEC program policy (Section V B(7)c) is a follows:

> Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive receptors are present. Sound pressure increases of more than 6 dB may require closer analysis of impact potential depending on existing SPL's [sound pressure levels] and the character of surrounding land use and receptors.

What this essentially says is that cumulative increases in the total ambient sound level of 6 dBA or less are unlikely to constitute an adverse community impact. From a practical standpoint, because decibels add logarithmically, this threshold means that noise from the project could exceed the existing background level by up to 5 dBA. For example, a background level of 40 dBA plus a project-only sound level of 45 dBA would equal a total cumulative level of 46 dBA – or 6 dBA above the original level.

3.1.3 COMPOSITE NOISE RATING METHOD

An additional approach towards evaluating potential community noise impacts that also considers the frequency content of both the background and the project sound levels is the modified Composite Noise Rating (CNR) method. This method, which is based on case histories of reaction to new noise sources (though not specifically wind turbines), dates back to 1955 and with minor modifications has been used by a number of federal agencies including the EPA[3].

The procedure involves the following steps:

1. Obtain a baseline rating classification, lower-case letter grade, from the predicted sound pressure level spectrum of the new noise source at the point of reception
2. Determine a background (masking noise) correction based on the average measured background sound level spectrum under comparable conditions
3. Apply a number of correction factors related to when the source is in operation, the character of the noise and the general attitude of the receiver
4. Determine a final upper-case rating classification after application of all corrections and adjustments. The final classification letter defines the expected reaction to the new source.

3.2 TURBINE SOUND LEVEL

The turbine model currently being considered for this project is the Vestas V110-2.2 MW[2].

The expected sound power level of this new model as a function of wind speed has been obtained from the manufacturer in a document entitled *Performance Specification V110-2.2 MW 60 Hz,* dated April 13, 2015[4].

For a 95 m hub height, the following overall sound power levels, tested in accordance with IEC 61400-11, are published for this model as a function of wind speed at the standardized measurement height of 10 m.

Table 3.2.1 *Sound Power Levels vs. Wind Speed for Vestas V110-2.2 MW*

Approx. Wind Speed at 10 m Height, m/s	Vestas V110-2.2 MW Mode 0 Sound Power Level, dBA re 1 pW
3	95.9
4	96.9
5	97.9
6	101.9
7	102.7
8	103.9
9	106.4
10	107.2
11	107.7
>11	107.7

It is important to note in this context that a sound *power* level is not the same thing as a sound *pressure* level, which is the familiar quantity measured by instruments and perceived by the ear. A power level is a specialized, derived value, expressed in terms of Watts, that is primarily used for acoustical modeling and in design analyses. It is a function of both the sound pressure level produced by a source at a particular distance and the effective radiating area or physical size of the source. The basic mathematical relationship between power and pressure is as follows:

$$Lw = Lp + 10 \log (A)$$

Where,

Lw = Sound Power Level, dB re 1 pW
Lp = Sound Pressure Level, dB re 20 μPa
A = The effective radiating surface area at the point of the pressure level measurement, m^2

In general, the ostensible magnitude of a sound power level is always considerably higher than the sound pressure level near a source because of the (normally large) area term. For example, the sound pressure level at 100 m from a wind turbine might be about 53 dBA and the area term for that distance would be 51 dBA with a resulting total power level of 104 dBA re 1 pW (the units of power levels are always denoted as decibels with reference to 1 picoWatt, or 10^{-12} W).

[2] One or two units may be a slightly down-rated version, the V110-2.0 MW, with similar or lower sound emissions.

The fundamental advantage of a power level is that the sound pressure level of the source can be calculated at any distance; hence its importance to noise modeling.

3.3 CRITICAL DESIGN LEVELS

From the field survey it was determined that the background sound level varies with wind speed. From Table 3.2.1 above it can be seen that the turbine sound level also varies with wind speed. In order to carry out the ambient-based NYSDEC assessment procedure some specific background level must be established against which to compare project noise on an apples-to-apples basis and calculate cumulative increases.

In terms of potential noise impacts the worst-case combination of background and turbine sound levels would occur at the wind speed where the background level is lowest relative to the turbine sound level – or, in other words, where the differential between the background level and turbine sound power level is greatest.

The following chart, Table 3.3.1, shows that this worst-case situation does not necessarily occur at the highest wind speeds when the turbines produce the most noise, as might be intuitively expected, but rather at intermediate wind speeds where the differentials between the seasonal background levels and the turbine sound power level are greatest. Even though the turbine sound level is lower than its maximum value in these cases the potential impact is higher because there is less background sound available to mask the sound emissions from the project.

Table 3.3.1 *Comparison of Background and Vestas V110-2.2 MW Turbine Sound Levels to Determine Critical Design Levels (at Maximum Differential)*

Integer Wind Speed at Standardized Hgt. of 10 m, m/s	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
V110-2.2 MW Sound Power Level, dBA re 1 pW	**96.9**	**97.9**	**101.9**	**102.7**	**103.9**	**106.4**	**107.2**	**107.7**
Typical Leq Sound Level **Wintertime**, dBA	40.9	42.0	**44.3**	45.5	46.6	48.9	50.1	52.4
Turbine Power Level – Background Sound Level Differential	56.0	55.9	**57.6** Max	57.2	57.3	57.5	57.1	55.3
Conservative L90 Sound Level **Wintertime**, dBA	32.3	33.7	**36.6**	38.1	39.5	42.4	43.9	46.7
Turbine Power Level – Background Sound Level Differential	64.6	64.2	**65.3** Max	64.6	64.4	64.0	63.3	61.0
Typical Leq Sound Level **Summertime**, dBA	42.3	42.9	44.1	44.6	45.2	46.4	**47.0**	48.2
Turbine Power Level – Background Sound Level Differential	54.6	55.0	57.8	58.1	58.7	60.0	**60.2 Max**	59.5
Conservative L90 Sound Level **Summertime**, dBA	35.9	36.9	38.9	39.9	40.9	**42.9**	43.9	45.9
Turbine Power Level – Background Sound Level Differential	61.0	61.0	63.0	62.8	63.0	**63.5 Max**	63.3	61.8

In general, the point of maximum sound exposure during the winter is at a moderate wind speed of 6 m/s while the critical design levels for summer are at substantially higher wind speeds of 9 and 10 m/s. This is because the quieter ambient conditions during the winter allow the project to be more readily audible during lighter winds. In the summertime the background sound level is considerably higher so the turbines need to be near the top of their sound output to be prominent relative to the environmental sound level.

Consequently, for design purposes, the background levels measured during a **6 m/s** wind will be used as a basis to calculate the NYSDEC cumulative increase thresholds for modeling and impact assessment purposes under wintertime conditions. The turbine sound power level is **101.9 dBA re 1 pW** during these conditions.

In the summer the critical wind speeds are at 9 and 10 m/s for conservative and typical conditions, respectively. The turbine sound power levels for these cases are considerably higher at **106.4 and 107.2 dBA re 1 pW**.

The following table summarizes the NYSDEC impact thresholds for each season based on a 6 dBA cumulative increase in the overall sound level. Because of logarithmic addition a differential of 5 dBA between the baseline background and project-only sound level leads to a total increase of 6 dBA.

Table 3.3.2 *Critical Design Levels and NYSDEC Impact Thresholds*

Season and Type of Impact	**Measured Critical Background Level and Wind Speed**	**Impact Threshold - Project-only Sound Level, dBA** (5 dBA above Background Level)	**Cumulative Sound Level with Project Operating, dBA** (6 dBA above Background Level)
Typical Impact Based on Leq Wintertime	44 dBA, 6 m/s	**49**	50
Conservative Impact Based on L90 Wintertime	37 dBA, 6 m/s	**42**	43
Typical Impact Based on Leq Summertime	47 dBA, 10 m/s	**52**	53
Conservative Impact Based on L90 Summertime	43 dBA, 9 m/s	**48**	49

Because the frequency content of the turbine sound power levels at various wind speeds are not given in the Vestas V110-2.2 MW information, the octave band levels have been estimated for design purposes by making adjustments to the known frequency spectrum of the similar Vestas V112-3.0 MW turbine. The resulting spectra tabulated below will be used in the modeling study for each design case.

Table 3.3.3 *Vestas V110-2.2 MW Octave Band Sound Power Level Spectrum at* **6 m/s** *Derived from Measured V112-3.0 MW Spectrum at 6 m/s*

Octave Band Center Frequency, Hz	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Lw V112-3.0 MW at 6 m/s, dB re 1 pW	117.2	113.6	111.6	106.0	103.8	100.9	98.3	92.9	81.5	**106.5**
Adjustment Factor, dB	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	
Est. Lw V110-2.2 MW at 6 m/s, dB re 1 pW **Design Level**	**112.6**	**109.0**	**107.0**	**101.4**	**99.2**	**96.3**	**93.7**	**88.3**	**76.8**	**101.9**

Table 3.3.4 *Vestas V110-2.2 MW Octave Band Sound Power Level Spectrum at* **9 m/s** *Derived from Measured V112-3.0 MW Spectrum at 7 m/s*

Octave Band Center Frequency, Hz	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Lw V112-3.0 MW at 7 m/s, dB re 1 pW	117.9	114.2	111.6	106.4	104.0	100.7	98.1	92.6	81.3	**106.5**
Adjustment Factor, dB	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	
Est. Lw V110-2.2 MW at 9 m/s, dB re 1 pW **Design Level**	**117.8**	**114.1**	**111.5**	**106.3**	**103.9**	**100.6**	**98.0**	**92.5**	**81.2**	**106.4**

Table 3.3.5 *Vestas V110-2.2 MW Octave Band Sound Power Level Spectrum at* **10 m/s** *Derived from Measured V112-3.0 MW Spectrum at 7 m/s*

Octave Band Center Frequency, Hz	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dBA**
Lw V112-3.0 MW at 7 m/s, dB re 1 pW	117.9	114.2	111.6	106.4	104.0	100.7	98.1	92.6	81.3	**106.5**
Adjustment Factor, dB	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7	
Est. Lw V110-2.2 MW at 10 m/s, dB re 1 pW **Design Level**	**118.6**	**114.9**	**112.3**	**107.1**	**104.7**	**101.4**	**98.8**	**93.3**	**82.0**	**107.2**

3.4 NOISE MODELING METHODOLOGY

Using the design sound power level spectra tabulated above, sound level contour plots for the site were calculated using the Cadna/A®, ver. 4.4.145 noise modeling program developed by DataKustik, GmbH (Munich). This software enables the project and its surroundings, including terrain features, to be realistically modeled in three-dimensions. In this case, the topography has been incorporated into the model because it is fairly significant. Each turbine is represented as a point noise source at a height of 95 m above the local ground surface (design hub height). The receptor height is set at a standard elevation of 1.5 m above local grade; this keeps the predicted levels on an equal footing with the background measurements, which were measured at a similar elevation.

The site plan used in the analysis is the latest known layout as of May 2015 and includes the full complement of 38 turbines despite the fact that only 36 turbines will actually be installed.

Apart from the turbines, the only other potential source of noise associated with the project is the step up transformer in the electrical substation where output from the project is connected to an existing transmission line. This substation is located outside of the project area some distance to the west in an area that is fairly remote from any homes. The nearest residence is about 540 ft. away from the transformer. The substation has not been included in the model partly because it is remote from the principal project area but, more importantly, because its A-weighted sound level, the quantity calculated by the program and depicted in the plots, does not characterize its potential noise impact in any meaningful way. Transformer noise is essentially tonal in character, a buzzing sound at harmonics of 120 Hz, and the octave band sound spectrum that might be used as a model input is too broad to convey any tonal content. In any event, any tones from the relatively small transformer associated with the project are not expected to be significant at the nearest houses simply because of the intervening distance, although it could conceivably be faintly audible during calm and quiet periods.

A somewhat conservative ground absorption coefficient of 0.5 has been assumed in the model since all of the intervening ground between the turbines and potentially sensitive receptors essentially consists of acoustically absorptive wooded areas or open farm fields. The ISO ground absorption coefficient ranges from 0 for water or hard concrete surfaces to 1 for absorptive surfaces, such as farm fields, wooded areas or sand. Consequently, a higher coefficient on the order of 0.8 or 0.9 could be justified here; however, for conservatism a value of 0.5 has been used.

Foliage in thickly wooded areas normally provides some additional sound attenuation (a separate phenomenon from ground absorption). Even though this site is mostly wooded, this potentially significant loss has been neglected in all calculations.

To be conservative the sound emissions from each turbine is assumed to be the downwind sound level in *all directions simultaneously*. In other words, although physically impossible, an omni-directional wind is assumed. This approach yields a contour plot that essentially shows the maximum possible sound level at any given point and sometimes also shows levels that cannot possibly occur – such as between two or more adjacent turbines, since the wind would have to be blowing in two opposing directions at the same time. In a more realistic scenario with, for example, a wind out of the west the contour lines might occur slightly closer to the turbines on the west side and would remain largely as shown on the east.

At the risk of overestimating potential project sound levels, the various conservative assumptions in the modeling analysis have been applied to ensure that project noise does not exceed predicted levels under most normal conditions and also to allow some design margin for times when atmospheric conditions may occasionally favor noise propagation relative to average conditions, such as during temperature inversions. The model represents a situation at any given receptor point that would require a convergence of the following conditions:

- **Wind Direction** – from all the turbines towards the receptor point
- **Wind Speed** - only the critical wind speed produces the plotted contours; under all other wind conditions the impact threshold contour lines would contract closer to the turbines
- **Low Ground Porosity** – normally woods and farm fields are more absorptive than assumed in the model
- **Observer Outside** – the plotted sound levels occur outside; sound levels inside of any dwelling will be 10 to 20 dBA lower

3.5 MODEL RESULTS AND IMPACT ASSESSMENT – NYSDEC CRITERION

Preliminary noise modeling indicated that the potential for community noise impacts exists with this project. This early modeling work essentially performed the function of the First Level Noise Impact Assessment in the NYSDEC assessment procedure and indicated that a Second Level assessment was necessary. A Second Level noise model considers the actual circumstances of the site including any attenuation that might be afforded by such factors as terrain, vegetation or man-made barriers.

The overall results of the Second Level model are shown in Plots 1 through 4, summarized below, where the outermost sound level contour is associated with a specific impact threshold based on the assumed background level and season.

Plot 1 – Typical Impact – Wintertime Conditions
Plot 2 – Conservative Impact – Wintertime Conditions
Plot 3 – Typical Impact – Summertime Conditions
Plot 4 – Conservative Impact – Summertime Conditions

These plots illustrate the project-only sound levels that might occur under the conservative assumptions described above in Section 3.4.

Plot 1 shows the Project sound levels out to a level of 49 dBA, which represents the 6 dBA cumulative increase threshold recommended by the NYSDEC based on the measured average, or Leq, sound level (44 dBA) during a 6 m/s wind in the wintertime. The region inside the threshold line represents the area where turbine noise might result in an adverse impact relative to the "typical" background level. In this instance, all homes are clearly well outside the 49 dBA threshold line, which occurs fairly close to each turbine and well short of the minimum 1200 ft. (365 m) setback. This plot indicates that no significant adverse impact is expected under "typical" wintertime conditions.

In **Plot 2** the sound emissions of the project are shown out to 42 dBA, which is the NYSDEC 6 dBA increase threshold if the background sound level during cold weather conditions is taken to be the near-minimum L90 level of 37 dBA. This is the background sound level that occurs for only a small percentage of the time during lulls in the wind and when all sources of man-made noise are at a temporary minimum. This plot is different from Plot 1 in that several homes are on or just inside of the nominal impact threshold line. Under these specific circumstances – wintertime, 6 m/s wind, background level at a minimum – project noise may be clearly perceptible by some of the nearest residents and some degree of adverse reaction is theoretically possible. It is important to note, however, that this increase in sound level occurs outside – rather than inside homes where most people are in the winter. Of the four residences that are on or inside the threshold two are project participants. The specific status, address and mean sound level at each of these residences are tabulated below.

Table 3.5.1 *Residences within Potential Noise Impact Threshold*

Map Ref. Nbr.	Street Address	City	Participation	Expected Average Project Sound Level, dBA
231	3082 Cable Rd	Arkwright	Non - Participant	42
232	3085 Cable Rd	Arkwright	Non - Participant	43
233	Meadows Rd	Arkwright	Participant	43
387	9566 Center Rd	Arkwright	Participant	43

In **Plot 3** the "typical" impact threshold of 52 dBA for warm weather conditions is illustrated. All homes are also well outside this theoretical impact threshold indicating that little or no adverse effect is likely.

Finally, the "conservative" impact during the summer is illustrated in **Plot 4**, based on the L90 background level of 43 dBA measured during the leaf-on, summertime survey. Although the hypothetical impact region is somewhat similar to the conservative wintertime case, there are no homes actually on or inside the 48 dBA threshold.

This series of plots essentially demonstrates that the project is not expected to generate sound levels above the NYSDEC 6 dBA cumulative impact threshold at residences in the project area during most conditions. It is only during the "conservative" winter scenario when the background sound level is assumed to be at a near-minimum that the State guideline might be temporarily exceeded by 1 or 2 dB at a handful of residences. However, during the winter the sound emissions from the project are less likely to be noticeable, since people are inside most of the time.

As a general additional comment, it should be noted that in the particular case of wind turbines a cumulative 6 dBA increase in sound level does not represent the point of inaudibility. Operational sound emissions from wind turbines are often unsteady and variable with time largely because the wind does not always blow in a completely smooth and ideal manner. When unsettled air or gusty winds interact with the rotor, or the airflow is not perfectly perpendicular to the rotor plane, a temporary increase in turbulence and noise results. On top of this, turbines often (although not always) produce a periodic swishing sound. These temporal characteristics make operational noise more perceptible than it would be if it were always bland and continuous in nature. Consequently, wind turbines can commonly be discerned at significant distances even though the actual sound level may be quite low and/or comparable to the magnitude of the background level. Therefore the audibility of the project at residences beyond the thresholds shown in the plots certainly cannot be ruled out.

There may also be times, due to wind and atmospheric conditions, when project sound levels temporarily increase to levels that are higher than the predicted mean levels. During these - usually brief - periods of elevated noise the potential for complaints would also increase.

3.6 MODEL RESULTS AND IMPACT ASSESSMENT – CNR METHOD

As discussed in Section 3.1.3 above, the modified Composite Noise Rating (CNR) method for evaluating potential noise impacts compares the background level to the predicted level of intrusive noise in terms of frequency content (as opposed to the overall A-weighted sound level alone) and other factors in order to predict community reaction. The derivation of these ratings is outlined below for the four design scenarios:

Typical Impact – Wintertime Conditions
Conservative Impact – Wintertime Conditions
Typical Impact – Summertime Conditions
Conservative Impact – Summertime Conditions

3.6.1 CNR Assessment – Wintertime Conditions

The first step in the evaluation process is to plot the octave band frequency spectrum of the predicted project-only sound level at a point of interest against a set of curves that generally map the perceptibility of the noise as a function of frequency. In Figure 3.6.1.1 below the predicted project sound level spectra under wintertime design conditions (6 m/s wind) ranging from 35 to 50 dBA in 5 dB increments are shown against the baseline CNR rating curves. This range covers all potential project sound levels at residences in the immediate site area. A lower-case classification letter, applicable to the regions between each curve, is assigned according to the highest region that the spectrum touches.

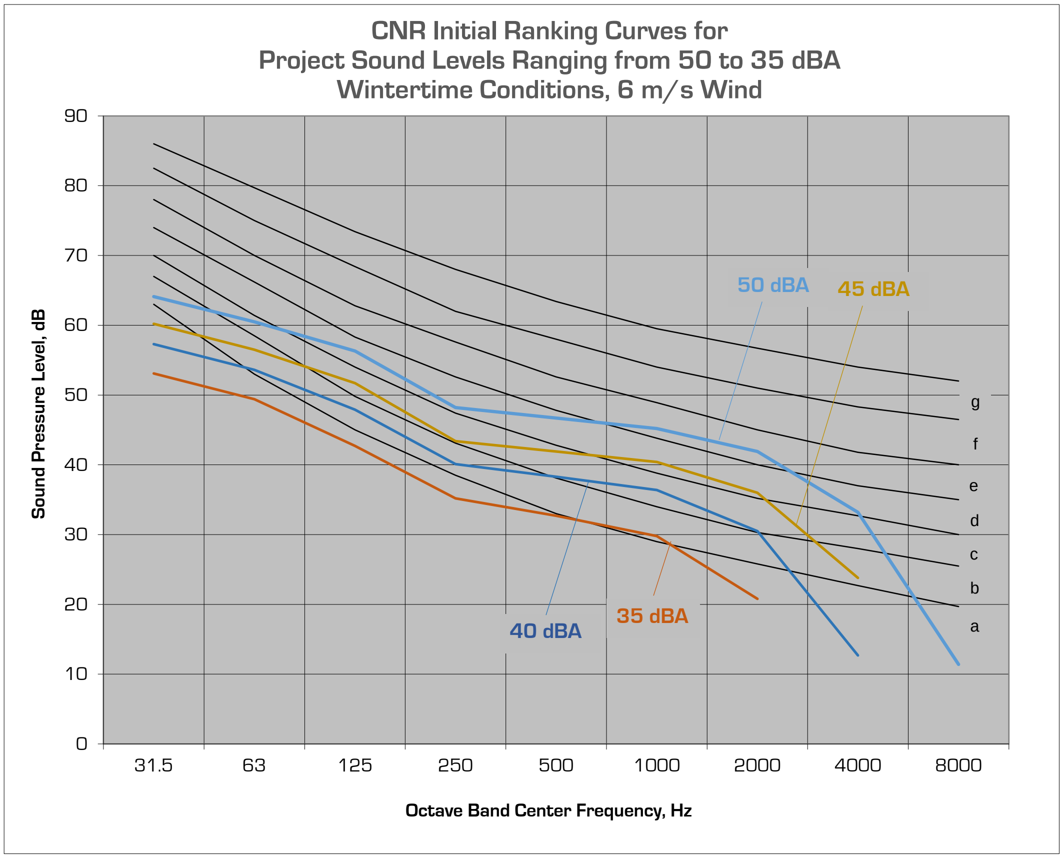


Figure 3.6.1.1

The baseline CNR classifications for wintertime conditions are listed in Table 3.6.1.1 beginning at 43 dBA, which is the maximum project sound level predicted at any residence.

Table 3.6.1.1 *Baseline CNR Classifications*
Wintertime Conditions

Project-only Sound Level, dBA	Baseline CNR Classification
43	c
42	c
41	c
40	c
39	c
38	c
37	b
36	b
35	b

Starting from this baseline rating classification a series of corrections or adjustments are made to estimate the final classification, which, in turn, gives an indication of the potential community reaction.

The first principal correction is for background masking noise. A second chart of curves is used to determine how well or poorly the background sound level frequency spectrum would act to mask the project sound level. The highest region intercepted determines the correction factor. Figure 3.6.1.2 shows the background corrections of **-2** and **+1** for “typical” and “conservative” conditions, respectively, based on the measured Leq and L90 levels at the critical wind speed of 6 m/s.

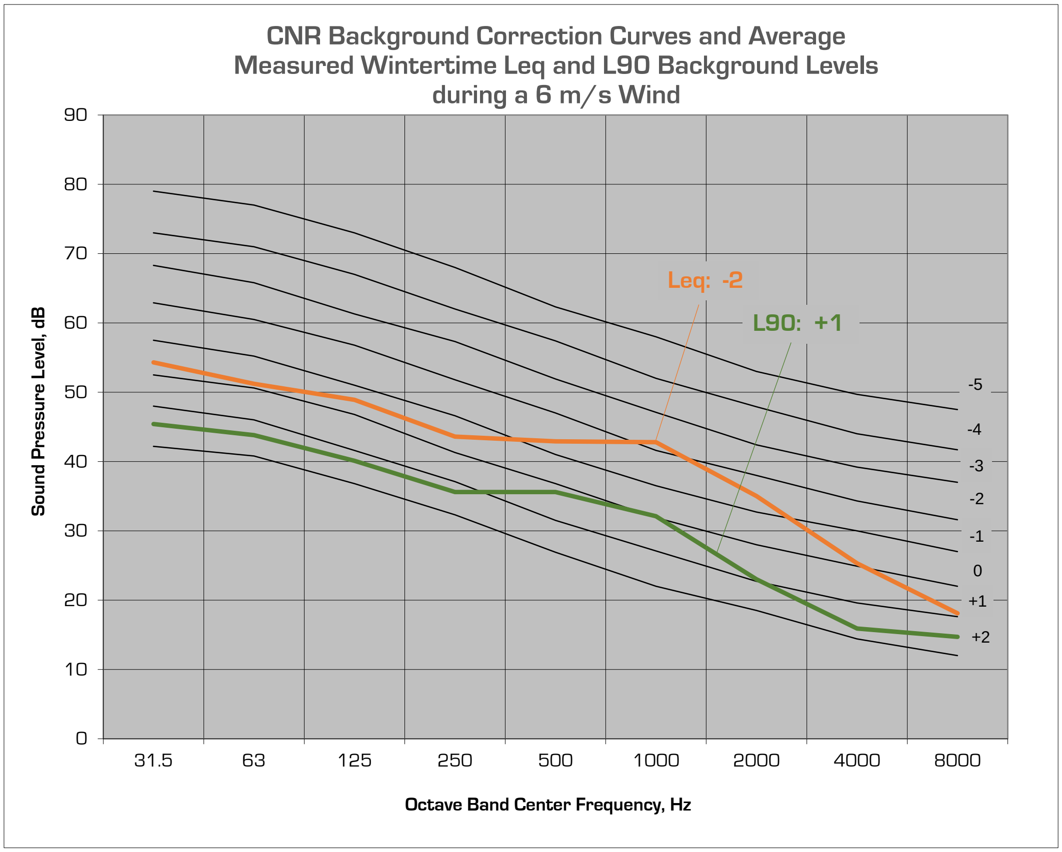


Figure 3.6.1.2

The remaining corrections to the baseline CNR rating relate to the temporal nature of the new noise source, its character and the general attitude of the observer.

The temporal correction accounts for the duration of the ostensibly intruding noise and when it occurs during the day or night and whether it changes with the seasons. Wind turbines do not operate on a continuous basis and much of the time when they are running winds are light and no significant noise is generated; consequently, a correction factor of **-1** for partial operation has been assumed.

The character correction takes into consideration the fact that noises that contain any kind of tone, impulse or excessive low frequency content are more apt to be considered objectionable than a broadband noise of the same magnitude. In the case of wind turbines, observed from a distance of at least 1200 feet, none of these particular character features will actually be present in the sound; however, wind turbines of this type can produce a certain amplitude modulation, or intermittent whooshing sound associated with the rotor that increases the perceptibility of the sound. Consequently, a negative adjustment factor of **+1** for adverse character has been used.

The final correction factor, ranging from -1 to +1, is associated with previous exposure and attitude. As it relates to the specific situation of a new wind energy project, the best interpretation of this correction is thought to be as follows:

Table 3.6.1.3 *CNR Correction Factors Related to Receptor Attitude*

CNR Correction Factor	Interpreted Significance
-1	Known to be favorable towards the project or project participant
0	Neutral or attitude unknown
+1	Known to be opposed to the project

While the specific attitude of each resident towards the project is not known, it is our understanding from the developer that the community attitude is generally favorable. Consequently, while a correction factor of -1 appears to apply to most of the community **0**, or neutral, has been assumed for conservatism. The wintertime adjustments are summarized below.

Table 3.6.1.4 *Summary of Correction Factors*
Wintertime Conditions

Correction	Correction Factors	
	Typical Conditions	Conservative Conditions
Background Correction	-2	+1
Temporal/Seasonal Correction	-1	-1
Character Correction	+1	+1
Exposure and Attitude	0	0
Net Correction	**-2**	**+1**

The final CNR classification for a specific receptor location is determined by applying the net correction to the baseline letter grade. For example, a baseline rating of "c" with a net correction of -1 would result in a final rating of "B", or one letter below the starting value. The nominal meaning of this final rating is given in the chart below.

Table 3.6.1.5 *Final CNR Ratings and Predicted Reactions*

Final CNR Rating	Mean Significance
A	No Reaction
B	No Reaction
C	No Reaction to Sporadic Complaints
D	Sporadic Complaints
E	Widespread Complaints or Single Threat of Legal Action
F	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
G	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
H	Several Threats of Legal Action or Strong Appeals to Local Officials to Stop the Noise
I	Vigorous Action

The following table relates predicted project-only sound levels, best illustrated in Plot 2, with the final CNR ratings for cold weather conditions.

Table 3.6.1.6 *CNR Ratings Associated with Predicted Project Sound Levels Wintertime Conditions*

Predicted Project-only Sound Level, dBA	Final CNR Rating – Typical	Final CNR Rating – Conservative
43	A	D
42	A	D
41	A	D
40	A	D
39	A	D
38	A	D
37	<A	C
36	<A	C
35	<A	C

The chart begins with 43 dBA because that is the maximum project sound level predicted at any residence within the site area. The chart ends at 35 dBA because such a level is so quiet and comparable to the natural background level that complaints are extremely rare and unlikely below that point.

What this listing shows is that "no reaction" is expected under typical wintertime conditions. This conclusion agrees with the NYSDEC relative increase assessment discussed in the previous section for this scenario (Plot 1).

If the conservative, near-minimum L90 background sound level is assumed then little or no reaction is anticipated at all locations where the project sound level is 37 dBA or less (C rating) but "sporadic complaints" (D rating) are possible at residences where the project sound level is in the 38 to 43 dBA range. This region would extend 4 dB beyond the nominal impact threshold illustrated in Plot 2 and would encompass a number of homes. The conclusion that there could be sporadic complaints essentially agrees with the winter conservative case discussed with regard to Plot 2 in the previous section.

While these two independent assessment methodologies point to the possibility of sporadic complaints under certain conditions in the wintertime, it should be noted once again that the modeling is conservative in the following ways:

- Minimal background masking noise, which occurs infrequently, is assumed
- A critical wind speed of 6 m/s is assumed to be blowing. At all other wind speeds the potential intrusiveness of project noise would be less. Based on the met tower data a wind speed in the 5.5 to 6.5 m/s range occurs only about 13% of the time
- Any given point is assumed to be simultaneously downwind of every turbine in the project and therefore experiencing a theoretical maximum project noise level
- The predicted sound levels occur outside; interior sound levels would be substantially lower and most people are inside most of the time in the winter
- Despite the appearance that most of the community has a favorable attitude towards the project a neutral attitude is conservatively assumed in the CNR calculation, in effect increasing the final letter grade by one.

3.6.2 CNR Assessment – Summertime Typical Conditions

The initial project ranking is slightly different for typical summertime conditions because the critical design case is based on a higher turbine sound power level associated with 10 m/s wind conditions. The predicted spectra over the range from 50 to 35 dBA are plotted against the ranking curves below.

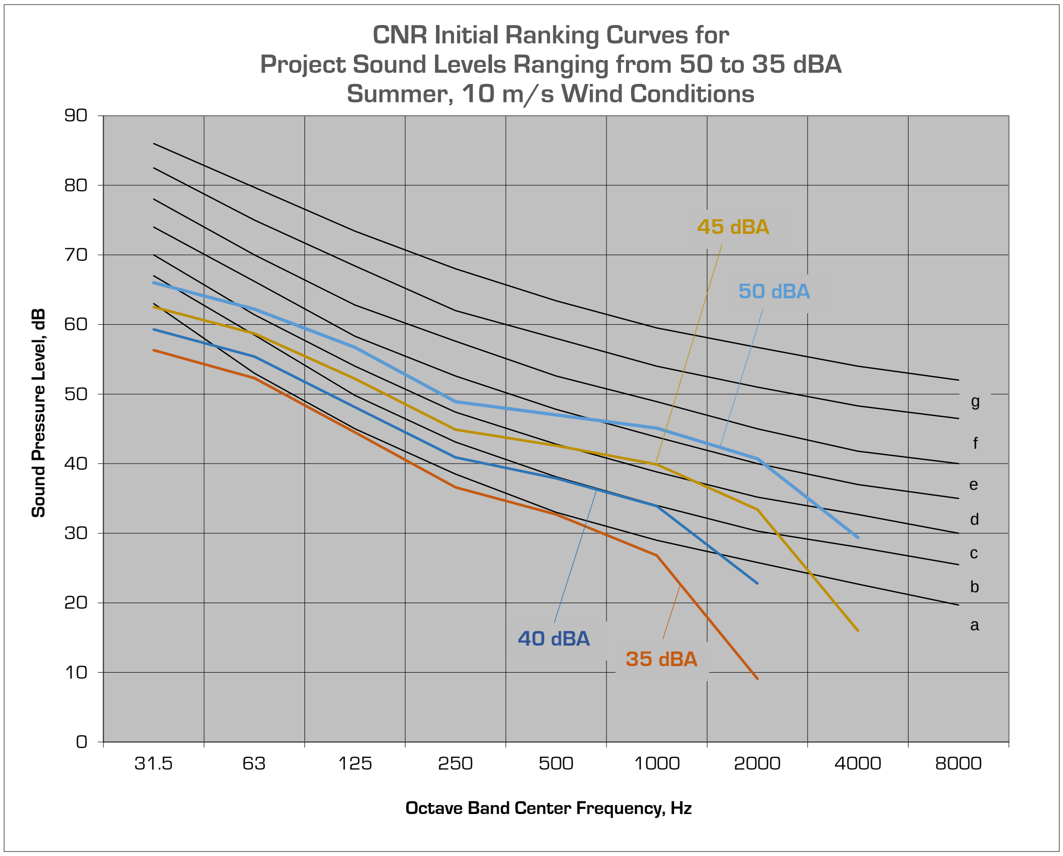


Figure 3.6.2.1

The baseline CNR classifications for typical summertime conditions are listed in Table 3.6.2.1 beginning at 48 dBA, which is the maximum project sound level predicted at any residence.

Table 3.6.2.1 *Baseline CNR Classifications*
Typical Summertime Conditions

Project-only Sound Level, dBA	Baseline CNR Classification
48	d
47	d
46	d
45	d
44	c
43	c
42	c
41	c

Project-only Sound Level, dBA	Baseline CNR Classification
40	b
39	b
38	b
37	b
36	b
35	a

The background correction for this scenario is **-4** as shown in the figure below.

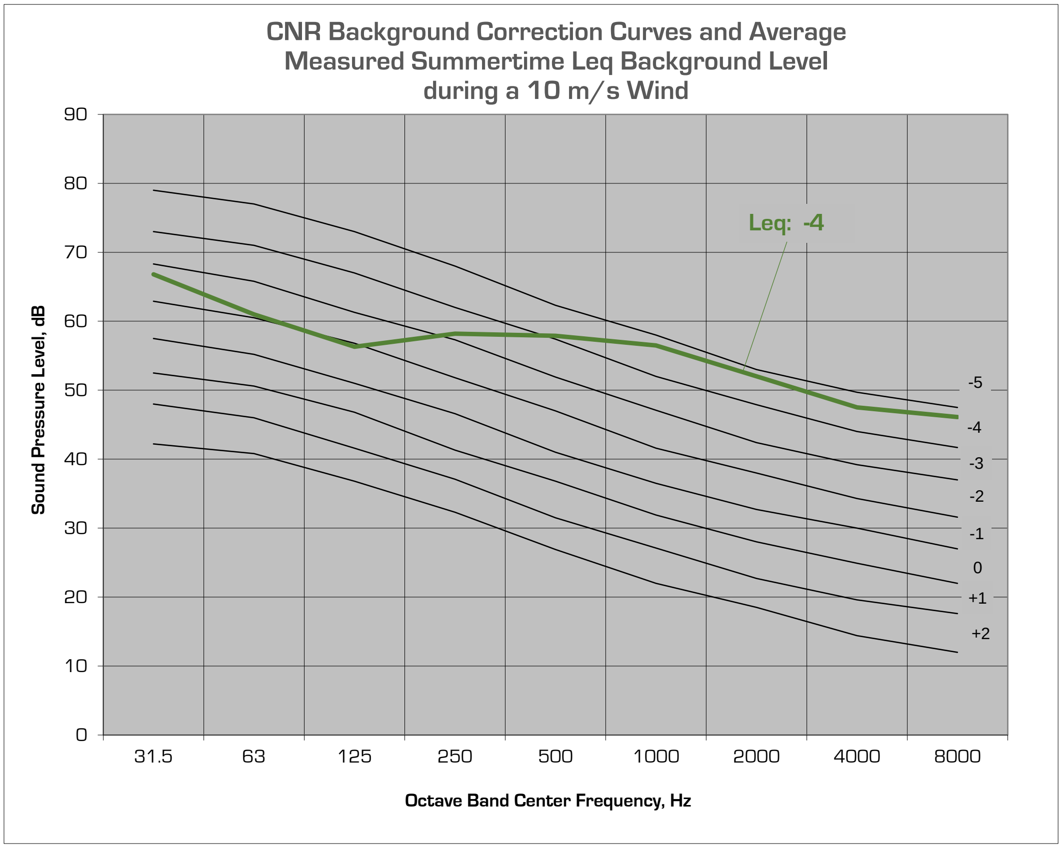


Figure 3.6.2.2

The remaining corrections are the same as in the winter analysis. All corrections are summarized below.

Table 3.6.2.2 *Summary of Correction Factors*
Typical Summertime Conditions

Correction	Correction Factor
Background Correction	-4
Temporal/Seasonal Correction	-1
Character Correction	+1
Exposure and Attitude	0
Net Correction	**-4**

The following table relates predicted project-only sound levels with the final CNR ratings for typical summertime conditions.

Table 3.6.2.3 *CNR Ratings Associated with Predicted Project Sound Levels*
Typical Summertime Conditions

Predicted Project-only Sound Level, dBA	Final CNR Rating – Typical
48	A
47	A
46	A
45	A
44	<A
43	<A
42	<A
41	<A
40	<A
39	<A
38	<A
37	<A
36	<A
35	<A

These results indicate that "no reaction" (see Table 3.6.1.5) is expected under typical summertime conditions irrespective of the predicted sound level. This conclusion agrees with the NYSDEC relative increase assessment discussed in the Section 3.5 in conjunction with Plot 3.

3.6.3 CNR Assessment – Summertime Conservative Conditions

The initial project rankings based on 9 m/s wind conditions are shown in the following graphic.

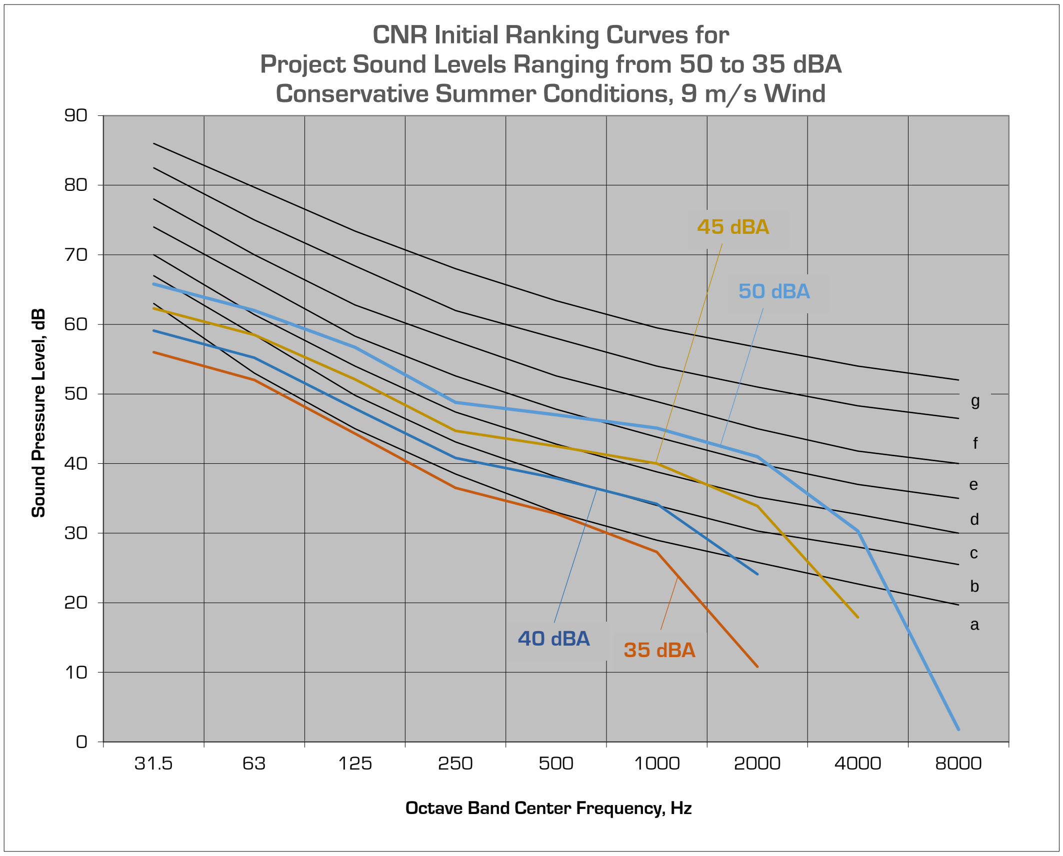


Figure 3.6.3.1

The baseline CNR classifications for conservative summertime conditions are listed in Table 3.6.3.1 beginning at 48 dBA, which again is the maximum project sound level predicted at any residence.

Table 3.6.3.1 *Baseline CNR Classifications*
Conservative Summertime Conditions

Project-only Sound Level, dBA	Baseline CNR Classification
48	d
47	d
46	d
45	d
44	c
43	c
42	c
41	c
40	c
39	b
38	b
37	b

Project-only Sound Level, dBA	Baseline CNR Classification
36	b
35	a

The background correction for this scenario is **-3** as shown in the figure below.

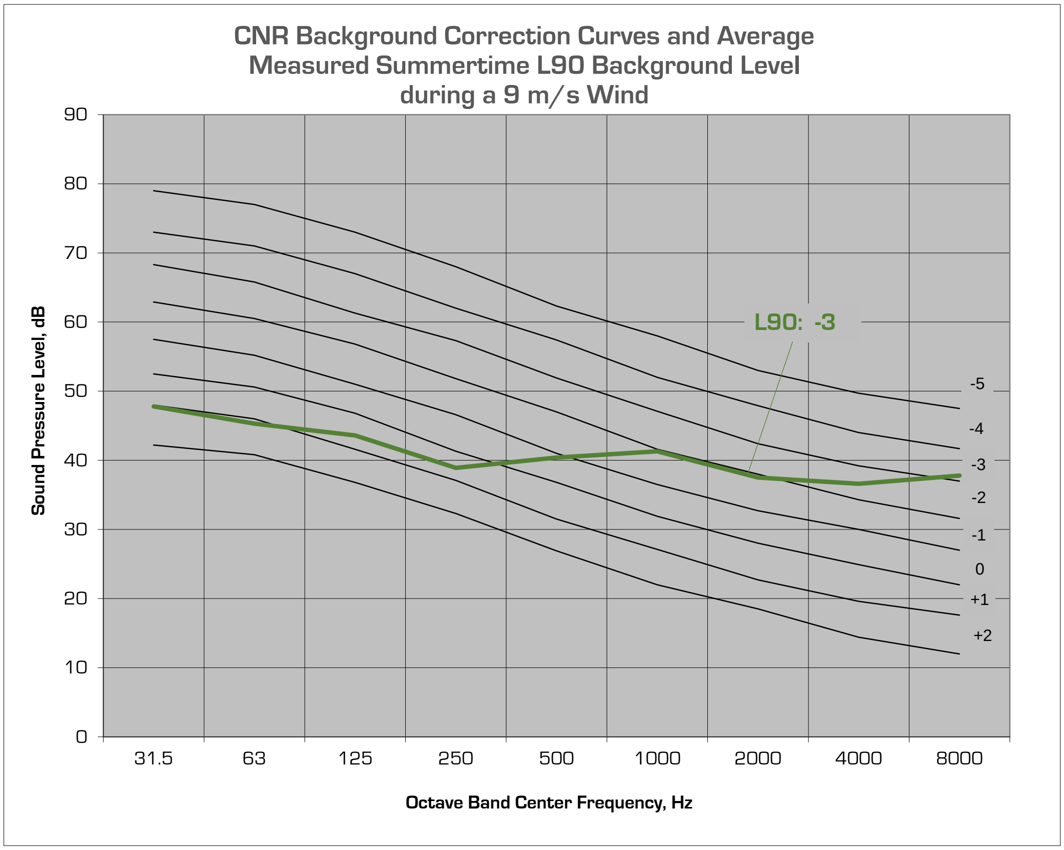


Figure 3.6.3.2

The remaining corrections are the same as in previous analyses. All corrections are summarized below.

Table 3.6.3.2 *Summary of Correction Factors*
Conservative Summertime Conditions

Correction	Correction Factor
Background Correction	-3
Temporal/Seasonal Correction	-1
Character Correction	+1
Exposure and Attitude	0
Net Correction	**-3**

The following table relates predicted project-only sound levels with the final CNR ratings for conservative summer conditions.

Table 3.6.3.3 *CNR Ratings Associated with Predicted Project Sound Levels Conservative Summertime Conditions*

Predicted Project-only Sound Level, dBA	Final CNR Rating – Conservative
48	B
47	B
46	B
45	B
44	A
43	A
42	A
41	A
40	A
39	<A
38	<A
37	<A
36	<A
35	<A

These result indicate that "no reaction" is expected under conservative summertime conditions (see Table 3.6.1.5). This conclusion also agrees with the NYSDEC relative increase assessment discussed in the Section 3.5 (Plot 4).

3.7 CUMULATIVE NOISE IMPACTS

At the present time there are no existing wind projects in the immediate vicinity of the Arkwright project area so there would be no impact from cumulative or aggregate noise. The nearest known potential wind project that is in the development phase is several miles from the Arkwright site and, even if built, would be much too far away to affect in any way the sound level within the project area.

3.8 SUBSTATION NOISE

The substation associated with the Arkwright Summit Wind Farm is located in an open field about 5 miles west the main project area at the tie-in point to an existing transmission line just north of CR 112 in the Town of Pomfret. Based on first-hand observations and detailed noise modeling analyses of similar substations for other projects, it can be safely said that the sound emissions from the relatively small substations and transformers connected with wind projects of this size are virtually negligible. A slight hum may be audible at times at the fence immediately surrounding such a substation but this sound, including its tonal character, fades out quickly and becomes completely inconsequential at fairly short distances. Highly, if not grossly, conservative modeling analyses for comparable substations typically put the total sound level at a very low level of approximately 35 dBA at 400 ft. Such a sound level is similar to the natural background sound level typically measured in rural areas. The nearest houses to the Arkwright substation are at least 800 ft. away meaning that the substation sound emissions should be insignificant, if they are audible at all. Consequently, no adverse noise impact is anticipated.

3.9 Compliance with the Local Wind Energy Facility Law

It is evident from Plot 4, which is essentially based on the maximum turbine sound power level, that a project-only sound level of 50 dBA or more will not occur at any homes or other sensitive receptors within the project area as required by the Town of Arkwright.

It should be noted, however, that certain unsettled or unusual wind/weather conditions, such as might be associated with the arrival a frontal system or temperature inversion, could cause project noise to briefly increase and possibly approach or exceed 50 dBA at some residences. However, under all normal conditions compliance is expected.

3.10 Low Frequency Noise

Concerns about annoyance and/or adverse health effects from excessive low frequency noise from proposed wind farms are commonly voiced but they have apparently grown out of internet misinformation or anecdote without any real basis in fact. The widespread belief that wind turbines produce elevated or even harmful levels of low frequency and infrasonic sound has been repeatedly and independently disproven by numerous investigators[5,6,7,8,9]. These studies show that the low frequency sound emissions from wind turbines are essentially comparable to or less than the natural low frequency sound level typically present in a rural environment and well below the threshold of perceptibility.

Having said that, however, the issue of potential health effects from wind turbines is the subject of a long-running and on-going debate amongst experts in the wind turbine noise field and a final consensus has yet to be arrived at. Real symptoms have and are being experienced by some residents living in proximity to some wind projects but no plausible link to the sound emissions from the turbines, low frequency or otherwise, has ever been found.

In an effort to resolve this conundrum once and for all the Government of Canada (Health Canada) has recently completed a very extensive epidemiological study[10] using both self-reported and objectively measured health outcomes to impartially investigate and quantify the prevalence of health effects and health indicators among a large sample of residents living within 11 km of wind projects. In general, it was found that there was no statistically significant exposure-response relationship between wind turbine noise and such factors as sleep disturbance, sleep disorders, migraines, dizziness, diabetes, hypertension, hair cortisol concentrations, blood pressure, resting heart rate, perceived stress or any measure of quality of life. In many cases worse or more prevalent symptoms, such as sleep disturbance, for instance, were reported by residents living far away from any turbines.

Additional recent studies, such as Howe[11] and Tonin[12], suggest a psychosomatic origin for what appear to be legitimate and very real symptoms. In the Tonin study volunteers were split into two groups and exposed in a double blind experiment to (inaudible) infrasonic sound through special headphones and queried afterwards for their reactions. Prior to the test one group was given internet articles describing the supposed adverse effects of low frequency wind turbine noise while the other group was given different articles asserting that there is no significant impact from such sound. The results show, at least for the short-term exposures in the study, that those who were preconditioned to believe there would be an adverse effect reported them to a statistically significant extent while no effect at all was observed by the other group.

3.11 Construction Noise

Noise from construction activities associated with the project may temporarily constitute a moderate, unavoidable impact at some homes in the project area. Assessing and quantifying these impacts is difficult because construction activities will constantly be moving from place to place around the site leading to highly variable impacts with time at any given point.

In general, the maximum potential noise impact at any single residence might be analogous to a few days to a few weeks of repair or repaving work occurring on a nearby road or to the sound of machinery operating on a nearby farm. More commonly (at houses that are some distance away), the sounds from project construction are likely to be faintly perceived as the far off noise of diesel-powered earthmoving equipment characterized by such things as irregular engine revs, back up alarms, gravel dumping and the clanking of metal tracks.

Construction of the project is anticipated to consist of several principal activities:

- Access road construction and electrical tie-in line trenching
- Site preparation and foundation installation at each turbine site
- Material and subassembly delivery
- Turbine erection

The individual pieces of equipment likely to be used for each of these phases and their typical noise levels as reported in the *Power Plant Construction Noise Guide* (Empire State Electric Energy Research Corp.[13]) are tabulated below in Table 3.9.1. It should be noted that this reference is quite old, dating back to 1977, and the equipment sound levels in it are somewhat higher than the values that can be found in more recent references, such as from the FHWA[14] for modern construction equipment. These older, higher values have been deliberately used just to be conservative.

Table 3.11.1 shows the maximum total sound levels due to construction at each turbine site that might temporarily occur at the closest non-participating residences at least 1200 ft. away. The distance from a specific construction site to the point where construction noise would drop to 40 dBA is also shown in the table. A bland, steady sound level of 40 dBA is generally considered so quiet (about the sound level in a library) that it is not usually viewed as objectionable even when the background, or masking, sound level is negligible. Unlike for the operational project, wind speed is irrelevant to the background level during the construction phase since there will be times when construction is occurring during calm and quiet periods.

Table 3.11.1 *Construction Equipment Sound Levels by Phase*

Equipment Description	Typ. Sound Level at 50 ft., dBA	Est. Maximum Total Level at 50 ft. per Phase, dBA*	Max. Sound Level at a Setback Distance of 1200 ft., dBA	Distance Until Sound Level Decreases to 40 dBA, ft.
Road Construction and Electrical Line Trenching				
Dozer, 250-700 hp	88	92	61	5500
Front End Loader, 300-750 hp	88			
Grader, 13-16 ft. blade	85			
Excavator	86			
Foundation Work, Concrete Pouring				
Piling Auger	88	88	57	4200
Concrete Pump, 150 cu yd/hr	84			

Equipment Description	Typ. Sound Level at 50 ft., dBA	Est. Maximum Total Level at 50 ft. per Phase, dBA*	Max. Sound Level at a Setback Distance of 1200 ft., dBA	Distance Until Sound Level Decreases to 40 dBA, ft.
Material and Subassembly Delivery				
Off Hwy Hauler, 115 ton	90	90	59	4800
Flatbed Truck	87			
Turbine Erection				
Mobile Crane, 75 ton	85	85	54	3400

* Not all vehicles are likely to be in simultaneous operation. Maximum level represents the highest level realistically likely at any given time.

What the values in this table generally indicate is that, depending on the particular activity, sounds from construction equipment are likely to be significant at distances of up to 5500 feet – which means that construction will occur close enough to many homes within the project area that its noise will be clearly audible.

Sound levels ranging from 54 to 61 dBA might temporarily occur at the closest homes to turbine locations over several weeks due to construction activities and somewhat higher levels might be temporarily experienced at homes that are very close to road construction or trenching operations. Such levels would not generally be considered acceptable on a permanent basis or outside of normal daytime working hours (when all project construction is planned), but as a temporary, daytime occurrence construction noise of this magnitude may go unnoticed by many in the project area. For others, project construction noise may be an unavoidable temporary impact.

Noise from the very small amount of daily vehicular traffic to and from the current site of construction should be negligible in magnitude relative to normal traffic levels (even given the rural nature of the roads in the project area) and temporary in duration at any given location.

4.0 SUMMARY AND CONCLUSIONS

Field surveys of existing sound levels under both wintertime and summertime conditions within the Arkwright Summit Wind Farm project area indicate that background sound levels are highly variable and dependent on wind speed, particularly during the winter. Noises from roadways and other man-made sources are relatively insignificant over most of the site and existing sound levels are largely dominated by natural sources.

A regression analysis of sound levels vs. wind speed shows that the average, or "typical" background sound level increases with wind speed and ranges from about 41 to 50 dBA, irrespective of season, over the range of wind speeds where turbine noise is variable; i.e. from about 4 m/s (measured at a standard elevation of 10 m) to 11 m/s when the turbine rotor reaches maximum rotational speed and sound output becomes constant. The near-minimum (L90) sound level increases from 32 to 47 dBA over the same wind speed range during winter conditions and from 36 to 46 in the summer. A fairly uniform sound level was found to exist at all 5 monitoring stations used for the warm weather survey and at 7 of the 8 positions used for the winter survey. Consequently, the average sound levels from all positions, neglecting the one anomalous winter position, reasonably characterize the site-wide sound level.

A comparison, as a function of wind speed, between the background sound levels and the variable sound power level of Vestas V110-2.2 MW turbine currently planned for the project indicates that the maximum potential for an adverse impact from noise occurs at intermediate wind speeds of 6, 9 and 10 m/s, depending on season and the measurement metric. At these wind speeds the greatest differential generally exists between the turbine sound level and the amount of masking background noise available to obscure project noise. This analysis showed that the "typical" (Leq) background sound level likely to exist throughout the site area in the winter under these critical design conditions (a moderate 6 m/s wind) was **44 dBA** and the "conservative", near-minimum (L90) sound level, was **37 dBA**. In the summertime the point of maximum possible project audibility occurred during higher wind speeds of 9 and 10 m/s – essentially when the turbines would be producing the maximum sound emissions. Under these design conditions the "typical" background sound level was **47 dBA** and the "conservative" L90 level was **43 dBA**. By definition L90 sound levels only occur 10% of the time, so these lower, conservative levels do not represent the permanent background sound level, but rather momentarily low levels.

In the New York State Department of Environmental Conservation's Program Policy *Assessing and Mitigating Noise Impacts* a cumulative increase in total sound level up to 6 dBA is characterized as having "potential for adverse noise impact only in cases where the most sensitive of receptors are present" and is suggested as a threshold for determining what areas might be adversely impacted by a new noise source and what areas should see "no appreciable effect". Using the design background levels discussed above as a baseline the thresholds for a potentially adverse noise impact would be as follows:

Table 4.0.1 *Critical Design Levels and NYSDEC Impact Thresholds*

Season and Type of Impact	**Measured Critical Background Level and Wind Speed**	**Impact Threshold - Project-only Sound Level, dBA** (5 dBA above Background Level)	**Cumulative Sound Level with Project Operating, dBA** (6 dBA above Background Level)
Typical Impact Based on Leq Wintertime	44 dBA, 6 m/s	**49**	50
Conservative Impact Based on L90 Wintertime	37 dBA, 6 m/s	**42**	43
Typical Impact Based on Leq Summertime	47 dBA, 10 m/s	**52**	53
Conservative Impact Based on L90 Summertime	43 dBA, 9 m/s	**48**	49

A "Second Level" modeling study, carried out per the NYSDEC guidelines, showed that the region where noise impacts might occur (i.e. where an increase of 6 dBA or more is predicted) does not encompass any homes under most conditions. It is only during conservative wintertime conditions, when the background level is essentially at a minimum, that several of the closest residences may temporarily experience an increase of about 6 dBA. Under these circumstances it should be noted that residents are less likely to be sensitive to outdoor sound because they generally spend more time indoors during windy wintertime conditions. Under most normal conditions in both the winter and summer, however, the sound emissions from the project would be less, if not significantly less, perceptible.

An additional independent analysis of the potential project noise impact based on the modified CNR method was also carried out. This approach evaluates the frequency content of the background and project sound levels and considers other factors such as the temporal characteristics of the noise source and any character content. This analysis essentially confirmed the findings of the modeling analysis using the NYSDEC guidance and indicated that "no reaction" was likely under most circumstances and that "sporadic complaints" could be possible under conservative wintertime conditions if a very low background sound level is assumed.

Although these analyses suggest that the sound emissions from the project may be perceptible at times during the winter, it should be noted that the modeling is conservative in a number of important respects:

- The L90 background level that is assumed in the "conservative" analyses represents the quietest lulls between wind gusts, farm equipment, cars passing by, dogs barking, etc. As such, this level quantifies a very low value for environmental masking noise. The survey data shows that most of the time a substantially higher background sound level will exist.

- The noise model assumes that the wind is blowing simultaneously from all directions and that the turbine sound level experienced at any given point is the sound level that would occur downwind from all turbines in the project.

- The ground surface is assumed to have a fairly low absorptivity – normally wooded areas (which cover most of the site) and farm fields are highly absorptive.

- The predicted sound levels occur *outside*. Sound levels inside of any dwelling will be 10 to 20 dBA lower. This reduction generally puts the project sound level inside any home below the sleep disturbance threshold of 30 dBA published by the World Health Organization[15]

These conservative assumptions are intended to over-estimate project sound levels under most normal conditions so that some allowance or buffer exists to cover the intermittent occurrence of certain atmospheric conditions that allow turbine noise to be more readily perceived, such as during stable atmospheric conditions that sometimes develop in the evening or at night.

In any case, the modeling analysis shows that full compliance with the local town law relating to wind energy facilities is expected. The maximum allowable sound level of 50 dBA is predicted to occur well short of any residence or potentially sensitive receptor.

Although concerns are often raised with respect to low frequency noise emissions from wind turbines, no adverse impact of any kind related to low frequency noise is expected from this project. An extensive and impartial governmental study recently completed by Health Canada shows no relationship between various health symptoms and exposure to the sound emissions from wind turbines. Other studies suggest a psychosomatic origin to the very real health issues that have inexplicably occurred at some wind project sites.

Unavoidable noise impacts may occur during the construction phase of the project. Construction noise, sounding similar to that of distant farming equipment, is anticipated to be sporadically audible at most homes within the immediate project vicinity on a temporary basis. The maximum magnitude of construction noise at the nearest homes to individual turbine locations is not expected to exceed 54 to 61 dBA depending on the particular activity. Somewhat higher levels are possible where road building or trenching activities occur fairly close to homes.

END OF REPORT TEXT

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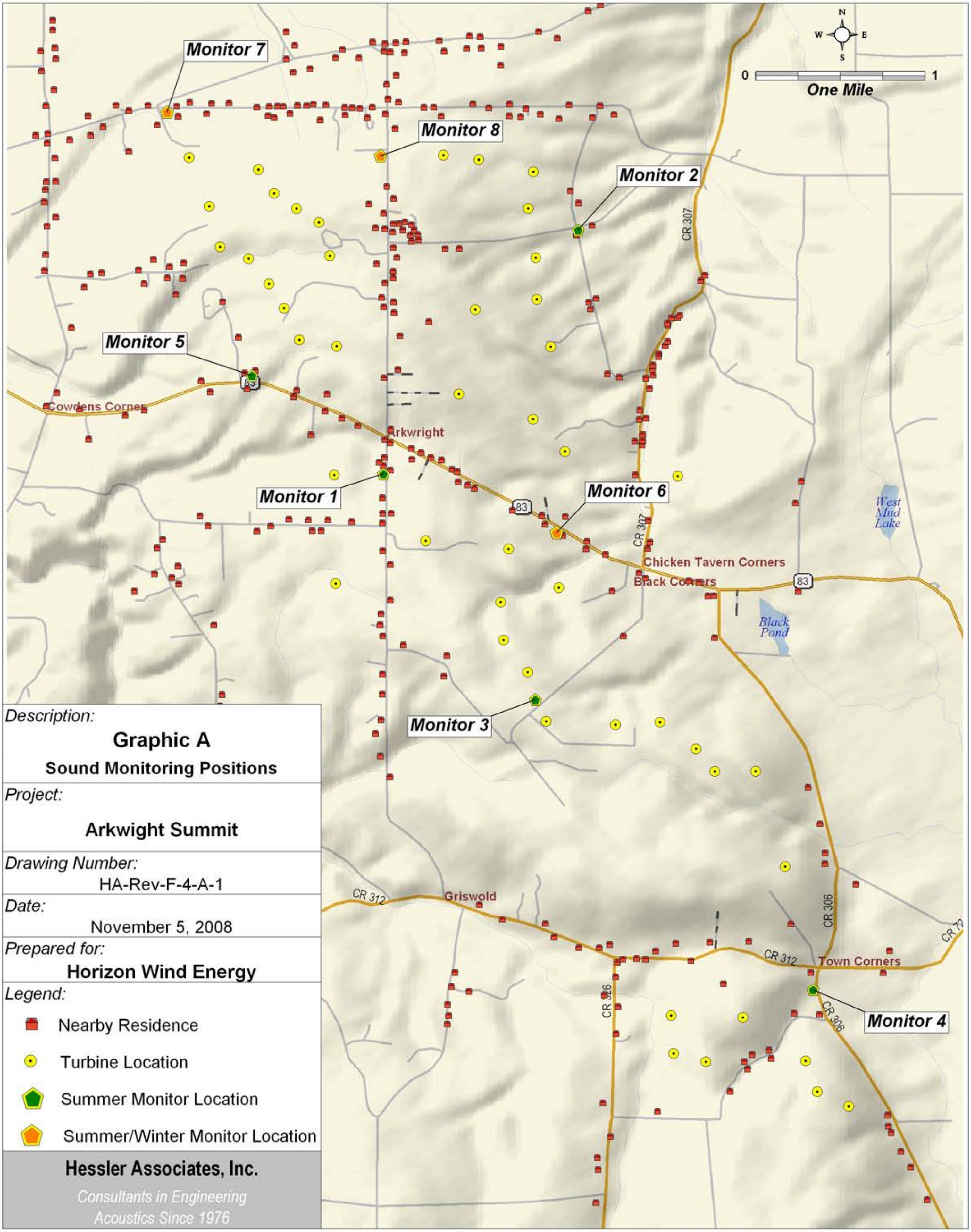

Description:

Graphic A

Sound Monitoring Positions

Project:

Arkwight Summit

Drawing Number:

HA-Rev-F-4-A-1

Date:

November 5, 2008

Prepared for:

Horizon Wind Energy

Legend:

- Nearby Residence
- Turbine Location
- Summer Monitor Location
- Summer/Winter Monitor Location

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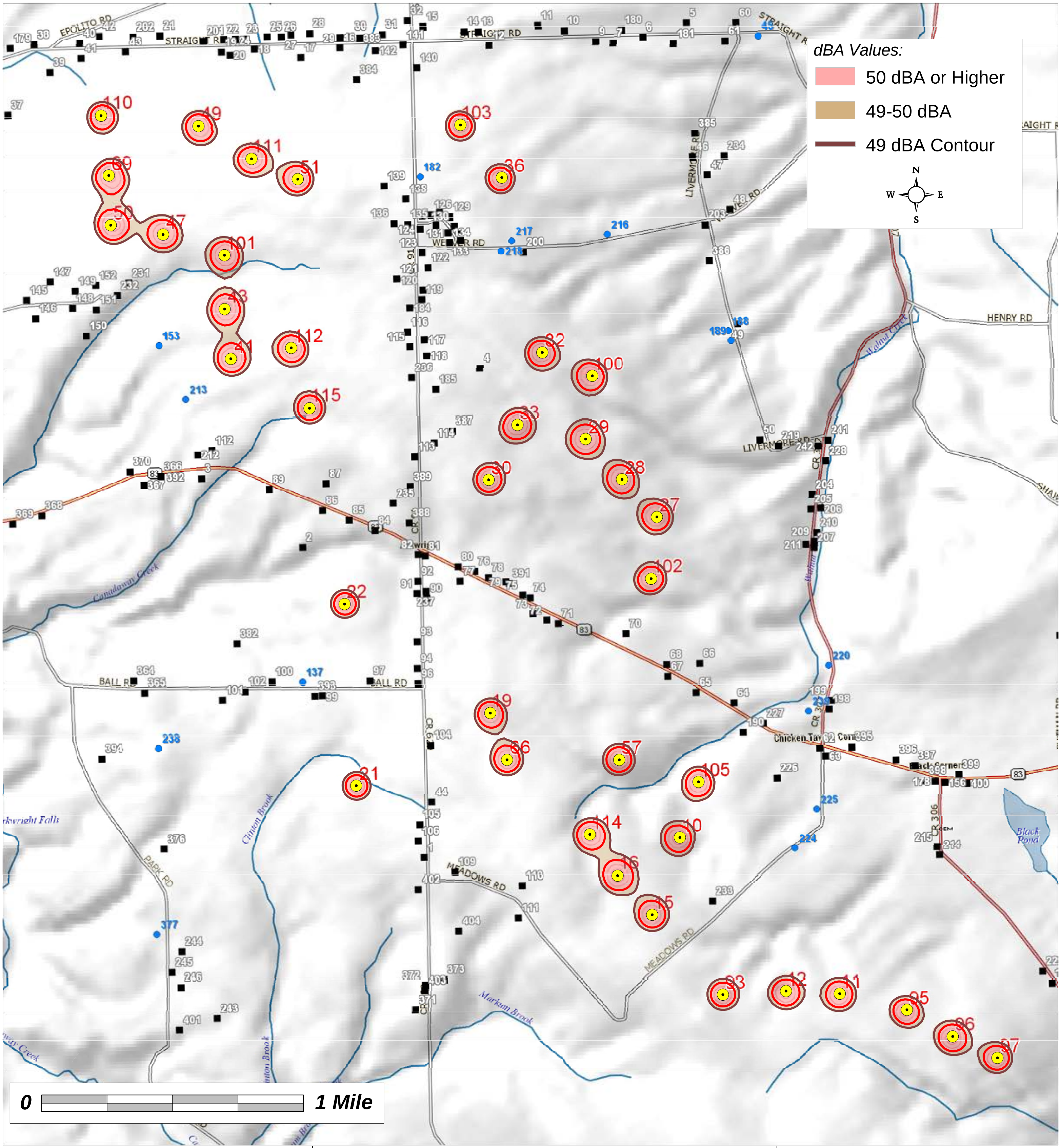

Project:	Description:	Legend:
Arkwright Summit Wind	**Plot 1 - Wintertime Conditions**	Turbine Location
Prepared for:	**Predicted Sound Contours (dBA) with an**	Nearby Residence
Arkwright Summit, LLC	**Omnidirectional 6 m/s Wind Vestas V110 Turbines**	Seasonal Cabin
Date: September 16, 2015 / Drawing #: AS-Rev-O-1-1	**"Typical" Impact Threshold of 49 dBA** **Based on Average (Leq) Background Level**	

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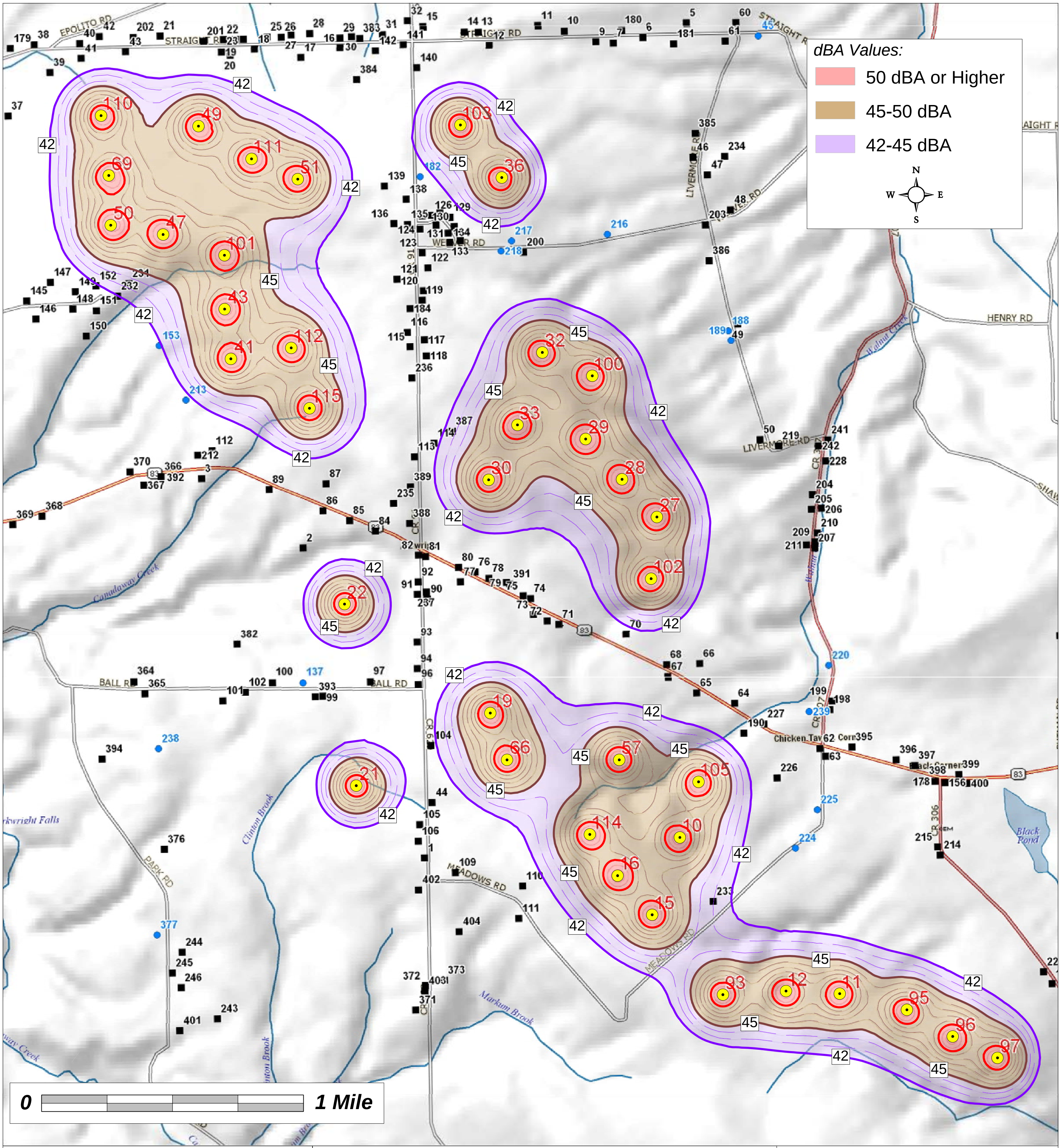

Project: **Arkwright Summit Wind**	*Description:*	*Legend:*
Prepared for: **Arkwright Summit, LLC**	**Plot 2 - Wintertime Conditions**	Turbine Location
Date: September 17, 2015 — *Drawing #:* AS-Rev-O-1-2	**Predicted Sound Contours (dBA) with an Omnidirectional 6 m/s Wind Vestas V110 Turbines "Conservative" Impact Threshold of 42 dBA Based on Typical (L90) Background Level**	Nearby Residence Seasonal Cabin

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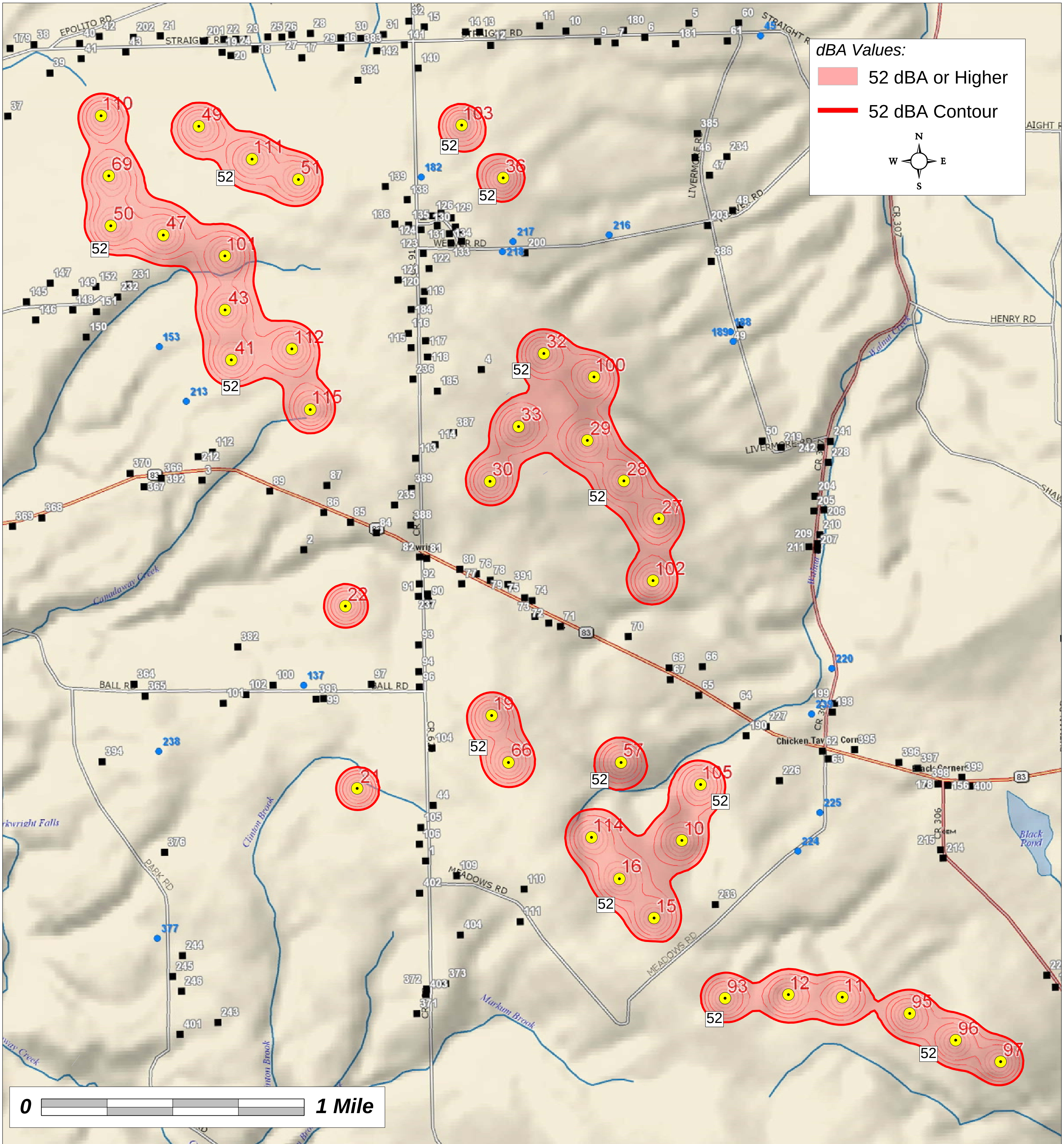

Project:	Description:	Legend:
Arkwright Summit Wind	**Plot 3 - Summertime Conditions**	Turbine Location
Prepared for: **Arkwright Summit, LLC**	**Predicted Sound Contours (dBA) with an Omnidirectional 10 m/s Wind Vestas V110 Turbines "Typical" Impact Threshold of 52 dBA Based on Average (Leq) Background Level**	Nearby Residence
Date: September 17, 2015 — Drawing #: AS-Rev-O-1-3		Seasonal Cabin

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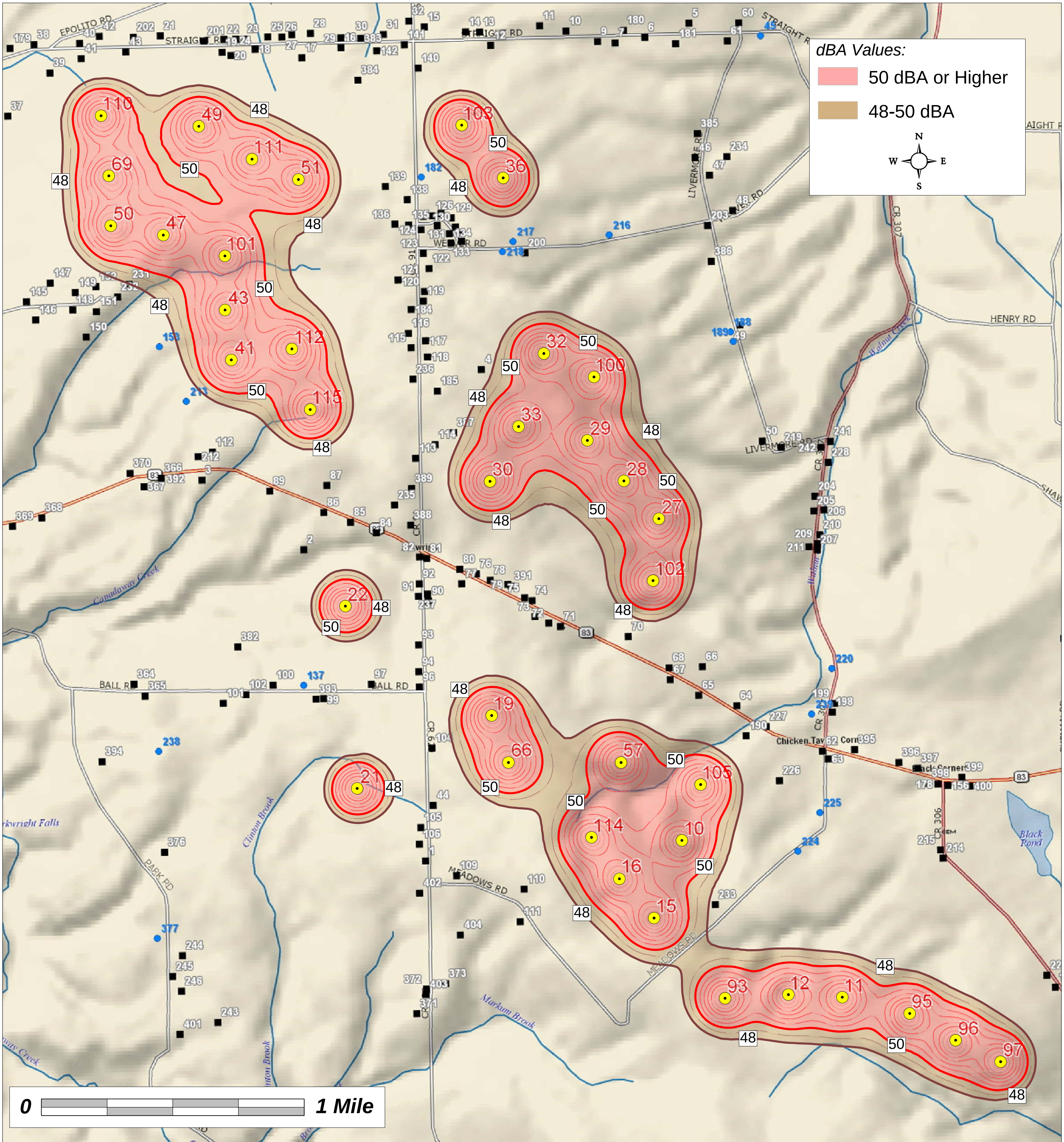

Project:	Description:	Legend:
Arkwright Summit Wind	**Plot 4 - Summertime Conditions**	Turbine Location
Prepared for: **Arkwright Summit, LLC**	**Predicted Sound Contours (dBA) with an Omnidirectional 9 m/s Wind Vestas V110 Turbines "Conservative" Impact Threshold of 48 dBA Based on Average (L90) Background Level**	Nearby Residence
Date: September 18, 2015 — Drawing #: AS-Rev-O-4-1-4		Seasonal Cabin

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