Henvey Inlet Wind LP

Henvey Inlet Wind

Henvey Inlet Wind Energy Centre

Noise Impact Assessment

Final Draft

DNV·GL

HENVEY INLET WIND PROJECT

Renewable Energy Approval Application - Noise Impact Assessment

Henvey Inlet Wind LP

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1 INTRODUCTION

GL Garrad Hassan Canada, Inc. ("DNV GL") was retained by Henvey Inlet Wind LP (the "Proponent" or "Pattern") to prepare a Noise Impact Assessment (NIA) of the Henvey Inlet Wind Project (the "Project").

Although the Project is located within the Henvey Inlet First Nation Reserve, on federal land, it is important to note that this NIA was prepared in accordance with the Ontario Regulation 359/09 (Renewable Energy Approvals [REA] under Part V.0.1 of the Ontario Environmental Protection Act [EPA]) [1]. It also follows the Ontario Ministry of the Environment and Climate Change (MOECC) 2008 NPC Noise Interpretation Guidelines [2] (the Noise Guidelines).

The proposed Project is located approximately 70 km north of Parry Sound, and on the east cost of the Georgian Bay. The layout being evaluated was provided by the Proponent [3] and consists of 99 wind turbine locations. The current layout has a nameplate capacity of 317.4 MW. DNV GL notes that the anticipated nameplate capacity of the Project is estimated to be 300 MW. The proposed layout contains four different V126 Vestas wind turbines models. The two substation transformer locations have been determined and they have been included in this assessment.

The objective of this assessment is twofold:

1. Confirm the sound level limit requirements for the Project by providing an assessment of the existing baseline environmental noise conditions in the vicinity of the wind farm; and
2. Predict the noise levels generated by the Project at all Points of Reception (PoR) within 1,500 m of the Project turbines. Note, all receptors located on Reserve lands are considered a "Participating Receptor" for the purpose of this assessment, thus MOECC noise limits do not apply.

2 GENERAL DESCRIPTION OF PROJECT SITE

2.1 General characteristics

A map of the Project area is shown in Appendix A. Project components will be installed on Henvey Inlet First Nation Reserve land. Energy generated by the Project will be collected via overhead or underground cabling and directed to two on-site substations. The Project can be considered to have a North section and a South section, divided by the inlet.

The Project lies on predominantly flat woodland that includes various water bodies and wetlands. Figure 2-1 shows an example of a typical view of the land and features of the study area.

2.2 Land use description

The development pattern is typical of the Georgian Bay East coast area. Dwellings are located mostly along the coast line of the Georgian Bay and Key River. The Project area is currently used for outdoor recreational purposes. The surrounding area mostly consists of Crown Land and French River Provincial Park. There are no operational wind farms or solar farms within 5 km of the project area. Figure 2-1 presents a typical view of the land from the shore line, including typical natural features of the Project area.

Figure 2-1 Sample photo of the Project study area

2.3 Points of reception

The Noise Guidelines generally define a point of reception (PoR) as a house, campground, church, school or other sensitive building that is not located on the same premises as the wind farm, including its turbines and ancillary structures. A PoR can also be located on a vacant lot (vacant lot receptor or VLR) that has residence as a permitted use and are identified as Vacant Lot Receptors (VLR).

The Project is located on First Nation Reserve land where no set lots are delineated within the Reserve. DNV GL consulted the First Nation Band to understand the future Band uses of the Project area. The First Nations Band has indicated that the building of the turbines will not impact any future uses on the site. The project area is surrounded by Crown Land, and French River Provincial Park. No new dwellings are permitted within the areas surrounding the Project. No campsites within French River Provincial Park are located 1,500 m from the Project.

DNV GL concludes that there are no VLRs within the Project area or within 1,500 m of the Project as per the O. Reg. 359/09 and the Noise Guidelines since all private lands contain an existing dwelling.

PoR locations for the Project, also referred to as receptors, were identified by DNV GL using base data from recent aerial photos and field reconnaissance completed in June 2015 to verify locations and building types. The height of each PoR, taken to be 1.5 m for one-storey houses and 4.5 m for two-storey houses, was also noted. All PoRs, as defined by the Noise Guidelines, are considered in this NIA.

A residence or VLR located on the same premises as the wind turbine(s) or other Project infrastructure is not a PoR as defined by the Noise Guidelines, and considered a “Participating Receptor” and thus MOECC noise limits do not apply. Any residence located on the First Nation Reserve was considered a Participating Receptor in this study.

The coordinates of all PoRs and Participating Receptors are listed in Appendix C, respectively.

3 DESCRIPTION OF POINTS OF RECEPTION

There are 25 receptors located within 1,500 m of a Project wind turbine or the substation, among which none are VLRs. There are 5 Participants within 1,500 m, of which none are VLRs.

3.1 Receptor classes

The MOECC categorizes PoR into three classes: 1, 2, and 3. Class 1 refers to an acoustic environment typical of a major population centre where the background noise is dominated by the urban hum. These areas are highly urbanized and have moderate to high noise levels throughout the day and night. Class 2 areas have an acoustic environment characterized by low ambient sound levels between 19:00 and 07:00, whereby the evening and nighttime levels are defined by natural sounds, infrequent human activity and no clearly audible sounds from stationary sources (e.g., industrial and commercial facilities). Class 3 areas are typical of rural and/or small communities (i.e., with populations of less than 1000) and an acoustic environment that is dominated by natural sounds with little or no road traffic.

Within the study area the main sources of ambient sound that currently exist include:

- Vehicular traffic on the local and side roads, some of which are gravel roads;
- Small motorized boats on the rivers and bay;
- Outdoor recreational uses sounds;
- Occasional sounds due to anthropogenic domestic activities; and
- Natural sounds.

Based on these conditions, **all PoR are considered as having a Class 3 acoustic environment.**

3.2 Determination of applicable noise limits

As stated in the MOECC guidelines [2], the noise limits for a wind farm are set according to the Noise Guidelines in NPC-205/NPC-232 while taking into account the wind-generated background noise.

For a Class 3 area, the sound level limits as defined in the Noise Guidelines are described in the sections below.

3.2.1 Wind turbine installations in Class 3 areas (rural), wind speeds below 6 m/s

The lowest sound level limit expressed in terms of L_{eq} is: i) 40 dBA; or ii) the minimum hourly background sound level established in accordance with Publications NPC-232/NPC-233, whichever is higher.

3.2.2 Class 3 areas, wind speeds above 6 m/s

The lowest sound level limit expressed in terms of L_{eq} is: i) the wind-induced background sound level, expressed in terms of ninetieth percentile sound level (L_{A90}) plus 7 dB; or ii) the minimum hourly background sound level established in accordance with Publications NPC-205/NPC-232/NPC-233, whichever is higher.

The applicable noise limits should be those defined by the MOECC as summarized below in Table 3-1.

Table 3-1 Summary of noise limits for points of reception (Class 3)

Wind Turbine Noise Criterion NPC-232 [dBA]	Wind Speed [m/s]				
	6	7	8	9	10
	40	43	45	49	51

4 DESCRIPTION OF SOURCES

4.1 Turbine description

Four Vestas turbine models are under consideration, as described in Table 4-1. The proposed turbine models are all 3-bladed, upwind, horizontal-axis turbines. The rotor diameter of each wind turbine model is 126 m.

Table 4-1 Summary of turbine models used at the Henvey Inlet Site

Turbine model nameplate	Maximum rated power [MW]	Hub height [m]	Peak sound power level [dBA]	Number of turbines
V126-3.3MW Mode 0 Serrated trailing edges, max. power 3300kW	3.3	117	106.0	90
V126-3.3MW Mode 2 Serrated trailing edges, max. power 3175kW	3.175	117	104.5	1
V126-3.3MW Mode 3 Serrated trailing edges, max. power 2979kW	2.979	117	102.5	4
V126-3.3MW Mode 4 Serrated trailing edges, max. power 1325kW	1.325	117	98.3	4
			Total	**99**

Full noise specifications as provided by the manufacturer to the Proponent can be found in Appendix D. Coordinates of all turbines are listed in Appendix E, including a description of which turbine model is used at each wind turbine location for the Project.

4.2 Substation

The Project includes two substation located in the Project Area and in close proximity to the wind turbines. One is located on the North section of the Project and the other on the South section of the Project area. Each substation is planned to include one transformer [4]. The estimated noise emissions of the Henvey Inlet transformers are described in Section 5.3.

The transformer coordinates, as provided by the Proponent, are included in Appendix E.

4.3 Adjacent wind farms

DNV GL has identified no operational wind farms adjacent to the Project.

4.4 Sound barrier

No sound barrier is planned for the Project substations.

5 NOISE EMISSION RATINGS

5.1 Henvey Inlet turbines

Guaranteed broadband sound power levels and octave band sound power levels were provided by Vestas [5] for each of the four wind turbine modes under consideration and are shown in Appendix D. For each mode, Vestas has provided octave-band sound power levels corresponding to 117 m height wind speeds of 3 to 20 m/s. Vestas has also provided a comfort letter [6], included in Appendix D, which guarantees the maximum broadband sound power level of each turbine model. Using the provided octave-band power levels for each wind speed provided, a number of wind speeds had to be scaled to total the full sound power level. This is noted in Table 5-1 to Table 5-4.

A noise measurement campaign of the turbines in accordance with IEC 61400–11 Ed. 3 [7] was not available at the time of preparing this report.

For each wind turbine mode, DNV GL has determined which octave band sound power levels corresponding to a 117 m wind speed contribute to the greatest sound pressure level all receptors. For Noise Mode 0 with serrated trailing edges, the octave-band PWL corresponding to a 117 m wind speed of 17 m/s contributes the greatest sound pressure level at all receptors. For Noise Mode 2 with serrated trailing edges, the octave band PWL corresponding to a 117 m wind speed of 20 m/s contributes the greatest sound pressure level at all receptors. For Noise Mode 3 with serrated trailing edges, the octave band PWL corresponding to a 117 m wind speed of 20 m/s contributes the greatest sound pressure level at all receptors. For Noise Mode 4 with serrated trailing edges, the octave band PWL corresponding to a 117 m wind speed of 16 m/s contributes the greatest sound pressure level at all receptors.

The 17 m/s octave band levels of the Mode 0 turbines, the 20 m/s octave band levels of the Mode 3 turbines and Mode 4 turbines, and the 16 m/s octave band levels of the Mode 4 turbines and the 10 m/s octave band levels were used to calculate the sound levels at all receptors in this report.

Vestas has confirmed [5] that the Vestas turbines to be supplied for the Project have not been found to produce tonal audibility levels above 3 dB as stated in the acoustic emissions documents (Appendix D) and calculated using the criteria specified in accordance with IEC 61400-11:2002. In addition, Vestas has indicated that no test uncertainty needs to be included in the calculated tonal audibility per IEC 61400-11:2012. Therefore a tonality penalty has not been applied to noise from the Vestas turbines.

The acoustic emissions of the four turbine models under consideration are shown in Table 5-1 to Table 5-4.

The Octave Bands provided by Vestas [5] have been marginally scaled by 0.1 dBA, for Mode 0 and Mode 4 in order to match the overall broadband levels provided.

Table 5-1 Vestas V126-3.3MW Mode 0 Serrated trailing edges, max. power 3300kW wind turbine acoustic emission summary

Make and Model: Vestas V126-3.3MW Mode 0 Serrated trailing edges, max. power 3300kW																				
Electrical Rating: 3.300 MW																				
Hub Height (m): 117 m																				
Wind Shear Coefficient: 0.32 to 0.36 , Worst case summer night time shear of the region																				
	Octave band sound power level [dB]																			
	Manufacturer's emission levels at Hub Height Wind Speed (117 m)															Adjusted emission levels				
Wind speed [m/s]	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	6	7	8	9	10
Frequency [Hz]																				
31.5	106.0	108.7	111.2	112.9	113.6	114.4	115.2	115.5	115.9	116.3	116.6	116.8	116.9	117.1	117.3	116.8	116.8	116.8	116.8	116.8
63	105.2	107.3	109	110.4	110.9	111.3	111.7	111.8	112	112.2	112.4	112.5	112.5	112.6	112.7	112.5	112.5	112.5	112.5	112.5
125	101.9	103.9	105.8	107.2	107.7	107.8	107.9	107.9	107.9	108.0	108.1	108.1	108.1	108.1	108.1	108.1	108.1	108.1	108.1	108.1
250	99.1	101.7	104.1	106.0	106.7	106.5	106.5	106.4	106.3	106.3	106.3	106.3	106.2	106.2	106.2	106.3	106.3	106.3	106.3	106.3
500	93.0	97.0	100.5	103.2	104.2	104.2	104.3	104.2	104.2	104.2	104.3	104.3	104.2	104.2	104.3	104.3	104.3	104.3	104.3	104.3
1000	89.3	93.6	97.4	100.3	101.3	101.4	101.4	101.3	101.4	101.4	101.5	101.5	101.4	101.4	101.5	101.5	101.5	101.5	101.5	101.5
2000	87.0	90.1	92.8	94.9	95.6	95.5	95.5	95.4	95.3	95.3	95.4	95.4	95.3	95.3	95.3	95.4	95.4	95.4	95.4	95.4
4000	82.2	84.4	86.5	88.0	88.5	88.2	88.1	87.8	87.7	87.7	87.7	87.6	87.5	87.4	87.4	87.6	87.6	87.6	87.6	87.6
8000	68.2	69.0	69.8	70.6	70.7	69.9	69.2	68.7	68.4	68.2	68.1	67.9	67.6	67.4	67.4	67.9	67.9	67.9	67.9	67.9
A-weighted	96.3	99.6	102.7	105.1	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0

Table 5-2 Vestas V126-3.3MW Mode 2 Serrated trailing edges, max. power 3175kW wind turbine acoustic emission summary

Make and Model: Vestas V126-3.3MW Mode 2 Serrated trailing edges, max. power 3175kW																				
Electrical Rating: 3.300 MW																				
Hub Height (m): 117 m																				
Wind Shear Coefficient: 0.32 to 0.36 , Worst case summer night time shear of the region																				
	Octave band sound power level [dB]																			
	Manufacturer's emission levels at Hub Height Wind Speed (117 m)															Adjusted emission levels				
Wind speed [m/s]	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	6	7	8	9	10
Frequency [Hz]																				
31.5	106.2	108.8	110.7	111.3	111.6	112.5	113.4	114.2	114.7	115	115.2	115.4	115.7	115.9	116.1	116.1	116.1	116.1	116.1	116.1
63	105.3	107.3	108.7	109.1	109.3	109.9	110.3	110.8	111.1	111.1	111.2	111.3	111.5	111.6	111.7	111.7	111.7	111.7	111.7	111.7
125	101.9	103.9	105.3	105.7	105.9	106.3	106.5	106.8	106.9	106.9	106.9	106.9	107.0	107.0	107.1	107.1	107.1	107.1	107.1	107.1
250	99.1	101.7	103.4	104.0	104.2	104.5	104.7	105.0	105.1	105.0	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9	104.9
500	93.1	97.0	99.5	100.4	100.8	101.4	101.8	102.3	102.6	102.6	102.6	102.6	102.7	102.7	102.7	102.7	102.7	102.7	102.7	102.7
1000	89.4	93.6	96.3	97.3	97.7	98.3	98.8	99.4	99.7	99.8	99.8	99.8	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9
2000	87.1	90.1	92.0	92.7	92.9	93.3	93.6	93.9	94.1	94.0	93.9	93.9	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0
4000	82.3	84.4	85.8	86.3	86.4	86.6	86.6	86.8	86.8	86.5	86.4	86.3	86.4	86.3	86.3	86.3	86.3	86.3	86.3	86.3
8000	68.2	69.0	69.4	69.5	69.4	69.1	69.1	68.3	67.9	67.4	67.1	66.9	66.9	66.7	66.6	66.6	66.6	66.6	66.6	66.6
A-weighted	96.4	99.6	101.8	102.6	102.9	103.4	103.8	104.2	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5	104.5

Table 5-3 Vestas V126-3.3MW Mode 3 Serrated trailing edges, max. power 2979kW wind turbine acoustic emission summary

Make and Model: Vestas V126-3.3MW Mode 3 Serrated trailing edges, max. power 2979kW																				
Electrical Rating: 3.300 MW																				
Hub Height (m): 117 m																				
Wind Shear Coefficient: 0.32 to 0.36 , Worst case summer night time shear of the region																				
	Octave band sound power level [dB]																			
	Manufacturer's emission levels at Hub Height Wind Speed (117 m)															Adjusted emission levels				
Wind speed [m/s]	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	6	7	8	9	10
Frequency [Hz]																				
31.5	106.4	108.8	109.5	109.6	109.7	110.7	111.6	113	113.2	113.4	113.6	113.9	114.1	114.4	114.4	114.4	114.4	114.4	114.4	114.4
63	105.5	107.1	107.7	107.8	107.8	108.5	109.0	110.0	109.9	109.9	109.9	110.1	110.2	110.3	110.3	110.3	110.3	110.3	110.3	110.3
125	101.9	103.5	104.0	104.2	104.4	104.9	105.2	105.9	105.7	105.6	105.5	105.6	105.6	105.6	105.6	105.6	105.6	105.6	105.6	105.6
250	99.0	101.1	101.7	102.0	102.3	102.8	103.1	103.8	103.6	103.4	103.3	103.3	103.3	103.3	103.3	103.3	103.3	103.3	103.3	103.3
500	93.0	96.2	97.2	97.5	98.0	98.8	99.4	100.4	100.5	100.5	100.5	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6	100.6
1000	89.3	92.8	93.9	94.3	94.7	95.6	96.3	97.3	97.4	97.5	97.5	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
2000	87.0	89.4	90.2	90.5	90.8	91.4	91.7	92.5	92.4	92.3	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2
4000	82.1	83.8	84.3	84.6	84.8	85.1	85.2	85.8	85.4	85.2	85.0	85.0	84.9	84.8	84.8	84.8	84.8	84.8	84.8	84.8
8000	67.8	68.2	68.3	68.6	68.8	68.6	68.1	68.1	67.3	66.8	66.3	66.2	66.0	65.9	65.9	65.9	65.9	65.9	65.9	65.9
A-weighted	96.3	98.9	99.8	100.1	100.5	101.2	101.7	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5

Table 5-4 Vestas V126-3.3MW Mode 4 Serrated trailing edges, max. power 1325kW wind turbine acoustic emission summary

Make and Model: Vestas V126-3.3MW Mode 4 Serrated trailing edges, max. power 1325kW																				
Electrical Rating: 3.300 MW																				
Hub Height (m): 117 m																				
Wind Shear Coefficient: 0.32 to 0.36 , Worst case summer night time shear of the region																				
	Octave band sound power level [dB]																			
	Manufacturer's emission levels at Hub Height Wind Speed (117 m)															Adjusted emission levels				
Wind speed [m/s]	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	6	7	8	9	10
Frequency [Hz]																				
31.5	106.1	107.0	108.4	109.3	109.9	110.3	110.8	111.1	111.3	111.6	111.9	112.0	112.2	112.4	112.6	111.9	111.9	111.9	111.9	111.9
63	105.3	106.1	106.9	107.2	107.6	107.8	108.0	108.2	108.3	108.5	108.6	108.6	108.7	108.8	109	108.6	108.6	108.6	108.6	108.6
125	101.9	102.9	103.2	103.3	103.3	103.4	103.4	103.5	103.5	103.6	103.7	103.6	103.6	103.6	103.7	103.7	103.7	103.7	103.7	103.7
250	99.1	100.6	100.6	100.4	100.3	100.3	100.3	100.3	100.2	100.3	100.2	100.1	100.1	100	100	100.2	100.2	100.2	100.2	100.2
500	93.1	95.2	95.5	95.5	95.5	95.5	95.5	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
1000	89.3	91.7	92.0	92.0	92.1	92.1	92.1	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2
2000	87.1	88.8	88.9	88.8	88.7	88.6	88.6	88.7	88.6	88.7	88.7	88.6	88.5	88.6	88.5	88.7	88.7	88.7	88.7	88.7
4000	82.3	83.7	83.4	83.1	82.9	82.8	82.7	82.6	82.6	82.6	82.5	82.4	82.3	82.3	82.3	82.5	82.5	82.5	82.5	82.5
8000	68.3	69.2	68.1	67.2	66.8	66.5	66.3	66.1	66.0	65.9	65.7	65.6	65.5	65.5	65.4	65.7	65.7	65.7	65.7	65.7
A-weighted	96.3	98.2	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3

5.1 Henvey Inlet substations transformers

The noise contribution of the Henvey Inlet substations has been considered in this analysis. Noise emission from the two Project substations mainly originates from one transformer. The transformer rating is estimated to be 170 MVA-230 kV [4]. The choice of transformer has not yet been finalized, but will be sourced in accordance with permitted specifications. The Proponent has specified that the final transformer sound power level will not exceed what has been modeled in this report.

The broadband sound power level of the Henvey Inlet transformers have been conservatively estimated to be 113.5 dBA, based on an audible noise level of 85 dBA, as guaranteed and sourced by the Proponent, in accordance with the application of standard IEEE C57.12.90 [9]. This includes a 5 dBA tonal penalty, as prescribed in Publication NPC-104.

The transformer's measurement surface area, as defined in standard IEEE C57.12.90, has been estimated to be 223 m^2 (see Appendix F). This calculation is based on a four sided polygon perimeter that includes a 2 m offset from all fan-cooled surfaces, as well as the top area of the measurement surface. A sketch of the plan view of the transformer, showing the approximate perimeter of the measurement surface area, is included in Appendix F. The substation coordinates, as provided by the Proponent, are included in Appendix E.

The transformer's broadband sound power level L_W has been estimated as a function of its sound pressure level and measurement surface area using the following equation, as defined by IEEE C57.12.90.

$$L_W = L_P + 10 * logS$$

A broadband sound power level of 113.5 dBA was used for the transformer for all noise modeling. The calculation of the broadband level is summarized in Table 5-5.

Table 5-5 Henvey Inlet transformers sound power level calculation summary

Transformer Power Rating [MVA]	170
Transformer Voltage Rating [kV]	230
Sound Pressure Level L_P [dBA]	85
Sound measurement area S (m^2)	223
Sound Power Level [dBA] (without penalty)	108.5
Sound Power Level L_W [dBA] (with penalty)	**113.5**

Table 5-6 provides the octave band sound power levels of the Henvey Inlet substation transformers using a typical octave band sound distribution for a large transformer [9],[10]. Table 5-7 details the octave band calculation. The transformer has been conservatively modeled as a point source at a height of 4 m.

Table 5-6 Henvey Inlet Wind Project substation transformer sound power level

	Octave band sound power level* (dBA)									
Frequency (Hz)	32	63	125	250	500	1000	2000	4000	8000	Broadband
PWL (dBA)	70.7	89.9	102	104.5	109.9	107.1	103.3	98.1	89	113.5

* Includes 5 dBA penalty to account for tonality.

Table 5-7 Henvey Inlet Wind Project ransformer octave band calculation details

32	63	125	250	500	1000	2000	4000	8000	Frequency [Hz]
-1	5	7	2	2	-4	-9	-14	-21	Typical Outdoor Transformer Octave band relative distribution [dB Lin]
-39.4	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	dB Lin to dBA Conversion Scale
-40.4	-21.2	-9.1	-6.6	-1.2	-4.0	-7.8	-13.0	-22.1	Typical Outdoor Transformer Octave band relative distribution [dBA]
70.7	89.9	102	104.5	109.9	107.1	103.3	98.1	89	Scaled to 113.5 dBA Transformer

6 NOISE IMPACT ASSESSMENT

The sound pressure levels at each PoR, and Participants for the aggregate of all wind turbines and substation associated with the Project were calculated based on the ISO 9613-2 method.

The International Standards Organization (ISO) 9613 standard [11], [12] provides a prediction of the equivalent continuous A-weighted sound pressure level at a distance from one or more point sources under meteorological conditions favorable to propagation from sources of sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, commonly occurring at night.

The method consists of octave-band algorithms (i.e., with nominal mid-band frequencies from 63 Hz to 8 kHz) for calculating the attenuation of the emitted sound. The algorithm takes into account the following physical effects:

- Geometrical divergence – attenuation due to spherical spreading from the sound source;
- Atmospheric absorption – attenuation due to absorption by the atmosphere; and
- Ground effect – attenuation due to the acoustical properties of the ground.

ISO-9613-2 parameters were set as follows:

- Ambient air temperature: 10ºC;
- Ambient barometric pressure: 101.32 kPa;
- Humidity: 70%;
- Source ground factor: 0.8;
- Middle ground factor: 0.8;
- Receptor ground factor: 0.8;
- Water feature ground factor: 0
- The effect of topography was considered.

A ground factor of 0.8 and 0 is considered appropriate for such a site, depending on the ground cover. All water features are considered to be at a ground factor of 0. All land features are considered at 0.8 as they are composed of 83% wooded areas and 17% barren areas.

Additional calculations concerning propagation through foliage were not performed in this NIA, implying that the values calculated for sound attenuation are likely to be conservative in areas where there is foliage present in the line of sight between any turbine and a PoR. The estimated accuracy of the ISO 9613 method, as stated in ISO 9613-2, is ± 3 dB.

The wind turbine and transformer noise emission ratings used for each octave band were those specified in Section 5. The noise impact was calculated for each PoR and Participant located within 1,500 m of one or more turbines or substation, and the calculated noise level was then compared with the applicable noise limit for each PoR as stated in Table 3-1.

Noise levels were calculated at 4.5 m above ground level for 2-storey PoR/Participants and at 1.5 m above ground level at 16 points along a 30-m radius circle for each 1-storey PoR/Participant. For Receptors R1000, R1098, and Participants R1101 and R2043, the 16 points were confined to the property line. For the 1-storey buildings, the highest of these 16 values was chosen and presented in the table of noise levels.

6.1 Evaluation of site topography

Section 7.3.1 of ISO 9613-2 [12] states that when calculating the ground attenuation A_{gr}, the General method of calculation is applicable only to ground which is approximately flat, either horizontally or with a constant slope. DNV GL has reviewed the topography at the Henvey Inlet site to determine if a correction is needed to account for different ground conditions, such as concave terrain.

The Institute of Acoustics (UK) has published a good practice guide (the "Guide") for the assessment of wind turbine noise [13], with Sections 4.3.9 and 4.3.10 of the Guide proposing a 2-step methodology for assessing whether or not a correction to the modelling is needed to account for concave topography. As a first-step, the Guide recommends the use of the criterion shown below to quantitatively evaluate the level of concavity between a turbine and a receptor.

$$h_m \geq 1.5 \cdot Abs(h_s - h_r)/2$$

In this criterion, h_m is the mean height above ground of the direct line of sight from the receiver to the source, as defined in ISO 9613-2. h_s is the height of the source, and h_r is the height of the receiver.

If the criterion is met, then examination of ground profiles between sources and receivers is necessary, as a second-step, to assist with determining the application of a correction factor. The Guide states that the increase in sound level caused by concave terrain can be explained by the reduced ground effect and the potential for additional reflection paths that may exist, as shown in Figure 6-1, taken directly from [13].

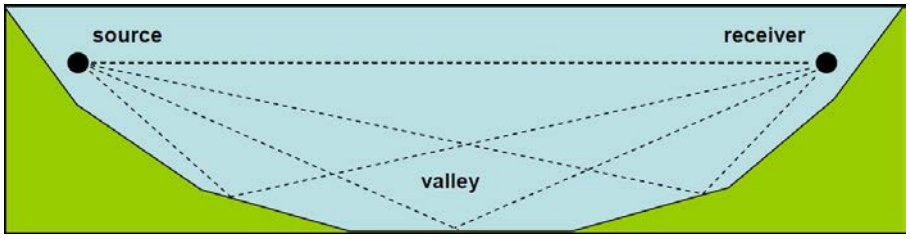


Figure 6-1 Diagram of multiple reflection paths for sound propagation across concave ground

DNV GL has reviewed the topography at the Henvey Inlet site and evaluated the above criterion for each turbine-receptor pair. It was found that for all turbine to receiver paths, h_m is below the threshold, indicating that concave paths are not present. Therefore, DNV GL did not apply any concavity penalty.

7 NOISE IMPACT ASSESSMENT RESULTS

The noise level at each PoR within 1,500 m of any turbine or substation of the Project, for wind speeds between 6 m/s and 10 m/s, is tabulated in Table 7-1. For each PoR, the following information is provided:

- The distance to the closest wind turbine or substation;
- For PoR at 1.5 m above ground level, the sound pressure level presented for wind speeds from 6 m/s to 10 m/s is the maximum noise level on the circumference of a 30-m radius circle centered on the PoR;
- For PoR at 4.5 m above ground level, the sound pressure level presented for wind speeds from 6 m/s to 10 m/s is the noise level at the PoR location at its respective height;
- The sound level limit for that PoR according to the Noise Guidelines at each wind speed from 6 m/s to 10 m/s;
- The applicable background sound level; and
- Whether or not the noise levels at the PoR comply with the Noise Guidelines (for continued reference, compliance is confirmed for all PoR).

The closest distance between a wind turbine and a PoR for this project is 833 m between Turbine 28 and Receptor 1097.

The highest calculated noise level at a PoR was found at Receptor 1000 at 40.0 dBA. Receptor sound levels are listed in Table 7-1.

The results show that the Project complies with the applicable MOECC environmental Noise Guidelines at all wind speeds modelled (i.e., 6, 7, 8, 9 and 10 m/s). Noise iso-contour maps illustrating the maximum noise contribution of the Project are shown in Appendix A.

Similarly, the maximum noise level at each Participant within 1,500 m of any Project turbine or substation is tabulated in Table 7-2. Sample calculations of two example Receptors are presented in Appendix G.

Table 7-1 Noise impact assessment summary

Point of Reception ID	Receptor height [m]	Distance to nearest source [m]	Nearest source [ID]	Calculated sound pressure level at receptor [dB(A)] at selected wind speed in m/s					Sound level limit [dB(A)] at selected wind speed in m/s					Applicable background sound level	Compliant (Yes/No)
				6 or <	7	8	9	10	6 or <	7	8	9	10	NPC 232 (C 3)	
R1000	1.5	948	82	40.0	40.0	40.0	40.0	40.0	40	43	45	49	51	40	Yes
R1006	1.5	1086	77	35.9	35.9	35.9	35.9	35.9	40	43	45	49	51	40	Yes
R1007	1.5	937	77	39.1	39.1	39.1	39.1	39.1	40	43	45	49	51	40	Yes
R1008	4.5	1030	77	39.1	39.1	39.1	39.1	39.1	40	43	45	49	51	40	Yes
R1093	1.5	935	16	36.9	36.9	36.9	36.9	36.9	40	43	45	49	51	40	Yes
R1094	4.5	920	16	39.8	39.8	39.8	39.8	39.8	40	43	45	49	51	40	Yes
R1095	1.5	929	16	39.7	39.7	39.7	39.7	39.7	40	43	45	49	51	40	Yes
R1097	4.5	833	74	39.8	39.8	39.8	39.8	39.8	40	43	45	49	51	40	Yes
R1098	1.5	961	74	39.9	39.9	39.9	39.9	39.9	40	43	45	49	51	40	Yes
R1099	1.5	1034	35	38.1	38.1	38.1	38.1	38.1	40	43	45	49	51	40	Yes
R1282	4.5	853	84	39.9	39.9	39.9	39.9	39.9	40	43	45	49	51	40	Yes
R1288	1.5	1029	77	38.5	38.5	38.5	38.5	38.5	40	43	45	49	51	40	Yes
R1289	1.5	1040	77	38.3	38.3	38.3	38.3	38.3	40	43	45	49	51	40	Yes
R1290	1.5	1025	77	38.5	38.5	38.5	38.5	38.5	40	43	45	49	51	40	Yes
R1291	1.5	1042	77	38.3	38.3	38.3	38.3	38.3	40	43	45	49	51	40	Yes
R1292	1.5	1050	77	37.8	37.8	37.8	37.8	37.8	40	43	45	49	51	40	Yes
R1293	1.5	1044	77	38.3	38.3	38.3	38.3	38.3	40	43	45	49	51	40	Yes
R1294	1.5	1041	77	38.3	38.3	38.3	38.3	38.3	40	43	45	49	51	40	Yes
R1295	1.5	1045	77	38.3	38.3	38.3	38.3	38.3	40	43	45	49	51	40	Yes
R1296	1.5	1033	77	38.5	38.5	38.5	38.5	38.5	40	43	45	49	51	40	Yes
R1297	1.5	1020	77	38.6	38.6	38.6	38.6	38.6	40	43	45	49	51	40	Yes
R1298	1.5	1011	77	38.5	38.5	38.5	38.5	38.5	40	43	45	49	51	40	Yes
R1299	1.5	1024	77	38.5	38.5	38.5	38.5	38.5	40	43	45	49	51	40	Yes
R1300	1.5	1029	77	38.5	38.5	38.5	38.5	38.5	40	43	45	49	51	40	Yes
R2028	4.5	989	73	39.9	39.9	39.9	39.9	39.9	40	43	45	49	51	40	Yes

1. For single storey receptors, the sound levels were considered at 1.5 m above grade and 30 m horizontally from the dwelling, in 16 evenly spaced directions. In this way, a circle of 16 dummy receptors was created around each single storey receptor. The reported sound level at each receptor is then taken to be the maximum sound level from the circle of dummy receptors. The coordinates of the circle point with the maximum sound level for each of the 240 one-storey receptors are shown in a table in Appendix C (UTM17-NAD83 projection).

Table 7-2 Noise impact assessment summary – Participants

Participant ID	Height [m]	Distance to nearest source [m]	Nearest source ID	Max Calculated sound pressure level [dBA]
R1011	1.5	720	Transformer North	45.0
R1281	4.5	920	13	40.6
R1283	4.5	843	28	42.3
R1285	4.5	498	Transformer North	44.9
R2043	1.5	709	7	45.0

8 CONCLUSION

Based on the approach presented in this NIA, the Project is compliant with the MOECC noise limits at all PoR within 1,500 m of the Project's noise sources, for wind speeds of 6, 7, 8, 9, and 10 m/s.

9 REFERENCES

[1] Ontario Regulation 359/09 (Renewable Energy Approvals (REA)

[2] MOECC Noise Guidelines for Wind Farms, Interpretation for Applying NPC Publications, October 2008.

[3] Henvey Inlet Wind Farm Turbine Layout, received via email from the Proponent (A. Wagner) to DNV GL, “Turbines_HIW_L14R00-Draft”, 1 September 2015.

[4] Email from Proponent to DNV GL, Henvey Inlet transformer description, 25 August 2015.

[5] Vestas, Vestas Wind Turbine Generator Contract Acoustic Emissions, V126 3.3 (2A), four models, received via email from the Proponent to DNV GL, 1 September 2015.

[6] Vestas, V126 3.3 turbine emissions comfort letter, 9 September 2015.

[7] International Electrotechnical Commission (IEC), 2006. IEC 61400 – 11 Ed. 2.1 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques. 46 p.

[8] International Electrotechnical Commission (IEC), 2012. IEC 61400 – 11 Ed. 3.0 Wind turbines– Part 11: Acoustic noise measurement techniques. 58 p.

[9] IEEE C57.12.90 – Distribution, Power, and Regulating Transformers. 2010

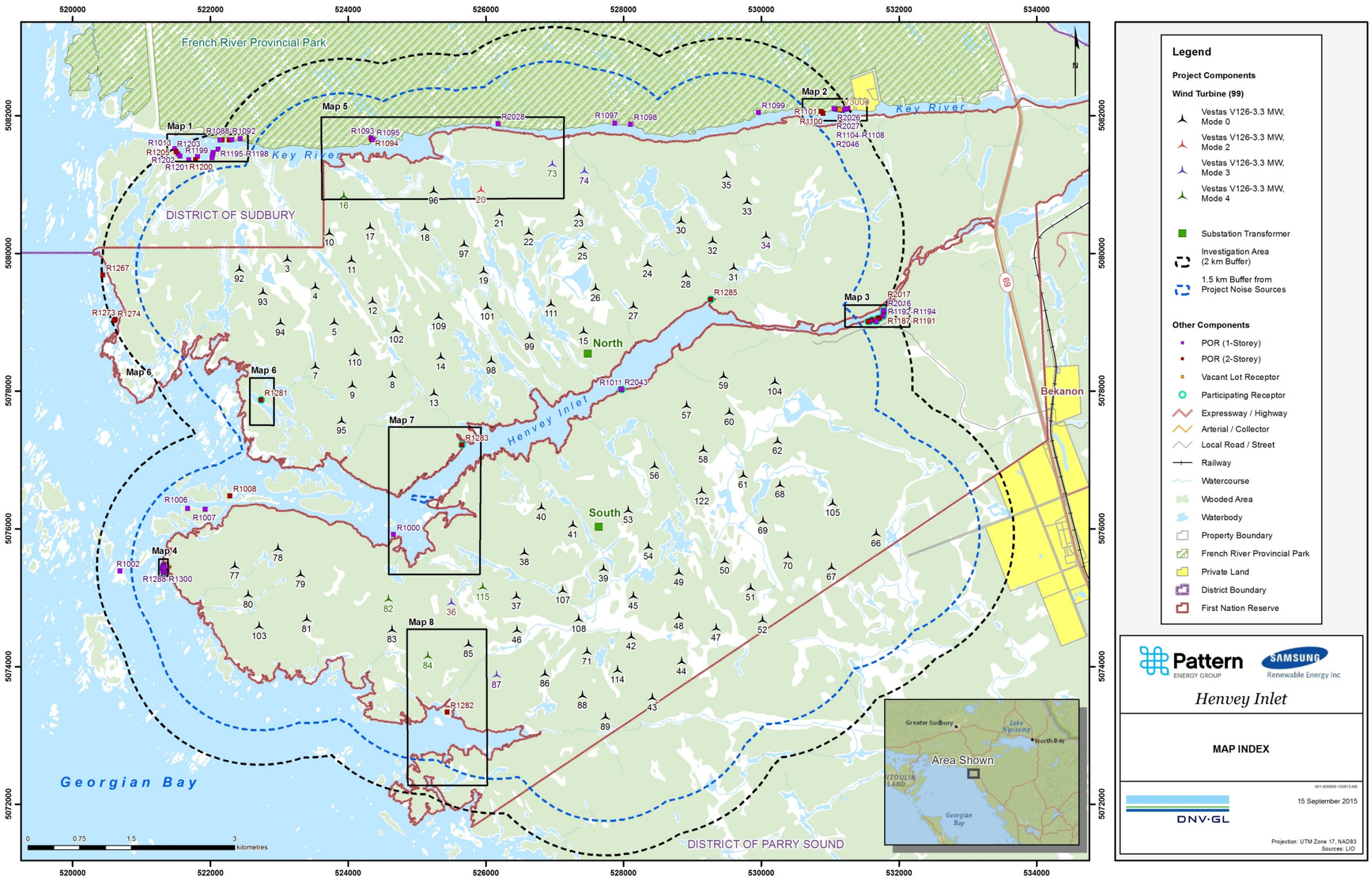
[10] Handbook of Acoustics – Malcolm J. Crocker, 1998.

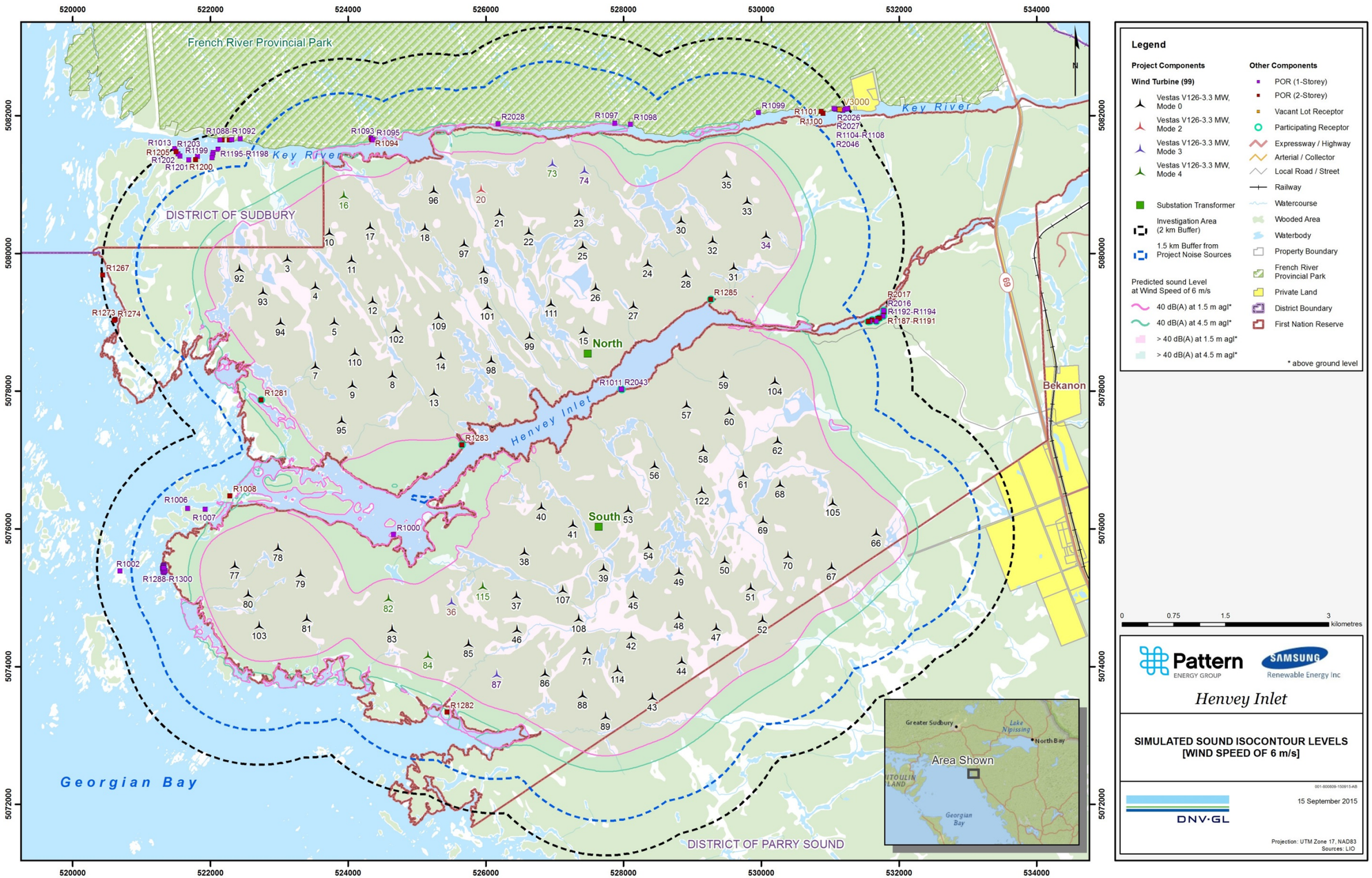
[11] International Organization for Standardization (ISO), 1993. Acoustics - Attenuation of Sound During Propagation Outdoors - Calculation of the Absorption of Sound by the Atmosphere. ISO 9613-1. 33 p.

[12] International Organization for Standardization (ISO), 1996. Acoustics - Attenuation of Sound During Propagation Outdoors - General Method of Calculation. ISO 9613-2. 25 p.

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

APPENDIX A – NOISE ISO-CONTOUR MAPS


French River Provincial Park
DISTRICT OF SUDBURY
DISTRICT OF PARRY SOUND
Georgian Bay
Key River
Henvey Inlet
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Map 8
North
South
Bekanon
69
0 0.75 1.5 3 kilometres
520000 522000 524000 526000 528000 530000 532000 534000
5082000 5080000 5078000 5076000 5074000 5072000
Legend
Project Components
Wind Turbine (99)
Vestas V126-3.3 MW, Mode 0
Vestas V126-3.3 MW, Mode 2
Vestas V126-3.3 MW, Mode 3
Vestas V126-3.3 MW, Mode 4
Substation Transformer
Investigation Area (2 km Buffer)
1.5 km Buffer from Project Noise Sources
Other Components
POR (1-Storey)
POR (2-Storey)
Vacant Lot Receptor
Participating Receptor
Expressway / Highway
Arterial / Collector
Local Road / Street
Railway
Watercourse
Wooded Area
Waterbody
Property Boundary
French River Provincial Park
Private Land
District Boundary
First Nation Reserve
Pattern ENERGY GROUP
SAMSUNG Renewable Energy Inc
Henvey Inlet
MAP INDEX
Greater Sudbury
Lake Nipissing
North Bay
Area Shown
Georgian Bay
001-800809-150915-AB
15 September 2015
DNV·GL
Projection: UTM Zone 17, NAD83
Sources: LIO



Legend

Project Components

Wind Turbine (99)

- Vestas V126-3.3 MW, Mode 0
- Vestas V126-3.3 MW, Mode 2
- Vestas V126-3.3 MW, Mode 3
- Vestas V126-3.3 MW, Mode 4
- Substation Transformer
- Investigation Area (2 km Buffer)
- 1.5 km Buffer from Project Noise Sources

Predicted sound Level at Wind Speed of 6 m/s

- 40 dB(A) at 1.5 m agl*
- 40 dB(A) at 4.5 m agl*
- > 40 dB(A) at 1.5 m agl*
- > 40 dB(A) at 4.5 m agl*

Other Components

- POR (1-Storey)
- POR (2-Storey)
- Vacant Lot Receptor
- Participating Receptor
- Expressway / Highway
- Arterial / Collector
- Local Road / Street
- Railway
- Watercourse
- Wooded Area
- Waterbody
- Property Boundary
- French River Provincial Park
- Private Land
- District Boundary
- First Nation Reserve

* above ground level

Pattern ENERGY GROUP

SAMSUNG Renewable Energy Inc

Henvey Inlet

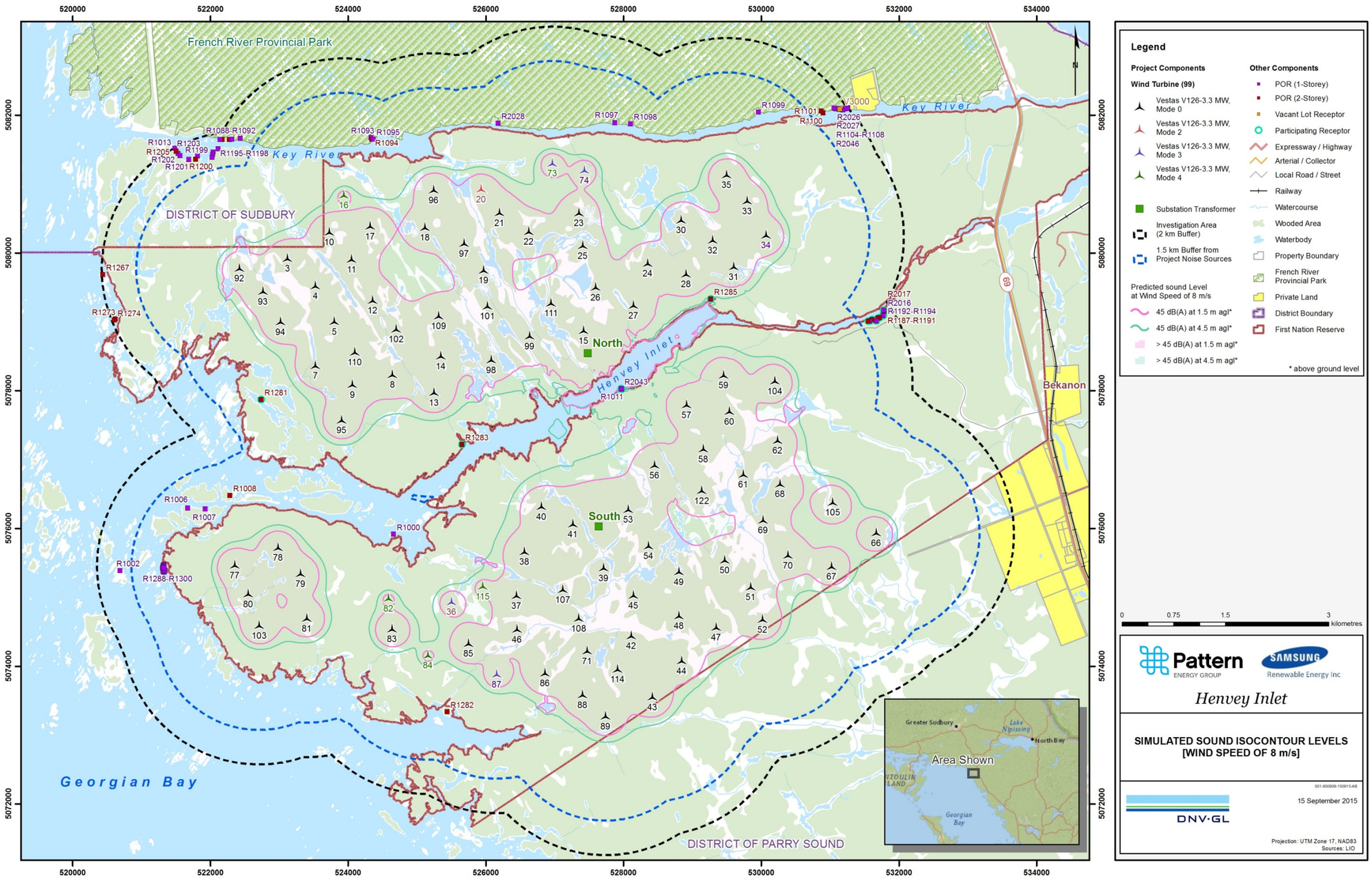
SIMULATED SOUND ISOCONTOUR LEVELS [WIND SPEED OF 6 m/s]

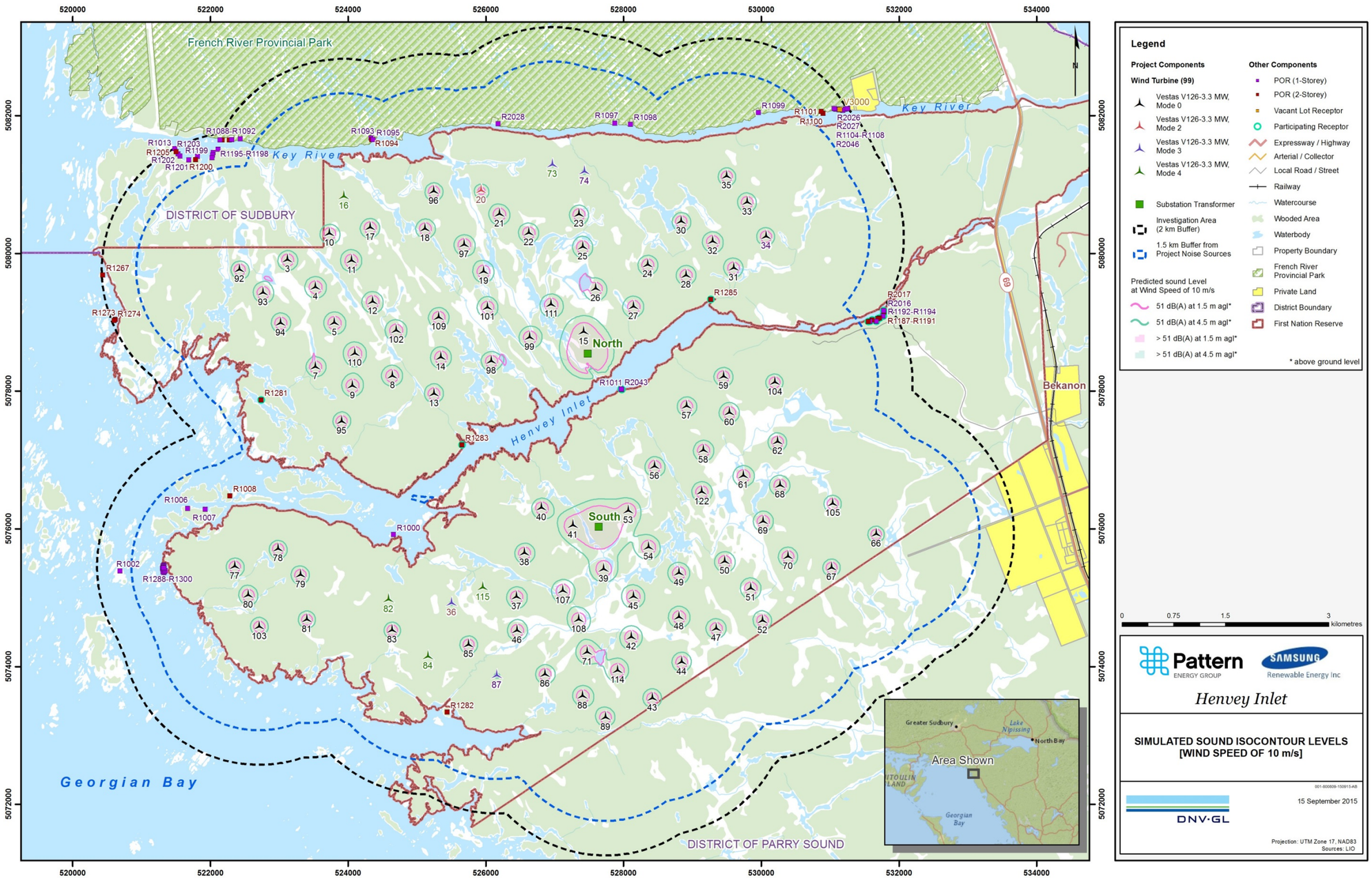
001-800809-150915-AB

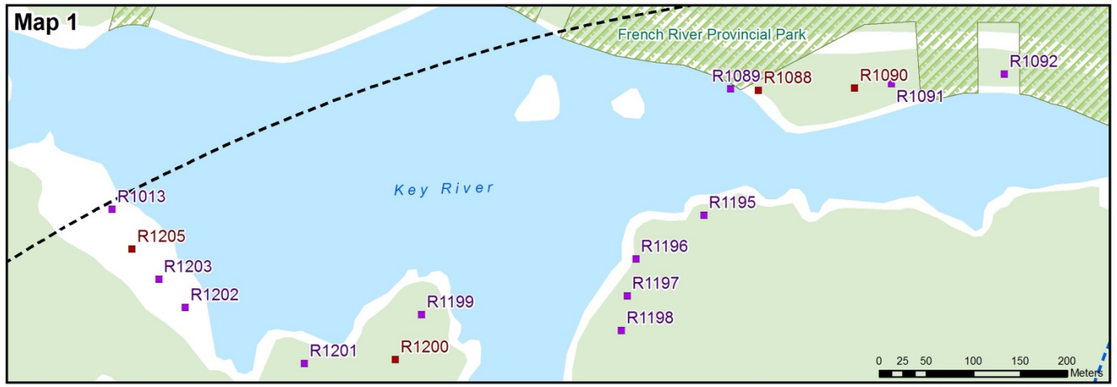
15 September 2015

DNV·GL

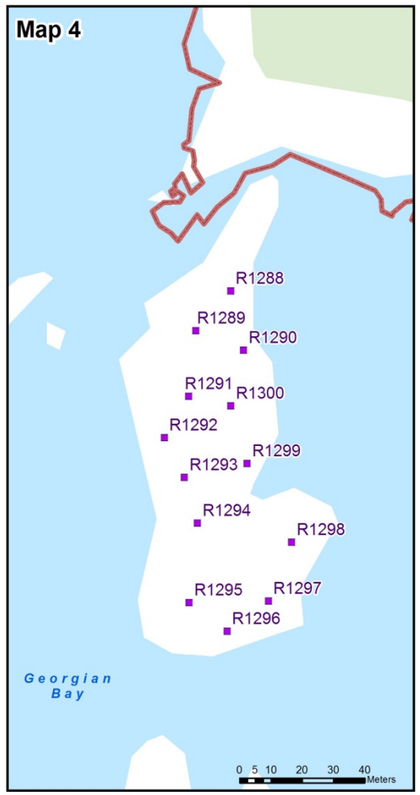
Projection: UTM Zone 17, NAD83
Sources: LIO

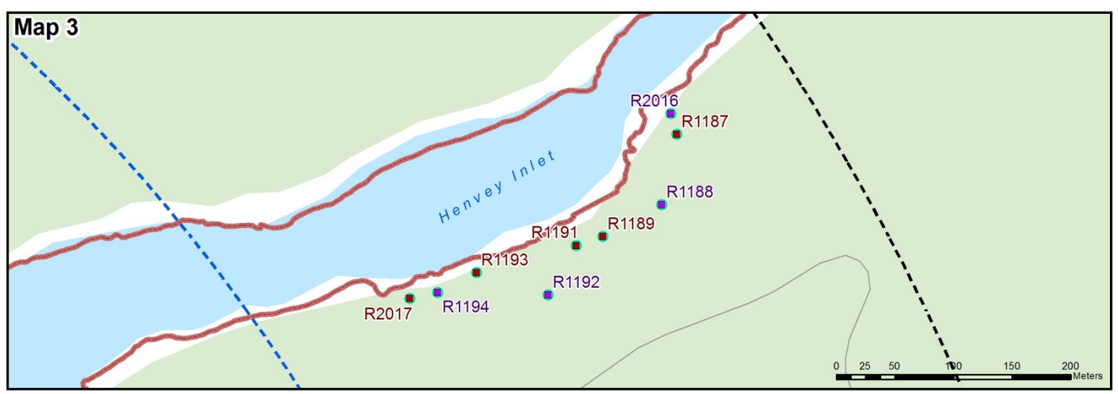

French River Provincial Park
DISTRICT OF SUDBURY
DISTRICT OF PARRY SOUND
Georgian Bay
Key River
Henvey Inlet
North
South
Bekanon
V3000
R1088-R1092
R1093
R1094
R1095
R1097
R1098
R1099
R1100
R1101
R2026
R2027
R1104-R1108
R2046
R2028
R1013
R1203
R1205
R1199
R1195-R1198
R1202
R1201
R1200
R1267
R1273
R1274
R1281
R1283
R1285
R2017
R2016
R1192-R1194
R1187-R1191
R2043
R1011
R1008
R1006
R1007
R1000
R1002
R1288-R1300
R1282
Greater Sudbury
Lake Nipissing
North Bay
Area Shown
Georgian Bay
520000
522000
524000
526000
528000
530000
532000
534000
5082000
5080000
5078000
5076000
5074000
5072000
Legend
Project Components
Wind Turbine (99)
Vestas V126-3.3 MW, Mode 0
Vestas V126-3.3 MW, Mode 2
Vestas V126-3.3 MW, Mode 3
Vestas V126-3.3 MW, Mode 4
Substation Transformer
Investigation Area (2 km Buffer)
1.5 km Buffer from Project Noise Sources
Predicted sound Level at Wind Speed of 8 m/s
45 dB(A) at 1.5 m agl*
45 dB(A) at 4.5 m agl*
> 45 dB(A) at 1.5 m agl*
> 45 dB(A) at 4.5 m agl*
Other Components
POR (1-Storey)
POR (2-Storey)
Vacant Lot Receptor
Participating Receptor
Expressway / Highway
Arterial / Collector
Local Road / Street
Railway
Watercourse
Wooded Area
Waterbody
Property Boundary
French River Provincial Park
Private Land
District Boundary
First Nation Reserve
* above ground level
0
0.75
1.5
3
kilometres
Pattern ENERGY GROUP
SAMSUNG Renewable Energy Inc
Henvey Inlet
SIMULATED SOUND ISOCONTOUR LEVELS
[WIND SPEED OF 8 m/s]
001-800809-150915-AB
15 September 2015
DNV·GL
Projection: UTM Zone 17, NAD83
Sources: LIO

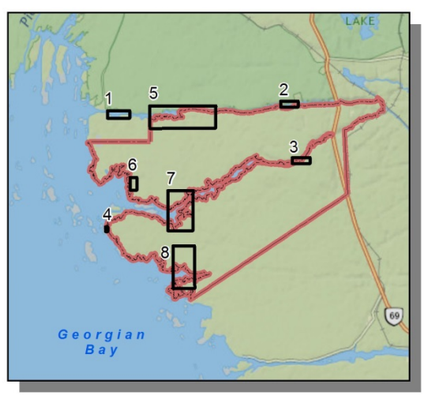

French River Provincial Park
DISTRICT OF SUDBURY
DISTRICT OF PARRY SOUND
Georgian Bay
Key River
Henvey Inlet
North
South
Bekanon
Greater Sudbury
Lake Nipissing
North Bay
Area Shown
Georgian Bay
520000
522000
524000
526000
528000
530000
532000
534000
5082000
5080000
5078000
5076000
5074000
5072000
Legend
Project Components
Wind Turbine (99)
Vestas V126-3.3 MW, Mode 0
Vestas V126-3.3 MW, Mode 2
Vestas V126-3.3 MW, Mode 3
Vestas V126-3.3 MW, Mode 4
Substation Transformer
Investigation Area (2 km Buffer)
1.5 km Buffer from Project Noise Sources
Predicted sound Level at Wind Speed of 10 m/s
51 dB(A) at 1.5 m agl*
51 dB(A) at 4.5 m agl*
> 51 dB(A) at 1.5 m agl*
> 51 dB(A) at 4.5 m agl*
Other Components
POR (1-Storey)
POR (2-Storey)
Vacant Lot Receptor
Participating Receptor
Expressway / Highway
Arterial / Collector
Local Road / Street
Railway
Watercourse
Wooded Area
Waterbody
Property Boundary
French River Provincial Park
Private Land
District Boundary
First Nation Reserve
* above ground level
0
0.75
1.5
3
kilometres
Pattern ENERGY GROUP
SAMSUNG Renewable Energy Inc
Henvey Inlet
SIMULATED SOUND ISOCONTOUR LEVELS
[WIND SPEED OF 10 m/s]
001-800809-150915-AB
15 September 2015
DNV·GL
Projection: UTM Zone 17, NAD83
Sources: LIO

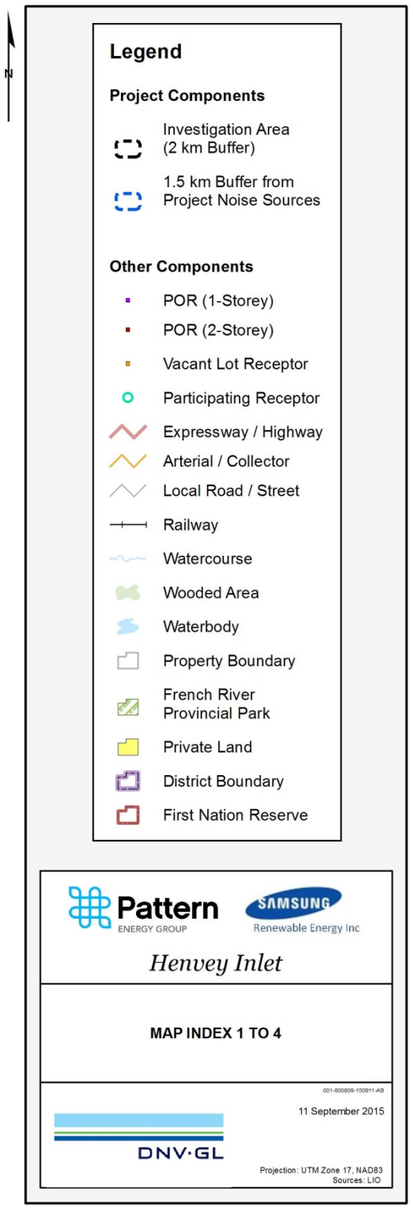

Map 1
French River Provincial Park
R1089
R1088
R1090
R1091
R1092
Key River
R1013
R1205
R1203
R1202
R1199
R1201
R1200
R1195
R1196
R1197
R1198
0 25 50 100 150 200
Meters

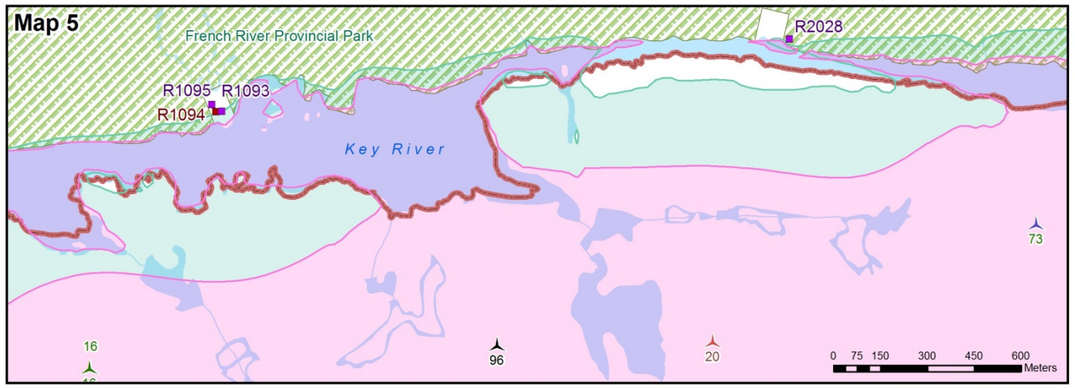

Map 2
French River Provincial Park
R2046
R1105
V3000
R1107
R1108
R1104
R2027
R1106
R2026
R1101
R1100
Key River
0 25 50 100 150 200
Meters

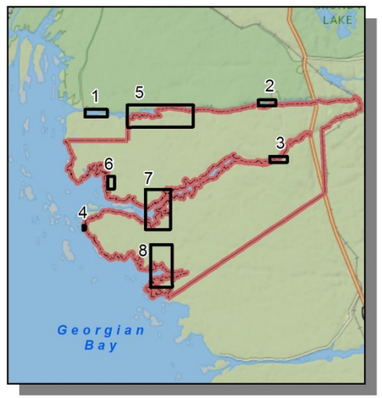

Map 4
R1288
R1289
R1290
R1291
R1300
R1292
R1299
R1293
R1294
R1298
R1295
R1297
R1296
Georgian Bay
0 5 10 20 30 40
Meters

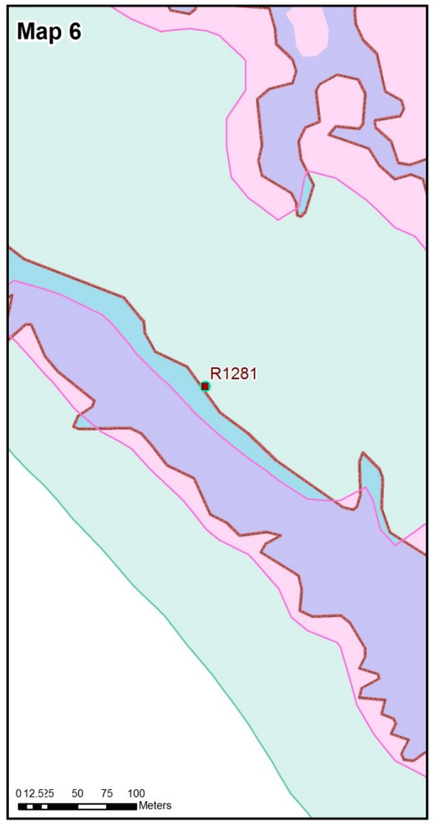

Map 3
R2016
R1187
Henvey Inlet
R1188
R1189
R1191
R1193
R1192
R2017
R1194
0 25 50 100 150 200
Meters

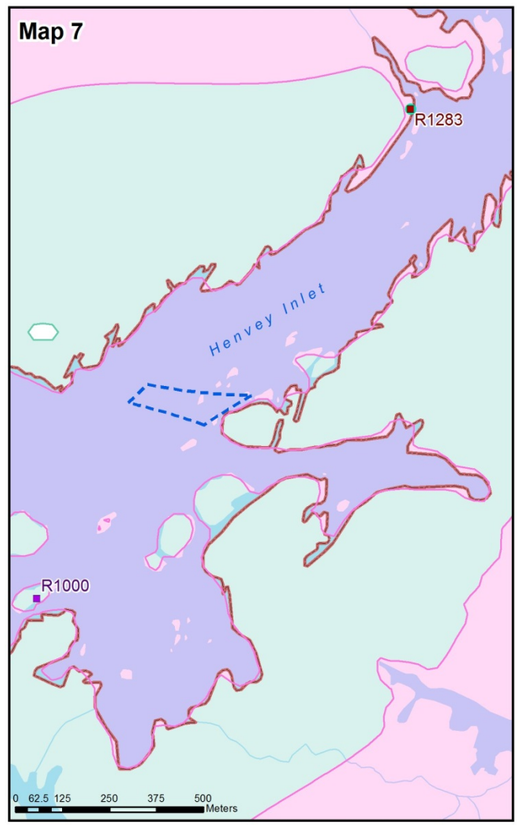

LAKE
1
5
2
3
6
7
4
8
69
Georgian Bay

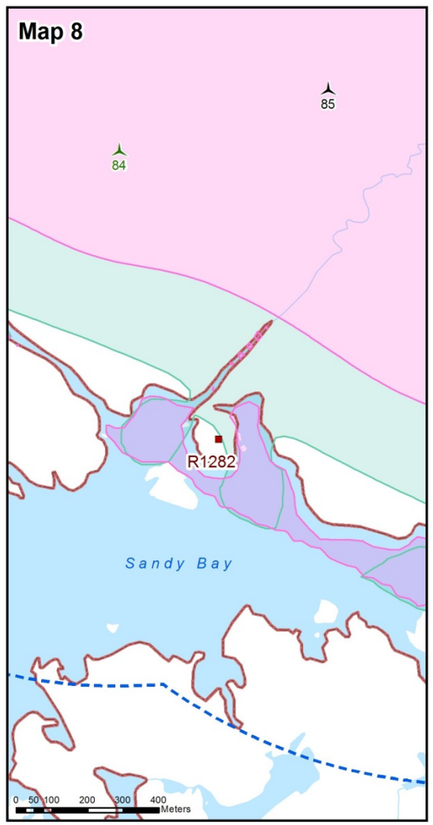

Legend
Project Components
Investigation Area (2 km Buffer)
1.5 km Buffer from Project Noise Sources
Other Components
POR (1-Storey)
POR (2-Storey)
Vacant Lot Receptor
Participating Receptor
Expressway / Highway
Arterial / Collector
Local Road / Street
Railway
Watercourse
Wooded Area
Waterbody
Property Boundary
French River Provincial Park
Private Land
District Boundary
First Nation Reserve
Pattern ENERGY GROUP
SAMSUNG Renewable Energy Inc
Henvey Inlet
MAP INDEX 1 TO 4
11 September 2015
DNV·GL
Projection: UTM Zone 17, NAD83
Sources: LIO











Legend

Project Components

Wind Turbine (99)

- Vestas V126-3.3 MW, Mode 0
- Vestas V126-3.3 MW, Mode 2
- Vestas V126-3.3 MW, Mode 3
- Vestas V126-3.3 MW, Mode 4
- Investigation Area (2 km Buffer)
- 1.5 km Buffer from Project Noise Sources

Predicted sound Level at Wind Speed of 6 m/s

- 40 dB(A) at 1.5 m agl*
- 40 dB(A) at 4.5 m agl*
- > 40 dB(A) at 1.5 m agl*
- > 40 dB(A) at 4.5 m agl*

Other Components

- POR (1-Storey)
- POR (2-Storey)
- Vacant Lot Receptor
- Participating Receptor
- Expressway / Highway
- Arterial / Collector
- Local Road / Street
- Railway
- Watercourse
- Waterbody
- Property Boundary
- French River Provincial Park
- Private Land
- District Boundary
- First Nation Reserve

* above ground level

Pattern ENERGY GROUP

SAMSUNG Renewable Energy Inc

Henvey Inlet

MAP INDEX 5 to 8

001-800609-150915-AB

15 September 2015

DNV·GL

Projection: UTM Zone 17, NAD83
Sources: LIO

APPENDIX B – COORDINATES OF POINTS OF RECEPTION

Coordinates of all modeled Points of Reception for the Henvey Inlet Wind Project (UTM17-NAD83 projection) are given in the table below:

Receptor ID	Easting [m]	Northing [m]	Base Elevation [m]
R1000	524659	5075916	176
R1006	521670	5076295	179
R1007	521927	5076285	179
R1008	522283	5076478	180
R1093	524333	5081674	180
R1094	524345	5081651	180
R1095	524365	5081652	180
R1097	527875	5081890	179
R1098	528102	5081873	180
R1099	529959	5082046	181
R1282	525440	5073337	181
R1288	521325	5075473	176
R1289	521314	5075461	176
R1290	521329	5075454	176
R1291	521312	5075440	176
R1292	521304	5075427	176
R1293	521310	5075414	176
R1294	521315	5075399	176
R1295	521312	5075374	176
R1296	521324	5075365	176
R1297	521337	5075374	176
R1298	521345	5075393	176
R1299	521331	5075418	176
R1300	521325	5075437	176
R2028	526180	5081883	183

For single storey receptors, the sound levels were considered at 1.5 m above grade and 30 m horizontally from the dwelling, in 16 evenly spaced directions. In this way, a circle of 16 dummy receptors was created around each single storey receptor. The reported sound level at each receptor is then taken to be the maximum sound level from the circle of dummy receptors. For Receptors R1000, and R1098, the 16 points were confined to the property line. The table below shows the coordinates of the circle point with the maximum sound level for each of the 20 one-storey receptors (UTM17-NAD83 projection).

	Receptor location		Maximum sound level location			
Receptor ID	Easting	Northing	ID	Easting	Northing	Sound Level [dBA]
R1000	524659	5075916	Pt12-R1000	524631	5075904	40.0
R1006	521670	5076295	Pt1-R1006	521670	5076325	35.9
R1007	521927	5076285	Pt11-R1007	521905	5076263	39.1
R1093	524333	5081674	Pt15-R1093	524312	5081695	36.9
R1095	524365	5081652	Pt2-R1095	524376	5081679	39.7
R1098	528102	5081873	Pt3-R1098	528123	5081894	39.9
R1099	529959	5082046	Pt15-R1099	529938	5082067	38.1
R1288	521325	5075473	Pt13-R1288	521295	5075473	38.5
R1289	521314	5075461	Pt11-R1289	521293	5075439	38.3
R1290	521329	5075454	Pt13-R1290	521299	5075454	38.5
R1291	521312	5075440	Pt11-R1291	521291	5075418	38.3
R1292	521304	5075427	Pt12-R1292	521276	5075415	37.8
R1293	521310	5075414	Pt11-R1293	521289	5075392	38.3
R1294	521315	5075399	Pt10-R1294	521303	5075371	38.3
R1295	521312	5075374	Pt13-R1295	521282	5075373	38.3
R1296	521324	5075365	Pt11-R1296	521303	5075343	38.5
R1297	521337	5075374	Pt13-R1297	521307	5075374	38.6
R1298	521345	5075393	Pt9-R1298	521345	5075363	38.5
R1299	521331	5075418	Pt11-R1299	521309	5075397	38.5
R1300	521325	5075437	Pt11-R1300	521304	5075415	38.5

APPENDIX C – COORDINATES OF PARTICIPANTS

Coordinates of all modeled participants for the Project (UTM17-NAD83 projection) are given in the table below:

Participant ID	Easting [m]	Northing [m]	Base Elevation [m]
R1011	527976	5078024	176
R1281	522738	5077872	177
R1283	525655	5077219	176
R1285	529269	5079332	181
R2043	527966	5078029	176

APPENDIX D – TURBINE NOISE SPECIFICATIONS

This appendix contains the following supporting documentation for the Vestas V126-3.3MW Turbine models:

- Comfort letter from Vestas
- Acoustic emission specifications for each turbine model

Vestas
1417 NW Everett Street
Portland, Oregon, 97209
September 1, 2015

Sir/Madam
RE: Henvey Inlet Wind Project
Ontario Ministry of the Environment and Climate Change
135 St. Clair Ave. W., 1st Floor
Toronto ON M4V 1P5

Dear Sir/Madam:

In respect to the Henvey Inlet Wind Project, Vestas will provide the following turbines: V126 3.3MW (Mode 0, 1, 2, 3, 4), as applicable for the Project Site. In accordance with the Turbine Supply Agreement to be executed between Vestas and the Project Developer, Vestas guarantees the maximum broadband sound power level values for these units at their respective maximum rated power levels shown below.

Official Nameplate	Maximum Rated Power Level	Maximum Broadband Sound Power Level	Hub Height
V126 Mode 0, Serrated Blade, Max. Power 3300kW	3.300MW	106.0dBA	117m
V126 Mode 1, Serrated Blade, Max. Power 3300kW	3.300MW	105.8dBA	117m
V126 Mode 2, Serrated Blade, Max. Power 3175kW	3.175MW	104.5dBA	117m
V126 Mode 3, Serrated Blade, Max. Power 2979kW	2.979MW	102.5dBA	117m
V126 Mode 4, Serrated Blade, Max. Power 1325kW	1.325MW	98.3dBA	117m

Vestas confirms that the acoustic emission data sheets correspond to each of the nameplate wind turbine generators listed above. These sound power levels are presented with reference to the IEC 61400-11 ed. 3, dated 2012, based on a hub height of 117m.

Vestas also confirms that the wind turbine generators to be supplied for the Project will emit a tonal audibility level below 3 dB, as stated in the acoustic emission datasheets, and calculated using the

criteria specified in accordance with IEC 61400-11 ed.3 dated 2012. No additional test uncertainty needs to be included to neither the specified sound power level nor the specified tonal audibility level.

Sincerely,

Vestas

Date
Portland, 1 September 2015

HENVEY INLET WIND

Noise Mode 0 – 3.3 MW

1/1 Octave Band Performance (with serrated trailing edges)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
8 Hz	34.1	32.7	31.8	33.6	36.0	38.3	39.7	40.3	41.5	42.4	43.0	43.6	44.0	44.4	44.7	45.0	45.2	45.6
16 Hz	53.9	52.9	52.4	54.5	57.5	60.4	62.5	63.2	63.8	64.2	64.6	64.8	65.0	65.2	65.3	65.6	65.7	65.8
31.5 Hz	66.2	65.3	64.8	66.7	69.3	71.8	73.5	74.2	75.0	75.7	76.1	76.5	76.9	77.1	77.3	77.5	77.7	77.9
63 Hz	78.5	77.9	77.8	79.1	81.1	82.8	84.2	84.7	85.1	85.4	85.6	85.8	86.0	86.1	86.2	86.3	86.4	86.5
125 Hz	84.3	84.1	84.4	85.9	87.8	89.7	91.1	91.6	91.7	91.7	91.8	91.8	91.9	91.9	91.9	92.0	92.0	92.0
250 Hz	87.9	88.0	88.5	90.6	93.1	95.5	97.4	98.1	97.9	97.8	97.8	97.7	97.7	97.6	97.6	97.6	97.6	97.6
500 Hz	85.8	85.7	86.4	89.9	93.8	97.3	100.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.1
1 kHz	85.0	84.8	85.6	89.4	93.6	97.4	100.3	101.3	101.4	101.3	101.3	101.4	101.4	101.4	101.4	101.4	101.4	101.5
2 kHz	85.1	85.1	85.8	88.3	91.3	94.0	96.1	96.8	96.7	96.6	96.6	96.5	96.5	96.5	96.5	96.5	96.5	96.5
4 kHz	80.6	80.9	81.5	83.3	85.4	87.5	89.0	89.5	89.2	89.0	88.8	88.7	88.7	88.6	88.5	88.5	88.4	88.4
8 kHz	65.3	65.9	66.7	67.2	67.9	68.7	69.5	69.6	68.8	68.0	67.6	67.3	67.1	66.9	66.7	66.5	66.3	66.3
A-wgt	93.2	93.2	93.7	96.4	99.6	102.7	105.1	106	106	106	106	106	106	106	106	106	106	106

Uncertainty

All required siting uncertainty is included in the above octave bands, and ranges from 0.6 to 1.2dB, depending on the frequency, with the largest values at low and high frequencies.

Tonal Audibility Level

The tonal audibility level will be within 3dB when determined according to the methods described in IEC 61400-11, Ed. 3, 2012.

Maximum Nameplate Power

3.3 MW

The noise data contained herein is estimated and no warranties are implied.

Vestas Americas

1417 NE Everett Street, Portland, OR 97209, USA
Tel: +1 503 327 2000, vestas-americas@vestas.com, www.vestas.com
Company Reg. Name: Vestas - American Wind Technology, Inc., Communication name: Vestas Americas

Date
Portland, 1 September 2015

HENVEY INLET WIND

Noise Mode 2 – 3.175 MW

1/1 Octave Band Performance (with serrated trailing edges)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
8 Hz	34.1	32.7	31.8	33.6	36.2	37.9	38.5	38.8	39.9	40.9	41.8	42.6	42.9	43.3	43.6	43.9	44.3	44.4
16 Hz	53.9	52.9	52.4	54.5	57.6	59.7	60.4	60.7	61.5	62.3	63.0	63.5	63.7	63.9	64.1	64.3	64.4	64.5
31.5 Hz	66.2	65.3	64.8	66.8	69.4	71.3	71.9	72.2	73.1	74.0	74.7	75.3	75.6	75.8	76.1	76.3	76.5	76.6
63 Hz	78.5	77.9	77.8	79.1	81.1	82.5	82.9	83.1	83.7	84.1	84.5	84.9	84.9	85.0	85.2	85.3	85.4	85.4
125 Hz	84.3	84.1	84.4	85.8	87.8	89.2	89.6	89.8	90.2	90.4	90.6	90.8	90.8	90.8	90.9	90.9	90.9	90.9
250 Hz	87.9	88.0	88.5	90.5	93.1	94.8	95.4	95.6	95.9	96.1	96.3	96.5	96.4	96.3	96.4	96.3	96.3	96.2
500 Hz	85.8	85.7	86.4	89.9	93.8	96.3	97.2	97.6	98.2	98.6	99.0	99.4	99.4	99.4	99.5	99.5	99.5	99.4
1 kHz	85.0	84.8	85.6	89.4	93.6	96.3	97.3	97.7	98.3	98.8	99.3	99.7	99.8	99.8	99.9	99.9	99.9	99.8
2 kHz	85.1	85.1	85.8	88.3	91.3	93.2	93.9	94.1	94.5	94.8	95.0	95.3	95.2	95.1	95.2	95.2	95.2	95.1
4 kHz	80.6	80.9	81.5	83.3	85.4	86.8	87.3	87.4	87.6	87.6	87.7	87.8	87.5	87.4	87.4	87.4	87.3	87.2
8 kHz	65.3	65.9	66.7	67.1	67.9	68.3	68.4	68.3	68.0	67.5	67.1	66.8	66.3	66.0	65.9	65.8	65.6	65.4
A-wgt	93.2	93.2	93.7	96.4	99.6	101.8	102.6	102.9	103.4	103.8	104.2	104.5	104.5	104.5	104.5	104.5	104.5	104.5

Uncertainty

All required siting uncertainty is included in the above octave bands, and ranges from 0.6 to 1.2dB, depending on the frequency, with the largest values at low and high frequencies.

Tonal Audibility Level

The tonal audibility level will be within 3dB when determined according to the methods described in IEC 61400-11, Ed. 3, 2012.

Maximum Nameplate Power

3.175 MW

The noise data contained herein is estimated and no warranties are implied.

Vestas Americas

1417 NE Everett Street, Portland, OR 97209, USA
Tel: +1 503 327 2000, vestas-americas@vestas.com, www.vestas.com
Company Reg. Name: Vestas - American Wind Technology, Inc., Communication name: Vestas Americas

Vestas

Date
Portland, 1 September 2015

HENVEY INLET WIND

Noise Mode 3 – 2.979 MW

1/1 Octave Band Performance (with serrated trailing edges)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
8 Hz	34.1	32.7	31.9	34.0	36.4	37.1	37.0	37.2	38.2	39.4	40.8	41.2	41.6	41.9	42.2	42.6	42.9	43.2
16 Hz	53.9	52.9	52.4	54.8	57.4	58.2	58.3	58.6	59.5	60.4	61.5	61.8	62.0	62.2	62.4	62.6	62.7	62.9
31.5 Hz	66.2	65.3	64.8	67.0	69.4	70.1	70.2	70.4	71.3	72.2	73.5	73.8	74.0	74.3	74.5	74.7	75.0	75.2
63 Hz	78.5	77.9	77.8	79.3	80.9	81.5	81.6	81.7	82.3	82.8	83.7	83.7	83.7	83.8	83.9	84.0	84.1	84.2
125 Hz	84.3	84.1	84.4	85.8	87.4	87.9	88.1	88.4	88.8	89.1	89.7	89.6	89.5	89.5	89.5	89.5	89.5	89.6
250 Hz	87.9	88.0	88.5	90.4	92.5	93.1	93.4	93.8	94.2	94.5	95.1	95.0	94.8	94.8	94.7	94.7	94.7	94.6
500 Hz	85.8	85.7	86.4	89.8	93.0	94.0	94.3	94.9	95.6	96.2	97.1	97.3	97.3	97.4	97.4	97.4	97.4	97.4
1 kHz	85.0	84.8	85.6	89.3	92.8	93.9	94.3	94.8	95.6	96.3	97.2	97.4	97.5	97.6	97.6	97.6	97.6	97.6
2 kHz	85.1	85.1	85.7	88.2	90.6	91.4	91.7	92.1	92.6	92.9	93.6	93.6	93.5	93.5	93.4	93.4	93.4	93.4
4 kHz	80.6	80.9	81.5	83.1	84.8	85.3	85.6	85.9	86.1	86.2	86.7	86.4	86.2	86.1	86.0	85.9	85.8	85.8
8 kHz	65.3	65.9	66.7	66.7	67.1	67.2	67.5	67.8	67.5	67.0	66.9	66.2	65.7	65.3	65.1	64.9	64.8	64.6
A-wgt	93.2	93.2	93.7	96.3	98.9	99.8	100.1	100.5	101.2	101.7	102.5	102.5	102.5	102.5	102.5	102.5	102.5	102.5

Uncertainty

All required siting uncertainty is included in the above octave bands, and ranges from 0.6 to 1.2dB, depending on the frequency, with the largest values at low and high frequencies.

Tonal Audibility Level

The tonal audibility level will be within 3dB when determined according to the methods described in IEC 61400-11, Ed. 3, 2012.

Maximum Nameplate Power

2.979 MW

The noise data contained herein is estimated and no warranties are implied.

Vestas Americas

1417 NE Everett Street, Portland, OR 97209, USA
Tel: +1 503 327 2000, vestas-americas@vestas.com, www.vestas.com
Company Reg. Name: Vestas - American Wind Technology, Inc., Communication name: Vestas Americas

Date
Portland, 1 September 2015

HENVEY INLET WIND

Noise Mode 4 – 1.325 MW

1/1 Octave Band Performance (with serrated trailing edges)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
8 Hz	34.1	32.7	31.8	33.5	34.2	36.0	37.3	38.2	38.9	39.4	39.9	40.2	40.6	40.9	41.3	41.5	41.8	42.1
16 Hz	53.9	52.9	52.4	54.4	55.8	56.8	57.6	58.2	58.6	58.9	59.3	59.5	59.7	59.9	60.1	60.3	60.5	60.7
31.5 Hz	66.2	65.3	64.8	66.7	67.6	69.0	69.9	70.5	70.9	71.4	71.7	71.9	72.1	72.4	72.6	72.8	73.0	73.2
63 Hz	78.5	77.9	77.8	79.1	79.9	80.7	81.0	81.4	81.6	81.8	82.0	82.1	82.2	82.3	82.4	82.5	82.6	82.8
125 Hz	84.3	84.1	84.4	85.8	86.8	87.1	87.2	87.2	87.3	87.3	87.4	87.4	87.4	87.5	87.5	87.5	87.5	87.6
250 Hz	87.9	88.0	88.5	90.5	92.0	92.0	91.8	91.7	91.7	91.7	91.7	91.6	91.6	91.5	91.5	91.5	91.4	91.4
500 Hz	85.8	85.7	86.4	89.8	92.0	92.3	92.3	92.3	92.3	92.3	92.4	92.4	92.3	92.3	92.4	92.4	92.4	92.4
1 kHz	85.0	84.8	85.6	89.3	91.7	92.0	92.0	92.1	92.1	92.1	92.2	92.2	92.1	92.1	92.2	92.2	92.2	92.2
2 kHz	85.1	85.1	85.8	88.3	90.0	90.1	90.0	89.9	89.8	89.8	89.9	89.8	89.8	89.8	89.8	89.7	89.8	89.7
4 kHz	80.6	80.9	81.5	83.3	84.7	84.4	84.1	83.9	83.8	83.7	83.6	83.6	83.5	83.4	83.4	83.3	83.3	83.3
8 kHz	65.3	65.9	66.7	67.2	68.1	67.0	66.1	65.7	65.4	65.2	65.0	64.9	64.7	64.5	64.5	64.4	64.4	64.3
A-wgt	93.2	93.2	93.7	96.3	98.2	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3

Uncertainty

All required siting uncertainty is included in the above octave bands, and ranges from 0.6 to 1.2dB, depending on the frequency, with the largest values at low and high frequencies.

Tonal Audibility Level

The tonal audibility level will be within 3dB when determined according to the methods described in IEC 61400-11, Ed. 3, 2012.

Maximum Nameplate Power

1.325 MW

The noise data contained herein is estimated and no warranties are implied.

Vestas Americas

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APPENDIX E – COORDINATES OF TURBINES AND TRANSFORMERS

Coordinates of turbines considered in the Henvey Inlet Project are listed below in UTM17-NAD83 projection.

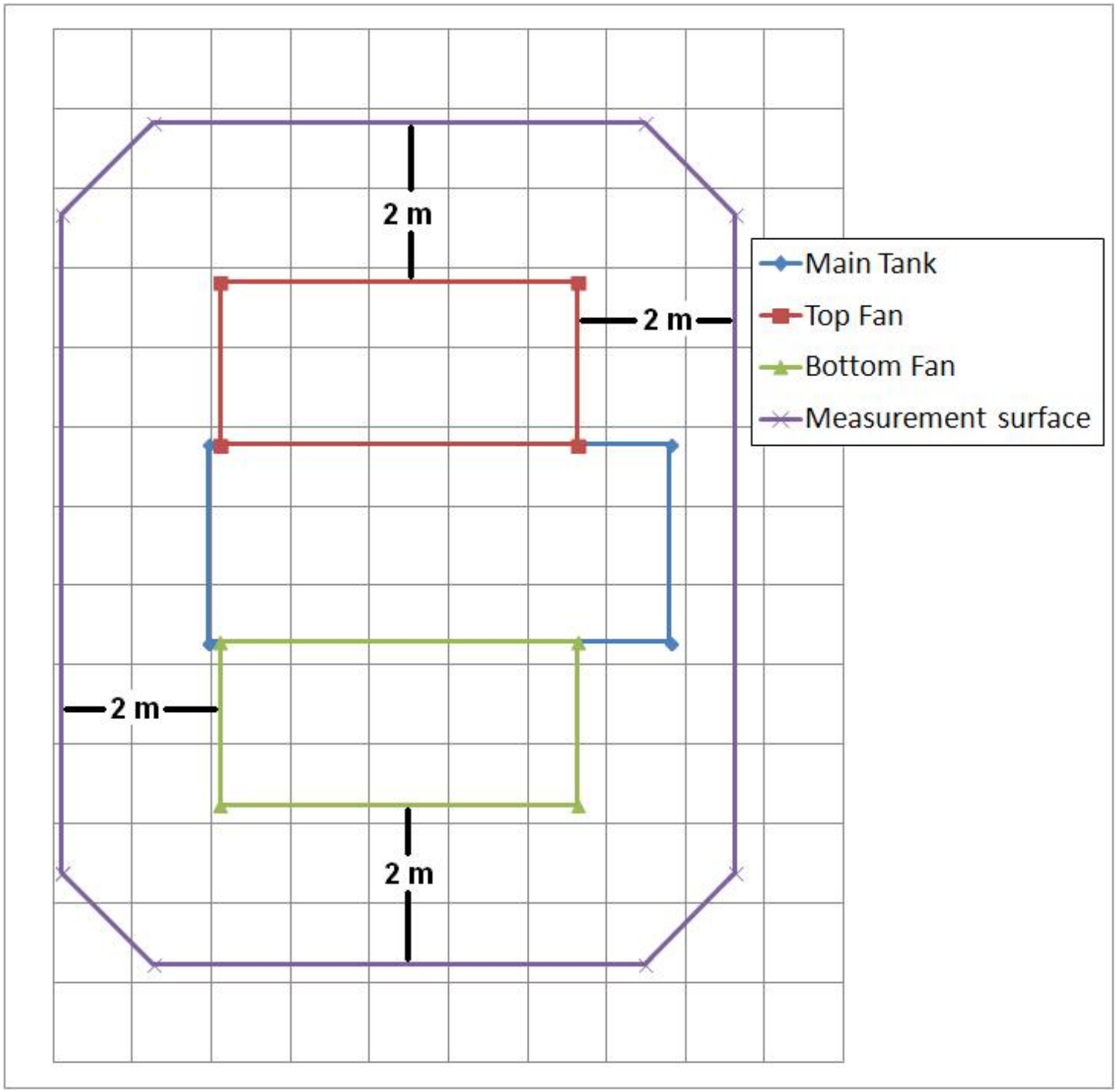
Turbine ID	Easting [m]	Northing [m]	Turbine Mode	Max Power [MW]	Broadband PWL [dBA]	Base Elevation [m]
3	523121	5079906	Mode 0	3.3	106	300
4	523527	5079507	Mode 0	3.3	106	304
5	523801	5078989	Mode 0	3.3	106	303
7	523524	5078349	Mode 0	3.3	106	298
8	524642	5078218	Mode 0	3.3	106	302
9	524064	5078074	Mode 0	3.3	106	300
10	523729	5080288	Mode 0	3.3	106	303
11	524049	5079892	Mode 0	3.3	106	306
12	524357	5079296	Mode 0	3.3	106	306
13	525248	5077957	Mode 0	3.3	106	299
14	525350	5078487	Mode 0	3.3	106	304
15	527421	5078857	Mode 0	3.3	106	307
16	523941	5080825	Mode 4	1.325	98.3	298
17	524323	5080374	Mode 0	3.3	106	300
18	525119	5080356	Mode 0	3.3	106	303
19	525968	5079735	Mode 0	3.3	106	307
20	525935	5080910	Mode 2	3.175	104.5	307
21	526198	5080567	Mode 0	3.3	106	307
22	526627	5080295	Mode 0	3.3	106	307
23	527354	5080566	Mode 0	3.3	106	307
24	528351	5079834	Mode 0	3.3	106	316
25	527408	5080090	Mode 0	3.3	106	307
26	527595	5079486	Mode 0	3.3	106	307
27	528146	5079222	Mode 0	3.3	106	313
28	528910	5079678	Mode 0	3.3	106	317
30	528837	5080463	Mode 0	3.3	106	317
31	529601	5079784	Mode 0	3.3	106	317
32	529297	5080169	Mode 0	3.3	106	317

Turbine ID	Easting [m]	Northing [m]	Turbine Mode	Max Power [MW]	Broadband PWL [dBA]	Base Elevation [m]
33	529797	5080740	Mode 0	3.3	106	317
34	530071	5080243	Mode 0	3.3	106	317
35	529499	5081120	Mode 0	3.3	106	317
36	525504	5074920	Mode 3	2.979	102.5	297
37	526446	5075009	Mode 0	3.3	106	307
38	526560	5075647	Mode 0	3.3	106	307
39	527713	5075411	Mode 0	3.3	106	307
40	526809	5076303	Mode 0	3.3	106	307
41	527265	5076047	Mode 0	3.3	106	307
42	528114	5074425	Mode 0	3.3	106	307
43	528421	5073536	Mode 0	3.3	106	307
44	528847	5074062	Mode 0	3.3	106	307
45	528144	5075012	Mode 0	3.3	106	307
46	526456	5074519	Mode 0	3.3	106	305
47	529348	5074549	Mode 0	3.3	106	307
48	528808	5074717	Mode 0	3.3	106	307
49	528807	5075356	Mode 0	3.3	106	307
50	529470	5075524	Mode 0	3.3	106	317
51	529849	5075135	Mode 0	3.3	106	317
52	530020	5074662	Mode 0	3.3	106	317
53	528070	5076261	Mode 0	3.3	106	307
54	528366	5075731	Mode 0	3.3	106	307
56	528453	5076902	Mode 0	3.3	106	308
57	528916	5077778	Mode 0	3.3	106	317
58	529162	5077137	Mode 0	3.3	106	317
59	529453	5078210	Mode 0	3.3	106	323
60	529540	5077683	Mode 0	3.3	106	317
61	529742	5076770	Mode 0	3.3	106	317
62	530238	5077263	Mode 0	3.3	106	317
66	531670	5075919	Mode 0	3.3	106	317
67	531023	5075433	Mode 0	3.3	106	317
68	530276	5076631	Mode 0	3.3	106	317

Turbine ID	Easting [m]	Northing [m]	Turbine Mode	Max Power [MW]	Broadband PWL [dBA]	Base Elevation [m]
69	530029	5076106	Mode 0	3.3	106	317
70	530390	5075594	Mode 0	3.3	106	317
71	527472	5074206	Mode 0	3.3	106	307
73	526968	5081286	Mode 3	2.979	102.5	307
74	527432	5081184	Mode 3	2.979	102.5	307
77	522354	5075451	Mode 0	3.3	106	297
78	522983	5075707	Mode 0	3.3	106	297
79	523310	5075327	Mode 0	3.3	106	297
80	522549	5075033	Mode 0	3.3	106	297
81	523404	5074679	Mode 0	3.3	106	297
82	524586	5074970	Mode 4	1.325	98.3	297
83	524641	5074525	Mode 0	3.3	106	297
84	525161	5074143	Mode 4	1.325	98.3	297
85	525749	5074315	Mode 0	3.3	106	297
86	526860	5073884	Mode 0	3.3	106	307
87	526160	5073866	Mode 3	2.979	102.5	304
88	527405	5073568	Mode 0	3.3	106	307
89	527740	5073257	Mode 0	3.3	106	307
92	522423	5079763	Mode 0	3.3	106	297
93	522766	5079426	Mode 0	3.3	106	299
94	523022	5078984	Mode 0	3.3	106	300
95	523906	5077558	Mode 0	3.3	106	297
96	525245	5080899	Mode 0	3.3	106	307
97	525687	5080122	Mode 0	3.3	106	307
98	526081	5078430	Mode 0	3.3	106	307
99	526639	5078778	Mode 0	3.3	106	307
101	526026	5079213	Mode 0	3.3	106	307
102	524699	5078878	Mode 0	3.3	106	306
103	522710	5074574	Mode 0	3.3	106	297
104	530197	5078125	Mode 0	3.3	106	322
105	531039	5076363	Mode 0	3.3	106	317
107	527118	5075097	Mode 0	3.3	106	307

Turbine ID	Easting [m]	Northing [m]	Turbine Mode	Max Power [MW]	Broadband PWL [dBA]	Base Elevation [m]
108	527349	5074679	Mode 0	3.3	106	307
109	525317	5079070	Mode 0	3.3	106	307
110	524099	5078545	Mode 0	3.3	106	302
111	526947	5079256	Mode 0	3.3	106	307
114	527914	5073940	Mode 0	3.3	106	307
115	525956	5075143	Mode 4	1.325	98.3	300
122	529137	5076532	Mode 0	3.3	106	317
Transformer North	527480	5078545		-	113.5	194
Transformer South	527641	5076030		-	113.5	194

APPENDIX F – HENVEY INLET EXAMPLE TRANSFORMER DIAGRAM

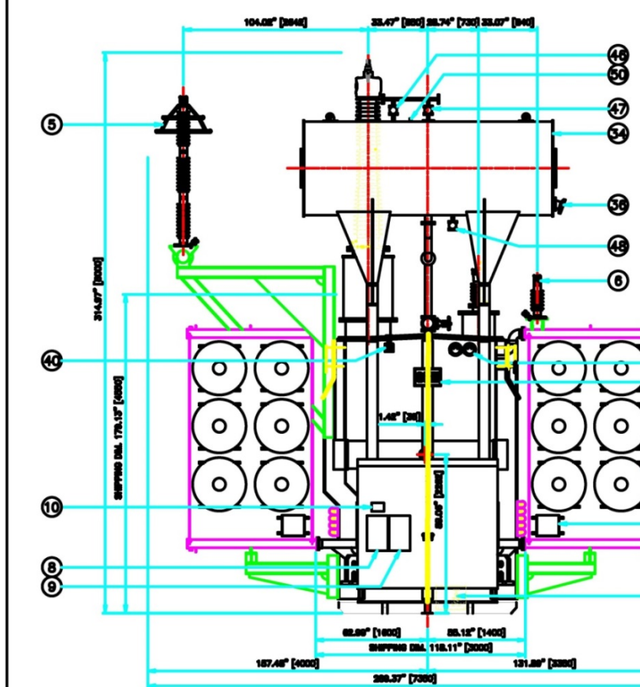


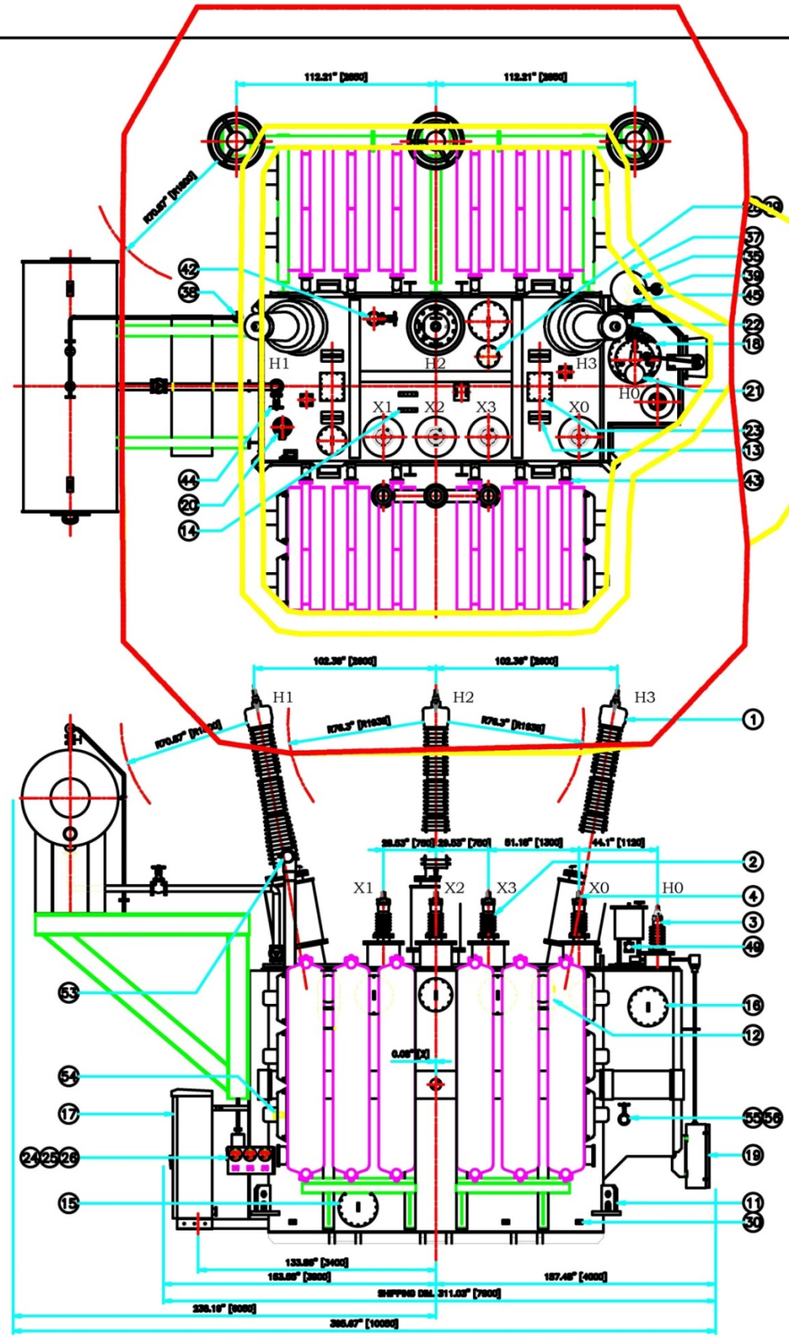
Henvey Inlet transformer – diagram of sound measurement surface area, as per IEEE C57.12.9

# WEIGHT #	
CORE AND COIL	: 153,880 lbs (69,800 kg)
TANK AND FITTING	: 86,640 lbs (39,300 kg)
INSULATING OIL	: 72,972 lbs (33,100 kg)
SHIPPING (WITHOUT OIL)	: 189,154 lbs (85,800 kg)
TOTAL	: 313,493 lbs (142,200 kg)

NOTE

1. DIMENSION TOLERANCE : ± 5%
2. ALL DIMENSIONS ARE IN INCHES [MILLIMETERS].
3. ⊕ MARK : COMPLETE CENTER OF GRAVITY (WITH OIL)





PART LIST

ITEM	DESCRIPTION
1	H.V BUSHING
2	X.V BUSHING
3	H.V NEUTRAL BUSHING
4	X.V NEUTRAL BUSHING
5	H.V ARRESTER
6	X.V ARRESTER
7	HICO MARK
8	NAMEPLATE
9	VALVE LOCATION NAMEPLATE
10	OIL LEVEL TEMPERATURE CURVE PLATE
11	TRANSFORMER JACKS STEPS WITH PULLING EYE
12	LIFTING HOOK FOR MAIN TANK
13	LIFTING STUD FOR CORE & COIL ASS'Y
14	SUPPORT FOR MULTI-AXIS IMPACT RECORDER
15	MANHOLE
16	HANDHOLE
17	LOCAL CONTROL PANEL
18	ON LOAD TAP CHANGER
19	MOTOR DRIVE UNIT FOR OLTC
20	PRESSURE RELIEF DEVICE FOR MAIN TANK
21	PRESSURE RELIEF DEVICE FOR OLTC TANK
22	PROTECTIVE RELAY FOR OLTC
23	END FRAME SUPPORTER
24	WINDING TEMPERATURE INDICATOR FOR H.V
25	WINDING TEMPERATURE INDICATOR FOR X.V
26	OIL TEMPERATURE INDICATOR
27	THERMO POCKET FOR TOP OIL & WINDING TEMPERATURE
28	GROUNDING BUSHING FOR CORE
29	GROUNDING BUSHING FOR END FRAME
30	GROUNDING TERMINAL
31	COOLING RADIATORS
32	FAN WITH MOTOR
33	JUNCTION BOX FOR COOLING FANS
34	CONSERVATOR FOR MAIN TANK
35	CONSERVATOR FOR OLTC TANK
36	OIL LEVEL GAUGE FOR MAIN CONSERVATOR
37	OIL LEVEL GAUGE FOR OLTC CONSERVATOR
38	BREATHER FOR MAIN CONSERVATOR
39	BREATHER FOR OLTC CONSERVATOR
40	UPPER FILTER VALVE
41	LOWER FILTER & DRAIN VALVE WITH SAMPLING DEVICE
42	VACUUM VALVE FOR MAIN TANK
43	INLET AND OUTLET VALVE FOR RADIATOR
44	CONNECTING VALVE FOR MAIN CONSERVATOR
45	CONNECTING VALVE FOR OLTC CONSERVATOR
46	VACUUM VALVE FOR CONSERVATOR
47	EQUALIZING VALVE FOR CONSERVATOR
48	DRAIN VALVE FOR MAIN CONSERVATOR
49	DRAIN VALVE FOR OLTC CONSERVATOR
50	AIR VENT FOR CONSERVATOR
51	AIR RELEASE PLUG FOR RADIATOR
52	DRAIN PLUG FOR RADIATOR
53	GAS ACCUMULATION INDICATOR
54	SAMPLING VALVE FOR GAS ACCUMULATION INDICATOR
55	CONNECTING VALVE FOR RAPID PRESSURE RISE RELAY
56	RAPID PRESSURE RISE RELAY

TYPE	POWER TRANSFORMER
DWG. NAME	OUTLINE
SCALE	1/25
DATE	2008.03.03

HICO HYOSUNG CORPORATION

APPENDIX G – SAMPLE CALCULATION FOR NOISE MODELING

Resulting A-weighted sound pressure level at Receptor 1000 and 1097

The calculation of cumulative receptor noise levels from wind turbines uses the methodology of ISO 9613-2, "*Acoustics — Attenuation of sound during propagation outdoors: Part 2: General method of calculation*". These calculations are conducted with CadnaA *(which is an implementation of ISO 9613-1 and ISO 9613-2)*.

As an example, in this appendix, the results are presented at Receptors 1000 and 1097. The following inputs and conditions were used:

- Turbine locations;
- Receptor locations.

Turbine characteristics and modelling parameters:

- Hub-height: 117 m as noted in Appendix F;
- Ambient air temperature: 10ºC;
- Ambient barometric pressure: 101.32 kPa;
- Relative humidity: 70%;
- Wind speed (10 m above ground level): 6 m/s;
- Source ground factor: 0.8;
- Middle ground factor: 0.8;
- Receptor ground factor: 0.8;
- Water feature ground factor: 0

See Section 5 for source broadband and octave band sound power levels.

The following table presents an example result and intermediate values of the calculations as the A-weighted sound pressure levels at two chosen example receptors, due to each turbine or substation and each octave band. The A-weighted sound pressure levels at the example Receptor 1000 and 1097 for all bands and all noise sources within 5000 m are 39.8 and 39.4dBA respectively.

Sample Calculations

Sound pressure levels at Receptor 1000

Source ID	Distance* [m]	Octave band sound pressure levels [dBA]									Broad-band SPL by source [dBA]
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
3	4278	-2.9	5.6	4.6	6.6	7.5	3.1	-27.2	+	+	12.9
4	3768	-2.1	6.5	5.8	8.1	9.4	5.9	-21.3	+	+	14.4
5	3193	-0.8	7.8	7.4	10.0	11.9	9.4	-14.3	+	+	16.7
7	2688	0.7	9.4	9.2	12.2	14.5	12.8	-7.9	-78.2	+	19.1
8	2306	2.1	10.8	10.4	13.5	16.2	15.5	-2.8	-64.1	+	20.9
9	2242	2.3	11.0	10.9	14.2	16.8	16.0	-2.0	-61.9	+	21.5
10	4472	-3.1	5.4	4.2	6.0	6.7	2.0	-29.3	+	+	12.3
11	4025	-2.5	6.1	4.9	7.0	8.1	4.4	-24.2	+	+	13.4
12	3396	-1.3	7.3	6.5	8.9	10.7	8.0	-16.8	+	+	15.6
13	2128	2.8	11.5	11.3	14.6	17.5	17.0	-0.2	-57.1	+	22.2
14	2665	0.8	9.5	9.1	12.0	14.4	13.0	-7.4	-76.8	+	19.1
15	4037	-2.5	6.1	7.2	9.6	10.3	5.6	-23.2	+	+	15.2
16	4963	-8.7	0.7	-1.6	-1.9	-4.1	-10.1	-41.8	+	+	5.0
17	4473	-3.1	5.4	3.8	5.6	6.4	1.9	-29.4	+	+	12.0
18	4466	-3.1	5.4	3.9	5.7	6.5	2.0	-29.3	+	+	12.1
19	4039	-2.5	6.1	4.8	6.8	8.1	4.5	-24.2	+	+	13.4
21	4901	-3.7	4.7	2.8	4.3	4.8	-0.3	-34.1	+	+	10.8
22	4803	-3.6	4.9	3.5	5.0	5.5	0.4	-32.8	+	+	11.3
25	5000	-3.9	4.6	3.0	4.4	4.8	-0.6	-34.9	+	+	10.8
26	4624	-3.3	5.2	4.0	5.7	6.4	1.7	-30.5	+	+	12.0
27	4807	-3.6	4.9	6.6	8.8	8.5	1.7	-31.7	+	+	13.8
36	1311	4.9	13.8	17.8	22	23.7	21.7	9.7	-27.8	+	28.0
37	2008	3.4	12.1	16.3	20.8	22.4	19.4	2.6	-51.3	+	26.5
38	1924	3.8	12.5	16.5	20.9	22.7	20	3.7	-48.1	+	26.8
39	3098	-0.4	8.2	11.7	15.4	16.1	11.4	-11.9	+	+	20.5
40	2188	2.6	11.3	15.2	19.5	21.0	17.9	0.0	-57.9	+	25.1
41	2612	1.1	9.7	13.3	17.3	18.5	14.7	-5.7	-73.4	+	22.7
42	3765	-2.0	6.5	9.6	12.9	13.1	7.3	-20.1	+	+	17.7
43	4453	-3.1	5.4	8.4	11.3	10.8	3.5	-28.0	+	+	15.9
44	4581	-3.3	5.2	7.7	10.4	9.9	2.7	-29.5	+	+	15.1
45	3602	-1.8	6.8	10.3	13.7	14.0	8.4	-18.0	+	+	18.6
46	2279	2.2	10.9	14.8	19.0	20.5	17.1	-1.3	-61.5	+	24.6
47	4886	-3.7	4.8	7.2	9.8	9.0	1.2	-32.8	+	+	14.4
48	4320	-2.9	5.6	8.5	11.4	11.1	4.3	-26.4	+	+	16.1
49	4187	-2.7	5.8	8.7	11.7	11.5	4.9	-24.9	+	+	16.4
50	4829	-3.6	4.9	7.2	9.8	9.1	1.4	-32.3	+	+	14.4
53	3431	-1.3	7.2	10.6	14.0	14.5	9.3	-16.0	+	+	19.0
54	3714	-1.9	6.6	9.8	13.1	13.3	7.6	-19.4	+	+	18.0
56	4648	-3.4	5.1	7.7	10.4	9.8	2.5	-30.1	+	+	15
57	4668	-3.4	5.1	7.8	10.5	9.8	2.3	-30.4	+	+	15.1
60	3922	-2.3	6.3	9.5	12.7	12.7	6.5	-21.8	+	+	17.4

Source ID	Distance* [m]	Octave band sound pressure levels [dBA]									Broad-band SPL by source [dBA]
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
71	3294	-1	7.6	11.3	14.9	15.4	10.2	-14.4	+	+	19.8
77	2354	1.8	10.5	9.0	11.8	14.7	14.5	-4.2	-67.2	+	19.7
78	1693	4.6	13.4	12.1	15.4	18.9	19.8	5.1	-42.6	+	24.0
79	1476	5.8	14.6	15.3	19.1	22.3	22.4	8.8	-33.9	+	27.0
80	2290	2.0	10.7	11.1	14.4	16.9	15.5	-2.9	-64.4	+	21.4
81	1766	4.3	13.0	16.1	20.4	22.5	20.5	5.0	-44.3	+	26.7
82	955	4.8	14.6	18.1	21.4	21.5	19.8	11.8	-16.8	+	26.9
83	1396	6.4	15.2	19.0	23.7	26.0	24.2	11.0	-29.4	+	30.1
84	1846	-0.9	8.9	12.2	15	14.2	11	-2.4	-51.3	+	19.8
85	1940	3.6	12.4	16.6	21	22.7	19.8	3.3	-49.2	+	26.8
86	2998	-0.2	8.5	12.1	15.9	16.7	12	-10.7	-87.6	+	21
87	2543	-0.9	7.8	11.4	14.8	15.4	11.2	-8.1	-74.2	+	19.9
88	3615	-1.8	6.8	10.4	13.8	14.0	8.2	-18.3	+	+	18.6
89	4071	-2.5	6.0	9.3	12.4	12.3	5.6	-23.6	+	+	17.1
92	4452	-3.1	5.4	4.4	6.3	7.0	2.2	-29.1	+	+	12.5
93	3990	-2.4	6.1	5.4	7.6	8.7	4.7	-23.8	+	+	13.8
94	3480	-1.6	7.0	6.7	9.1	10.7	7.6	-17.8	+	+	15.6
95	1811	4.1	12.9	13.1	16.7	19.7	19.6	4.1	-45.9	+	24.4
97	4332	-2.9	5.6	4.3	6.2	7.1	2.8	-27.6	+	+	12.6
98	2891	0.1	8.8	8.6	11.4	13.5	11.7	-10.0	-84.5	+	18.3
99	3483	-1.5	7.1	6.5	8.8	10.5	7.8	-17.4	+	+	15.5
101	3572	-1.7	6.8	6.3	8.6	10.2	7.3	-18.6	+	+	15.2
102	2965	-0.1	8.5	7.9	10.6	12.7	10.8	-11.4	-87.9	+	17.5
103	2369	1.7	10.4	13.0	16.9	18.6	15.7	-3.5	-66.7	+	22.8
107	2595	1.1	9.8	13.6	17.5	18.8	14.9	-5.4	-72.8	+	22.9
108	2963	-0.1	8.6	12.1	15.8	16.7	12.3	-10.3	-86.2	+	21
109	3225	-0.9	7.8	7.1	9.6	11.5	9.2	-14.6	+	+	16.4
110	2691	0.7	9.4	9.1	12.1	14.3	12.7	-7.9	-78.2	+	19.0
111	4051	-2.5	6	5.1	7.1	8.3	4.6	-24.1	+	+	13.5
114	3810	-2.1	6.5	9.9	13.2	13.3	7.2	-20.5	+	+	17.9
115	1514	1.0	10.7	14.6	17.7	17.2	14.4	3.2	-37.7	+	22.6
122	4522	-3.2	5.3	7.9	10.7	10.2	3.1	-28.8	+	+	15.4
Total A-Weighted Sound Pressure Level											40.0

* Includes the heights of noise sources and receptors.
+ indicates values below -88.0 dBA

Sound pressure levels at Receptor 1097

Source ID	Distance* [m]	Octave band sound pressure levels [dBA]									Broad-band SPL by source [dBA]
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
4	4959	-3.9	4.6	5.8	9.0	8.3	0.1	-34.5	+	+	13.6
8	4894	-3.8	4.7	6.1	9.2	8.6	0.5	-33.8	+	+	13.8
10	4446	-3.2	5.3	6.8	10.3	10.2	2.9	-28.7	+	+	15.0
11	4318	-3.0	5.5	7.1	10.7	10.7	3.6	-27.2	+	+	15.5
12	4372	-3.1	5.5	7.1	10.6	10.5	3.3	-27.9	+	+	15.3
13	4731	-3.6	4.9	6.6	9.8	9.2	1.4	-31.9	+	+	14.4
14	4239	-2.9	5.7	7.6	11.1	11.0	4.1	-26.3	+	+	15.8
15	3069	-0.4	8.2	11.0	15.1	16.1	11.2	-12.2		+	20.3
16	4077	-7.5	2.0	3.2	5.4	3.1	-4.2	-31.0	+	+	9.9
17	3864	-2.3	6.3	8.2	12.1	12.5	6.2	-21.9	+	+	17.0
18	3156	-0.7	7.9	10.3	14.6	15.6	10.5	-13.4	+	+	19.7
19	2880	0.1	8.8	11.4	15.8	16.9	12.3	-9.9	-84.4	+	21.0
20	2177	1.9	10.5	13.0	17.5	19.1	15.8	-2.0	-60.2	+	23.2
21	2139	2.7	11.4	14.3	19.2	21.0	17.7	-0.1	-57.5	+	24.9
22	2029	3.2	11.9	14.9	19.8	21.6	18.5	1.4	-53.4	+	25.6
23	1428	6.3	15.0	18.4	23.6	25.9	23.9	10.4	-30.6	+	29.9
24	2114	2.8	11.5	14.7	19.4	21.2	17.9	0.3	-56.5	+	25.1
25	1863	3.9	12.7	15.8	20.8	22.7	19.9	3.8	-47.2	+	26.7
26	2423	1.6	10.3	13.3	17.9	19.4	15.6	-3.9	-67.9	+	23.4
27	2685	0.7	9.4	12.3	16.7	18.0	13.7	-7.3	-77.3	+	22.0
28	2446	1.6	10.2	13.3	17.8	19.3	15.4	-4.1	-68.7	+	23.3
30	1726	4.6	13.3	16.7	21.7	23.7	21.2	5.9	-42	+	27.7
31	2726	0.6	9.3	12.3	16.6	17.8	13.5	-7.8	-78.8	+	21.9
32	2236	2.3	11	14.3	18.9	20.5	17	-1.3	-61	+	24.5
33	2244	2.3	11.0	14.2	18.9	20.6	17.1	-1.3	-61.1	+	24.5
34	2748	0.5	9.2	12.2	16.5	17.7	13.4	-8.0	-79.5	+	21.8
35	1802	4.2	13.0	16.4	21.4	23.4	20.7	5.0	-44.7	+	27.4
56	4244	-2.9	5.7	7.8	11.3	11.1	4.2	-26.2	+	+	15.9
57	4926	-3.8	4.6	6.4	9.4	8.6	0.5	-34.0	+	+	13.9
58	4006	-7.3	1.3	3.8	7.3	7.3	0.8	-28.2	+	+	12.0
59	4526	-8.0	0.4	2.6	5.8	5.4	-2.1	-34.2	+	+	10.4
73	1096	6.4	15.3	18.1	23.0	25.2	23.5	12.7	-20.3	+	29.4
74	842	8.7	17.6	20.8	25.7	28.0	26.8	17.5	-9.6		32.4
96	2813	0.3	9.0	11.3	15.9	17.2	12.8	-9.0	-82.0	+	21.3
97	2815	0.3	9.0	11.6	16.0	17.2	12.8	-9.1	-82.1	+	21.3
98	3899	-2.4	6.2	8.5	12.2	12.4	6.0	-22.3	+	+	17.0
99	3351	-1.2	7.4	10.1	14.1	14.7	9.4	-15.7	+	+	19.1
101	3256	-1	7.7	10.3	14.4	15.2	9.9	-14.5	+	+	19.4
102	4379	-3.1	5.4	7.2	10.6	10.5	3.3	-27.9	+	+	15.3
104	4426	-3.1	5.4	7.6	10.8	10.5	3.2	-28.3	+	+	15.4
109	3809	-2.2	6.3	8.7	12.4	12.7	6.5	-21.3	+	+	17.2
111	2795	0.4	9	11.9	16.3	17.4	13	-8.7	-81.3	+	21.5
Total A-Weighted Sound Pressure Level											39.8

* Includes the heights of noise sources and receptors.
+ indicates values below -88.0 dBA

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter, and greener.