HERITAGE WIND PROJECT

PRE-CONSTRUCTION SOUND LEVEL IMPACT ASSESSMENT

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Section 9.0

Future Sound Levels

9.0   FUTURE SOUND LEVELS

9.1   Sound Propagation

The noise impacts associated with the proposed Project were predicted using the Cadna/A noise calculation software developed by DataKustik GmbH. This software implements the ISO 9613-2 international standard for sound propagation (Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation). The benefits of this software are a more refined set of computations due to the inclusion of topography, ground attenuation, multiple reflections, drop-off with distance, and atmospheric absorption. The Cadna/A software allows for octave band calculation of sound from multiple sources as well as computation of diffraction.

9.2   Equipment and Operating Conditions

9.2.1   Wind Turbines

The sound level analysis includes 33 wind turbines. There are two wind turbine models (or equivalent) being considered in this PNIA. The list of wind turbine manufacturers, models, hub heights, and rotor diameters examined for this assessment are presented below in Table 9-1. Each of the turbines includes the low-noise blade option, sometimes referred to as serrated trailing edge, or low-noise trailing edge blades.

Table 9-1   Wind Turbines Analyzed for Sound Level Assessment

Manufacturer	Wind Turbine Model	Maximum Electrical Power (kW)	Hub Height (m)	Rotor Diameter (m)	Range of Rotor Speed (rpm)
General Electric	GE5.5-158	5,500	125.4	158	6.0-10.1
Vestas	V162-5.6	5,600	125	150	4.3-12.1

Technical reports from GE[47] and Vestas[48] were provided by the Applicant, which documented the expected sound power levels associated with each of the wind turbines. Of the two wind turbine options, the GE5.5-158 has the highest broadband A-weighted sound power level, and therefore modeling results of this turbine result in the highest broadband sound levels. Table 9-2 shows the broadband sound power levels as a function of wind speed from these technical reports. Under peak sound level producing conditions the GE5.5-158 wind turbine has an A-weighted sound power level of <BEGIN CONFIDENTIAL INFORMATION>   dBA. The Vestas V162-5.6 wind

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[47]   GE Renewable Energy, Technical Documentation Wind Turbine Generation Systems 5.x-158 -60 Hz with LNTE, Rev. 01 -EN 2019-04-02.

[48]   Vestas Wind Systems A/S, V162-5.6 MW Third Octave Noise Emission, DMS 0079-5298_01.

turbine has an A-weighted sound power level of . <END CONFIDENTIAL INFORMATION> The maximum octave band sound power levels for each wind turbine type are presented in Table 9-3A (A-weighted) and Table 9-3B (unweighted). For each octave band, the highest sound power level published by the manufacturer has been used and input to the Cadna/A software, regardless of the wind speed at which they occur. The sound power levels presented in both tables do not include an uncertainty factor. <BEGIN CONFIDENTIAL INFORMATION>

Table 9-2   Wind Turbine Broadband Sound Power Levels vs. Wind Speed

Hub Height Wind Speed (m/s)	3	4	5	6	7	8	9	10	>10
GE5.5-158 HH-125.4m Broadband Sound Power Level (dBA)									
Vestas V162-5.6 HH-125m Broadband Sound Power Level (dBA)									

Notes: 1. Sound power level is constant from the respective wind speed to the cut-out wind speed.

ND = No data. The manufacturer does not present sound levels at this wind speed.

Table 9-3A   Wind Turbine Maximum Octave Band Sound Power Levels (dBA)

| Wind Turbine Type | Sound Power Levels per Octave-Band Center Frequency (Hz) | | | | | | | | | |
	16	31.5	63	125	250	500	1k	2k	4k	8k
GE5.5-158										
V162-5.6										

Table 9-3B   Wind Turbine Maximum Octave Band Sound Power Levels (dB)

| Wind Turbine Type | Sound Power Levels per Octave-Band Center Frequency (Hz) | | | | | | | | | |
	16	31.5	63	125	250	500	1k	2k	4k	8k
GE5.5-158										
V162-5.6										

<END CONFIDENTIAL INFORMATION>

9.2.2   Collection Substation

In addition to the wind turbines, there will be a collector substation located within the Project area. One step-up transformer rated at 222 MVA is proposed for the substation. Since source-specific sound data are not yet available, Epsilon estimated the broadband sound power level and octave band sound level emissions using the techniques in the Electric Power Plant Environmental Noise Guide (Edison Electric Institute), Table 4.5 Sound Power Levels of Transformers. Table 9-4 summarizes the sound power level data used in the modeling.

Table 9-4   Collector Substation Transformer Sound Power Levels

Maximum Rating MVA	Broadband Sound Power Level dBA	Sound Power Levels per Octave-Band Center Frequency (Hz)								
		31.5 dB	63 dB	125 dB	250 dB	500 dB	1k dB	2k dB	4k dB	8k dB
222	103.4	100	106	108	103	103	97	92	87	80

9.3   Modeling Inputs and Scenarios

9.3.1   Common Modeling Inputs

Inputs and significant parameters employed in the model common to all modeling scenarios for this Project are described below:

♦ *Project Layout:* A wind turbine layout was provided by the Applicant to the Project team on August 29, 2019 (Layout 034). The 33 proposed wind turbines were input into the model. The substation location was provided by the Applicant to the Project team on August 23, 2019. For the modeling analysis, it was assumed that the collector substation transformer would be located at the center of the substation pad. The proposed wind turbines and substation for the Project are shown in Figure 9-1. All point sources in the model, including their coordinates, are presented in Tables D-1 through D-2 in Appendix D representing the two different turbine model options.

♦ *Receptor Locations:* A modeling receptor dataset was provided by the Applicant to the Project team on March 15, 2019. The 1,594 receptors from this dataset were input into the Cadna/A model. These receptors include the sensitive receptors identified in Section 6.1 above. The 1,594 receptors are a combination of both participating and non-participating sound sensitive locations within at least one mile from the Project boundary which ensures all locations within one mile of a proposed wind turbine location are represented. These receptors were modeled as discrete points at a height of 1.5 meters AGL to mimic the ears of a typical standing person. These locations are shown in Figure 9-1. The modeling receptors, including their coordinates, tax code, participation status, and receptor type are listed in tabular form in Table D-3 in Appendix D.

The nine receptor categories discussed previously were grouped into four general categories in order to simplify the mapping. Year-round residents and seasonal residents remained their own categories. The Public category includes public, commercial, and institutional uses. The Unknown category includes unknown, dilapidated residences, other, and not present locations.

♦ *Terrain Elevation:* Elevation contours for the modeling domain were directly imported into Cadna/A which allowed for consideration of terrain shielding where appropriate. The terrain height contour elevations for the modeling domain were generated from elevation information derived from the National Elevation Dataset (NED) developed by

the U.S. Geological Survey. The site topography is gently sloping or steady-sloping from the wind turbines to the sensitive receptors.

♦ *Uncertainty factor:* Some wind turbine manufacturers provided a K (uncertainty) factor for the sound power levels presented in the technical documents. Typically, uncertainty factors for wind turbines are 2 decibels or less. For this analysis an uncertainty factor of 2.0 dBA was assumed and added to the sound power level for each modeled wind turbine. This is accomplished by adding 2 dB to each octave band frequency in the model.

♦ The highest sound power level for each octave band was input to the model regardless of what wind speed generated this sound level. When combined into an overall A-weighted sound level, this represented an additional 0.0 to 0.4 dBA of conservatism to model results depending on the wind turbine manufacturer.

♦ The meteorological correction term (Cmet) was set to zero.

♦ No additional attenuation due to tree shielding, air turbulence, or wind shadow effects was considered in the model.

♦ No corrections or adjustments were made to the model results.

9.3.2   Short-Term Modeling Scenarios - ISO 9613-2

Short-term sound level modeling was conducted using the Cadna/A noise calculation software which incorporates the ISO 9613-2 international standard for sound propagation.   For this modeling scenario, the octave band data for both wind turbine types were input into Cadna/A to calculate wind turbine generated sound pressure levels during conditions when worst-case sound power levels are expected.   Modeling assumptions inherent in the ISO 9613-2 calculation methodology, or selected as conditional inputs by Epsilon, were implemented in the Cadna/A software for this modeling scenario to ensure conservative results (i.e., higher sound levels), and are described below:

♦ *Ground Attenuation:* Spectral ground absorption was calculated using a G-factor of 0.5 which corresponds to "mixed ground" consisting of both hard and porous ground cover. This is consistent with the modeling guidelines of NARUC 2011. Fourteen bodies of water were identified within the Project area. These were identified using a vector file of area hydrography features such as lakes, ponds, reservoirs, major rivers, streams, canals, etc. in New York State, published by the New York State Office of Cyber Security in January, 2008. These fourteen areas were set to G=0 representing completely reflective surfaces. This is the most conservative setting available.

♦ As per ISO 9613-2, the model assumed favorable conditions for sound propagation, corresponding to a moderate, well-developed ground-based temperature inversion, as might occur on a calm, clear night or equivalently downwind propagation.

♦ All modeled sources were assumed to be operating simultaneously and at the design wind speed corresponding to the greatest sound level impacts.

♦ Meteorological conditions assumed in the model (temperature=10℃ & relative humidity=70%) were selected to minimize atmospheric attenuation in the 500 Hz and 1000 Hz octave bands where the human ear is most sensitive.

Sound pressure levels due to operation of all 33 wind turbines and the collector substation transformer were modeled at all 1,594 receptors within and surrounding the Project area. The sound levels calculated are 1-hour L_{eq} sound levels. A review of 8,760 hours (one year) of on-site wind speed data found that there were only three (3) of the 365 nights in an entire year that maintained a hub height wind speed of 10 m/s for all 9 hours of the night to produce the highest sound level from the GE5.5-158 wind turbine for those 9 consecutive hours. Therefore, on those nights, the Leq 9-hour sound level would be equal to the highest Leq 1-hour. On all other nights, the Leq 9-hour sound level will be less than the sound levels calculated by the Leq 1-hour. The same is true for the daytime sound levels where there was only one (1) day in the entire year that maintained a hub height wind speed of 10 m/s for all 15 hours of the day to produce the highest sound level from the GE5.5-158 wind turbine for those 15 consecutive hours. The same worst-case 1-hour modeled sound level is assumed to be equal to the worst-case modeled 15-hour daytime level.

In addition to modeling at discrete points, sound levels were also modeled throughout a large grid of receptor points, each spaced 20 meters apart to allow for the generation of sound level isolines. Tabular results and sound level isolines were calculated and generated for the entire Project area. Although tabular results for both of the turbine models were calculated, sound level isolines were only generated for the GE turbine model, because it has the highest A-weighted sound power level.

9.3.3 Long-Term Modeling Scenarios – ISO 9613-2 Annual Sound Level Metrics

Over the course of a year, sound levels associated with the operation of wind turbines will at times be less than the modeled worst-case / short-term sound levels. In order to quantify this reduction, differences in the wind turbine sound power levels due to changes in hub height wind speeds were addressed in the sound level modeling meteorological adjustments to the calculations. Sound power levels related to the hub height wind speeds presented in Table 9-2 were used in the calculations.

A full year of 2018 on-site meteorological data were used to calculate the hub height wind speed and related sound power levels for each hour of the year (8760 hours). Table 9-5 summarizes the wind speeds for the year in terms of hours below cut-in speed, above cut-out speed, and missing data. From these data, it can be seen that the wind turbines would be expected to operate at some level approximately <BEGIN CONFIDENTIAL INFORMATION> <END CONFIDENTIAL INFORMATION> with a 125m hub height. The hourly wind speeds drive the resultant sound power level of the wind turbines. Using these data, the sound level exceeded for

10% of the time over the course of one year (L_{10}) was calculated, as well as the sound exceeded for 50% of the time over the course of one year (L_{50}). These calculations were done for two scenarios: all hours in a year (including hours below cut-in speed and above cut-out wind speed), and only those hours in a year above cut-in speed and below cut-out wind speed. The L_{10} and L_{50} wind speed results are summarized in Table 9-6, and the associated sound power levels for each wind turbine under consideration, are shown in Table 9-7. The sound power levels in Table 9-7 do not include any uncertainty factor.

The same full year of on-site wind speed data were used to calculate an equivalent sound level for all nighttime hours in one year ($L_{eq, night, outside}$). This was done using the percent time matched to sound power level at a given wind speed and was calculated on an energy basis for all wind turbines under consideration. These calculations were done for two scenarios: all hours in a year (including hours below cut-in wind speed), and only those hours in a year above cut-in speed. There were zero hours above cut-out speed. The associated sound power levels for each wind turbine under consideration, are shown in Table 9-8. The sound power levels in Table 9-8 do not include any uncertainty factor. Details of data and calculations are in spreadsheet format and will be filed with the Hearing Examiner and treated by the Records Access Officer or other presiding officer as confidential. <BEGIN CONFIDENTIAL INFORMATION>

Table 9-5   Summary of Annual On-Site Hub Height Wind Speeds (2018)

	125m Hub Height
2018 Hours	
Hours below 3 m/s (cut-in)	
Hours above 24.5 m/s (cut-out)	
Missing hours	
Total hours of operation	

Table 9-6   Summary of Annual On-Site Hub Height Wind Speed Statistics (2018)

Scenario	L10 Wind Speed (125m)	L50 Wind Speed (125m)
Operational		
All hours		

Table 9-7   Summary of L$_{10}$, L$_{50}$ Annual Sound Power Levels (dBA)

Wind Turbine	L$_w$, All Hours (dBA)	Lw, Operational Hours (dBA)
GE5.5-158 (HH-125.4m), L$_{10}$		
GE5.5-158 (HH-125.4m), L$_{50}$		
V162-5.6 (HH-125m), L$_{10}$		
V162-5.6 (HH-125m), L$_{50}$		

Notes: 1. The GE5.5-158 model represents the worst case L$_{10}$ and L$_{50}$ annual sound level for both scenarios (with and without non-operational hours).

Table 9-8   Summary of L$_{EQ}$, Night, Outside Sound Power Levels (dBA)

Wind Turbine	All Nighttime Hours	Operational Nighttime Hours
GE5.5-158 (HH-125.4m)		
V162-5.6 (HH-125m)		

Notes: 1. The GE5.5-158 model represents the worst case annual nighttime LEQ sound level for both scenarios (with and without non-operational hours). <END CONFIDENTIAL INFORMATION>

9.3.4   Modeling Accuracy

Use of the 1.5m receptor height, coupled with the other conservative modeling assumptions discussed in Section 9.3, has proven to be an accurate predictor of actual sound levels in the real world. For example, the Massachusetts Clean Energy Center "Massachusetts Study on Wind Turbine Acoustics" (February 2016) showed 1-hour measured L$_{eq}$ sound levels matched well with modeled values at this height. Four seasons of sound level measurements at a ridgeline wind farm in Maine using a 1.5-meter receptor height were likewise less than pre-construction modeled sound levels ("Regulating and predicting wind turbine sound in the U.S."; Kaliski, Bastasch, and O'Neal, presented at INTER-NOISE 2018, Chicago, IL, 2018).

Cooper and Evans present the results of a detailed study comparing measured versus modeled sound levels.[49] The modeling used a 1.5-meter receptor height but did not use a 2 dBA manufacturer's uncertainty factor. Once the 2 dBA uncertainty is factored in, the results found that modeling overpredicted actual measured results except in cases of "concave" topography between the wind turbine and receptor. In that case an additional 3 dBA is recommended to be

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[49] J. Cooper and T. Evans, "Accuracy of noise predictions for wind farms," 5th International Conference on Wind Turbine Noise, Denver, CO, August 2013.

added to the modeling results (see next section for further discussion of concavity). In addition, a receptor height of 1.5 meters is the recommended height in the NARUC-2011 document as required in the Project's understanding of the required DPS scope of studies.

The conservative set of modeling assumptions for this analysis is consistent with the modeling recommendations in NARUC 2011 with the exception that NARUC does not include the uncertainty factor "K", and the modeling for this project does add the "K" factor. Thus, these model results are more conservative (higher) than what NARUC would predict. In addition, the use of these model inputs has been verified through post-construction sound level measurement programs at operating wind energy facilities. According to the Massachusetts Study on Wind Turbine Acoustics,[50] "The ISO 9613-2 model with mixed ground (G=0.5) with +2 dB added to the results was most precise and accurate at modeling the hourly L_{eq}, as compared to individual five-minute periods." A recent post-construction measurement program conduction by Epsilon in the Rocky Mountain region found measured sound levels met the regulatory sound level limit under worst-case operating conditions at locations modeled to be at the regulatory limit.

A closer examination of the topography was made between the wind turbines and receptors where modeled results were within 3 dBA of the design goal. A look at the terrain profiles indicate generally flat, or gently sloping terrain, and no instances of the concave geometry as described in Evans and Cooper.[51] This is consistent with the guidance from the Institute of Acoustics discussion of propagation "across a valley" where a correction factor may be warranted.[52] No such topography exists in the facility area, therefore, no concave correction was used in the modeling.

9.4 Modeling Results

Since the ISO 9613-2 standard does not include the 16 Hz frequency, results at the 16 Hz octave band for each receptor and for each wind turbine manufacturer were extrapolated from the 31.5 Hz results. The extrapolation is the difference between the specific manufacturer's sound power data at 16 Hz and the sound power data at 31.5 Hz used for modeling as presented in Table 9-3B. For example, the GE5.5-158 has a sound power level of 123.1 dB at 16 Hz and 120.3 dB at 31.5 Hz. Thus the 31.5 Hz modeled results for this wind turbine were scaled up by 2.8 dB (123.1 dB-120.3 dB) to calculate the expected sound levels at 16 Hz.

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

[51] Evans, T. and J. Cooper, "Comparison of Predicted and Measured Wind Farm Noise Levels and Implications for Assessments of New Wind Farms," Acoustics Australia, Vol. 40, No. 1, April 2012.

[52] "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise," Institute of Acoustics, Hertfordshire, UK, May 2013.

9.4.1 Short-Term – GE5.5-158, HH-125.4m

Table E-1 in Appendix E shows the predicted "Project-Only" short-term broadband (dBA) and octave band (dB) sound levels under conditions specified in Section 9.3.2 sorted by modeling receptor ID for the GE5.5-158 turbine model at a hub height of 125.4 meters. Table E-1.1 presents the same data sorted by sound level from high to low. The tables present modeled 1-hour L_{eq} sound levels at the 1,594 receptors included in the analysis. The broadband sound levels range from 29 to 55 dBA. Ninety-four non-participating receptors would be over the design goal of 45 dBA if no NRO is applied. All participating receptors meet the design goal of 55 dBA. As discussed previously, the 1-hour L_{eq} is equivalent to the nighttime 9-hour L_{eq} and to the daytime 15-hour L_{eq}. In addition to these discrete modeling points, sound level contours generated from the modeling grid are presented in an overview figure, Figure 9-2, accompanied by a series of inset maps that provide a higher level of detail at all modeled receptors. The sound contour figure set for short-term sound level results was generated only for the GE turbine model, because it has the highest A-weighted sound power level. The contour maps for the other turbine model will show lower impacts. The results in Figure 9-2 do not include the effects of NRO where applicable (see text below).

In order to meet the design goal at all non-participating receptors, this wind turbine model requires an NRO mode to be placed on multiple turbines. At this time, the turbine manufacturer has not completed the technical NRO documents for this specific model. However, based on NRO results for other wind turbines, a reasonable approach is to assume mitigation in 1 dBA increments. One possible NRO mode strategy is as follows:

♦ T4 must have a 1 dBA reduction, down to a broadband SPL of 106.5 dBA.

♦ T10 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T12 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T14 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T15 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T17 must have a 1 dBA reduction, down to a broadband SPL of 106.5 dBA.

♦ T18 must have a 3 dBA reduction, down to a broadband SPL of 104.5 dBA.

♦ T19 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T20 must have a 4 dBA reduction, down to a broadband SPL of 103.5 dBA.

♦ T22 must have a 1 dBA reduction, down to a broadband SPL of 106.5 dBA.

♦ T23 must have a 3 dBA reduction, down to a broadband SPL of 104.5 dBA.

♦ T24 must have a 3 dBA reduction, down to a broadband SPL of 104.5 dBA.

♦ T25 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T27 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T28 must have a 3 dBA reduction, down to a broadband SPL of 104.5 dBA.

♦ T31 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

♦ T32 must have a 2 dBA reduction, down to a broadband SPL of 105.5 dBA.

Specific mitigation measures will be presented in the compliance filing report upon selection of a final wind turbine manufacturer, including details on any necessary NRO based on actual technical documentation. Results for the GE5.5-158 wind turbine are presented in this section without taking credit for NRO. However, a full list of mitigated and unmitigated results for the GE model are shown in Tables E-1 and E-1.1 in Appendix E.

Table 9-9 presents the number of sensitive noise receptors that have been modeled to experience a worst-case sound level of 35 dBA or greater. Modeled sound levels have been rounded to the nearest integer and presented in 1 dBA increments by receptor participation status. The highest non-participating receptors are predicted to be receptors #347, #836, #1042, #1047, and #1048 at 48 dBA. The highest participating receptor is predicted to be receptor #1706 at 55 dBA.

Table 9-9 **Participating and Non-Participating Receptors Modeled at 35 dBA or Greater---GE5.5-158 (No NRO)**

| Modeled Leq Sound Level [dBA][1] | # of Receptors | | | | | | | |
| | Year-Round Residence | | Seasonal Residence | | Unknown | | Public | |
	Participating	Non-Participating	Participating	Non-Participating	Participating	Non-Participating	Participating	Non-Participating
55	0	0	0	0	1	0	0	0
54	0	0	0	0	0	0	0	0
53	0	0	0	0	1	0	0	0
52	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0
50	0	0	0	0	1	0	0	0
49	0	0	0	0	0	0	0	0
48	2	3	0	0	6	2	0	0
47	3	12	0	0	7	9	6	0
46	7	30	1	0	16	32	6	6
45	7	40	0	0	6	25	13	3
44	9	39	0	0	6	24	5	7
43	1	40	0	0	5	41	13	7
42	3	51	0	0	6	42	11	0
41	9	43	2	0	8	37	0	6
40	4	44	0	0	8	38	1	12
39	3	45	0	1	5	38	0	9
38	2	55	0	0	6	43	0	17
37	2	28	0	0	3	30	0	11
36	0	25	0	4	1	35	0	3
35	1	29	0	4	5	48	0	4

Notes: 1. Rounded to the nearest whole decibel.

9.4.2 Short-Term – V162-5.6, HH-125m

Table E-2 in Appendix E shows the predicted "Project-Only" short-term broadband (dBA) and octave band (dB) sound levels under conditions specified in Section 9.3.2 sorted by modeling receptor ID for the V162-5.6 turbine model at a hub height of 125 meters. Table E-2.1 presents the same data sorted by sound level from high to low. The tables present modeled 1-hour L_{eq} sound levels at the 1,594 receptors included in the analysis. The broadband sound levels range from 27 to 51 dBA. All non-participating receptors meet the design goal of 45 dBA. All participating receptors meet the design goal of 55 dBA. As discussed previously, the 1-hour L_{eq} is equivalent to the nighttime 9-hour L_{eq} and to the daytime 15-hour L_{eq}.

Table 9-10 presents the number of sensitive noise receptors that have been modeled to experience a worst-case sound level of 35 dBA or greater. Modeled sound levels have been rounded to the nearest integer and presented in 1 dBA increments by receptor participation status. The highest non-participating receptors are predicted to be receptors #164, #824, #836, and #1042 at 45 dBA. The highest participating receptor is predicted to be receptor #1706 at 51 dBA.

Table 9-10   Participating and Non-Participating Receptors Modeled at 35 dBA or Greater---V162-5.6

Modeled L_{eq} Sound Level [dBA][1]	# of Receptors							
	Year-Round Residence		Seasonal Residence		Unknown		Public	
	Participating	Non-Participating	Participating	Non-Participating	Participating	Non-Participating	Participating	Non-Participating
51	0	0	0	0	1	0	0	0
50	0	0	0	0	1	0	0	0
49	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0
47	0	0	0	0	1	0	0	0
46	0	0	0	0	0	0	0	0
45	1	4	0	0	3	0	1	0
44	3	9	0	0	8	11	6	0
43	8	30	1	0	17	29	4	6
42	7	42	0	0	7	26	14	3
41	9	39	0	0	6	26	5	7
40	1	45	0	0	6	41	14	7
39	4	50	0	0	6	42	10	0
38	8	46	2	0	7	46	0	6
37	5	39	0	0	8	35	1	14
36	3	56	0	1	7	38	0	10
35	1	50	0	0	4	47	0	16

Notes: 1. Rounded to the nearest whole decibel.

9.4.3 Long-Term – ISO 9613-2 L_{10}, L_{50}, and Nighttime L_{EQ} Annual Sound Level Results

A full year of 2018 on-site meteorological data was used to determine the equivalent L_{10}, L_{50} and nighttime L_{EQ} sound power levels for each wind turbine type over an entire year as described in Section 9.3.3. The long-term sound levels have been analyzed using two methodologies. The first

method, "Method 1" (no zeros), includes only periods when the wind turbines are expected to be operating based on the annual meteorology (i.e., above cut-in wind speed). This is conservative in that there will be periods during the year when the sound level associated with the wind turbines will be zero as they will not be operating. These periods have the potential to reduce the sound levels for the various metrics presented in this analysis. The second method, "Method 2" (with zeros), includes all hours (both operational and non-operational periods) in the calculation. This is more realistic of long-term/annual conditions as there will be periods during a year when the wind turbines are not operating. For each of these long-term scenarios, the wind turbine with the highest resulting sound power level has been modeled. All other wind turbines being considered would result in lower long-term sound level impacts.

For annual L_{10} modeling, the wind turbine with the highest equivalent sound power level was the GE5.5-158, as shown in Table 9-7. For annual L_{50} modeling, the wind turbine with the highest equivalent sound power level was the GE5.5-158, as shown in Table 9-7. For annual nighttime $L_{eq, night, outside}$ modeling, the wind turbine with the highest equivalent sound power level was the GE5.5-158, as shown in Table 9-8.

Using the highest resulting sound power levels from Table 9-7, the annual Project L_{10} and L_{50} sound level at each noise sensitive location has been calculated. Using the highest resulting sound power levels from Table 9-8, the annual L_{eq} nighttime noise level ($L_{eq, night, outside}$) has been calculated at each of the modeled noise sensitive locations. $L_{eq, night, outside}$ is the equivalent continuous sound level determined over all nighttime periods during the year with the Exhibit 19 regulations defining nighttime as the period from 10 p.m. to 7 a.m. (1001.19(f)(2)). The definition, as presented in the 2009 WHO document, refers to ISO 1996-2: 1987 and identifies night as an eight-hour period. The more recent ISO 1996-1:2016 (Acoustics – description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures) defines $L_{eq, night, outside}$ and provides various time frames for a nighttime period.

$L_{eq, night, outside}$ Project sound levels range from 24 to 49 dBA for "Method 1" (no zeros) and 23 to 49 dBA for "Method 2" (with zeros) calculations. The highest $L_{eq, night, outside}$ level at a participating receptor is 49 dBA (Receptor ID 1706). The highest $L_{eq, night, outside}$ level at a non-participating receptor is 43 dBA (Receptor IDs 164; 810; 811; 824). In addition to these discrete modeling points, sound level contours generated from the modeling grid are presented in an overview figure, Figure 9-3, accompanied by a series of inset maps that provide a higher level of detail at all modeled receptors. This sound contour figure set for $L_{eq, night, outside}$ Project sound levels was generated only for the GE 5.5-158 model, because it has the highest A-weighted sound power level for this metric. Table 9-11 and Table 9-12 summarize the number of receptors equal to or greater than 40 dBA for the $L_{eq, night, outside}$ modeling for each of the two wind turbines under consideration.

Annual Project L_{10} sound levels range from 27 to 53 dBA for both the "Method 1" (no zeros) calculations and the "Method 2" (with zeros) calculations. The highest L_{10} level at a non-participating receptor is 46 dBA (Receptor IDs 164, 347, 836, 1042, 1047, and 1048).

Annual Project L_{50} sound levels range from 21 to 46 dBA for both the "Method 1" (no zeros) calculations and the "Method 2" (with zeros) calculations. The highest L_{50} level at a non-participating receptor is 41 dBA (Receptor IDs 164, 810, 811, and 824).

The annual L_{10}, L_{50}, and nighttime L_{EQ} ($L_{eq, night, outside}$) values for all receptors are presented in Table F-1 (Method 1 – No Zeros) and Table F-2 (Method 2 – With Zeros) in Appendix F.

Table 9-11   Number of Receptors Modeled at 40 dBA or Greater for L_{EQ}-night-outside---GE5.5-158

Modeled Leq Sound Level (dBA)[1]	Method 1 – Without Zeros		Method 2 – With Zeros	
	# of Receptors		# of Receptors	
	Participating	Non-Participating	Participating	Non-Participating
50	0	0	0	0
49	1	0	1	0
48	1	0	0	0
47	0	0	1	0
46	0	0	0	0
45	0	0	0	0
44	1	0	1	0
43	2	4	2	4
42	13	14	11	11
41	28	45	23	38
40	26	65	27	67

Notes: 1. Rounded to the nearest whole decibel.

Table 9-12   Number of Receptors Modeled at 40 dBA or Greater for L_{EQ}-night-outside---V162-5.6

Modeled Leq Sound Level (dBA)[1]	Method 1 – Without Zeros		Method 2 – With Zeros	
	# of Receptors		# of Receptors	
	Participating	Non-Participating	Participating	Non-Participating
50	0	0	0	0
49	0	0	0	0
48	0	0	0	0
47	1	0	1	0
46	0	0	0	0
45	1	0	1	0
44	0	0	0	0
43	0	0	0	0
42	2	3	2	3
41	2	1	1	1
40	9	10	9	7

Notes: 1. Rounded to the nearest whole decibel.

9.5   Total Sound Levels - Modeled Combined with Ambient

9.5.1   Assignment of Ambient Sound Levels to Modeling Locations

Measured ambient data were assigned to each modeling receptor based on proximity between measurement points and the similarity of the soundscape between the evaluated position and the location where the ambient noise levels were measured. Assumptions regarding the similarities of soundscapes were based on personal observations at each of the sound level measurement locations and on a review of the aerial imagery for the area. The modeling receptors were not visited during the measurement program to confirm/deny assumptions made regarding the soundscapes. Table G-1 in Appendix G presents the sound level modeling locations with their assigned ambient measurement location.

9.5.2   Future Total Sound Levels

The worst-case future noise level during the daytime period at all receptors has been determined by logarithmically adding the daytime ambient sound level (L_{90}), calculated from background sound level monitoring in the summer and winter, to the modeled upper tenth percentile sound level (L_{10}) of the Project as per Section 1001.19(f)(4) of the Article 10 regulations. The L_{10} statistical noise descriptor corresponds to estimates for one year of operation using the sound power levels for the GE5.5-158, as presented in Table 9-7. These worst-case total future annual sound levels range from 30 to 47 dBA for the Method 1 and the Method 2 calculations. These worst-case future noise levels during the daytime period are presented in Table G-2A (Method 1) and Table G-2B (Method 2) in Appendix G.

The worst-case future noise level during the summer nighttime period at all receptors has been determined by logarithmically adding the summer nighttime ambient sound level (L_{90}), calculated from background sound level monitoring, to the modeled upper tenth percentile sound level (L_{10}) of the Project as per Section 1001.19(f)(5) of the Article 10 regulations. The L_{10} statistical noise descriptor corresponds to estimates for summer nighttime period for one year of operation. Worst case future total summer nighttime noise levels range from 28 to 46 dBA for the Method 1 and the Method 2 calculations. These worst-case future noise levels during the summer nighttime period are presented in Table G-2A (Method 1) and Table G-2B (Method 2) in Appendix G.

The worst case future total noise level during the winter nighttime period at all receptors has been determined by logarithmically adding the winter nighttime ambient sound level (L_{90}), calculated from background sound level monitoring, to the modeled upper tenth percentile sound level (L_{10}) of the Project as per Section 1001.19(f)(6) of the Article 10 regulations. The L_{10} statistical noise descriptor corresponds to estimates for winter nighttime period for one year of operation. Worst case future winter nighttime noise levels range from 28 to 46 dBA for the Method 1 and the Method 2 calculations. These worst-case future noise levels during the winter nighttime period are presented in Table G-2A (Method 1) and Table G-2B (Method 2) in Appendix G.

The typical Project daytime noise level at all receptors, that has been determined by logarithmically adding the daytime equivalent average sound level (L_{eq}) calculated from background sound level monitoring, to the modeled median Project sound pressure level (L_{50}) as per Section 1001.19(f)(9) of the Article 10 regulations. The L_{50} statistical noise descriptor corresponds to estimates for one year of operation using the sound power levels for the GE5.5-158, as presented in Table 9-7. Typical Project daytime noise levels range from 47 to 64 dBA for the Method 1 and Method 2 calculations. These typical Project daytime noise levels are presented in Table G-2A (Method 1) and Table G-2B (Method 2) in Appendix G.

9.6 Infrasound and Low Frequency Sound

GE provided one-third octave band sound power level data from 12.5 Hz to 10,000 Hz for the GE5.5-158, and Vestas provided one-third octave band sound power level data from 6.3 Hz to 10,000 Hz for the V162-5.6. No reference sound power level data below 6.3 Hz are available from any of the manufacturers. Therefore, sound power level data were extrapolated from each manufacturer's lowest published octave band down to 0.5 Hz. The extrapolation process assumed a 1 dB per octave increase in sound power levels from the lowest published value to 0.5 Hz as shown in the research.[53] The infrasound and low frequency sound power levels are shown in Table 9-13, and represent the highest sound level under any wind speed from any turbine model for each one-third octave band.

Research by Hubbard and Shepherd,[54] and Health Canada[55] has shown that within approximately the first 1000 meters of a wind turbine, infrasound and low frequency sound levels decrease according to spherical spreading (-6 dB per doubling of distance). At distances beyond approximately 1000 meters, the one-third octave band levels below ~70 Hz propagate cylindrically at closer to 3 dB per doubling of distance. Therefore, infrasound and low frequency levels for the Project were calculated assuming the following:

- ♦ 80 Hz and above – decrease spherically at all distances

- ♦ 63 Hz and below – decrease spherically from 0 to 1000 meters; decrease cylindrically beyond 1000 meters

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

[54] *Aeroacoustics of large wind turbines,* H. Hubbard. And K. Shepherd, J. Acoust. Soc. Am. 89(6), June 1991.

[55] *Wind turbine sound pressure level calculations at dwellings,* S. Keith et al, J. Acoust. Soc. Am. 139(3), March 2016.

Using these parameters, infrasound and low frequency sound levels were calculated using a spreadsheet approach for the nearest ten receptors to any wind turbine. These receptors included non-participating and participating locations. These ten receptor locations were scattered throughout the wind farm and were at a diverse assortment of locations throughout the wind farm, thus providing a good mix of worst-case conditions.

If no impacts are shown for these locations, then other more distant locations will show even lower sound levels and thus no impacts as well. Only drop-off with distance and atmospheric absorption were included in the calculations. Atmospheric absorption values were taken from ANSI/ASA S1.26-2014 for a temperature of 10 degrees C and 70% relative humidity. This standard only provides absorption values for one-third octave bands of 50 Hz and above, therefore, no atmospheric absorption occurs below 50 Hz. No ground absorption was assumed.

Table 9-14 presents the receptors, the wind turbines included in the calculations, and the distance from the wind turbine to each receptor. Inclusion of the more distant wind turbines is not necessary since they have a negligible effect on overall values which are controlled by the closest turbine(s). The results are shown in Table 9-15 for both the one-third octave bands and full octave bands at each of the ten locations analyzed. The results in Table 9-15 show the cumulative impact of infrasound from multiple wind turbines at a given location.

Predicted infrasound levels at the nearest non-participating receptor (#754) 421 meters from a wind turbine are consistent with those measured at 350 meters in the Massachusetts Research Study on Wind Turbine Acoustics.

Table 9-13   Maximum Wind Turbine Sound Power Levels—Infrasound & LFN (any WTG model)

One-Third Octave Band	Sound Power Level (dB)
0.5	*121.4*
0.63	*121.0*
0.8	*120.7*
1	*120.4*
1.25	*120.0*
1.6	*119.7*
2	*119.4*
2.5	*119.0*
3.15	*118.7*
4	*118.4*
5	*118.0*
6.3	117.7
8	116.6
10	114.9
12.5	118.8
16	118.5
20	117.5
25	116.4
31.5	115.4
40	114.5
50	113.3
63	112.2
80	110.5
100	108.5
125	106.6
160	104.7
200	103.2

Note: italicized sound levels are extrapolated.

Table 9-14   Locations Analyzed for Infrasound & LFN

Receptor ID	Wind Turbine ID	Approximate Distance to Receptor (meters)
560	T7	349.6
	T8	1252.4
	T6	1813.8
	T5	2135.0
	T4	2402.2
631	T2	401.7
	T3	544.6
	T1	723.3
	T4	1111.5
	T5	1601.5
754	T13	421.2
	T19	1509.3
	T16	1541.7
	T18	1723.3
	T15	1863.0
836	T24	437.6
	T28	493.2
	T26	741.2
	T23	1114.5
	T22	1268.7
1137	T28	351.8
	T24	1243.5
	T26	1569.0
	T31	1632.8
	T30	1642.0
1215	T30	448.9
	T32	558.9
	T31	634.7
	T33	999.6
	T29	1012.1
1238	T6	393.8
	T5	657.8
	T4	1023.7
	T7	1228.9
	T3	1949.5

Table 9-14   Locations Analyzed for Infrasound & LFN (Continued)

Receptor ID	Wind Turbine ID	Approximate Distance to Receptor (meters)
1249	T3	417.2
	T4	737.9
	T1	911.7
	T2	992.1
	T5	1207.4
1640	T18	141.4
	T16	572.2
	T19	1064.3
	T21	1337.8
	T13	1759.9
1706	T16	90.6
	T18	744.7
	T19	1503.4
	T13	1733.5
	T21	1974.0

Table 9-15   Calculated Sound Levels—Infrasound & LFN (no NRO)

Location	One-Third Octave Band Center Frequency (Hz)																										
	0.5	0.63	0.8	1	1.25	1.6	2	2.5	3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
ID #560	64	63	63	63	62	62	62	61	61	61	60	60	59	57	61	61	60	59	58	57	55	54	52	50	48	46	45
Octave bands				67			66			65			64			65			62			59			53		
ID #631	65	64	64	64	63	63	63	62	62	62	61	61	60	58	62	62	61	60	59	58	56	55	53	51	49	47	46
Octave bands				68			67			66			64			66			63			60			54		
ID #754	62	62	62	61	61	61	60	60	60	59	59	59	58	56	60	60	59	57	56	56	54	53	51	49	47	45	43
Octave bands				66			65			64			62			64			61			58			52		
ID #836	64	64	64	63	63	63	62	62	62	61	61	61	60	58	62	62	61	60	59	58	56	55	53	51	49	47	46
Octave bands				68			67			66			64			66			63			60			54		
ID #1137	64	63	63	63	62	62	62	61	61	61	60	60	59	57	61	61	60	59	58	57	56	54	52	50	48	47	45
Octave bands				67			66			65			64			65			63			59			54		
ID #1215	64	64	64	63	63	63	62	62	62	61	61	61	60	58	62	62	61	59	58	58	56	55	53	51	49	48	46
Octave bands				68			67			66			64			66			63			60			55		

Table 9-15   Calculated Sound Levels—Infrasound & LFN (no NRO) (Continued)

Location	One-Third Octave Band Center Frequency (Hz)																										
	0.5	0.63	0.8	1	1.25	1.6	2	2.5	3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
ID #1238	64	63	63	63	62	62	62	61	61	61	60	60	59	57	61	61	60	59	58	57	56	55	53	51	49	47	45
Octave bands				68			67			66			64			66			63			59			54		
ID #1249	64	63	63	63	62	62	62	61	61	61	60	60	59	57	61	61	60	59	58	57	56	54	53	51	49	47	45
Octave bands				67			66			65			64			65			63			59			54		
ID #1640	71	70	70	70	69	69	69	68	68	68	67	67	66	64	68	68	67	66	65	64	63	62	60	58	56	54	53
Octave bands				75			74			73			71			73			70			66			61		
ID #1706	74	74	74	73	73	73	72	72	72	71	71	71	70	68	72	71	70	69	68	68	66	65	63	61	60	58	56
Octave bands				78			77			76			74			76			73			70			65		

LEGEND

▭	Project Area
●	Wind Turbine
▮	Substation
▨	Primary Laydown Area
▨	Alternative Laydown Area
●	Year-Round Residence
●	Seasonal Residence
●	Public
●	Unknown
▨	Participating Parcel
▨	Non-Participating Parcel
▨	NYS DEC Land
▬	State Route
▬	County Road
▭	Town Boundary
▭	County Boundary

Scale 1:57,600
1 inch = 4,800 feet

0   2,400   4,800
Feet

Ridgeway
Albion
Murray
Shelby
Barre
Clarendon
Alabama
Oakfield
Elba
Byron

Orleans County
Genesee County

Heritage Wind   Orleans County, New York

EPSILON
ASSOCIATES INC.

Figure 9-1
Sound Level Modeling Locations

Holley Rd

1120_74-1-43.122
1120_74-1-43.11
1120_74-1-43.2
1120_74-1-41.211
1120_74-1-42.11
1120_74-1-41.11
1120_74-1-23
1120_74-1-22
1120_74-1-21
1120_74-1-44
1120_74-1-42.212
1120_74-1-41.12
1120_85-1-4.1
1120_85-1-64
1120_85-1-3.1
1120_85-1-6
1120_85-1-7.1
1120_85-1-1.333
1120_85-1-1.322
1120_85-1-1.31
1120_85-1-1.331
1120_85-1-8.12
1120_85-1-1.321
1120_85-1-8.11
1120_85-1-63
1120_85-1-2.2
1120_85-1-1.11
1120_85-1-1.211
1120_85-1-2.1
1120_85-1-32.11
1120_85-1-32.12
Riches Corners Rd
1120_85-1-34.11
1120_85-1-31.21
1120_85-1-12.1
1120_85-1-65
1120_85-1-31.113
1120_85-1-13.1
30
1120_85-1-37.1
30
1120_85-1-66
1120_85-1-14
1120_85-1-60.2
E County House Rd
Orleans County
Albion
1120_85-1-62
1120_85-1-31.112
1120_85-1-15.1
1120_85-1-35.1
1120_85-1-61
1120_85-1-60.1
1120_85-1-31.12
1120_85-1-26
1120_85-1-17.1
1120_85-1-24.2
1120_85-1-23
1580
1120_85-1-27
1120_85-1-30.12
1584
1120_85-1-24.1
1570
1581
1577
1583
1120_85-1-43.12
1120_85-1-40.2
1120_85-1-35
1582
1576
1120_85-1-30.11
1120_85-1-22.2
1120_85-1-37.5
1120_85-1-28
1575
1120_85-1-29.2
1570
1120_85-1-22.1
E Lee Rd
1595
1120_85-1-4.1
1576
1572
1579
1120_85-1-43.11
1120_85-1-42.1
Gilbey Rd
1574
1120_85-1-42.2
1120_85-1-40.1
1120_85-1-38
1120_85-1-30.2
1573
1120_85-1-47
1120_85-1-29.1
1120_85-1-45

bing

Legend

▭	Project Area
●	GE 5.5-158 LNTE Turbine, HH = 125.4m
▭	Substation
▭	Primary Laydown Area
▭	Alternative Laydown Area
●	Year-Round Residence
·	Seasonal Residence
○	Public
·	Unknown
▭	Participating Parcel
▭	Non-Participating Parcel
▭	NYS DEC Land
▭	Town Boundary
▭	County Boundary

Predicted Sound Level (dBA)
— 5 dBA Contour Interval
— 1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Index grid: 1 2 3 4 5 / 6 7 8 9 10 11 12 13 14 / 15 16 17 18 19 20 21 22 23 24 25 / 26 27 28 29 30 31 32 33 34 35 36 / 37 38 39 40 41 42 43 44 45 46 47 48 49 / 50 51 52 53 54 55 56 57 58 59 60 61 62 / 63 64 65 66 67 68 69 70 71 72 73 74 / 75 76 77 78 79 80 81 82 83 84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 1 of 84
Short-Term Sound Level Modeling Results

Holley Rd

1120_74-1-21   1120_74-1-20

1120_85-2-1.1   1120_85-2-2   30

1120_85-1-10.1

30

1120_85-2-1.22

1120_85-1-8.11

1120_85-1-10.2

1120_85-2-3.1

1120_85-1-9

1120_85-1-12.1

1120_85-2-1.21

E County House Rd   1591

1592

Albion

Orleans County

1120_85-1-11

1120_85-1-15.1

35

1120_85-2-44

1120_85-1-17.1   1120_85-2-38   1120_85-2-45

1120_85-1-23   1120_85-1-17.2   1120_85-2-36   1120_85-2-40   1120_85-2-46

1585   1586   1120_85-2-37   1120_85-2-39   1120_85-2-42

1597   1598   1120_85-2-35   1120_85-2-43

1120_85-2-34.12   1120_85-1-18   1563   1120_85-1-19

E Lee Rd

1120_85-1-22.2   1120_85-1-21   1561

1120_85-1-20   1120_85-1-22.1

Legend

Project Area		**Predicted Sound Level (dBA)**	
⬤ GE 5.5-158 LNTE Turbine, HH = 125.4m	○ Public	5 dBA Contour Interval	
	• Unknown	1 dBA Contour Interval	
Substation	**Participating Parcel**		
Primary Laydown Area	**Non-Participating Parcel**	Scale 1:4,800	
Alternative Laydown Area	**NYS DEC Land**	1 inch = 400 feet	
◉ Year-Round Residence	**Town Boundary**	0 200 400	
• Seasonal Residence	**County Boundary**	Feet	

Heritage Wind   Orleans County, New York

EPSILON

Figure 9-2, Map 2 of 84
Short-Term Sound Level Modeling Results

30

1120_85-2-4

1120_85-2-5.11

1120_85-2-8

1120_85-2-9

30

1120_85-2-48

Transit Rd

1120_85-2-5.2

1120_85-2-47.3

159.3

Holley Rd

1120_85-2-7.11

1120_85-2-47.2

1120_85-2-3.1

Albion

Murray

Orleans County

35

1120_85-2-47.1

1594

1120_85-2-13

1120_85-2-20

1120_85-2-18

1120_85-2-26

1120_85-2-24

1120_85-2-23

1120_85-2-22

1120_85-2-21

1120_85-2-19

1120_85-2-25

1120_85-2-46

1120_85-2-14

40

1120_85-2-17.11

Clarendon

bing

Legend

▢ Project Area	○ Public	**Predicted Sound Level (dBA)**	
● GE 5.5-158 LNTE Turbine, HH = 125.4m	● Unknown	— 5 dBA Contour Interval	
▢ Substation	▢ Participating Parcel	— 1 dBA Contour Interval	
▢ Primary Laydown Area	▢ Non-Participating Parcel		
▢ Alternative Laydown Area	▢ NYS DEC Land		
● Year-Round Residence	▢ Town Boundary		
• Seasonal Residence	▢ County Boundary		

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

1	2	3	4	5
6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

Heritage Wind   Orleans County, New York

EPSILON

Figure 9-2, Map 3 of 84
Short-Term Sound Level Modeling Results

G:\Projects2\NY5078\LAYOUT_034\MXD\9-2_Short-Term_Sound_Level_Modeling_Results_20190927.mxd

30

30

30

1355
1354

Holley Rd
1349 1348 1350 1352
1351 1353

Murray

Orleans
County

Hinsburg Rd

1347
1344
1346 1345 1343

1339 1340

1338

1342
1341

1357
1358
1356

35

1359 1361
1360 1599
1534 1535 1537 1536
1533

bing

Clarendon

Legend

Project Area
GE 5.5-158 LNTE Turbine, HH = 125.4m
Substation
Primary Laydown Area
Alternative Laydown Area
Year-Round Residence
Seasonal Residence

Public
Unknown
Participating Parcel
Non-Participating Parcel
NYS DEC Land
Town Boundary
County Boundary

Predicted Sound Level (dBA)
5 dBA Contour Interval
1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

| 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36
37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62
63 64 65 66 67 68 69 70 71 72 73 74
75 76 77 78 79 80 81 82 83 84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 4 of 84
Short-Term Sound Level Modeling Results

Fanchur Rd

State Route 31

Holley Rd

Murray

Orleans
County

S Fancher Rd

30

Clarendon

bing

Legend			
Project Area	Public	**Predicted Sound Level (dBA)**	
GE 5.5-158 LNTE Turbine, HH = 125.4m	Unknown	5 dBA Contour Interval	
Substation	Participating Parcel	1 dBA Contour Interval	
Primary Laydown Area	Non-Participating Parcel		
Alternative Laydown Area	NYS DEC Land	Scale 1:4,800	
Year-Round Residence	Town Boundary	1 inch = 400 feet	
Seasonal Residence	County Boundary	0 200 400 Feet	

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 5 of 84
Short-Term Sound Level Modeling Results

Heritage Wind   Orleans County, New York

Figure 9-2, Map 6 of 84
Short-Term Sound Level Modeling Results

Albion

1120_84-1-58.112

1120_83-1-29.11

1120_84-1-56.1

1120_84-1-56.2

1120_84-1-55.2

1120_84-1-55.1

1120_84-1-54

1120_84-1-61.12

1120_84-1-60.1

1120_84-1-43.11

1120_84-1-44.11

1120_84-1-52.11

1120_84-1-50

1120_84-1-53

1120_84-1-52.12

1120_84-1-52.2

E Lee Rd

1120_84-1-51

1120_94-1-21.1

1120_95-1-6

W Lee Rd

30

1120_95-1-3.2

1120_95-1-3.1

1120_95-1-4

1120_95-1-7

1120_95-1-8

1120_95-1-9.12

1120_95-1-14.112

1120_95-1-14.111

1120_95-1-13

Oak Orchard Rd

1120_95-1-5

1120_95-1-9.11

Orleans County

1120_95-1-2.1

1120_95-1-1.11

1120_95-1-9.2

Barre

1120_95-1-12

1120_95-1-11

1120_95-1-10

1120_95-1-54

1120_95-1-53.1

1120_95-1-1.12

1120_95-1-55.12

1120_95-1-55.2

1120_95-1-55.11

1120_95-1-53.3

1120_95-1-56

1120_95-1-63.1

1120_94-1-23

1120_95-1-57

1120_95-1-58

1120_

1120_95-1-62A

1120_95-1-62

1120_95-1-59.1

1120_95-1-52.11

1120_95-1-63.3

1120_95-1-63.2

bing

Legend

Project Area	Public	**Predicted Sound Level (dBA)**
GE 5.5-158 LNTE Turbine, HH = 125.4m	Unknown	5 dBA Contour Interval
Substation	Participating Parcel	1 dBA Contour Interval
Primary Laydown Area	Non-Participating Parcel	
Alternative Laydown Area	NYS DEC Land	
Year-Round Residence	Town Boundary	
Seasonal Residence	County Boundary	

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

					1	2	3	4	5
				6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 7 of 84
Short-Term Sound Level Modeling Results

Albion

1120_84-1-43.11
1120_84-1-43.22
1120_84-1-43.12
1120_84-1-43.21
1120_84-1-42
1120_84-1-31.11
1120_84-1-31.122
1120_84-1-44.11
1120_84-1-35.11
1120_84-1-22
1120_84-1-50
1120_84-1-45.111
1120_84-1-29
1120_84-1-30.1
1120_84-1-24
1120_84-1-25
30
30
1120_84-1-49.1
1120_84-1-46
E Lee Rd
1120_84-1-47
1120_84-1-73
1120_84-1-26.1
1120_84-1-26.2
1120_84-1-27
1120_84-1-74.1
1120_84-1-28.1
1120_84-1-51
1120_84-1-45.12
1120_95-1-15.2
1120_95-1-15.11
1120_95-1-15.12
1120_95-1-16.2
1120_95-1-16.1
1120_95-1-17

Orleans
County

1120_95-1-14.111
1120_95-1-14.111
30
1120_95-1-11

Barre

1120_95-1-20
1120_95-1-53.2
1120_95-1-53.3
1120_95-1-29
1120_95-1-53.1

bing

▢ Project Area	○ Public
⬤ GE 5.5-158 LNTE Turbine, HH = 125.4m	● Unknown
▢ Substation	▢ Participating Parcel
▢ Primary Laydown Area	▢ Non-Participating Parcel
▢ Alternative Laydown Area	▢ NYS DEC Land
● Year-Round Residence	▢ Town Boundary
● Seasonal Residence	▢ County Boundary

Predicted Sound Level (dBA)
5 dBA Contour Interval
1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 8 of 84
Short-Term Sound Level Modeling Results

30

Lewis Rd

1120_84-1-16-2

E Lee Rd

1120_84-1-17

1120_84-1-18.1

1120_85-1-43.12

1120_84-1-18.2

1120_85-1-58

1120_85-1-43.2

1120_85-1-50

1120_84-1-21.1

1120_84-1-20.11

1120_85-1-51

1120_85-1-55

1120_85-1-56

1120_84-1-19

Albion

1120_84-1-76.1

1120_85-1-54

1120_85-1-43.3

1120_85-1-57.1

1120_84-1-22

1120_85-1-53.1

1120_85-3-3

1120_84-1-16.12

1120_85-3-2

1120_95-1-17

1120_95-1-18

1120_85-3-1

Orleans County

Barre

1120_96-1-1

1120_95-1-20

1120_95-1-19.121

1120_95-1-22

1120_96-1-65.1

1120_95-1-21.1

bing

1120_95-1-19.112

Project Area	Public	**Predicted Sound Level (dBA)**	
GE 5.5-158 LNTE Turbine, HH = 125.4m	Unknown	5 dBA Contour Interval	
Substation	Participating Parcel	1 dBA Contour Interval	
Primary Laydown Area	Non-Participating Parcel		
Alternative Laydown Area	NYS DEC Land		
Year-Round Residence	Town Boundary		
Seasonal Residence	County Boundary		

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

1	2	3	4	5
6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 9 of 84
Short-Term Sound Level Modeling Results

1120_85-1-46
1120_85-1-49 1120_85-1-45
1120_85-1-48
1120_85-1-43-2

Albion

1120_85-1-29-2 1120_85-1-29-1

1120_85-1-38

1120_85-1-30-2

1120_85-1-22-1

1120_85-1-47

1120_85-1-43-3

1120_85-3-3

1120_85-3-6-2

1231
1230

1120_85-3-7

1120_85-3-8

1120_85-3-9-1

1120_85-3-4

1120_85-3-5

1120_85-3-6-1

Orleans County

Culver Rd

1120_85-3-9-2

1120_96-1-4-12

463 1209
1208 1120_96-1-4-11

Barre

1120_96-1-2

459 1201
457 1202

1200 462 1120_96-1-3
1206 1205 450 1193 1194
1192
35
1120_96-1-4-22
1120_96-1-4-21

1120_96-1-1

1120_96-1-32

1181
1179

1120_96-1-66

1120_96-1-33

1180

1120_96-1-65-1

1120_96-1-65-2

1120_96-1-67

1120_96-1-52

1120_96-1-34

bing

Legend		
Project Area	Public	**Predicted Sound Level (dBA)**
GE 5.5-158 LNTE Turbine, HH = 125.4m	Unknown	5 dBA Contour Interval
Substation	Participating Parcel	1 dBA Contour Interval
Primary Laydown Area	Non-Participating Parcel	
Alternative Laydown Area	NYS DEC Land	
Year-Round Residence	Town Boundary	
Seasonal Residence	County Boundary	

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 10 of 84
Short-Term Sound Level Modeling Results

Figure 9-2, Map 11 of 84
Short-Term Sound Level Modeling Results

40

1120_85-2-25

1120_85-2-26

1120_85-2-46

40

1120_85-2-27.1

1120_85-2-17.11

Albion

1120_85-2-14

1120_85-2-15

1564

1120_85-2-17.12

1553

1563

1569

1566

1567

1120_85-2-16.1

1552

1568

1565

1551

Clarendon

Powerline Rd

1120_85-3-21

1232

1234

1233

1120_85-3-20.2

1135

1236

45

1120_85-3-20.1

1120_85-3-22

50

Orleans County

T29

55

T33

55

Barre

1120_96-1-9

T30

55

T32

55

1120_96-1-8.1

b bing

Heritage Wind   Orleans County, New York

	Legend
☐	Project Area
🟡	GE 5.5-158 LNTE Turbine, HH = 125.4m
🟧	Substation
	Primary Laydown Area
	Alternative Laydown Area
◉	Year-Round Residence
•	Seasonal Residence
○	Public
•	Unknown
	Participating Parcel
	Non-Participating Parcel
	NYS DEC Land
	Town Boundary
	County Boundary

Predicted Sound Level (dBA)
— 5 dBA Contour Interval
— 1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

1	2	3	4	5
6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

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Figure 9-2, Map 12 of 84
Short-Term Sound Level Modeling Results

Powerline Rd

Hindsburg Rd

Orleans
County

Clarendon

35

40

45

bing

Legend

- Project Area
- GE 5.5-158 LNTE Turbine, HH = 125.4m
- Substation
- Primary Laydown Area
- Alternative Laydown Area
- Year-Round Residence
- Seasonal Residence

- Public
- Unknown
- Participating Parcel
- Non-Participating Parcel
- NYS DEC Land
- Town Boundary
- County Boundary

Predicted Sound Level (dBA)
- 5 dBA Contour Interval
- 1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

1	2	3	4	5
6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 13 of 84
Short-Term Sound Level Modeling Results

Powerline Rd

30

Clarendon
Orleans
County

N Manning Rd

S Fancher Rd

35

30

1531
1540

1503
1502

1474
1475

1465

1460
1459
1461

bing

Legend:

Project Area	○ Public		**Predicted Sound Level (dBA)**
● GE 5.5-158 LNTE Turbine, HH = 125.4m	● Unknown		── 5 dBA Contour Interval
Substation	Participating Parcel		── 1 dBA Contour Interval
Primary Laydown Area	Non-Participating Parcel		
Alternative Laydown Area	NYS DEC Land		
● Year-Round Residence	Town Boundary		
· Seasonal Residence	County Boundary		

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 14 of 84
Short-Term Sound Level Modeling Results

1120_94-1-72.2 1120_94-1-74.112 1120_94-1-4 1120_94-1-69

1120_94-1-70

1120_94-1-72.1 1120_94-1-58.1

W Lee Rd

1120_94-1-57.3

1120_94-1-62

1120_94-1-57.1

1120_94-1-60

1120_94-1-61

1120_94-1-58.2

1120_94-1-57.21

Barre

Orleans
County

1120_94-1-57.22

1120_94-1-55

1120_94-1-59

1120_94-1-50.111

30

1120_94-1-54

1120_94-1-50.113

1120_94-1-46

1120_94-1-50.114 1120_94-1-45.131

bing

Project Area		Public	**Predicted Sound Level (dBA)**	
GE 5.5-158 LNTE Turbine, HH = 125.4m		Unknown	5 dBA Contour Interval	
Substation		Participating Parcel	1 dBA Contour Interval	
Primary Laydown Area		Non-Participating Parcel		
Alternative Laydown Area		NYS DEC Land		
Year-Round Residence		Town Boundary		
Seasonal Residence		County Boundary		

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

					1	2	3	4	5	
	6	7	8	9	10	11	12	13	14	
	16	17	18	19	20	21	22	23	24	25
	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 15 of 84
Short-Term Sound Level Modeling Results

1120_94-1-67

30

1120_94-1-66.11

1120_94-1-34.1

1120_94-1-62

1120_94-1-66.12

1120_94-1-66.2

1120_94-1-65.1

1120_94-1-64.122

392 1133

1120_94-1-64.2

1120_94-1-63 1132

Barre

Orleans
County

391 1120_94-1-64.11

1120_94-1-51

1120_94-1-50.112

1120_94-1-36.2

385

1120_94-1-36.1

1120_94-1-50.111

1120_94-1-49

378

1123 1124 1125

1120_94-1-48

376 1105

818

1120_94-1-47

372 1102 159 819

1101 1120_94-1-37.1

1120_94-1-37.2

1120_94-1-41.1

35

1120_94-1-46

1081

1083

1082

1120_94-1-45.131

1120_94-1-45.11

bing

1064 1063

Legend

Project Area	○ Public	**Predicted Sound Level (dBA)**
● GE 5.5-158 LNTE Turbine, HH = 125.4m	• Unknown	— 5 dBA Contour Interval
Substation	Participating Parcel	— 1 dBA Contour Interval
Primary Laydown Area	Non-Participating Parcel	
Alternative Laydown Area	NYS DEC Land	
● Year-Round Residence	Town Boundary	
• Seasonal Residence	County Boundary	

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Heritage Wind   Orleans County, New York

Figure 9-2, Map 16 of 84
Short-Term Sound Level Modeling Results

Epsilon

1120_94-1-29

1120_95-1-62A

1120_94-1-27

1120_94-1-23

1120_95-1-61.111A

1120_95-1-61.12A

1120_94-1-34.1

1120_94-1-30

1120_94-1-75

1120_95-1-43.1

1120_95-1-35.11

Barre

Orleans County

1120_94-1-36.2

1120_95-1-47-2.22

35

1120_95-1-46.2

1120_94-1-37.2

1120_94-1-38

1120_95-1-45

1120_94-1-41.1

1120_95-1-44.1

bing

40

Project Area		○ Public		**Predicted Sound Level (dBA)**	
⬤ GE 5.5-158 LNTE Turbine, HH = 125.4m		• Unknown		5 dBA Contour Interval	
■ Substation		Participating Parcel		1 dBA Contour Interval	
Primary Laydown Area		Non-Participating Parcel			
Alternative Laydown Area		NYS DEC Land			
○ Year-Round Residence		Town Boundary			
• Seasonal Residence		County Boundary			

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

	1	2	3	4	5
6	7	8	9	10 11 12 13 14
15 16 **17** 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36
37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62
63 64 65 66 67 68 69 70 71 72 73 74
75 76 77 78 79 80 81 82 83 84

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 17 of 84
Short-Term Sound Level Modeling Results

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 18 of 84
Short-Term Sound Level Modeling Results

1120_95-1-21.1
1120_95-1-63.1
1120_95-1-51.2
1120_95-1-51.3
1120_95-1-51.112
1166
415
410
437
1165
1120_95-1-51.12
1120_95-1-51.13
Lime Kiln Rd
1686
1120_95-1-30.1
1120_95-1-31
1687
405
1120_95-1-32
1688
1689
1120_95-1-29
1120_95-1-33
1120_95-1-30.2
1120_95-1-21.2
35
1120_95-1-28.2
Barre
*Orleans
County*
1120_95-1-27.1
1120_95-1-23.2
1120_95-1-26.21
1120_95-1-26.12
1120_95-1-24
1120_95-1-26.22
1075
1076
1120_95-1-25.23
1074
bing
1120_95-1-66
1120_95-1-65

▪ Project Area	○ Public	**Predicted Sound Level (dBA)**
● GE 5.5-158 LNTE Turbine, HH = 125.4m	▪ Unknown	── 5 dBA Contour Interval
▪ Substation	▫ Participating Parcel	── 1 dBA Contour Interval
▫ Primary Laydown Area	▫ Non-Participating Parcel	
▫ Alternative Laydown Area	▪ NYS DEC Land	
● Year-Round Residence	▫ Town Boundary	
▪ Seasonal Residence	▫ County Boundary	

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

									1	2	3	4	5
				6	7	8	9	10	11	12	13	14	
		15	16	17	18	**19**	20	21	22	23	24	25	
		26	27	28	29	30	31	32	33	34	35	36	
	37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62	
63	64	65	66	67	68	69	70	71	72	73	74		
75	76	77	78	79	80	81	82	83	84				

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 19 of 84
Short-Term Sound Level Modeling Results

1120_95-1-19.121

1120_95-1-19.112

1120_95-1-21.1

1120_95-1-19.22

1120_95-1-19.1

1120_95-1-65.1

1120_95-1-22

413

414

439

440

1190

413

1188

1189

Lime Kiln Rd

35

1120_95-1-21.2

1120_95-1-23.1

Barre

Orleans County

1120_95-1-64

Slime Kiln Rd

393

1134

1108

1120_95-1-23.2

363

1071

1072

1120_95-1-63

1120_95-1-24

1120_95-1-65.23

40

1120_106-1-10.1

1120_95-1-62.2

Legend		
Project Area	Public	**Predicted Sound Level (dBA)**
GE 5.5-158 LNTE Turbine, HH = 125.4m	Unknown	5 dBA Contour Interval
Substation	Participating Parcel	1 dBA Contour Interval
Primary Laydown Area	Non-Participating Parcel	
Alternative Laydown Area	NYS DEC Land	
Year-Round Residence	Town Boundary	
Seasonal Residence	County Boundary	

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

1	2	3	4	5				
6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74
75	76	77	78	79	80	81	82	83	84

Heritage Wind   Orleans County, New York

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Figure 9-2, Map 20 of 84
Short-Term Sound Level Modeling Results

Barre
Orleans
County

Legend:

Project Area
GE 5.5-158 LNTE Turbine, HH = 125.4m
Substation
Primary Laydown Area
Alternative Laydown Area
Year-Round Residence
Seasonal Residence

Public
Unknown
Participating Parcel
Non-Participating Parcel
NYS DEC Land
Town Boundary
County Boundary

Predicted Sound Level (dBA)
5 dBA Contour Interval
1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Heritage Wind   Orleans County, New York

Εpsilon

Figure 9-2, Map 21 of 84
Short-Term Sound Level Modeling Results

Legend

Project Area	
GE 5.5-158 LNTE Turbine, HH = 125.4m	
Substation	
Primary Laydown Area	
Alternative Laydown Area	
Year-Round Residence	
Seasonal Residence	

Public	
Unknown	
Participating Parcel	
Non-Participating Parcel	
NYS DEC Land	
Town Boundary	
County Boundary	

Predicted Sound Level (dBA)
- 5 dBA Contour Interval
- 1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400 Feet

Heritage Wind   Orleans County, New York

ΞPSILON

Figure 9-2, Map 22 of 84
Short-Term Sound Level Modeling Results

Figure 9-2, Map 23 of 84
Short-Term Sound Level Modeling Results

Heritage Wind   Orleans County, New York

Epsilon

Legend:

- Project Area
- GE 5.5-158 LNTE Turbine, HH = 125.4m
- Substation
- Primary Laydown Area
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- 5 dBA Contour Interval
- 1 dBA Contour Interval

Scale 1:4,800
1 inch = 400 feet

0   200   400
Feet

Heritage Wind   Orleans County, New York

Epsilon

Figure 9-2, Map 24 of 84
Short-Term Sound Level Modeling Results