Supplemental Report

Chebucto Terence Bay Wind Farm Environmental Assessment

CBCL Limited and AL-PRO Wind Energy Consulting Canada Inc.

1.0 Introduction

1.1 Proponent Information

Project Name:	Chebucto Terence Bay Wind Farm
Project Location:	Terence Bay, NS. PID: 00384966
Size of the Project:	Up to 7.2 Megawatts (MW)
Proponent Information:	Chebucto Terence Bay Wind Field Limited (CTB) 30 Memory Lane Lower Sackville, NS B4C 2J3 Attention: Terry Norman, President Tel: (902) 429-8810
Applicant:	CBCL Limited 1489 Hollis Street Halifax, Nova Scotia B3J 2R7
Applicant Contact Person:	Ann Wilkie, VP Environment CBCL Limited Phone: (902) 492-6764 Fax: (902) 423-3938 Email: annw@cbcl.ca

The following documentation was prepared as required by the *Nova Scotia Environment Act* and associated regulations.

Proponent's Signature

Date: October 14, 2014

Applicants Signature

Date: October 14, 2014

The proponent, Chebucto Terence Bay Wind Field Limited (CTB), is a Community Economic Development Corporation (CEDC) that is based in the Halifax Regional Municipality (HRM). Thirty-six percent of CTB is owned by 37 individual shareholders who are residents of Nova Scotia; the balance of the outstanding shares are owned by Chebucto Wind Field Limited (CWF) and Renewable Energy Services Limited (RESL).

1.2 Context

This report has been prepared by CBCL Limited and AL-PRO Wind Energy Consulting Canada Inc. in response to the request for additional information by the by the Minister of the Environment in regard to the Chebucto Terrence Bay Wind Farm. In particular, the Minister requested that more information be provided in the following areas:

i) Chebucto Terence Bay Wind Field Limited must provide clarification of the type of receptors within 2 km of the turbines and demonstrate that operational noise levels will not exceed 40 dBA at any receptor;

ii) The proponent must provide justification for the wind speed and ground attenuation variables used in the Noise Study; and

iii) A sound impact analysis for the Chebucto Terence Bay Wilderness Area is required.

2.0 Approach and Methodology

The following provides an account of the approach and detailed methodology used in the sound model and the area of application which speaks to items i) and ii) above.

2.1 Turbine Sound Power Level

The noise emission data provided by the manufacturer indicated that the highest sound power level for the E-92 is 105 dBA (Table 2.1). The manufacturer provided an extract of a test report completed by Műller-BBM, a third party German Consulting Firm, that shows the highest sound power level recorded was 105.4 dBA at a windspeed of 7 m/s @ 10m for a 98 m hub height. The total A-weighted sound power levels and octave sound power levels measured by Műller-BBM are summarized in Tables 2.1 and 2.2.

Table 2.1: Sound Power levels for the E-92 with 2,350 kW rated Power (Enercon GmbH)

Wind Speed @ 10 m (m/s)	Sound Power Level (dBA)	
	85 m	98 m
5	99.5	99.9
6	102.0	102.2
7	103.3	103.4
8	104.2	104.4
9	105.0	105.0
10	105.0	105.0
95% Rated Power	105.0	105.0

Since the 105.4 dBA is the highest sound power level recorded, it was selected for this analysis. It is also pointed out that this value was observed at a 98 m tower, whereas the Chebucto Terence Bay Wind Farm will utilize 85 m towers. Measured noise emissions increase slightly as tower heights increase which reflects a direct function of higher wind speeds at higher hub heights. Since the reference wind

Table 2.2: Extract From Test Report E-92 Mode 1 M111164-02 (Müller-BBM GmbH)

Wind Speed @ 10 m (m/s)	Sound Power Level (dBA)	Octave Sound Power Level (dB)							
		63	125	250	500	1000	2000	4000	8000
6	103.7	85.7	94.1	94.8	97.3	98.7	95.5	91.3	79.3
7	105.4	87.4	95.8	96.5	99.0	100.4	97.2	91.3	81.0
8	104.9	86.9	95.3	96.0	98.5	99.9	96.7	90.8	80.5

speed for sound modeling is measured at 10 m using the IEC 61400-11 *Acoustic noise measurement technique* standard, increasing tower heights result in increased wind speed and slight increases in sound emissions. This adds to the conservative nature of the 105.4 dBA model input used in this analysis.

These previously described sound power levels are based on standard rotor blade design which has a smooth trailing edge. Recent advances in turbine design and engineering have resulted in the development of Trailing Edge Serrations (TES) which are designed to reduce aerodynamic noise. Trailing Edge Serrations are a recent advancement and field measurements are not yet available for the E-92 Turbine. Test results from the E-82 turbine with TES show a reduction 1.5 dBA over the conventional, smooth trailing edge design (Table 2.3). The turbines to be used in the Chebucto Terence Bay Wind Farm will be Enercon E-92 turbines that are equipped with TES rotor blades; these will have a lower sound power level than the 105.4 dBA modeled in this study. The precise magnitude of the reduction is unknown at this time, but this development adds to the conservative nature of this sound analysis.

Table 2.2-3: Sound Power levels for the E-82 with 2,300 kW rated Power with Conventional and Trailing Edge Serration (TES) Rotor Design (Enercon GmbH)

Wind Speed @ 10 m (m/s)	Sound Power Level (dBA)	
	85 m	85 m w TES
5	96.6	96.7
6	101.0	100.0
7	103.5	101.8
8	104.0	102.5
9	104.0	102.5
10	104.0	102.5
95% Rated Power	104.0	102.5

2.2 Wind Direction

The ISO 9613-2 method considers conditions that are favourable to noise propagation from source to receiver. This involves a conservative assumption that all receivers are always downwind from every turbine. In real situations, noise propagation and attenuation in upwind directions leads to a reduction of incident noise levels at receptors located upwind from the turbines.

2.3 Geometric Divergence

The geometric divergence considers the spread of sound from a point source in a spherical dimension which is defined in the ISO 9613-2 standard.

2.4 Atmospheric Absorption

Atmospheric attenuation is strongly dependant on the sound frequency, ambient temperature and the relative humidity of the air. Table 2.4 shows the atmospheric absorption values used in this analysis which are based on a temperature of 10^{o}C and a relative humidity of 70%.

Table 2.4: Atmospheric Attenuation Coefficient per Octave Band.

Octave Band (Hz)	Air Absorption (dB/km)
31.5	0.0
63	0.1
125	0.4
250	1.0
500	1.9
1000	3.7
20000	9.7
4000	32.8
8000	117.0

2.5 Meteorological Coefficient

A meteorological coefficient can be assigned to the model to simulate sound damping due to unique meteorological conditions and noise propagation in the upwind direction. To maintain a conservative analysis, no meteorological coefficient was applied in the model.

2.6 Ground Effect

The ISO 9613-2 standard describes two main types of ground attenuation. The general method is a simple calculation that assumes the ground is flat or slopes with a constant pitch between the sound source and receptor. If this approach is used, a ground factor (G) is assigned to the calculation to define the ground porosity. Hard ground such as pavement, concrete, ice or water is assigned a value of 0, and porous ground which includes ground surfaces suitable for the growth of vegetation is considered to have a ground factor of 1.

In forested settings that have orographic displacement, the *Alternative method of calculation for A-weighted sound pressure levels* provides a more realistic calculation of the ground surface impact on sound attenuation. The standard identifies that this approach is used when:

- Only when the A-weighted sound pressure level at the receiver position is of interest;
- The sound propagation occurs over porous ground or mixed ground, most of which is porous; and
- The sound is not a pure tone.

This approach considers the ground as bare earth model and orographic displacement is considered in the model.

2.7 A-Weighted Sound Levels

The A-weighted sound pressure level closely replicates the relative loudness perceived by the human ear and is widely used for measuring environmental noise. A-weighting serves two important functions:

- it provides a single number measure of noise level by integrating sound levels at all frequencies; and
- it provides a scale for noise level as experienced or perceived by the human ear.

Under current policies and regulations, only sound audible to the human ear is considered when developing a sound study for a wind project.

2.8 Low Frequency Sound

Sound in the 20 to 200 Hz frequency range is commonly referred to as low-frequency sound and sound below 20 Hz is called infrasound. The audible frequency range that humans can hear extends down to 16 or 20 Hz.

In a study of low-frequency noise from large wind turbines, Moller and Pedersen (2010) concluded that the relative amount of low frequency noise is higher for turbines in the 2.3 to 3.6 MW class when compared to smaller (<2MW) turbines. In general, the results were characterized as a downward shift of the spectrum of approximately 1/3 of an octave. Although this distinction does exist, a report created by the Danish Firm DELTA (2010) for the Danish Energy Authority concluded that these differences are not detected by human hearing. Tickell (2012) compared sound levels for five different modern wind turbines in Japan with infrasonic and low frequency hearing thresholds. Sound measurements were recorded at distances equal to hub height + rotor diameter from each turbine which ranged from 285Kw to 2MW in size. A total of 8 hearing thresholds were compared to the measured sound levels for five turbines. The comparison shows that below 25 Hz, which includes the infrasonic range, the sound levels of the five turbines are below the threshold for hearing at distances of 44 to 77 m from turbines.

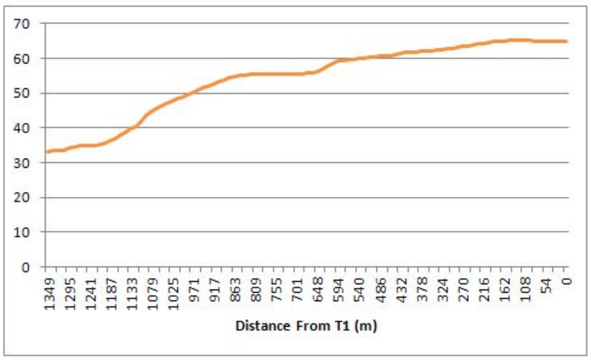
HGC Engineering (2010) completed a literature review in regard to Low Frequency Sound and Infrasound associated with wind turbine generator systems for the Ontario Ministry of Environment. Current, upwind design turbines produce broadband noise and the dominant frequency range is not in the low frequency or infrasound range. In the infrasound range (< 20 Hz), the authors reported that there is strong evidence that sound pressure levels are well below the average threshold of human hearing at setback distances typical in Ontario. Additionally, infrasonic noise below the threshold of hearing does not impact health. In the audible broad spectrum range which includes the low frequency range, publications by medical professionals indicate that at normal setback distances, the overall sound pressure levels produced by wind turbines does not pose a direct health risk (HGH Engineering, 2010).

The review indicates that audible noise does result in an annoyance for some people, which can contribute to stress related health impacts on some individuals (HGC Engineering, 2010). The annoyance factor was quantified in a report by DELTA (2008) which concluded that in laboratory experiments, the annoyance factor of low frequency sound increases more rapidly when the sound is audible. If tones are present, the annoyance factor increases (DELTA, 2008).

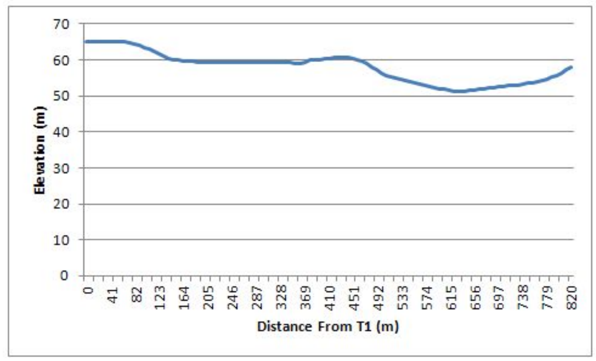
2.9 Terrain

In the case of the Chebucto Terence Bay Wind Farm, the terrain can be considered as rolling and the dominant vegetative communities are forests and low shrub barrens. Figure 2.1 identifies the location of the four orographic cross sections which are used to demonstrate the terrain profiles between two turbines and the closest receptors. Figure 2.2 shows the vertical cross sections between the turbine positions and the receptors.

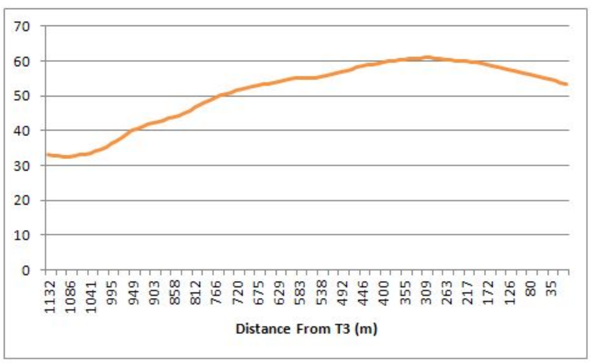
The westerly vertical profiles indicate that the terrain drops off in a westerly direction to the closest receptor in the study area (#91). In comparison, the easterly profiles show two shallow depressions between Turbine 1 and receptor #29. These profiles show the varying terrain conditions that occur in the vicinity of the Terence Bay Wind Project.



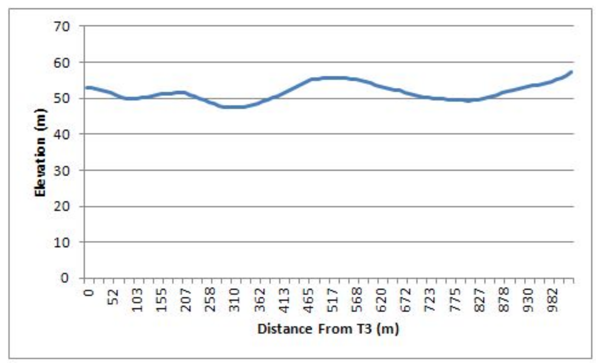
Cross Section Turbine position T1 to Receptor 91



Cross Section Turbine position T1 to Receptor 29



Cross Section Turbine position T3 to Receptor 91



Cross Section Turbine position T3 to Receptor 29

Figure 2.1: Cross Sectional Profiles

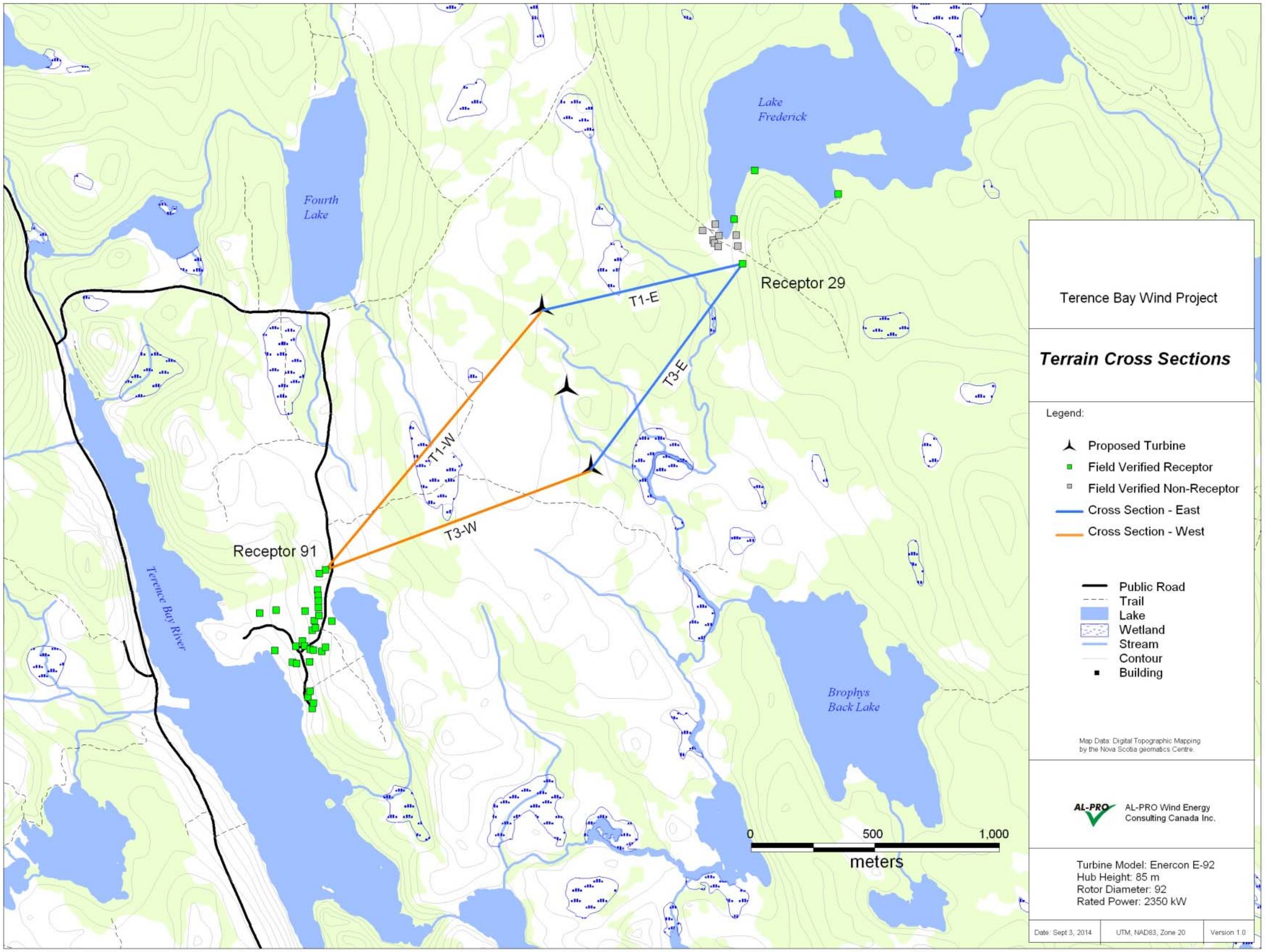


Figure 2.2: Location of Cross Sectional Profiles and Classified Receptors within 1.5 km of the Proposed Chebucto Terence Bay Wind Farm

When modeling sound propagation from wind turbines, the ground effect will have an impact on sound propagation and a realistic but conservative approach is required. In the case of the Chebucto Terence Bay Wind Farm, the Alternative method was selected since a hill or knoll between a turbine and receptor will have a slight impact on incident sound, whereas a valley or depression will have limited impact on sound levels at receptors. This methodology best models the actual terrain conditions that exist within the vicinity of the project area.

2.10 Pure Tones

An audible tone consists of a single frequency that dominates the one third octave band. Pure tones are much more annoying than broadband noise of the same level. Pure tones are defined (ISO 1996-2:2207) as single, one third octave band levels that exceed 15 dB for its direct neighbor bands centered on 25 to 125 Hz, 8 dB for bands centered on 160 to 400 Hz and 5 dB for bands centered on 500 Hz to 10 kHz.

Figure 2.3 shows the measured one third octave data for the Enercon E-92 Turbine. Pure tones can be identified by the absolute difference between the adjacent one third octave bands that exceed the definition above. In this case, as with most utility scale wind turbines, there are no pure tones emitted by the turbine.

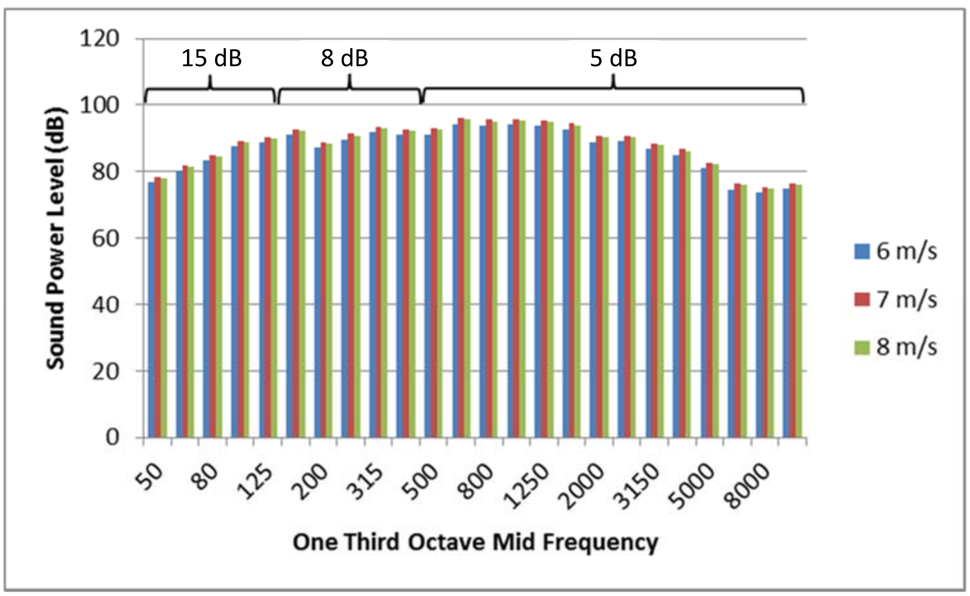


Figure 2.3: Measured One Third Octave Sound Power Levels for Three Reference Wind Speeds for the Enercon E-92 Highlighting the Broadband Nature of E-92 Sound Emissions (Műller-BBM)

3.0 Findings of Sound Analysis

3.1 Field Verified Receptors

The original list of receptors provided in Appendix L of the Chebucto Terence Bay Environmental Assessment Registration Document was a summary of all buildings contained within the Nova Scotia Topographic Database. The Nova Scotia Department of Environment (NSE) requested additional information on the type of receptors contained within the sound study. On September 3, 2014, all the receptors within 1.5 km of the proposed wind project were visited and categorized (see Appendix A). Receptors further than 1.5 km were not field categorized as the sound impacts are expected to be well below the maximum 40 dbA threshold level. During the field visits, it was confirmed that six previously mapped structures located to the west of Lake Frederick had been destroyed by fire; two others are old school buses. Table 3.1 identifies the receptors located within 1.5 km of the Chebucto Terence Bay Wind Farm, the use at each location, the distance to the closest turbine and the modeled sound pressure levels at each receptor. These results demonstrate that operational noise levels will not exceed 40 dbA at any receptor.

The location of each of the field verified receptors and non receptors are shown in Figure 3.1.

Table 3.1: Field Classified Receptors within 1.5 km of the Terence Bay Wind Project

ID	Easting*	Northing	Description	dBA	Closest Turbine (m)
20	443,967	4,928,886	burnt structure		
21	444,008	4,928,846	burnt structure		
22	444,013	4,928,835	burnt structure		
23	444,017	4,928,910	old bus		
24	444,030	4,928,822	two burnt structures		
25	444,032	4,928,865	old bus		
26	444,094	4,928,931	cabin, useable	36.44	858
27	444,108	4,928,823	burnt structure		
28	444,102	4,928,866	burnt structure		
29	444,128	4,928,752	standing cabin, no apparent use	37.44	831
30	444,176	4,929,127	standing cabin, no apparent use	34.23	1,025
31	444,513	4,929,032	cabin, recent activity	31.57	1,282
65	442,180	4,927,344	home, civic not visible	30.37	1,456
66	442,241	4,927,194	civic 6	30.06	1,468
67	442,246	4,927,357	civic 19	30.69	1,391
68	442,311	4,927,147	civic 532	29.56	1,433
69	442,325	4,927,210	Shed	30.7	1,388
70	442,329	4,927,140	civic 532 garage	29.62	1,421
71	442,353	4,927,233	civic 517	31.02	1,352
72	442,361	4,927,212	Shed	30.97	1,356
73	442,362	4,927,353	home, civic not visible	31.7	1,287
74	442,374	4,927,006	civic 66	29.18	1,464
75	442,380	4,927,148	civic 16	29.94	1,375
76	442,382	4,927,198	civic 516	31.03	1,345

ID	Easting*	Northing	Description	dBA	Closest Turbine (m)
77	442,383	4,927,029	civic 66 pool	29.34	1,442
78	442,391	4,927,275	civic 507 garage	31.58	1,298
79	442,392	4,926,960	home, civic not visible	29.03	1,479
80	442,396	4,927,195	civic 516 shed	31.12	1,335
81	442,397	4,926,981	garage assoc w 79	29.16	1,462
82	442,400	4,927,313	civic 501 garage	31.78	1,272
83	442,405	4,927,285	civic 507	31.66	1,281
84	442,414	4,927,438	civic 487	32.58	1,204
85	442,416	4,927,415	civic 491	32.44	1,212
86	442,416	4,927,394	civic 491 garage	32.33	1,221
87	442,416	4,927,366	civic 495	32.18	1,233
88	442,419	4,927,334	civic 501	32.03	1,245
89	442,420	4,927,503	civic 481	32.96	1,174
90	442,431	4,927,189	civic 502 garage	31.34	1,309
91	442,445	4,927,518	Garage	33.25	1,145
92	442,445	4,927,207	civic 510	31.53	1,288
93	442,470	4,927,312	civic 502	32.30	1,211

*UTM, NAD83, Zone 20

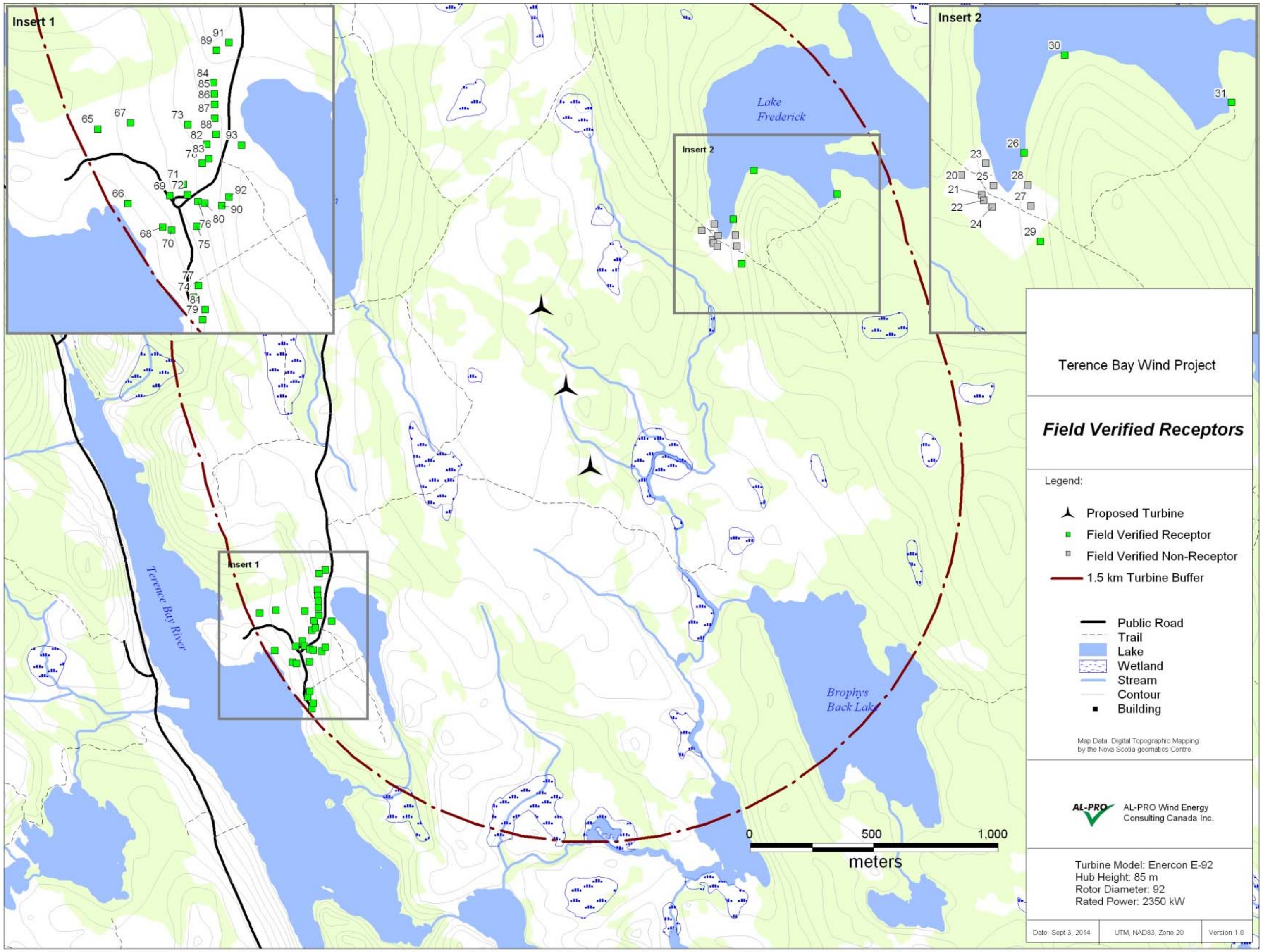


Figure 3.1: Detailed Map of Field Classified Sound Receptors with 1.5 km of the Proposed Turbines

3.2 Mapped Buildings

Table3.2 shows a listing of the modeled sound impacts for all buildings identified from the Nova Scotia Topographical database located between 1.5 and 2.0 km of the proposed wind farm. Figure 3.2 identifies the locations of the various buildings.

Table 3-2: Mapped Buildings between 1.5 and 2.0 km of the Terence Bay Wind Project

ID	Easting	Northing	dBA	Closest Turbine (m)
1	441,342	4,928,282	26.86	1,997
2	441,360	4,928,213	26.95	1,990
3	441,354	4,928,254	26.92	1,989
4	441,361	4,928,190	26.95	1,993
5	441,368	4,928,160	26.97	1,992
6	441,386	4,928,069	26.83	1,995
7	441,410	4,927,971	26.69	1,999
8	441,423	4,928,186	27.11	1,933
9	441,418	4,928,151	27.06	1,945
10	441,427	4,928,451	26.63	1,895
11	441,431	4,928,469	26.65	1,890
12	441,443	4,927,938	26.85	1,978
13	441,456	4,927,969	26.69	1,956
14	441,475	4,927,909	26.75	1,957
15	441,510	4,927,843	26.87	1,947
16	441,518	4,927,828	26.90	1,945
17	441,521	4,927,806	27.31	1,947
18	441,533	4,927,774	27.58	1,943
19	441,544	4,927,700	27.59	1,951
32	441,623	4,927,307	27.28	1,991
33	441,625	4,927,335	27.37	1,981
34	441,666	4,927,258	27.29	1,966
35	441,673	4,927,207	27.19	1,978
36	441,677	4,927,453	27.76	1,899
37	441,685	4,927,402	27.68	1,905
38	441,689	4,927,133	27.04	1,991
39	441,690	4,927,202	27.24	1,964
40	441,697	4,927,112	27.01	1,992
41	441,699	4,927,161	27.16	1,971
42	441,709	4,927,135	27.13	1,972
43	441,713	4,927,266	27.48	1,919
44	441,716	4,927,085	27.00	1,986
45	441,721	4,927,101	27.08	1,974
46	441,723	4,927,064	26.97	1,988
47	441,731	4,927,226	27.46	1,917

ID	Easting	Northing	dBA	Closest Turbine (m)
48	441,740	4,927,063	27.03	1,973
49	441,764	4,927,103	27.26	1,935
50	441,776	4,927,073	27.20	1,937
51	441,808	4,927,068	27.34	1,910
52	441,810	4,926,889	26.73	1,995
53	441,836	4,926,840	26.68	1,998
54	441,853	4,926,890	26.92	1,957
55	441,859	4,926,867	26.87	1,964
56	441,871	4,926,806	26.70	1,988
57	441,876	4,926,840	26.84	1,965
58	441,886	4,926,828	26.84	1,963
59	441,920	4,926,755	26.70	1,977
60	441,965	4,926,710	26.70	1,968
61	441,992	4,927,293	29.09	1,649
62	442,064	4,927,172	29.02	1,635
63	442,072	4,927,196	29.17	1,617
64	442,094	4,926,519	26.38	1,997
94	441,809	4,926,981	27.05	1,949

*UTM, NAD83, Zone 20

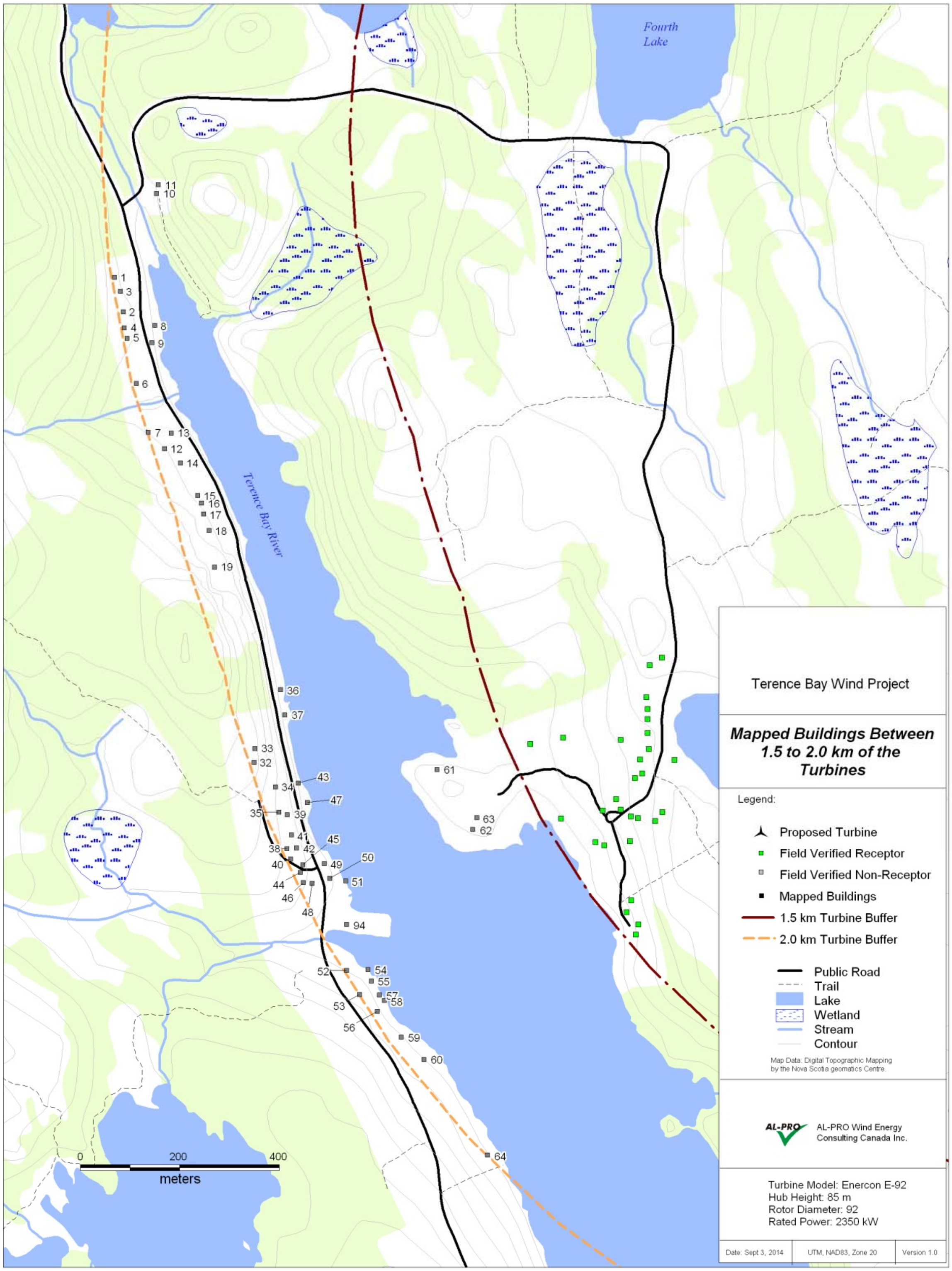


Figure 3.2: Detailed Map of Buildings Mapped from the Nova Scotia Topographical Database Located Between 1.5 and 2.0 km of the Proposed Wind Turbines.

4.0 Terence Bay Wilderness Area

The Terence Bay Wilderness Area was identified as an ecological area of both important and recognized legislative value in the environmental assessment of the Chebucto Bay Wind Farm. The proximity of the project area to the wilderness area was acknowledged and the Terence Bay Wilderness Area was identified as a Valued Ecosystem Component (VEC) in Table 7.1. As detailed in section 7.1, for an impact to occur, there has to be a link between the Project and the VEC, i.e., a pathway. There is, it is suggested no direct link and therefore no impact. NSE requested further consideration of this conclusion.

4.1 Analysis

The ecological characteristics of the project area are fully documented in the environmental assessment and its location adjacent the Terence Bay wilderness area is acknowledged. The project site is accessed from the south and west for hunting and related recreational purposes, but there is no easy access or trail system from the project site into the wilderness area. Those you use the wilderness area for recreational purposes are unlikely either to seek or find easy access into the wind farm site.

As detailed in Table 4.4 of the environmental assessment, 20 species that are listed either provincially under the *Endangered Species Act* or federally under the *Species at Risk Act (SARA)* were identified as potentially being present in, or in the vicinity of, the project site. There would, however, be no physical intrusion into the Terence Bay Wilderness Area during either project construction or operation and therefore no disruption to flora or ground conditions within the wilderness area. Further, neither plant species of concern (section 4.4.2), nor lichen species of concern (section 4.4.4) were identified as present within the project site during the dedicated field programs. Secondary research determined that the project site did not provide suitable habitat for the wood turtle (section 4.3.2.1), the monarch butterfly (section 4.3.6.1), or for bats (section 4.3.7.1). Based on these findings, it was concluded that since there was no pathway from project activities to these species, there could be no impact on them either within the project area or in wilderness lands abutting the project area.

Noise, or the lack thereof, can be considered as both a physical attribute of interest and as a potential catalyst of change or annoyance, i.e., it can be described as a physical VEC, or as a factor attributable to the construction or operation of the wind farm that can cause change to occur in one or more of the other VECs.

As stated in section 7.3.6, the field teams saw evidence of both bear and deer presence on the project site; they noted moose scat and an old browse and evidence of smaller mammals. It is widely recognized that noise emissions from wind turbines can theoretically disturb animal communication, and that visual stimuli, including reflections, shadows and lighting, may annoy or stress both wildlife and livestock. The studies available suggest a lack of such effects, or a swift habituation to the disturbance, and therefore a limited impact. The available research would also appear to suggest that there are different responses to construction as opposed to the operation of the turbines. The few available studies of the construction phase point at some, albeit temporary impacts. For North American elk, for example, Walker et al (2006) describe some impact from a wind farm during its construction, but the animals did not shift home ranges, and no effects on the population could be noted. Similar results were found in Norway where reindeer avoided sites during construction, but subsequently returned to graze within the turbines while they were in operation (Olof Hellin et al. 2012). The construction season for the Chebucto Terence Bay wind farm will be short; no serious consequences for mammals are predicted.

It has been suggested that the very low frequencies, 4 – 16 Hz (infrasound) transmitted through the ground could affect burrowing animals, but there has been very little research undertaken on this phenomenon (Seattle Audubon, 2014). No further observations are therefore possible.

With respect to birds, it is recognized that the situation is more challenging. As indicated in section 7.3.4.2 of the environmental assessment, there will be some habitat loss on the project site to accommodate the turbines and access roads, but the greater portion of the project site will not be disturbed. As stated, there will be no physical disturbance to the lands or waters within the wilderness area. The effects on breeding bird nesting sites should be minimal if clearing is done outside the bird breeding season, i.e., May 1st to August 31st for most avian migratory species.

A recently reported study by Pearce-Higgins et al in the Journal of Applied Ecology tested the following three predictions with respect to the impact of wind farms on birds:

i) Population densities will be reduced on wind farms during construction as a result of disturbance;
ii) Population trends on wind farms post construction will be different to trends on reference sites as a result of either disturbance or collision mortality; and
iii) Any negative effects at wind farms will be greatest at sites with a high generating capacity that contain more or larger turbines.

The findings highlighted considerable differences between species, but interestingly found little evidence for differences in population trends between operational wind farms and the reference sites. This implies that any increase in mortality through collision with operating turbines, or other changes associated with wind farm operation, has little effect on local avian populations. Further, following any detrimental effects of disturbance during construction, populations may become habituated to operational wind farms. It must be stressed that this is but one study; there are contrary results (Stewart, Pullen & Coles. 2007). This emphasizes the need for additional research and the need to categorize the specific bird species involved, i.e., different species will respond in different fashions both to an operating wind farm and in response to other factors including location, food supply and weather.

Pearce-Higgins et al do suggest that the main negative effects of wind farms on avian populations are likely associated with disturbance during construction. Another study collaborated this observation; they found that the density of all avian species declined during the construction phase, but that most species returned to pre-construction densities during the operational phase (Drewitt and Langston, 2006). In summary, the high levels of human activity during construction are likely to cause birds to vacate territory close to the work. It is in this context again stressed that the footprint associated with the construction of the turbines at the project site is small and the duration of the construction period short.

Sound impacts associated with the operation of the three turbines will be localized to within 1 km of the project site. Figure 4.1 shows the current boundary of the Terence Bay Wilderness area and the

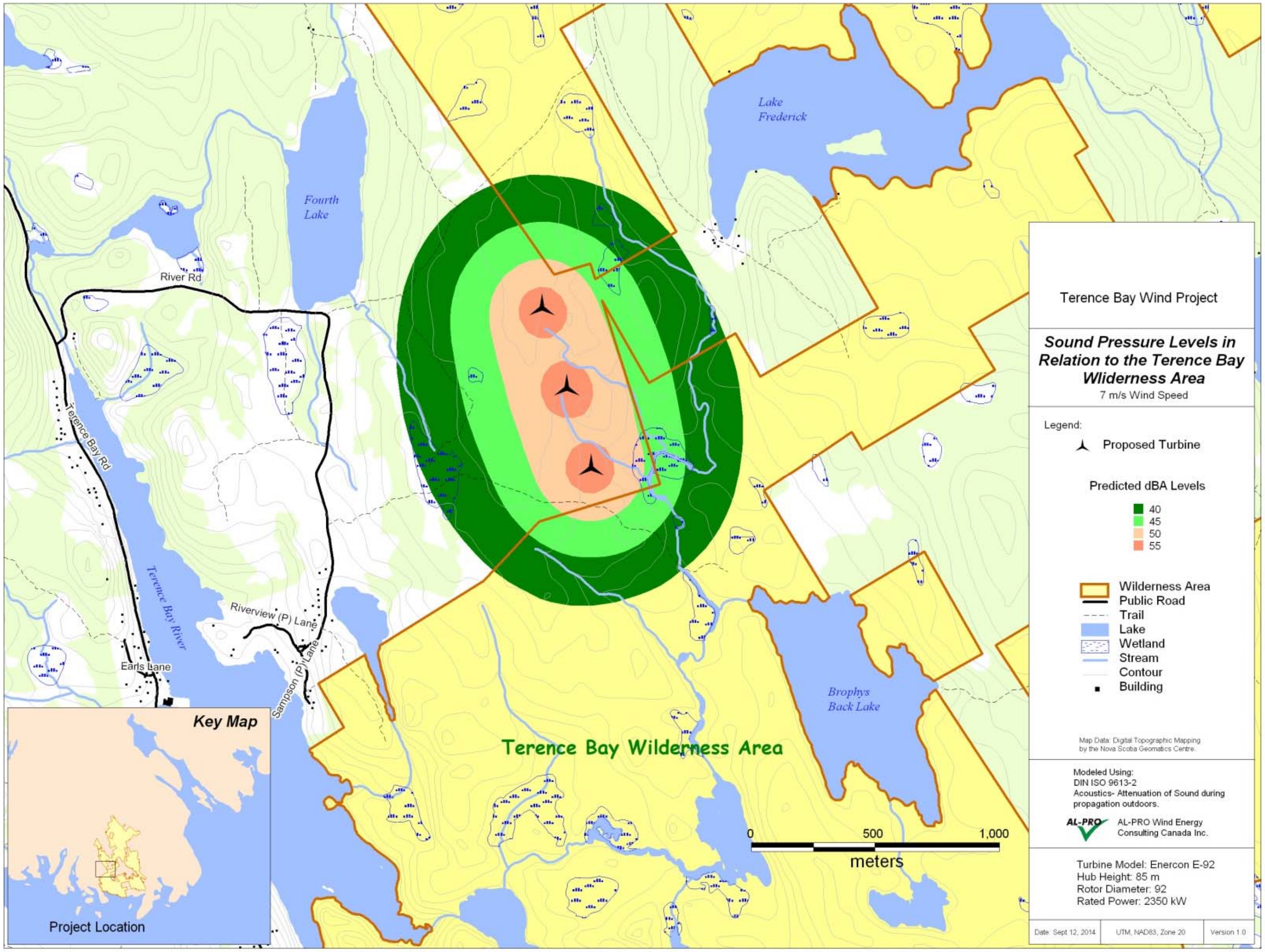


Figure 4.1: Sound Pressure Levels in the Terence Bay Wilderness Area.

modelled sound impacts for the turbines. As previously mentioned, the sound modelling is based on conservative assumptions and model inputs. The sound levels in acreage impacted are summarized in Table 4.1. The area that will receive A-weighted sound pressure levels of greater than 40 dBA is 69 ha which represents 1.54% of the entire wilderness area.

Table 4.1: Total Area within the Terence Bay Wilderness Area Impacted by the Terence Bay Wind Project

Sound Level (dBA)	Area (ha)	Percent of Total Area
40 - 45	45.6	1.02
45 - 50	21.6	0.48
50 - 55	1.8	0.04
Total Area Impacted[1]	69.0	1.54

1. Total area of wilderness area is 4,456 ha.

Low-frequency noise has been shown to impair male-female reproductive communication in urban birds (Halfwerk et al., 2011). Therefore, it may be that birds will be similarly affected by low-frequency sound emissions from operating wind turbines. As signal efficiency depends on song frequency in the presence of ambient noise, those species with high frequency songs may derive an advantage during sexual signaling in noisy conditions, whereas low frequency songs are likely to be disadvantaged. But further research is required on the consequences of low frequency noise associated with operating wind turbines in a rural environment and its impact, if any, on different species.

In summary, there may be some displacement of birds during construction within the construction site and at the boundaries of the Terence Bay Wilderness Area, perhaps in a radius of up to 500 -600 m from the sound source. During project operation, however, most animal and bird behavior would likely habituate to the presence of the three operating turbines. Substantive research, however, would be required to verify this probability with respect to individual species. There is therefore a low possibility that there could be some species adaptation to the presence of the turbines, that some very localized displacement could occur, or that the masking of birds calls, particularly those in the lower range, would pose a problem

Table 4.2 provides succinct observations to the points raised by NSE based upon the above and the materials provided in the environmental assessment.

Table 4.2: Response to Issues Raised

Issue	Response
Effect on adjacent ecosystems and constituent species in the wilderness area.	No direct pathway to impact ecosystems and constituent species in the wilderness area.
Literature review on acoustic effects, particularly low frequency noise (LFN), on wildlife in or near conservation areas.	Limited literature found and none directly involving conservation areas.

Issue	Response
Expand noise analysis into wilderness area.	See Table 4.1.
LFN and its impacts.	Very limited research available; some adaptation might be expected.
Reductions in bird densities, displacement and nesting behaviors.	Might anticipate some limited adaptation through the construction period, but unlikely to be significant reductions in bird densities, substantive displacement or changes in nesting behaviors through wind farm operation. Need substantive research at the species level to accurately and with confidence, respond to the noise associated with operating wind farms.
Masking of bird and animal alarm calls.	May be some masking of alarm calls in the lower frequencies, but more research required by species to verify.
Physical and climatic sensitivities to LFN.	No broad research on the specifics of this issue identified, and certainly no work done on the circumstances surrounding the site.
Mitigating factors.	Not applicable in the circumstances.
Recreation in the wilderness area.	No anticipated impacts on recreational patterns in the wilderness area that might be attributed to the proposed wind farm.

5.0 Summary

The following model inputs provide a realistic but conservative quantification of the conditions found in the vicinity of the Terence Bay Wind Project.

- The measured turbine maximum sound pressure level of 105.4 dbA which occurs at 7 m/s (v_{10}) was used in this analysis which is slightly higher than the 105 dBA maximum level provided by the manufacturer;
- Sound power levels for conventional rotor blades were modeled. Turbines equiped with the new TES blade design area expected to further reduce turbine sound power levels;
- The alternative ground attenuation model was used which takes the terrain between the turbine and receptor into effect when calculating ground attenuation. The ground is considered porous or mixed ground which simulates actual conditions;
- The analysis included modeling favourable downwind propagation conditions for all turbine sites simultaneously;
- The attenuation of sound propogation through foliage (forest vegetation) or screening objects were not considered in the analysis; and
- Sound pressure levels at receptors are modeled outside of buildings.

The predicted sound levels at the various receptors are conservatively calculated when compared to the long term average sound levels expected at each receptor. There may be conditions which include periods of high atmospheric stability coupled with high wind shear or temperature inversions that may lead to sound levels that are or are perceived as higher than those modeled.

Overall, the sound modeling methodology provides an analytical methodology to model expected sound levels to an established noise limit. The noise limit in Nova Scotia is 40 dBA and none of the receptors have predicted sound levels that exceed this threshold. No adverse impact related to sound is expected for this project.

The expected impact of the Terence Bay Wilderness Area is expected to be minimal. The total area impacted by increased sound levels is 1.54% of the total Wilderness Area.

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APPENDIX A

Field Verified Receptors

As indicated in Section 3.1, in early September all the receptors within 1.5 km of the proposed wind farm were visited and categorized. Figure 1 identifies those receptors located between Little Lake and Terence Bay; Figure 2 identifies those receptors in the vicinity of Lake Frederick. In all cases but five, photographs were taken and are attached.

CBCL LIMITED
Consulting Engineers

1000 m Buffer
Structure

ID	Photo	Comments
65	65	home, civic not visable
66	66	civic 6
67	67	civic 19
68	68	civic 535
69	No Photo	shed
70	70	civic 535 garage
71	71-72	civic 517
72	71-72	shed
73	No Access	home, civic not visable
74	74	civic 66
75	75	civic 16
76	76	civic 516
77	77	civic 66 pool
78	78-83	civic 507 garage
79	No Access	home, civic not visable
80	76	civic 516 shed
81	No Access	garage associated with point 79
82	No Access	civic 501 garage
83	78-83	civic 507
84	84	civic 487
85	85-86	civic 491
86	85-86	civic 491 garage
87	87	civic 495
88	88	civic 501
89	89	civic 481
90	90-92	civic 502 garage
91	91	civic 481 garage
92	90-92	civic 510
93	93	civic 502

FIGURE 1

Terrance Bay Wind Farm

Structure Identification Within 1.5 km Of Nearest Turbine

Coordinate System: NAD 1983 UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983
Units: Meter

0 30 60 120 m

1:2,500 Scale when printed @ 11" x 17"

C:\Work\121216_Fig1.mxd

ID# 65: Residence 1,456m distance

ID# 67: Residence 1,391m distance

ID# 66: Residence 1,468m distance

ID# 68: Residence 1,433m distance

ID# 70: Residence, garage 1,421, distance

ID# 71-72: Residence, shed 1,356m distance

ID# 74: Residence 1,464m distance

ID# 75: Residence 1,376m distance

ID# 76: Residence 1,345 m distant

ID# 77: Residence and pool 1,442 m distant

ID# 78-83: Residence 1,281 m distant

ID# 84: Residence 1,204 m distant

ID# 85-86: Residence 1,212 m distant

ID# 87: Residence 1,233 m distant

ID# 88: Residence 1,245 m distant

ID# 89: Residence 1,174 m distant

ID# 90-92: Residence 1,288 m distant

ID# 91: Garage 1,145 m distant

ID# 93: Residence 1,211 m distant

CBCL LIMITED
Consulting Engineers

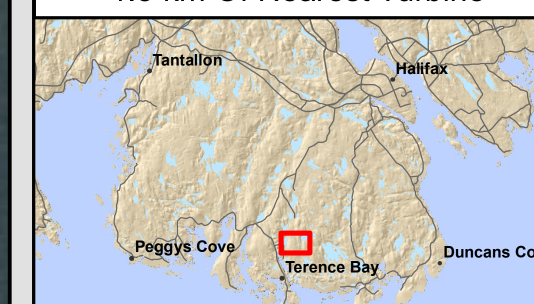
1000 m Buffer
Structure

ID	Photo	Comments
20	20	burnt structure
21	21	burnt structure
22	22	burnt structure
23	23	old bus
24	24	two burnt structures
25	25	old bus
26	26	standing cabin, usable, no recent activity
27	27	burnt structure
28	28	burnt structure
29	29	standing cabin, no apparent use
30	30a	standing cabin, no apparent use
31	31	standing cabin, recent activity

FIGURE 2

Terrance Bay Wind Farm

Structure Identification Within 1.5 km Of Nearest Turbine



Coordinate System: NAD 1983 UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983
Units: Meter

0 20 40 80 m

1:1,700 Scale when printed @ 11" x 17"


ID# 20: Burnt structure


ID# 21: Burnt structure


ID# 22: Burnt structure


ID# 23: Old bus


ID# 24: Two burnt structures


ID# 25: Old Bus


ID# 26: Cabin 858 m distant


ID#27: Burnt structure


ID# 28: Burnt structure


ID# 29: Standing cabin 831 m distant


ID# 30: Standing cabin 1,025 m distant


ID# 31: Standing cabin