# SOUTH BRANCH WIND FARM

## DESIGN AND OPERATIONS REPORT

Report 6 of 9

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APPENDIX E CBC TV POTENTIAL IMPACT ASSESSMENT REPORT

APPENDIX F RADIO COMMUNICATION, RADAR, AND SEISMO-ACOUSTIC IMPACT ASSESSMENT REPORT

APPENDIX G ICE THROW REPORT

# LIST OF REPORTS REFERENCED

South Branch Wind Farm Project Description Report

South Branch Wind Farm Water Assessment Report

South Branch Wind Farm Natural Heritage Assessment Report

- Appendix C Pre Construction Bird Reports
- Appendix D Pre Construction Bat Reports
- Appendix I Post-Construction Monitoring Plan: Birds and Bats

South Branch Wind Farm Archaeological and Heritage Assessment Report

South Branch Wind Farm Construction Plan Report

- Appendix A Construction Site Plan

South Branch Wind Farm Decommissioning Plan Report

# 1. INTRODUCTION

## 1.1. PURPOSE

This South Branch Wind Farm Design and Operations Report outlines the information requested under Item 4 of Table 1 in *Ontario Regulation 359/09* (O. Reg 359/09) regarding *Renewable Energy Approvals* under *Part V.0.1 of the Environmental Protection Act*. The report also includes information suggested in the Ontario Ministry of the Environment (MOE) publication *Technical Bulletin #2: Guidance for Preparing the Design and Operations Report as Part of an Application Under O.Reg.359/09.*

A preliminary version of this report is made available to Aboriginal stakeholders, public stakeholders and agency stakeholders for review prior to the Renewable Energy Approval (REA) submission. This report is available online for download at www.prowind.ca and available in hard copy at select locations identified on the website and in newspaper advertisements.

A final version of this report is included in the REA submission to the MOE for the South Branch Wind Farm.

## 1.2. PROJECT BACKGROUND

Prowind Inc. (Prowind) is a Canadian wind energy developer based in Hamilton, Ontario. It is affiliated with its parent company, Prowind GmbH, based in Osnabrück, Germany. Prowind's mandate is to create small-scale, renewable and zero-emission power generation. Prowind believes in distributed generation that has a minimum impact on the surrounding environment and landscape.

The proposed South Branch Wind Farm is a 30 MW, Class 4 wind energy facility under O. Reg 359/09. The wind farm will consist of up to fourteen wind turbine generators[1], access roads, a substation, and a combination of buried and overhead electrical cabling to connect the turbines to the substation, and the substation to the feeder line.

The project is proposed on privately owned, agricultural land as well as municipal easements surrounding the Town of Brinston, Ontario. The project turbines are located in two main areas. The western area is defined by properties directly on each side of Byker Road, between Dobbie Road and Branch Road to the north and Pitt Road and Sandy Creek Road to the south. Turbines in the eastern area lie on either side of Brinston Road/County Road 16 between Oak Valley Road to the north and Cook Road to the south.

The project has been contracted to sell power for a period of 20 years once constructed and may remain operational for a period of 25 years in total.

[1] Earlier versions of REA reports indicated the South Branch Wind Farm would host as many as 15 turbines. One of these proposed turbine locations, that of Turbine 14, was deemed unsuitable during environmental field studies and was subsequently removed from the wind farm design. Original turbine identifiers have been preserved for clarity.

Figure 1 illustrates the project location within Ontario. A simplified project layout is presented in Figure 2 for ease of reference.

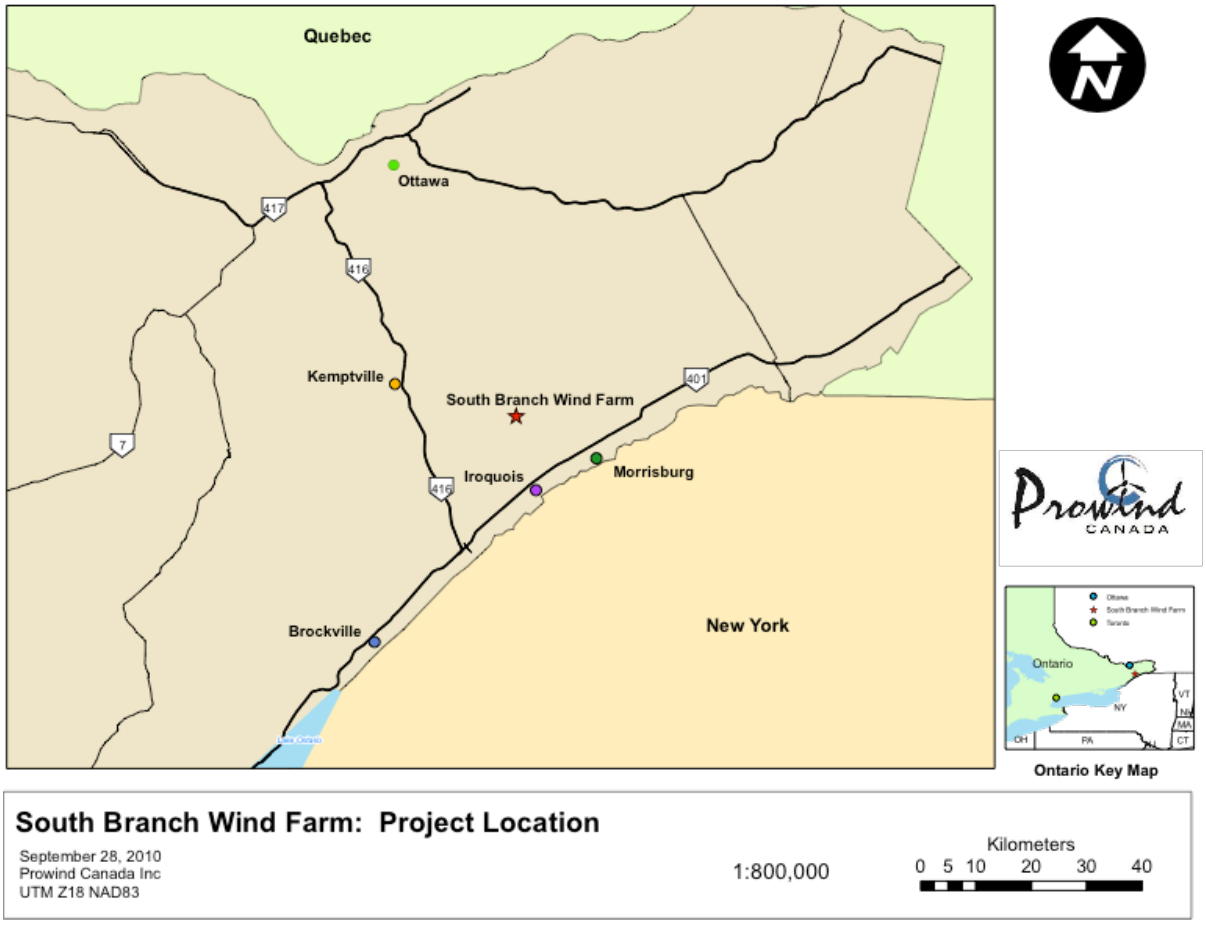



FIGURE 1 PROJECT LOCATION WITHIN ONTARIO

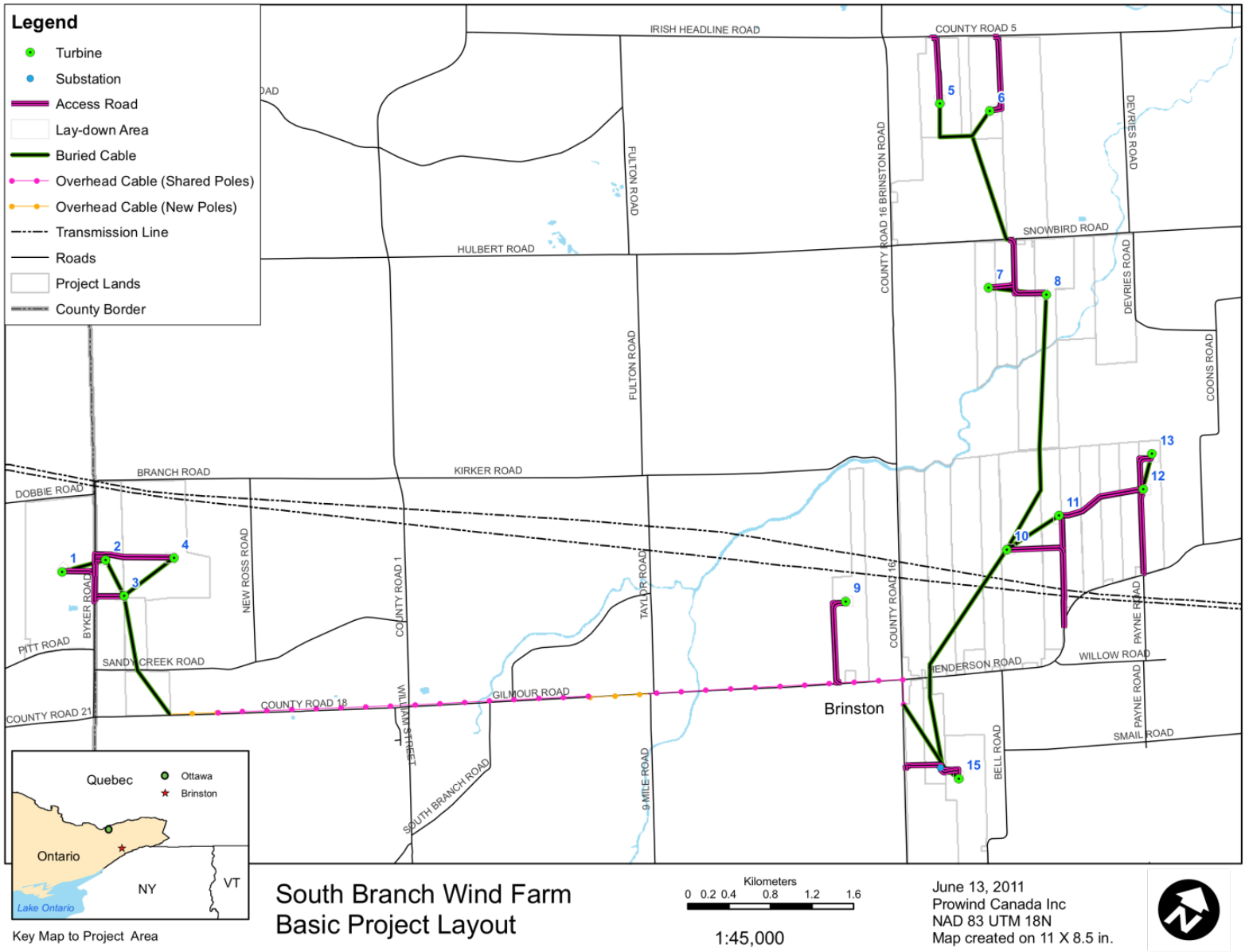



FIGURE 2 BASIC PROJECT LAYOUT

# 2. FACILITY DESIGN PLAN

This section provides design description and detail for each element of the South Branch Wind Farm as well as the significant features that lie near the project boundary.

## 2.1. SITE PLAN

Two site plan diagrams for the South Branch Wind Farm are included as Appendix A of this report. A third site plan diagram, the construction site plan is presented in Appendix A of the *Construction Plan Report*. The content of each diagram is outlined in the following sections.

### 2.1.1. Operational Footprint Site Plan

This version of the site plan shows the extent of the project during the operational phase. It illustrates the following elements:

- property associated with the renewable energy facility,
- all turbines, crane pads, buildings, structures, roads, utility corridors, rights of way and easements required in respect of the renewable generation facility and situated within 300 m of the facility,
- noise receptors (as defined in the MOE's October 2008 "*Noise Guidelines For Wind Farms*" document),
- land contours, surface water drainage, water bodies, and significant or provincially significantly natural features
- surrounding land use via aerial imagery

### 2.1.2. Setback Site Plan

This version of the site plan illustrates the setbacks from each turbine and from the project boundary to all relevant features required under O. Reg 359/09. Setback summary tables and impact analysis reporting are also referenced. The following additional features are shown:

- property associated with the renewable energy facility,
- all turbines, lay down areas, buildings, structures, roads, utility corridors, rights of way and easements required in respect of the renewable generation facility and situated within 300+ m of the facility,
- noise receptors (as defined in the MOE's October 2008 "Noise Guidelines For Wind Farms" document),
- land contours, surface water drainage, water bodies, and significant or provincially significantly natural features
- the project boundary including the portion of the collection system to the connection point with Hydro One's grid

- a buffer indicating 120 m from the project boundary
- surrounding land use via aerial imagery

### 2.1.3. Construction Site Plan

This version of the site plan illustrates the proposed project footprint during the construction and decommissioning phases. The following features are shown:

- properties associated with the renewable energy facility,
- all turbines, crane pads and lay down areas, buildings, structures, roads, utility corridors, rights of way and easements required in respect of the renewable generation facility and situated within 300+ m of the facility,
- noise receptors (as defined in the MOE's October 2008 "*Noise Guidelines For Wind Farms*" document),
- land contours, surface water drainage, water bodies, and significant or provincially significantly natural features
- the project boundary
- a buffer indicating 120 m from the project boundary
- temporary topsoil stockpiles
- surrounding land use via aerial imagery

## 2.2. PROPERTY ASSOCIATED WITH THE RENEWABLE ENERGY GENERATION FACILITY

Properties that will host project turbines, roads, substation, operation and maintenance building, storage structures, and/or cabling are outlined in yellow on all three site plan diagrams. The details of the properties are presented in Table 1.

TABLE 1 PROPERTY ASSOCIATED WITH THE WIND FARM

| Property Label | Listed Owner | Legal Description | Municipality |
|---|---|---|---|
| P1 | Cynthia Byker and William Byker | Part of the south or front half commons Lot A and Part of the Rear Half Commons, Lot A and Part of Lots 1 & 2, Concession 7 as described in Deed 137799 | Geographic Township of Edwardsburgh, Township of Edwardsburg-Cardinal, County of Grenville |
| P2 | Cynthia Byker and William Byker, John Byker as 1/2 interest | West half of Lot 37, Concession 6 and the Commons Lot, lying immediately along the west side of said Lot 37, save and except Parts 1 and 2 on Plan 8R-2500, as described in Deed 106385 and 43154 | Geographic Twp of Matilda, Twp of South Dundas (TSD), United Counties of Stormont, Dundas and Glengarry (SD&G) |
| P3 | William Byker in Trust for himself and John Byker | North half of Lot 36, Concession 6, as firstly described in Deed 89800 | Geographic Twp of Matilda, TSD, SD&G |
| P3 | William Byker in Trust for himself and John Byker | Northeast ¼ of Lot 37, Concession 6, as thirdly described in Deed 89800 | Geographic Twp of Matilda, TSD, SD&G |
| P3 | William Byker in Trust for himself and John Byker | Part of Lot 35, Concession 6, being Part 1 on Plan 8R-3926, as fourthly described in Deed 89800 | Geographic Twp of Matilda, TSD, SD&G |
| P4, P5 | William Byker and Cindy Byker | South half of the east half of Lot 37, Concession 6, as thirdly described in Deed 49132 | Geographic Twp of Matilda, TSD, SD&G |
| P5 | William Byker and Cindy Byker | West half of Lot 36, Concession 6, lying south of the traveled Township Road, as fourthly described in Deed 49132 | Geographic Twp of Matilda, TSD, SD&G |
| P6 | Friesdeel Farms Inc. | Part of Lot 17, Concession 8, as described in Deed 121073 | Geographic Twp of Matilda, TSD, SD&G |
| P7 | Thurler Farms Inc. | North half of the east half of Lot 16, Concession 8, as firstly described in Deed 59896 | Geographic Twp of Matilda, TSD, SD&G |
| P7 | Thurler Farms Inc. | Northeast quarter of the west half of Lot 16, Concession 8, as secondly described in Deed 59896 | Geographic Twp of Matilda, TSD, SD&G |
| P8 | Thurler Farms Inc. | Part of Lot 15, Concession 8, as firstly described in Deed 51207 | Geographic Twp of Matilda, TSD, SD&G |
| P9 | Thurler Farms Inc. | Part of Lots 16 and 17, Concession 8, as thirdly described in Deed 59896 | Geographic Twp of Matilda, TSD, SD&G |
| P9 | Thurler Farms Inc. | Part of Lot 18, Concession 8, as fourthly described in Deed 59896 | Geographic Twp of Matilda, TSD, SD&G |
| P10 | Thurler Farms Inc. | Part of the west half of Lot 16, Concession 7, lying north of the South Branch of the Nation River as described in Deed 85116 | Geographic Twp of Matilda, TSD, SD&G |
| P11 | Thurler Farms Inc. | East half of Lot 16, Concession 7, lying north of the Nation River as thirdly described in Deed 51207 | Geographic Twp of Matilda, TSD, SD&G |
| P12 | Thurler Farms Inc. | Part of the west half of Lot 15, Concession 7, lying north of the South Branch of the Nation River | Geographic Twp of Matilda, TSD, SD&G |
| P13 | Oliver Thurler | Part of the West half of Lot 15, Concession 7, having PIN 66111-0082 as described in Deed DR106853 | Geographic Twp of Matilda, TSD, SD&G |
| P14, P15 | Thurler Farms Inc. | Part of the West half of Lot 15, Concession 7, having PINs 66111-0171 and 66111-0173, as described in Deed 51207 | Geographic Twp of Matilda, TSD, SD&G |
| P16 | Thurler Farms Inc. | Part of the east half of Lot 15, Concession 7, lying north of the South Branch of the Nation River | Geographic Twp of Matilda, TSD, SD&G |
| P16 | Thurler Farms Inc. | East half of Lot 15, north of the South Branch of the Nation River and the west half of the northwest quarter of Lot 14, Concession 7, as described in Deed 73528 | Geographic Twp of Matilda, TSD, SD&G |

| Property Label | Listed Owner | Legal Description | Municipality |
|---|---|---|---|
| P17 | Tibben Farms Inc. | Part of Lot 15, Concession 7, lying south of the South Branch of the Nation River | Geographic Twp of Matilda, TSD, SD&G |
| P18 | Tibben Farms Inc. | Part of Lot 19, Concession 6, as firstly described in Deed 108845 | Geographic Twp of Matilda, TSD, SD&G |
| P18 | Tibben Farms Inc. | South half of the east half of Lot 20, Concession 6, as secondly described in Deed 108845 | Geographic Twp of Matilda, TSD, SD&G |
| P19 | Tibben Farms Inc. | Part of the west half of Lot 18, Concession 6 and the west quarter of the east half of Lot 18 | Geographic Twp of Matilda, TSD, SD&G |
| P20 | Tibben Farms Inc. | West one-quarter of Lot 17, Concession 6, and east three-quarters of the east half of Lot 18, Concession 6, as described in Deed 99805 | Geographic Twp of Matilda, TSD, SD&G |
| P21 | Tibben Farms Inc. | East three-quarters of Lot 17, Concession 6, as firstly described in Deed 94733 | Geographic Twp of Matilda, TSD, SD&G |
| P22 | Ralph Tibben and William Tibben | Part of the west half of Lot 16, Concession 6, as described in Deed 83042 | Geographic Twp of Matilda, TSD, SD&G |
| P23 | Tibben Farms Inc. | West half of Lot 15, Concession 6, as firstly described in Deed 67194 | Geographic Twp of Matilda, TSD, SD&G |
| P23 | Tibben Farms Inc. | Part of East half of Lot 16, Concession 6, as secondly described in Deed 67194 | Geographic Twp of Matilda, TSD, SD&G |
| P23 | Tibben Farms Inc. | Part of Lot 16, Concession 6, being Part 2 on Plan 8R-1045 as thirdly described in Deed 67194 | Geographic Twp of Matilda, TSD, SD&G |
| P24 | William Tibben and Wilma Tibben | Part of the east half of Lot 15, Concession 6, as described in Schedule 'A' of Deed 49270 | Geographic Twp of Matilda, TSD, SD&G |
| P25 | Ralph Tibben and Japke Tibben | Part of the west half of Lot 14, Concession 6, as described in Deed 27132B | Geographic Twp of Matilda, TSD, SD&G |
| P26 | Ralph Tibben Jr. and Japke Tibben | Part of the east half of Lot 14, Concession 6, as firstly described in Deed 26465B | Geographic Twp of Matilda, TSD, SD&G |
| P27 | Ralph Tibben | Part of the west half of Lot 13, Concession 6, as secondly described in Deed 35240 | Geographic Twp of Matilda, TSD, SD&G |
| P28 | Francis William John Henderson | The east half of Lot 13, Concession 6 as firstly described in DRB13644 | Geographic Twp of Matilda, TSD, SD&G |
| P29 | Francis William John Henderson | The west half of Lot 12, Concession 6, as firstly described in Deed DR99431 | Geographic Twp of Matilda, TSD, SD&G |
| P29 | Francis William John Henderson | Part of the west half of Lot 12, Concession 6, being Part 1 on Plan 8R-1157, as secondly described in Deed DR99431 | Geographic Twp of Matilda, Twp of South Dundas, SD&G |
| P28, P29 | Francis William John Henderson | Part of the road allowance between Lots 12 and 13, Concession 6, lying north of Part 1 on Plan 8R-4726 as described in Deed DR114457 closed by DR114456 | Geographic Twp of Matilda, TSD, SD&G |
| P31 | Tibben Farms Inc. | Part of the northwest quarter of Lot 18, Concession 5, as firstly described in Deed 114986 | Geographic Twp of Matilda, TSD, SD&G |
| P31 | Tibben Farms Inc. | Part of the south half of Lot 18, Concession 5, as secondly described in Deed 114986 | Geographic Twp of Matilda, TSD, SD&G |
| P31 | Tibben Farms Inc. | Part of Lot 17, Concession 5, as thirdly described in Deed 114986 | Geographic Twp of Matilda, TSD, SD&G |
| P32 | Tibben Farms Inc. | Part of the northeast quarter of Lot 18, Concession 5, as described in Deed 103411 | Geographic Twp of Matilda, TSD, SD&G |
| P33 | Tibben Farms Inc. | Part of Lot 17, Concession 5, as firstly described in Deed 114987 | Geographic Twp of Matilda, TSD, SD&G |
| P33 | Tibben Farms Inc. | Part of Lot 17, Concession 5, as secondly described in Deed 114987 | Geographic Twp of Matilda, TSD, SD&G |

## 2.3. WIND TURBINES

### 2.3.1. Specifications

The project layout presents up to 14 wind turbine locations.. This approach was driven by the need for flexibility in turbine choice during the project's permitting and consultation phase. The need arose from several factors including which turbine makes and models will ultimately meet Ontario Domestic Content requirements. Turbine selection has been finalized since the initial draft version of this report was released. The project will utilize 10 Siemens 3.0 MW turbines with a 113 m rotor and a 99.5 m hub height. Apart from Tables 2, 3, and 4 in this report and the Noise Impact Assessment Appendix, Renewable Energy Approval (REA) reporting for the South Branch Wind Farm has been prepared based on conservative turbine specifications selected to present maximum possible dimensions so that the impact assessment considers the largest possible impact on the surrounding area. The maximum turbine parameters used were 14 turbines total, 118 m rotor diameter, 140 m hub height, and a 106.4 dBA maximum sound power level, with an understanding that the selected turbine model will have equal or lesser values for each parameter. The Siemens SWT-3.0-113 has lower values for all four parameters, and therefore a significantly lower impact on surroundings than is presented in the REA reporting.

Detailed turbine specifications are included as Appendix B, the *Turbine Specifications Report*.

Figure 3 illustrates turbine dimensions, Table 2 summarizes key turbine parameters, Table 3 summarizes the acoustic emission data used in the *Noise Impact Assessment Report* (contained in Appendix C), and Table 4 details certain wind conditions under which the turbine will automatically shut down as a protective measure.

The sound power data used in the previous *Noise Impact Assessment Report draft* corresponded to the highest manufacturer guaranteed sound power level being considered for the project, 106.4 dBA. The guaranteed maximum sound power level of the Siemens SWT-3.0-113 is 106.0 dBA, which results in a lower impact than was reported in the draft REA version. A new Noise Impact Assessment has been completed for the SWT-3.0-113.

In the case of damage to a major turbine component it is possible that noise emission could temporarily increase before the turbine is shutdown and/or repaired. Turbine monitoring is discussed in further detail in Section 3.1.

Turbine foundations will be made of steel reinforced concrete. The foundations will be up to 11 m in radius and up to approximately 3 m deep. Geotechnical analysis will be performed to finalize foundation design for each turbine location. Foundation geo-piles are not expected to be required at the South Branch Wind Farm based on available soil data, however there may be requirements for geo-piles at some turbine locations should bore hole samples indicate that additional support is required.

Each turbine will have a small electrical transformer mounted either within the base of the tower or on a small pad adjacent to the tower. Each transformer will be rated at up to approximately 3.5 MVA and will transform voltage from 690 V to 34.5 kV.

All modern turbines are equipped with lightning protection systems to prevent, mitigate, and detect damage caused by lightning strikes.

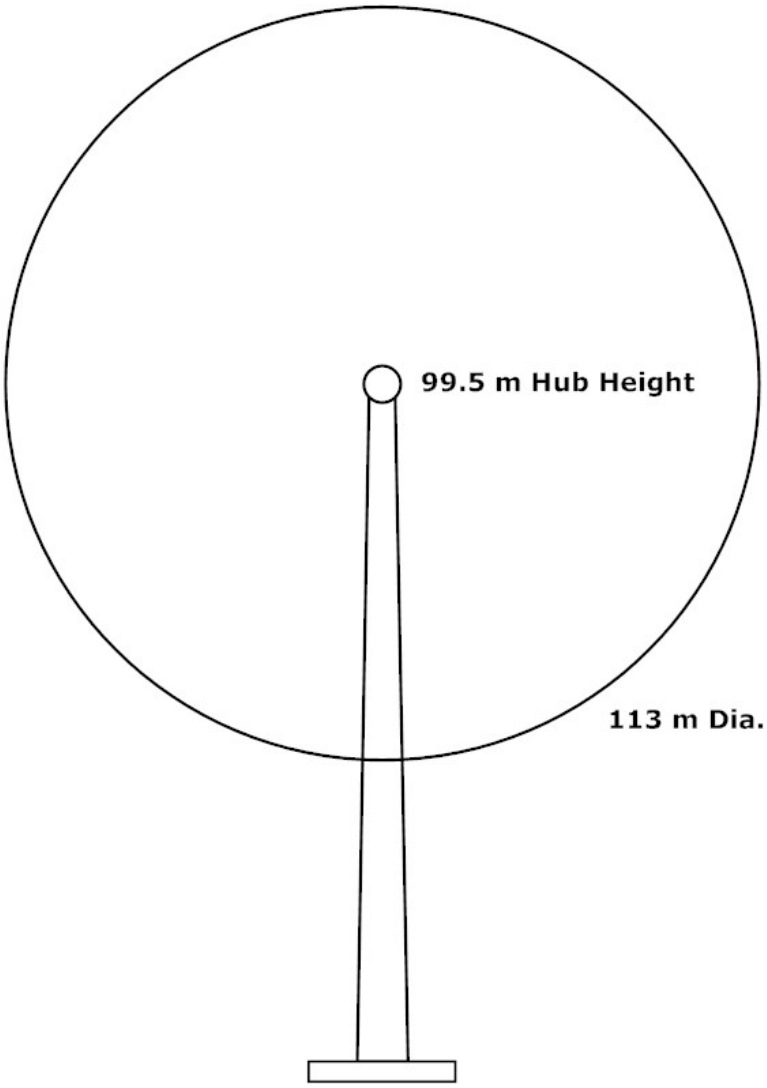



FIGURE 3 TURBINE DIMENSIONS (DRAWN TO SCALE)

TABLE 2 ASSUMED TURBINE SPECIFICATIONS

| | |
|---|---|
| **Make and Model** | Siemens SWT-3.0-113 |
| **Maximum Electrical Output Rating** | 3.0 MW |
| **Hub Height** | 99.5 m |
| **Rotor Diameter** | 113 m |
| **Range of Rotational Speeds** | 6-16 RPM, based on similar Siemens 23.113 technology (to be confirmed) |
| **Mode of Operation** | Horizontal Axis, Upwind, Pitch Controlled |
| **Diameter of Turbine Base** | Approximately 9.2 m maximum |
| **Approximate Foundation Diameter** | 22 m – depending on soil conditions |
| **Approximate Volume of Concrete Foundation** | Approximately 575 $m^3$ but may be as high as 815 $m^3$ if buoyancy forces are present |

TABLE 3 TURBINE ACOUSTIC EMISSIONS SUMMARY

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbine Make/Model: | Siemens SWT-3.0-113 | | | | | | | | | |
| Electrical Rating: | 3.0 MW | | | | | | | | | |
| Hub Height: | 99.5 m | | | | | | | | | |
| Wind Shear Exponent: | 0.40 or higher (summer night-time average) | | | | | | | | | |
| | Octave Band Sound Power Level (dB) | | | | | | | | | |
| | Manufacturer's Emission Levels | | | | | Generic Adjusted Emission Levels | | | | |
| Wind Speed | 6 | 7 | 8 | 9 | 10 | 6 | 7 | 8 | 9 | 10 |
| Frequency (Hz) | | | | | | | | | | |
| 63 | 85.2 | N/A | 86.9 | N/A | N/A | 86.9 | 86.9 | 86.9 | 86.9 | 86.9 |
| 125 | 91.5 | N/A | 94.8 | N/A | N/A | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 |
| 250 | 97.2 | N/A | 99.1 | N/A | N/A | 99.1 | 99.1 | 99.1 | 99.1 | 99.1 |
| 500 | 99.3 | N/A | 100 | N/A | N/A | 100 | 100 | 100 | 100 | 100 |
| 1000 | 100.1 | N/A | 99.6 | N/A | N/A | 99.6 | 99.6 | 99.6 | 99.6 | 99.6 |
| 2000 | 95.7 | N/A | 98.6 | N/A | N/A | 98.6 | 98.6 | 98.6 | 98.6 | 98.6 |
| 4000 | 85.3 | N/A | 91.5 | N/A | N/A | 91.5 | 91.5 | 91.5 | 91.5 | 91.5 |
| 8000 | 67.9 | N/A | 75.1 | N/A | N/A | 75.1 | 75.1 | 75.1 | 75.1 | 75.1 |
| Weighted Total | 104.7 | 105.8 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 |

TABLE 4 AUTOMATIC SHUTDOWN IN HIGH WINDS

| Cutout Wind Speed at Turbine Hub | Restart Wind Speed at Turbine Hub (after cutout event) |
|---|---|
| Approximately 25 m/s | Approximately 20 m/s |

### 2.3.2. Aeronautical Obstruction Lighting

Transport Canada's CAR621 publication specifies aeronautical obstruction lighting requirements for wind turbines. Amendments to CAR621 were published in late January 2012. Section 12.4 of CAR621 pertains to wind turbines with a total height greater than 150 m and states "The provision of marking and lighting for wind turbines higher than 150 m shall be determined through means of a risk assessment."

Prowind will submit an Aeronautical Obstruction Clearance Application to Transport Canada with a proposal that all turbines be equipped with CL-864 medium intensity red flashing beacons. These beacons are required to have a minimum intensity of 1,500 candelas and will be programmed to turn on and off in unison. In an effort to reduce visual impact at the ground level, Prowind will also propose using existing technology with very low levels of ground scatter so their visibility is heavily mitigated at ground level without restricting their visibility from the air. Consultation with Transport Canada is ongoing.

### 2.3.3. Turbine Setbacks

Table 5 and Table 6 summarize setbacks between turbines and relevant features as required in Table 1 of O. Reg 359/09 and MOE Technical Bulletin #2: *Guidance for Preparing the Design and Operations Report as Part of an Application Under O.Reg.359/09*. Setback definitions are outlined below:

- 'Nearest Non-Participating Receptor' setbacks were taken from Appendix C and were calculated based on UTM coordinates and elevations of the receptor centres and the centre of the turbine base. The specific dimension of the turbine base is generic at this time and is defined as having a radius of 4.6 m.
- Setbacks from 'Lot Lines', 'Nearest Public Roads', 'Utility Corridors', and 'Nearest Structures of Any Kind' were determined using Ontario Base Mapping data and GIS software in conjunction with ortho-rectified aerial photography. The setbacks reflect the distance from the centre of the turbine base to the edge of the referenced feature. A stated, the specific dimension of the turbine base is generically defined as having a radius of 4.6 m.
- Setbacks from 'Cultural Heritage Resources', 'Archaeological Resources', 'Water Bodies', and 'Significant Natural Features' were determined using Ontario Base Mapping data and GIS software in conjunction with ortho-rectified aerial photography. The setbacks are defined as horizontal distance between the project boundary and the edge of the referenced feature. The project boundary is based on the initial maximum turbine rotor diameter of 118 m.

Turbine setbacks exceed all applicable provincial regulations outlined in O. Reg 359/09. Setbacks from natural features and water bodies that are less than 120 m are addressed in the *Natural Heritage Resources Assessment Report* and the *Water Assessment Report.*

Turbine setbacks from lot lines that are less than outlined in Section 53 of O. Reg 359/09 have been addressed in the *Abutting Property Assessment Report*.

Turbine setbacks from non-participating receptors are less than those outlined in Section 55 of O. Reg 359/09. As such, a noise report has been prepared in accordance with the Ontario Ministry of the Environment's publication titled "Noise Guidelines for Wind Farms" dated October 2008. The report is included as Appendix C and demonstrates that the South Branch Wind Farm fully complies with Provincial noise regulations.

TABLE 5 SETBACK DISTANCES FROM TURBINES

| Measured from centre of turbine base | | | | | | Measured from Project Boundary | | | |
|---|---|---|---|---|---|---|---|---|---|
| Turbine ID # | Nearest Non-Participating Receptor (m) | Nearest Non-Participating Lot Line (m) | Nearest Structure of Any Kind (m) | Nearest Public Road (m) | Utility Corridor Easement* (m) | Cultural Heritage Resources closer than 120 m | Archaeological Resources Closer than 120 m | Water Body Closer than 120 m | Significant Natural Features Closer than 120 m |
| 1 | 639 | 354 | 283 | 316 | 848 | No | No | No | Woodland (37m), Woodland (29 m) |
| 2 | 776 | 760 | 548 | 103 | 660 | No | No | No | No |
| 3 | 714 | 210** | 464 | 284 | 975 | No | No | No | No |
| 4 | 782 | 139** | 680 | 753 | 547 | No | No | No | No |
| 5 | 586 | 198 | 623 | 493 | Over 3 km | No | No | No | Floodplain (0 m) |
| 6 | 738 | 184 | 936 | 724 | Over 3 km | No | No | No | Floodplain (0 m) |
| 7 | 678 | 128 | 639 | 452 | Over 2 km | No | No | No | Floodplain (0 m) |
| 8 | 662 | 87 | 633 | 545 | Over 1.5 km | No | No | 24 m | Floodplain (0 m) |
| 9 | 685 | 124 | 686 | 524 | 21 (Bell) 261 (Tx Lines) | No | No | 1 m | No |
| 10 | 811 | 788** | 799 | 827 | 264 (Bell) 245 (Tx Lines) | No | No | No | Floodplain (21 m) |
| 11 | 812 | 760** | 642 | 782 | 168 | No | No | No | Floodplain (0 m) |
| 12 | 699 | 173 | 631 | 561 | 290 | No | No | No | Floodplain (0 m) |
| 13 | 709 | 75 | 692 | 465 | 21 | No | No | 77 m | Woodland (81m) |
| 15 | 582 | 128 | 586 | 448 | Over 1.5 km | No | No | 27 m | No |

* does not include distance to electrical distribution lines

** irregular shaped lot parcels result in a separate measurement to the nearest non-participating lot line

TABLE 6 TURBINE SETBACKS FROM LOT LINES

| Turbine | Lot Line Setbacks (m) | | | | |
|---|---|---|---|---|---|
| | West* | East* | North* | South* | Nearest Non-Participant Property |
| 1 | 316 F | 354 | 703 | 737 | 354 |
| 2 | 99 F | 63 | 760 | 1058 | 760 |
| 3 | 7 | 827 | 1110 F | 14 | 210** |
| 4 | 496 | 335 | 749 F | 377 | 145** |
| 5 | 198 | 198 | 637 F | 316 | 198 |
| 6 | 184 | 110 | 718 F | 255 | 184 |
| 7 | 128 | 69 | 448 F | 829 | 128 |
| 8 | 109 | 87 | 542 F | 507 | 87 |
| 9 | 124 | 200 | 244 | 660 F | 124 |
| 10 | 52 | 339 | 933 | 1150 F | 788** |
| 11 | 174 | 19 | 663 | 1115 F | 760** |
| 12 | 29 | 173 | 464 | 809 F | 173 |
| 13 | 128 | 75 | 133 | 1116 F | 75 |
| 15 | 128 | 255 | 424 | 846 F | 128 |

* setbacks are measured parallel to lot and concession divisions and may not be in the exact cardinal direction listed

** irregular shaped lot parcels result in a separate measurement to the nearest non-participating lot line

F denotes measurement to the front of lot parcel

## 2.4. UTILITY CORRIDORS, RIGHTS OF WAY, AND EASEMENTS

### 2.4.1. Project Collection System

Turbines will be electrically connected to one another by buried and overhead cables referred to as the collection system. The collection system brings electricity and operational data from each turbine to the control and switchgear hardware in the substation. The electricity is then fed to the point of common coupling (PCC) with the Hydro One controlled grid.

The collection system consists of three electrical cables, a neutral ground, and a fibre optic cable for communication and control purposes. The collections system power lines will run at a system voltage of 34.5 kV between the turbines and the substation.

At the substation, the voltage will be increased to 44 kV so the lines between the substation and the distribution grid run at equal voltage. The grounding wire for the collection system will be the same diameter as the Hydro One system grounding wire to minimize any risk of stray voltage.

The collection system will consist of direct buried cabling as well as overhead lines on standard utility poles.

Direct burial will be used in all locations on-site where soil type and available space permits. This is done in two ways:

1. An excavator will dig a trench below the tile drainage system in an agricultural field and lay all cables and fibre optic line at a depth of 1 m or greater to avoid conflict with farming operations. All damage to tile drainage will be repaired by a contractor of the landowner's choosing. A small amount of crushed gravel or sand may be used to line the trench. Flagging will be placed above the buried cable to provide a physical warning to anyone performing future excavation. Material excavated from the trench will be used to refill the trench once the cables are in place. The trench will be compacted in approximately 20 cm increments and the original topsoil will be replaced.
2. In certain locations it is necessary to bore a path underground between two points and run the conduit and cables through the borehole. This method will be used to pass under roads, watercourses, and to traverse the Bell Easement described in Section 2.4.2. Figure 4 illustrates how directional boring will pass beneath a feature.

Consultation with the Township of South Dundas (TSD) roads manager has indicated that the use of overhead lines on shared poles with Hydro One are strongly preferred within the Township road allowance wherever possible. Consultation with the United Counties of Stormont, Dundas and Glengarry (SD&G) has indicated that a combination of buried cables and shared poles will be tolerated in County road allowances. It is possible that the existing Hydro One utility poles will be upgraded in accommodating the project collection system. The consultation process preceding a formal agreement with Hydro One has begun as part of the connection application stage of the project. This has included a site visit with a Hydro One technician. Hydro One has indicated that shared pole agreements are being arranged with many renewable energy project proponents across the Province. Shared poles with Hydro One are proposed along Glen Stewart Rd/Gilmour Rd and Brinston Road/County Rd 16 as shown on the Operational Site Plan in Appendix A.

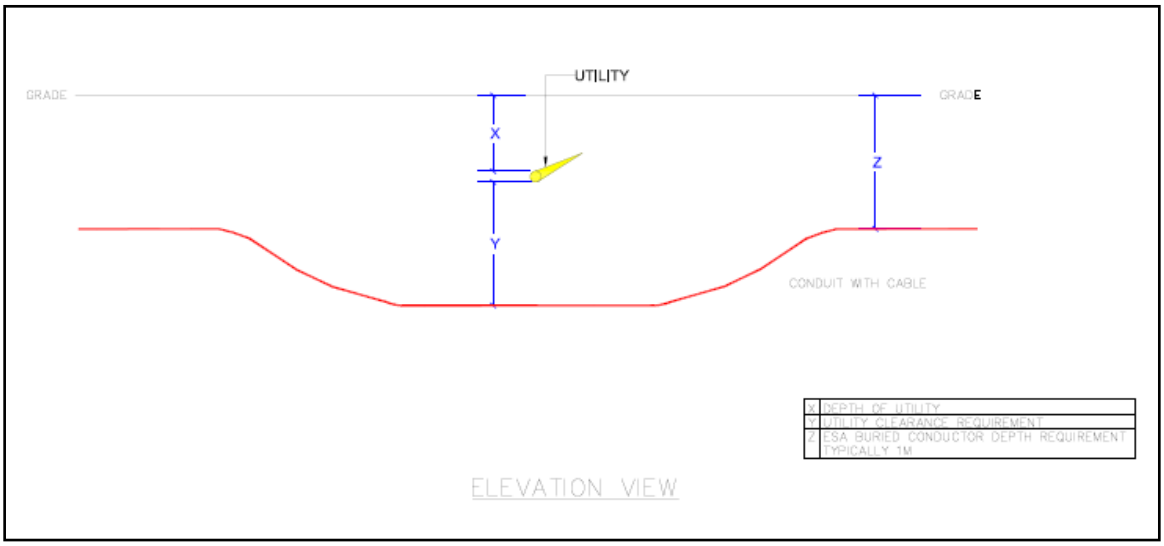



FIGURE 4 DIRECTIONAL BORE UNDER UTILITY (OR ROAD/FLOODPLAIN/DRAINAGE)

### 2.4.2. Utility Corridors

There are several utility corridors located near project infrastructure:

1. High Voltage Electrical Transmission Corridors: Two side-by-side sets of high voltage electric transmission pylons run through the project area and are shown on each site plan diagram. The southern-most set of pylons supports two 230 kV circuits while the northern-most support a single 230 kV circuit. O. Reg 359/09 does not specify setbacks from transmission lines. Prowind contacted the Independent Electricity System Operator, Hydro One, Ontario Power Generation, the Ministry of Energy and Infrastructure, and the Renewable Energy Facilitation Office to consult on acceptable setbacks from transmission lines. Recommended setbacks were obtained from Hydro One via the Renewable Energy Facilitation Office and were stated as follows:

    a. 230 kV setback: 250 m

    b. 115 kV setback: the greater of 125 m or total turbine height + 10 m

    The easements for the transmission pylons are 42.7 m and 45.7 m (140 ft. and 150 ft.) wide for the northern and southern-most easements respectively. All turbine setbacks from the transmission lines conform to Hydro One's recommendations.

2. Hydro One Distribution Lines: Hydro One distribution lines run along several road allowances within the project area:

    a. North-South along Brinston Road (County Road 16)

b. East-West along Gilmour Road and Henderson Road

c. East-West along Snowbird Road

d. East-West along Oak Valley Road

e. East-West along Pitt Road

No conflict between project infrastructure and this line is anticipated. Joint use of Hydro Ones poles for the project collection system is addressed in Section 2.4.1.

3. Bell Canada Easement: A Bell Canada easement runs diagonally through the eastern portion of the project near turbines 9-13. The easement is 30.5 m (100 ft.) wide. A small crossing of the easement by the project collection system is required in 2 locations: near the lay-down and cable route for Turbines 9 and between Turbines 8 and 10. Bell Canada has stated that "the [Prowind] encroachment will be tolerated". The utility will be crossed as indicated in Figure 4. Full details of the method for crossing the easement will be provided to Bell Canada once detailed engineering grade plans are drafted.

## 2.5. STRUCTURES

### 2.5.1. Substation

The substation will consist of fenced-in metal enclosures housing switchgear, communication hardware, a control room, over-current protection devices, metering equipment, an antenna mounted on a ~10 m tower, and a transformer for the project.

The transformer will be rated at approximately 33 MVA (slightly higher rated capacity than the wind farm for equipment safety purposes) to increase the collection system voltage from 34.5 kV to 44 kV before the connection to the distribution grid. Substation construction will involve the removal and redistribution of topsoil from an area approximately 14 m x 40.4 m. A concrete slab for each metal enclosure will be poured on top of a 0.6 m layer of engineered gravel.

The metal enclosures for the electrical components will be bolted to the concrete slabs outlined above. The precise dimensions of the electrical enclosures will be determined once specific equipment has been selected by the Engineering and Procurement Contractor. A draft preliminary site plan for the substation is included in Appendix A. Dimensions shown for the substation are sufficient to host the required equipment, but may be subject to minor alteration during the detailed design stage.

The small metal lattice tower will be approximately 10 m in height and will be mounted to a concrete footing. An antenna will be mounted on the tower for the purpose of allowing the electrical system operator to control the switches that connect the wind farm to the electrical grid.

### 2.5.2. Operations and Maintenance Building

An Operations and Maintenance Building will be required to host up to 4 staff members. The facility will consist of up to 4 workstations, a lunch room, and washroom facilities as a minimum. The structure will be connected to the project fibre-optic network to allow monitoring and control of the wind farm.

Four parking spaces for pick-up truck sized vehicles will be required outside the building.

For the sake of allowing for future flexibility there are 3 potential Operations and Maintenance Building locations outlined on the Operational Site Plan. Two of the proposed locations are existing buildings that would be renovated if selected. The remaining location is a site suitable for a newly constructed building approximately 6.1 m x 12.2 m (20 ft x 40 ft). A newly constructed single storey building would be built on a standard concrete foundation utilizing wood framing in accordance with the Ontario Building Code. A potable water storage tank, filled by supply trucks from an off-site supplier, will be installed to provide the facility with water. A septic system would be installed to treat waste water from the facility..

One of the 3 locations will be selected as the final Operations and Maintenance Building site prior to project construction. Each location shown on the Operations Site Plan is detailed below:

- 11058 Gilmour Road: an existing building in the hamlet of Brinston, ON. The structure is a former Town Hall and is currently vacant. The building interior would be assessed and renovated if required.
- 11099 Henderson Road: a new building would be constructed on a vacant portion of this project participant lot to host the facility. The building would be adjacent to existing farm buildings and measure approximately 6.1 m x 12.2 m (20 ft x 40 ft), with parking spaces for at least 4 pickup trucks.
- 11225 Henderson Road, Dundas Agri-Systems: this property is currently in use for agri-business and the interior can be upgraded with minor renovations to accommodate the addition of the required facilities.

### 2.5.3. Storage Shed

A storage shed approximately 6.1 m x 12.2 m (20 ft x 40 ft) will be built to store tools, spare parts, and waste fluids until a specialized contractor removes them for disposal. The shed will be built to a standard suitable for hazardous waste storage so that any leaks or spills of waste lubricants from the site are contained and prevented from contacting the ground or surface water. The shed will be constructed on Property P19 as indicated on the Operations Site Plan.

### 2.5.4. Existing Structures Within 300 m of the Facility

All existing structures within 300 m of project infrastructure have been highlighted on the site plan diagram. Setbacks from turbines to the nearest structure are provided in Table 5. These structures are all agricultural buildings or residences. There are no residences within 300 m of a turbine. Some residences are within 300 m of the collection system or an access road.

## 2.6. ROADS, TURBINE LAY-DOWN AREAS AND CRANE PADS

Access roads to project turbines will be 6 m wide during the operational phase and have a foundation of 'grade B' gravel and a finished surface of 'grade A' gravel. To construct the roads within agricultural fields the topsoil will be stripped and spread over the directly adjacent field. In total there will be 8.2 km of access roads required for all 14 turbines, of which 2.6 km will utilize existing driveways/laneways and road entrances.

Geotechnical testing will determine if further excavation is required to support the access road and will determine the thickness of each gravel layer. The roads must have a load bearing capacity of approximately 72 kPa at a 5.1 cm (2 in) depth below grade. Wherever possible, access roads will be built such that the surface of the road is roughly flush with the field surface to allow for minimal disruption of farming operations and drainage patterns. The extra gravel making up the 43 m turning radii required during the construction phase of the project will be removed during the operational phase.

A turbine component "lay-down" area covering approximately 1 hectare (100 m x 100 m) will be required around each turbine during the construction phase. This area is required to store tower sections, power electronics, blades, the nacelle and the rotor hub during the construction and decommissioning processes. The crane pad will also be located within this area. The turbine lay-down area will be constructed by stripping back the topsoil layer and covering the area with gravel. Topsoil will be stockpiled in low-lying windrows adjacent to the lay-down area and outside of the floodplain and will be seeded with vegetation suitable to prevent erosion if required. After the turbine is installed the gravel will be removed from the lay-down area with the exception of the crane pad and the topsoil will be returned. Topsoil storage locations are shown on the construction site plan.

A 20 m x 40 m crane pad will be constructed within the turbine lay-down area. The crane pad will be constructed of gravel such that the bearing capacity is a minimum of 287 kPa. The crane pad area will remain intact during the operational phase of the project. The topsoil from this area will be distributed over the cultivated fields directly surrounding the turbine (only on land of project participants).

Further details on soil storage during the construction phase of the project can be found in the *Construction Plan Report*.

## 2.7. CULTURAL HERITAGE RESOURCES

A Heritage Impact Assessment (HIA) was conducted for the South Branch Wind Farm project area to identify any important built heritage features or cultural heritage landscapes. This assessment involves desktop historical land use studies and windshield surveys of the area for identification of culturally significant heritage features. Full details on this assessment are presented in the *Archaeological and Heritage Resource Assessment Report.*

The HIA identified 3 cultural heritage landscapes (CHL) with cultural heritage value or interest (CHVI) in the vicinity of the project: Brinston, Hulbert and Dixon's Corners. Survey results indicated that none of the CHL will be detrimentally impacted by the introduction of the wind farm on the landscape.

The HIA also identified several built heritage (BH) resources with CHVI both near and abutting the project area. After thorough assessment of these resources within the context of the local region, the study concluded that these BH resources would not be negatively impacted by the wind farm construction or operation.

The survey recommended that the project be allowed to proceed without further heritage concerns. The Ministry of Tourism and Culture (MTC) concurred with this recommendation in their approval letter dated September 7, 2011.

## 2.8. ARCHAEOLOGICAL RESOURCES

Stage 1 and 2 Archaeological Studies were completed at the South Branch Wind Farm in 2010 and 2011. A summary of the results, along with the full text of the consultants reports for both Stage 1 and Stage 2 surveys are presented in the *Archaeological and Heritage Resource Assessment Report*.

Two Euro-Canadian find-spots were located during the Stage 2 surveys. Find-spot 1 did not meet the criteria established by the MTC for sites requiring further work. Find-spot 2 was located at the proposed base of Turbine 14. This area was considered to have sufficient cultural heritage value and/or interest to warrant a Stage 3 – Site Specific assessment. At the recommendation of the archaeological consultant, the Applicant elected to avoid the area and has since removed these lands from the project. Therefore, Turbine 14 and its related infrastructure have been removed from the project scope and are no longer present on the current site plan diagrams.

Survey results were submitted to MTC for review and approval. In their response letter dated September 9, 2011, MTC staff concurred with the recommendation that no further archaeological assessment will be required for this site and that the site is considered free of further archaeological concern.

## 2.9. WATER BODIES

### 2.9.1. Rivers

The South Branch of the South Nation River is a major river in the vicinity of the project; sections of this river and its tributaries lie within 300 m of project infrastructure. A detailed investigation of the potential impacts to water bodies is described in the *Water Assessment Report.*

The South Branch of the South Nation River will be intersected by project infrastructure in two locations and tributaries of this river in three locations. Electrical cabling will be directionally bored under the South Nation River and tributaries in these locations.

Figure 5 shows the South Nation River in the project area south of Turbine 8 at the approximate location of the proposed electrical cable crossing, looking east . At this location, the cable is proposed to be directionally bored under the river. The photo was taken on October 26, 2010.

Figure 6 shows the South Nation River from the bridge on Gilmour Road, looking north. This photo was taken on August 12, 2010. At this location, electrical cabling will be strung on existing overhead hydro poles or directionally bored under the river.

FIGURE 5 SOUTH NATION RIVER SOUTH OF TURBINE 8

FIGURE 6 SOUTH NATION RIVER FROM GILMOUR ROAD

### 2.9.2. Floodplain

Regulated floodplain data for the project area were obtained from South Nation Conservation (SNC). The regulated floodplain is shown on the site plan diagram. All turbines are located outside the regulated floodplain, however some of the lay-down areas will lie within the floodplain regulation area (15 m buffer around floodplain). Soil stockpiles will be located outside of the floodplain. Certain portions of the collection system will also pass through regulated floodplain as shown between Turbines 5, 6, 7, 8, and 10. Additionally, portions of the access roads to Turbines 6, 7, 8, 12, and 13 will traverse the regulated floodplain. Consultation with SNC has indicated that turbines are not permitted in the floodplain, but collection system cabling, lay-down areas and access roads are permitted provided that proper permits are secured and that drainage patterns are not affected.

### 2.9.3. Surface Water Drainage

Surface water drainage is shown on the site plan diagram. The surface water drainage data is based on Ontario Base Mapping at a scale of 1:10,000. Surface water drainage patterns will not be altered by the operation of the wind farm. Updated surface water records are outlined in the *Water Assessment Report*. Several of the surface water drains recorded on the Ontario Base mapping no longer exist as surface drainage as they have been tiled or levelled. Particular attention will be given to these areas to ensure that there is no disruption to the drainage pattern.

## 2.10. Significant Natural Heritage Features

Natural heritage feature mapping was conducted with records from Ministry of Natural Resources (MNR), Land Inventory Ontario (LIO), Natural Heritage Information Centre (NHIC) South Nation Conservation (SNC), United Counties of Stormont, Dundas and Glengarry (SD&G) and the Township of Edwardsburgh/Cardinal (TEC).

Records review and site investigations determined that several natural features are located within 120 m of the project area. These natural features include woodlands, wetlands, floodplain and wildlife habitat. This information, along with assessment methodology can be found in the *Natural Heritage Assessment Report.*

Many of the woodlands had been previously identified as significant by the MNR. For those woodlands that had not been evaluated for significance, the criteria for evaluating significance from the Ministry of Natural Resources' Natural Heritage Assessment Guide, was applied. There were 14 woodlands identified within 120 m of the project location; 12 of the woodlands are considered significant.

There were no records of wetlands identified during records review, but site investigation revealed the presence of 35 wetland units within 120 m of the project area. These wetlands were all assumed to be provincially significant and treated as such in the Environmental Impact Study portion of the report. This avenue is laid out in the MNR's Natural Heritage Assessment Guide, Appendix C which allows proponents to forego the in-depth wetland evaluation process and assume significance if no infrastructure is placed within any wetland unit, which is the case for the South Branch

Wind Farm. In one location, buried electrical cable will intersect with a wetland and will be directionally bored under the wetland feature. This occurs at a watercourse/wetland feature between County Road 18 and Sandy Creek Rd in the western portion of the project area. In several locations along Gilmour Road/Glen Stewart Road wetlands will be crossed by overhead cables, but the poles will easily span these features.

Several instances of Candidate Significant Wildlife Habitat was recorded during site investigation. The evaluation of significant determined that within five of the woodlands, Significant Woodland Amphibian Breeding Habitat was identified. Additionally, one wetland/watercourse feature was identified as potential Snapping Turtle habitat. The Snapping Turtle is a Special Concern species and the presence of its habitat requires significance designation.

None of the above noted features will be directly impacted during the operation of the South Branch Wind Farm. Infrastructure necessary for the South Branch Wind Farm was intentionally placed outside of natural features. Minor impacts during the construction process are outlined in the *Natural Heritage Assessment Report* and the *Construction Plan Report*.

In summary, no natural features and/or habitat will be removed from the project area. Construction will be limited to the lay-down areas that are located exclusively in agricultural fields; this immediately reduces the impacts on natural heritage features. Much of the risk associated with natural features exists in the form of potential impacts. Risks associated with the operation of the wind farm are exclusive to the potential mortality of birds and bats from rotating turbine blades. This was addressed with a post-construction monitoring plan.

Overall, risks to natural features at the South Branch Wind Farm are low. Intentional project design to reduce environmental impacts, as well as appropriate mitigation measures and monitoring plans will result in minimal impacts to natural heritage features at this wind farm.

# 3. Facility Operation Plan

## 3.1. Turbine Operation and Monitoring

Turbine operation and maintenance (O&M) will be contracted to a specialized third party service provider. The O&M service provider will have a staff of trained Wind Turbine Technicians, Site Supervisors, and a data monitoring centre located in the O&M building and also off-site to monitor the status of each turbine 24 hours per day, 365 days per year.

The scope of the O&M contract will include day-to-day monitoring and operation of the turbines via SCADA hardware and fibre optic communication linkage as well as on-going maintenance required on-site.

O&M staff will be stationed on-site in the O&M building discussed in Section 2.5.2. Turbine monitoring will encompass the following services as a minimum:

- meteorological monitoring and corresponding turbine operational decision making to ensure that maintenance crews are not endangered and that turbine design specifications are not exceeded during extreme weather events, e.g. precautionary turbine shutdown and blade feathering during storms and extreme events to prevent damage, Table 4 lists an additional, automatic turbine shutdown condition in high winds,
- turbine performance monitoring and tracking in relation to expected power output to identify maintenance issues, or issues that may be causing increased noise emission, and
- equipment diagnostic monitoring for parameters such as component vibrations, component temperatures, fluid pressures, power usage, emergency sensor triggers, etc.

In total over 500 parameters for each turbine will be continuously, and remotely monitored by a service provider to ensure that potential issues are identified and addressed.

Turbine maintenance contracts will encompass the following services as a minimum:

- response to issues identified via turbine monitoring,
- scheduled maintenance as per turbine manufacturer requirements and on-site diagnostics,
- fluid changes including removal and disposal of waste fluids (including those deemed to be hazardous), more information is contained in Section 3.2,
- replacement of broken or worn out minor components such as yaw motors, pitch actuators, lubricant pumps, fuses and circuit boards, etc.,
- responsibility for general site cleanliness, and
- major component replacement during the operation phase will be overseen by a selected Engineering and Procurement Contractor.

### 3.1.1. Project Collection System Maintenance

The wind farm collection system, as detailed in Section 2.4.1 and on the site plan diagrams, will be maintained by either the O&M contractor or a specialized subcontractor. Buried cables in general, require very little maintenance. Cables on shared Hydro One poles will be covered by an Emergency Services Agreement with Hydro One whereby Hydro One will be authorized to respond to any issues with the electrical lines or poles and bill the project proponent for the services. Non-emergency work on lines shared with Hydro One will be contracted to a qualified service provider and will be conducted in accordance with the Electrical Safety Code.

## 3.2. WASTE MANAGEMENT

Waste created at operational wind energy generation facilities is typically limited to relatively small quantities of exchanged lubricants and cooling fluids, grease-soaked rags, replaced turbine parts, and waste water and sewage from the O&M building.

All waste fluids from turbines will be collected by operation and maintenance staff or a qualified subcontractor. Waste fluids will be immediately removed from the site by a qualified subcontractor and recycled or disposed of in accordance with local regulations, or stored on-site in the shed detailed in Section 2.5.2 until such removal is possible.

Expected quantities of waste fluids to be created by the project during the operational phase are presented in Table 7. Some variation to these quantities is possible due to changing specifications from turbine manufacturers or increased frequency of fluid exchange due to issues identified during on-site monitoring. Emergency response to spills of waste fluid are addressed in Section 3.4.4.5.

TABLE 7 TOTAL EXPECTED QUANTITIES OF WASTE FLUIDS

| Type of Waste | Expected Quantity | Frequency |
|---|---|---|
| Gearbox Oil | 10500 L | Every 60 Months |
| Hydraulic System for Brake and Rotor Lock | 420 L | Every 60 Months |
| Yaw System Gear Oil | 180 L | Every 12 Months |
| Yaw Hydraulic System | 80 L | Every 60 Months |
| Pitch System Gear Oil | 42 L | Every 12 Months |
| Human Waste from Portable Toilets | Variable | As required by unit capacity |

It is expected that replacement of a small turbine component will occur annually per turbine. This may typically include a fluid pump, cooling fan, circuit board, sensor, yaw motor, pitch motor, etc. Qualified maintenance personnel will immediately remove any replaced parts from the site or place them in storage until removal can be arranged. These parts will be refurbished when possible or recycled/disposed of in accordance with local regulations.

It is expected that replacement of a major turbine component will occur every 7 years per turbine on average. This may typically include a gearbox, generator, or turbine blade and will require that a crane be brought to the site. Gearboxes and generators will be removed from the site for refurbishment. Turbine blades may be repaired and re-used but will more likely be taken off-site for disposal in a landfill once removed from the turbine hub.

There will be a minimum of 1 portable toilet on-site in the western portion of the project and a minimum of 1 in the eastern portion of the project and during the operation phase in addition to washroom facilities at the O&M building. The waste will be pumped out as needed by a local contractor. A likely interval for this service is monthly, but may be more frequent as needed.

Waste water from the O&M building will be processed by a building-specific septic system designed and installed in accordance with local regulations.

There are no planned water takings near or above 50,000 L/day on any day of the operational phase of the project.

## 3.3. ACCESS MAINTENANCE

Access to all turbines will be maintained year round. This is required for operations, maintenance and emergency response purposes.

Access road maintenance contract(s) will be awarded to a local service provider. The scope of access road maintenance will include snow removal and grading if/when necessary to allow all maintenance and emergency service vehicles to drive to each turbine.

Snow will be ploughed to the side of each access road or blown into adjacent fields belonging to participant owners. No salt or chemical treatments will be applied to access roads.

If needed, a 15,000 L water tank truck will be filled off-site and brought to the project area for dust suppression on the access roads.

## 3.4. EMERGENCY RESPONSE AND COMMUNICATION PLAN

### 3.4.1. Wind Farm Emergency Response Background

Emergency response at a wind farm can involve specialized training, equipment, and procedures due to the height and dynamic nature of the wind turbines. In rural areas, such as the site of the South Branch Wind Farm, it is common for local emergency services such as the fire department to be volunteer-based with a scope of service that does not cover certain potential emergencies at wind projects. For this reason highly trained wind farm construction as well as O&M staff provide emergency services "up tower" and transfer responsibility to local emergency services at a pre-determined location on the ground such as at a point near a wind turbine base.

The potential for coordinated emergency response by two or more separate entities requires that responsibility and communication structures are clearly defined between all groups. The following sections summarize the entities involved in emergency response for the project, provide an overview of their responsibilities and resources where applicable, define the communication chain between them, and discuss the general response to potential emergency scenarios related to wind projects.

#### 3.4.1.1. Construction and Decommissioning Phases

Specific emergency response procedures for the construction and decommissioning phases of the project will be established between the lead Engineering and Procurement Contractor (EPC) conducting the work, the Proponent, and Local Emergency Services. This will take place immediately after selection of an EPC and in advance of any construction or decommissioning activity conducted onsite.

Response to emergency scenarios such as vehicle/equipment accidents, fire, environmental emergencies, extreme weather, and emergencies "up-tower" will be addressed.

To reduce likelihood of confusion, all turbines will be assigned a civic address that will be marked on the road following standard protocols. This aids in communication of the location of interest in both emergency and non-emergency situations.

#### 3.4.1.2. Operation Phase

Specific emergency response procedures for the operation phase of the project will be established between the Operation and Maintenance Team (OMT) conducting the work, the Proponent, and Local Emergency Services. This will take place after a turbine supply agreement has been finalized, in advance of any construction activity conducted onsite. A sample *Emergency Preparedness and Fire Prevention* template as adapted by General Electric to each specific wind farm is included as Appendix D. This document

outlines the process and scope of emergency planning for the site during the operational phase of the project. Other turbine suppliers have documents of similar scope that will be adapted to the site if selected to supply turbines for the project.

### 3.4.2. Entities and Roles

The emergency response may consist of any of the entities listed in the sections below.

#### 3.4.2.1. Proponent

Certain staff of the proponent will be designated with the responsibility of being available for emergency response communication. This designation carries the responsibility to ensure that during each phase of the project the EPC and/or OMT for the site is aware of any emergency issue brought to the attention of the proponent and that local Emergency Services are also made aware of the same in the event that the emergency is beyond the scope handled exclusively by the EPC or OMT.

The proponent will also be responsible for notifying local media/emergency broadcaster(s) (if required) and nearby residents (if required) in the event of an emergency that threatens public health or safety.

The proponent will be available via mobile phone and a paging system at all times. The contact numbers for these devices will be determined and distributed to the EPC, OMT and Local Emergency Services in advance of any construction activity at the site.

#### 3.4.2.2. Engineering and Procurement Contractor

The EPC selected to oversee all construction and/or decommissioning work on-site and will be responsible for monitoring emergency response requirements during the construction and decommissioning phases.

The EPC's Site Manager will directly coordinate emergency response on-site and will contact local emergency services when required in adherence to pre-established division of responsibilities discussed under Section 3.4.1.1. The EPC will also be responsible for communicating the status of ongoing emergency response to the proponent and will be available via any number of the following contact avenues during emergencies:

- Two-way radio with proponent and/or Local Emergency Services - tuned to a frequency to be established in consultation with Local Emergency Services as discussed under Section 3.4.1.1.
- Mobile phone – specific number to be established as part of an Emergency Response Plan as outlined in Section 3.4.1.1.

#### 3.4.2.3. Operation and Maintenance Team

The OMT will be responsible for coordinating onsite emergency response during the operation phase of the project in accordance with the sample *Emergency Preparedness and Fire Prevention Plan* as outlined in Section 3.4.1.2. As a minimum, the OMT will consist of a Service Site Manager based on-site location and/or a Region Manager. Either one or both will be available 24 hours per day, 365 days per year. The OMT will

directly coordinate emergency response on-site and will contact local emergency services when required in adherence to pre-established division of responsibilities. The OMT will be available via any number of the following contact avenues during emergencies:

- two-way radio with proponent and/or Local Emergency Services - tuned to a frequency to be established in consultation with Local Emergency Services as part of the sample *Emergency Preparedness and Fire Prevention* plan, outlined in Section 3.4.1.2.,
- mobile phone – specific number to be established as part of the sample *Emergency Preparedness and Fire Prevention Plan* as outlined in Section 3.4.1.2., and
- a designated toll free number – specific number to be established as part of the sample *Emergency Preparedness and Fire Prevention* plan as outlined in Section 3.4.1.2.

The OMT will also be responsible to communicate the status of ongoing emergency response to the proponent.

#### 3.4.2.4. Local Emergency Services

Local Emergency Services consist of the five fire departments within 20 km of the site, the Ontario Provincial Police (OPP), and four ambulance stations within 20 km of the site. These emergency services will be contacted via 911 emergency dispatch, which can be initiated by any party, or by two-way radio as outlined above. Local Emergency Services will notify both the proponent and the OMT when informed of an emergency on-site as to enable appropriate coordination.

For reference purposes, Fire Department resources and proximity to the site are outlined in Table 8. Ambulance stations and their proximity to the site are outlined in Table 9. The nearest hospital is the Winchester District Memorial Hospital, 24 km from the site. The project is located between 4 OPP detachments: Winchester, Morrisburg, Kemptville, and Prescott.

#### 3.4.2.5. MOE and/or Spills Action Centre

The MOE and/or the MOE Spills Action Centre will be notified by the proponent of any incident requiring MOE attention. The EPC or OMT will also notify the MOE and/or the MOE Spills Action Centre of any incident requiring MOE attention at 1-800-268-6060.

#### 3.4.2.6. Media Broadcasters

Local radio and TV stations will be notified by the proponent of emergency events that may impact public health or safety in the vicinity of the project. Proposed stations to contact are listed in Tables 10 and 11. The TV stations listed in Table 11 are not offered in the project area itself, only in the listed urban areas surrounding the project.

TABLE 8 FIRE DEPARTMENT RESOURCES

| Fire Department Location | Approximate Distance from Project Boundary by Road (km) | Volunteer Staff | Equipment Resources |
|---|---|---|---|
| 6055 County Road 44, United Counties of Leeds and Grenville, Ontario | 14 | 27 | 3 Pumper/Tankers<br>1 Rescue Van |
| Cardinal | 18 | 25 | 1 Pumper/Tanker<br>2 Pumpers<br>1 Rescue Van |
| Morrisburg | 20 | 20-24 | 1 Tanker<br>1 Pumper<br>1 Rescue Van |
| Iroquois | 11 | 20-24 | 1 Tanker<br>1 Pumper<br>1 Rescue Van |
| Williamsburg | 12 | 20-24 | 1 Tanker<br>1 Pumper<br>1 Rescue Van |

TABLE 9 AMBULANCE RESOURCES

| Ambulance Station | Approximate Distance from Project Boundary by Road (km) | Staff | Hours of Operation |
|---|---|---|---|
| Winchester | 16 | 1 paramedic crew<br><br>When a crew is dispatched another may be shifted to the station to replace it | 24 hours, 7 days per week |
| Morrisburg | 20 | 1 paramedic crew<br><br>When a crew is dispatched another may be shifted to the station to replace it | 24 hours, 7 days per week |
| Spencerville | 12 | 1 paramedic crew<br><br>When a crew is dispatched another may be shifted to the station to replace it | 9 AM – 9 PM, 7 days per week |
| Prescott | 27 | 1 paramedic crew<br><br>When a crew is dispatched another may be shifted to the station to replace it | 24 hours, 7 days per week |

TABLE 10 LOCAL RADIO BROADCAST CONTACTS

| FM Frequency (MHz) | City of Origin | Station Name | Station ID | Contact Info | Language |
|---|---|---|---|---|---|
| 88.5 | Ottawa | Live 88.5 | CILV | 613.688.8888 | English |
| 89.1 | Ottawa | University of Ottawa Radio | CHUO | office (613) 562-5965 studio (613) 562-5967 | English and French |
| 90.7 | Ottawa | Radio Canada Ottawa/Gatineau Region | CBOF | 613 288 6600 | French |
| 91.5 | Ottawa | CBC Radio One | CBO | (613) 288-6485 | English |
| 92.1 | Cornwall | Chod FM | CHOD | 613-936-2463 | French |
| 93.1 | Ottawa | Carleton University Radio | CKCU | office (613) 520-2898 studio (613) 520-CKCU on-air interview line (613) 520-2759 | English |
| 93.9 | Ottawa | Bob FM | CKKL | 613-789-2486 x4287 | English |
| 94.5 | Ottawa | New | CJFO | no contact listed | French |
| 95.7 | Ottawa | Aboriginal Radio | CKAV-9 | no contact listed | English |
| 97.9 | Ottawa | CHIN | CJLL | 613-244-0979 | Multi-language |
| 98.5 | Ottawa | The Jewel | CJWL | (613) 241-9850 | English |
| 99.1 | Ottawa | | CHRI | | English |
| 99.7 | Ottawa | Easy Rock | CJOT | (613) 225-1069 | English |
| 100.3 | Ottawa | Magic | CJMJ | (613) 789-2486 | English |
| 101.1 | Smith Falls/Ottawa | Y101 | CKBY | 613-736-2001 | English |
| 102.1 | Brockville | Radio Canada Ottawa/Gatineau Region | CBOF | 613 288 6600 | French |
| 102.5 | Ottawa | Radio Canada - Espace Musique | CBOX | no contact listed for the Ottawa Station | French |
| 103.3 | Ottawa | CBC Radio 2 | CBOQ | 1-866-306-4636 | English |
| 104.9 | Brockville | Jr FM | CFJR | (613) 345-1666 | English |
| 105.3 | Ottawa | Kiss FM | CISS | 613-736-2001 | English |
| 106.1 | Ottawa | Chez | CHEZ | 613-736-2001 | English |
| 106.9 | Ottawa | The Bear | CKQB | (613) 225-1069 | English |
| 107.9 | Nepean | Algonquin College Radio | CKDJ | (613) 727-4723 Ext. 2408 or Ext. 2409 | English |
| **AM Frequency (kHz)** | **City of Origin** | **Station Name** | **Station ID** | **Contact Info** | **Language** |
| 580 | Ottawa | News Talk Radio | CFRA | 613-521-1000 | English |
| 1200 | Ottawa | Team 1200 | CFGO | (613) 750-1200 | English |
| 1310 | Ottawa | Oldies 1310 | CIWW | (613) 736-2001 | English |

TABLE 11 LOCAL TV BROADCAST CONTACTS

| Station Name | Channel | Contact Number |
|---|---|---|
| *TV* COGECO Brockville | 10 | 1-866-709-5098 |
| *TV* COGECO Cornwall | 11 | 613 937-2506 |
| Rogers TV - Ottawa | 22 | 613-728-2222 |

### 3.4.3. Emergency Response Chain of Communication

CONSTRUCTION AND DECOMMISSIONING PHASES

Figure 7 illustrates the chain of communication during an emergency response when the EPC detects the emergency. Figure 8 illustrates the chain of communication during an emergency response when a member of the public detects the emergency.

As previously discussed, the EPC will be responsible for determining if local emergency services are required for a potential emergency.

Once an emergency is known to the Proponent, the EPC, and Local Emergency Services (if required), all 3 groups will remain in regular communication to monitor the status of the emergency until a resolution has been achieved.

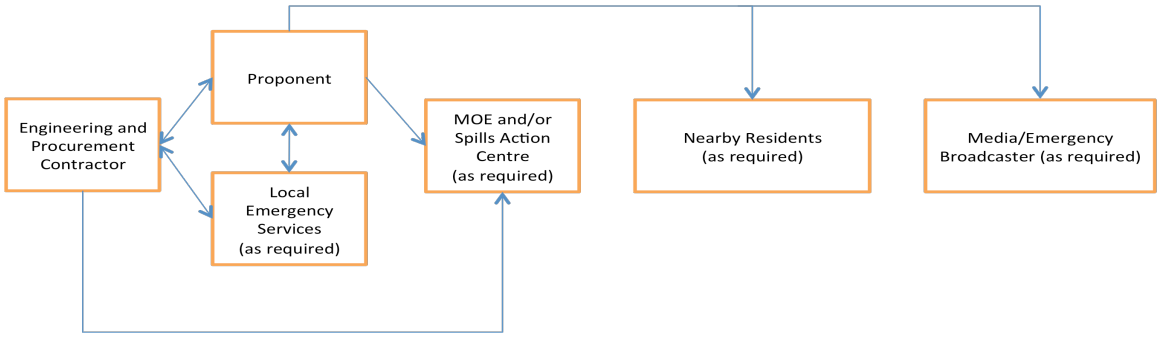



FIGURE 7 EMERGENCY COMMUNICATION CHAIN FROM EPC

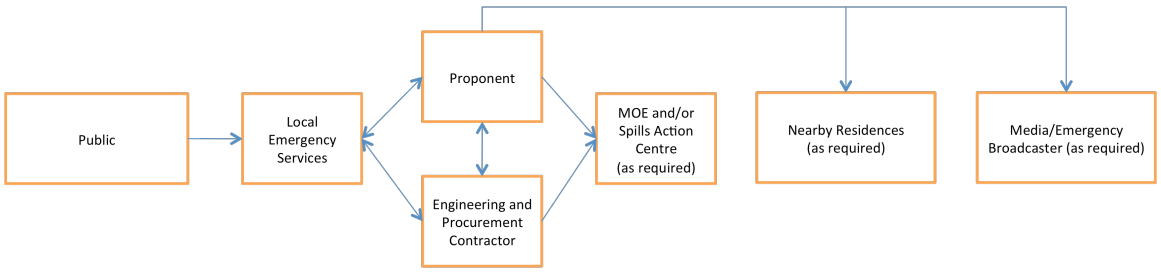



FIGURE 8 EMERGENCY COMMUNICATION CHAIN FROM PUBLIC

#### 3.4.3.1. Operation Phase

Figure 9 illustrates the chain of communication during an emergency response when the OMT detects the emergency. Figure 10 illustrates the chain of communication during an emergency response when a member of the public detects the emergency.

As previously discussed, the OMT will be responsible for determining if local emergency services are required for a potential emergency.

Once an emergency is known to the Proponent, the OMT, and Local Emergency Services (if required), all 3 groups will remain in regular communication to monitor the status of the emergency until a resolution has been achieved.

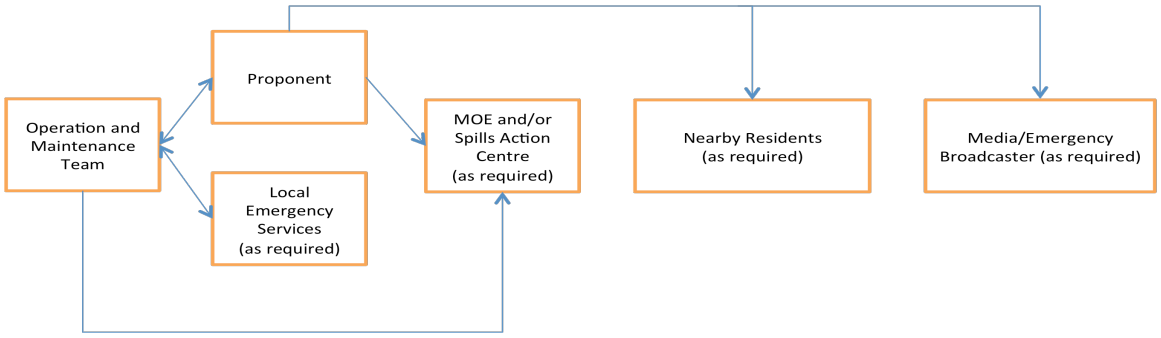



FIGURE 9 EMERGENCY COMMUNICATION CHAIN FROM OMT

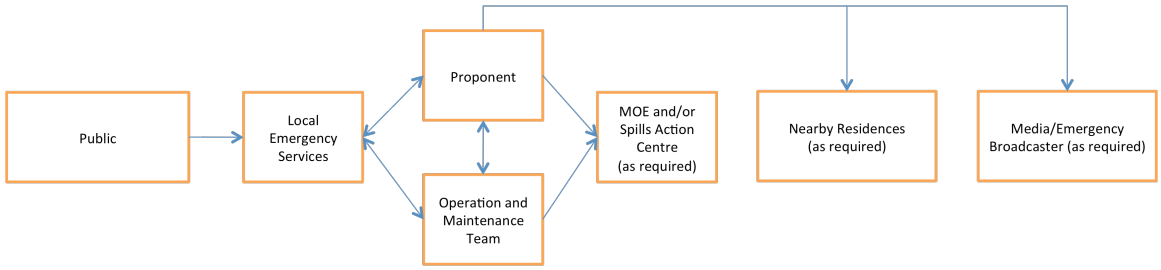



FIGURE 10 EMERGENCY COMMUNICATION CHAIN FROM PUBLIC

### 3.4.4. Typical Emergency Response Scenarios

As referenced in Sections 3.1.1.1 and 3.1.1.2 the EPC and OMT contractors will be required by the proponent to draft detailed emergency response plans, specific to the South Branch Wind Farm, in advance of any construction activity on-site. These plans will be developed through ongoing consultation with local emergency services. The following sections elaborate on typical emergency response scenarios for wind

projects and are intended to provide general response information on scenarios that will be addressed in greater detail before construction.

#### 3.4.4.1. Extreme Weather

Weather conditions will be continuously monitored by the site manager during all project phases to identify potential emerging hazards on the project site. Extreme weather events most likely to occur at the South Branch Wind Farm are lightning strikes, ice storms, tornado/funnel clouds/high winds, flooding from heavy rain, low temperatures and wind chill, as well as blizzards.

When weather forecasts indicate the likelihood of any of the above, on-site work plans will be modified to mitigate potential emergencies. This will occur in several stages as the potential for extreme weather increases. If necessary, all work will be stopped and staff will be instructed via two-way radio to secure equipment, vacate wind turbines and adjacent work areas, and take appropriate shelter. The status of the site and weather will be continually monitored and re-evaluated to determine if additional emergency response is required.

During the construction and decommissioning phases it will be necessary to assess the potential for extreme weather on an on-going basis to determine the eligible construction activities at the site and make decisions on securing equipment. For example, heavy lifting and up-tower work will not occur when there is a reasonable potential for extreme weather. Crane booms may need to be secured or lowered under certain conditions and personnel will vacate the proximity of fully or partially constructed turbines as well as cranes during times when there is a high probability of lightning strikes.

If necessary during the operation phase, turbines will be shut down, the blades will be feathered to negate lift, and the rotors will be locked to guard against excessive loads on the turbine machinery and structures.

#### 3.4.4.2. Ground Level Injury to Personnel

All construction, operation, and decommissioning staff will be fully trained in emergency first aid and will be required to be on-site with at least one additional staff member at all times. All staff will have access to two-way radio and or mobile phones while on-site with pre-designated emergency contacts.

All injuries on-site will be reported to the acting site manager for further direction on appropriate response. The chain of communication in

Figure 7 and Figure 9 will be followed as required. 9-1-1 dispatches will determine the appropriate responders in the event that local emergency services are required to attend to an injury and/or to transport injured personnel to hospital. If safe to do so, injured personnel will be transported to a predetermined meeting location for transfer of care to local emergency services. The local emergency services and the EPC/MMT will remain in ongoing contact to ensure proper coordination.

#### 3.4.4.3. Up-Tower Injury to Personnel

All work in the nacelle of the turbine during all phases of the project requires that a minimum of 2 staff be present in the nacelle. Work being performed in the hub of the turbine rotor requires that three staff be present in either the nacelle or hub. Regular two-way radio or mobile phone contact between up-tower staff and a supervisor will be maintained.

All staff working up-tower will be fully trained in tower evacuation and rescue and will be equipped with an emergency evacuation kit either on their person or within the nacelle.

All injuries on-site will be reported to the acting site manager for further direction on appropriate response. The chain of communication in

Figure 7 and Figure 9 will be followed as required. 9-1-1 dispatches will determine the appropriate responders in the event that local emergency services are required to attend to an injury and/or to transport injured personnel to hospital. If safe to do so, injured personnel will be transported to a predetermined meeting location for transfer of care to local emergency services.

#### 3.4.4.4. Vehicle/Equipment Accident

Vehicle and equipment accident response plans will be specific according to the project phase and the associated equipment. Potential elements in vehicle and/or equipment accidents such as personal injury, spill of hazardous fluids, and fire are detailed in the corresponding subsections of Section 3.4.4.

All accidents on-site will be reported to the acting site manager for further direction on appropriate response. The chain of communication in

Figure 7 and Figure 9 will be followed as required. 9-1-1 dispatches will determine the appropriate responders in the event that local emergency services are required to attend to an accident.

Though extremely rare, some of the unique types of vehicle and/or equipment accident risks that can exist at wind projects involve large cranes or the turbine structures themselves. Accidents of this magnitude will require careful and specific response evaluation. Equipment on-site such as other cranes or heavy machinery may be required in an emergency response in addition to EPC, OMT, and local emergency services.

#### 3.4.4.5. Spill of Hazardous Fluid

Hazardous fluids handling procedures will be established for the site by the EPC and OMT to cover all phases of the project.

All spills of hazardous fluids will be reported to the site manager to determine the appropriate response. Emergency spill kits will be located on-site at all times to allow a quick response to mitigate the extent of any spills. Sedimentation control measures will be placed between construction areas and surface water features. These control measures will slow the transport of contaminated soils and some liquids before

reaching any water features. This will lengthen the time available for clean-up and other emergency procedures.

If required, on-site construction equipment, local farm equipment, or a local contractor will be enlisted to excavate impacted soil to prevent penetration of hazardous fluids to ground water. In the case of a large spill the same may be enlisted to contain the spill and prevent it from reaching surface water sources.

Contaminated soil will be removed from the site and stored/disposed of according to environmental regulations.

Spills will be reported to the MOE Spills Action Centre.

#### 3.4.4.6. Fire

Fire prevention strategies will be established for the site by the EPC and OMT for all phases of the project. Remote monitoring of commissioned turbines will also occur to avoid operational modes that could cause a fire (such as component overheating) and will also be used to detect early signs of fire.

All fires on-site will be reported to the acting site manager for further direction on appropriate response. The chain of communication in

Figure 7 and Figure 9 will be followed as required. 9-1-1 dispatches will determine the appropriate responders in the event that local emergency services are required to respond to a fire.

All on-site personnel will be permitted to use fire extinguishers to eliminate fires in their incipient stage. If this is not possible personnel will attempt to remove additional fuel sources in the vicinity of the fire (if safe to do so) and will be evacuated from the area surrounding the fire.

Coordination with the local Fire Departments will occur to determine the course of the response.

The main potential type of fire unique to wind projects is a fire in the nacelle of a turbine. Fire in the nacelle of a turbine cannot be directly extinguished once past the incipient phase. The EPC or OMT and the local Fire Department will be required to monitor a fire in a turbine nacelle from a safe distance to prevent any spread of the fire to other locations. OPP will be called to divert traffic if a potential risk to a public roadway is determined during this time.

## 3.5. NON-EMERGENCY COMMUNICATIONS PLAN

Non-emergency communication will be conducted in a uniform manner for all phases of the project.

### 3.5.1. Outgoing

Non-emergency announcements and updates related to the project will be sent via email and regular mail to the project stakeholder mailing list and posted on a website

designated to the project (hand mailing may be utilized to reach local residents in a quick and efficient manner). The current project contact list of stakeholders will continue to be utilized for ongoing announcements during the construction, operation, and decommissioning phases. Stakeholders wishing to discontinue receipt of updates and announcements will be removed from the list at their request. Stakeholders wishing to be included on the list will be added at their request. The project website address will be sent to stakeholders and will be posted on at least two signs within public view in the project area.

Notification will be sent out in advance of the commencement of construction, at the completion of construction, in advance of any major component replacement during the operational phase, in advance of project decommissioning, and at any other time deemed necessary such as after unexpected work activity at the site or to present annual project performance to the community.

### 3.5.2. Incoming

Non-emergency incoming communication will be received by phone, mail, or through a designated email address for the project. These contact details will be provided to the stakeholders as outlined in Section 3.5.1, and will be posted on at least two signs within public view in the project area. The contact details for O&M staff and the proponent will be made available in these manners.

Communication received by phone may be followed up by or directed toward written submission to ensure proper documentation. Documentation of all relevant communication will be stored in a file on the proponent's electronic database for the duration of the project lifetime. Communication requiring follow-up action or response will be forwarded to/shared with proponent staff at the management level to determine the appropriate course of action or response. Proponent management staff will be responsible for determining the timing of any response in accordance with sound professional conduct and any applicable regulations.

Communication that is complaint related is further addressed in Sections 4.3-4.5 and 4.11.

The MOE Spills Action Centre will be informed of complaints received.

## 3.6. Ice Accumulation and Discharge

As with any tall structure, wind turbines can accumulate ice under certain atmospheric conditions. Some turbine models are able to detect and prevent ice build-up via the circulation of heated air within the blades, while other turbine models may be subject to ice build up while stationary or in motion.

In the latter case, a shutdown to mitigate the risk posed by ice being thrown from a moving rotor is generally required. For turbine models that do not have heated blades, shutdown due to potential ice build-up can be triggered automatically via several monitoring parameters or can be initiated manually based on weather forecasts and conditions, visual cues, turbine performance data, and by the addition of an optional freezing rain sensor to turbine parameter monitoring.

In response to consultation feedback, a study of the realistic risk posed by ice shedding and ice throw from the South Branch Wind Farm was commissioned and is included as Appendix G. The study was overseen by Dr. Jim Salmon, Carl Brothers P.Eng, and Peter Taylor of Zephyr North Inc and included an analysis of ice shedding from a moving rotor and a second analysis of ice shedding from a stationary rotor to represent post-mitigation impacts.

The potential for an ice fragment to strike a vehicle along a section of Byker Rd that lies between Pitt Rd and Dobbie Rd was calculated. This section of road is depicted in Figure 11. It is relatively narrow and presently receives no winter maintenance. To account for a potential future time when the road may be widened and kept open year round, the future driving surface was assumed to be 8 m wide with daily winter traffic of 100 vehicles.

As part of the Background section of the report the following information is provided:

> *It is important to appreciate that in almost all icing situations, these conditions will be predicted or detected and turbine operation will be terminated — automatically, or by the operator. Ice falling from the tower and blades would remain a problem but would be limited to the immediate vicinity of the turbine, and appropriate safety procedures can be implemented.*
>
> *It should be emphasized that a prudent wind farm operator would shut down turbines in icing conditions for both safety considerations and to avoid potential damage to the turbine. The initial estimates of risk do not take this into account but in Section 6.4 computations of ice fall from a stationary turbine are discussed. With sufficiently strong winds (30 m/s) the model predicts that ice fragments falling from the tip of a vertically upward pointing blade could be blown about 180 m downwind but with hub height winds < 20 m/s no fragments traveled more than 100 m downwind.*

The analyses in the report incorporate meteorological data on icing conditions in the region, a modern ice throw trajectory model, wind data from the project area, an analysis of a range of turbine models under consideration for the site to determine the worst-case (farthest distance) for ice throw, an estimate of the number of ice fragments released per ice day (suggested as being very conservatively high), and traffic/road conditions along Byker Rd as outlined above.

Results of the analyses are presented below:

- For a single turbine with a moving rotor: “Only 3.1% of the fragments travel beyond 100 m and 0.02% beyond 200 m.”
- With respect to cumulative impacts: “For the South Branch layout, however, the turbines are sufficiently well separated that there is minimal overlap between impacts from different turbines.”
- With respect to the probability of ice striking a vehicle on Byker Rd if the turbines are never shut down during icing events:

> *If vehicles travel at 15 m/s (54 km/hr) they will be within the 300 m road length for 20 s and occupy about 6 m². With 100 vehicles per day,…the annual likelihood of an ice-vehicle impact is 0.0013, i.e., one impact every 785 years.*

- With respect to the probability of ice striking a vehicle on Byker Rd from stationary turbines during icing events:

> *In a similar manner, the annual likelihood of vehicle impact with the turbine* stationary *during any icing events reduces to 0.0010, or one impact every 985 years.*

Zephyr North's report recommends that "…the primary ice-throw mitigation measure should be to cease operation of the turbines when there is a build-up of ice on the blades." Incorporating the information contained in the Mitigation Measures section of the report, ice build up on turbine models without heated blades will be detected using several techniques at the South Branch Wind Farm:

- Monitoring of atmospheric conditions: Atmospheric indicators such as instantaneous values and trends in temperature, humidity, precipitation, and barometric pressure will be used in conjunction with weather forecasting to anticipate and recognize conditions conducive to ice accumulation.
- Vibration sensors: If ice build-up occurs on the turbine rotor in an uneven configuration and the rotor begins to move or is in motion, a rotational imbalance may be detected giving wind farm operators the opportunity to initiate a shut-down of the turbine. This may also occur automatically.
- Reduced power output: It is typical that turbine rotor performance is significantly impacted by the presence of ice, similar to aircraft wings. Wind speed data and power production data will be constantly compared to identify discrepancies caused by potential ice build-up on the turbine rotor when weather conditions are conducive to icing. Wind speed sensors will be heated to prevent ice build-up. Wind farm operators will have the opportunity to initiate a shut-down of the turbine or this may also occur automatically.
- Visual Identification: All persons approaching a turbine will be required to visually assess the turbine structure for ice accumulation before proceeding (during the appropriate seasons). Signs will be installed on each access road to warn persons approaching the turbines about the risk of ice shedding and to remind them to visually inspect the turbines before proceeding.
- Freezing Rain Sensors (optional): An option available to wind farm operators is to install a freezing rain sensor to detect ice accumulation and communicate with the wind farm operation and control system. This could result in an automatic or manual shutdown of a turbine. At this time this ice detection method is considered optional.

Turbines will be shut down upon detection of ice accumulation or prior to imminent ice formation as determined via weather forecast and condition monitoring. Turbine

O&M staff will determine the appropriate course of action in resolving ice accumulation on turbines should blade heating not be an available option. Access to the turbines by site personnel will be restricted during periods of icing. If site personnel absolutely must access a turbine with ice accumulation, safety precautions will include but are not limited to remotely shutting down the turbine, yawing the turbine to position the rotor on the side opposite from the tower door, parking vehicles at a safe distance from the tower, approaching the turbine from the upwind direction, and restarting the turbine remotely when work is complete and the ice danger has been addressed. As always, standard personnel protective gear will be worn.

The times of year and weather conditions present when icing events occur correspond to times and conditions when agricultural fields are not being worked by farmers. However, project participant landowners and adjacent landowners will be educated by O&M staff on the hazards associated with ice accumulation in a manner consistent with O&M staff training to share proper awareness and mitigation of risk from ice build up on turbines. Communication between O&M staff and project landowners will occur when an icing hazard is determined to exist. Similarly, communication between O&M staff and project-adjacent landowners will occur when an icing hazard is determined to exist on-site.

FIGURE 11 NO-WINTER-MAINTENANCE SECTION OF BYKER RD (FACING SOUTH)

# 4. Environmental Effects Monitoring Plan

## 4.1. Bird and Bat Monitoring

The project is located within an active agricultural landscape where there is little remnant natural habitat remaining. The focus of pre-construction monitoring was on breeding birds, migrating birds, wintering birds, migrating and resident bats and

endangered species. Pre-Construction Monitoring Protocols were developed and vetted through MNR and Environment Canada (EC).

Specific performance objectives for pre-construction monitoring have not been identified by either the MNR or EC. Instead, pre-construction protocols were vetted through the agencies and a mutually agreed study plan was developed and implemented. Ongoing consultation was maintained to ensure that professional overview of the project occurred and that adaptations were made, if required. A completed pre-construction monitoring report is attached as Appendices C and D of the *Natural Heritage Assessment Report*.

The foremost important measure to minimize negative environmental effects was to choose a location that was unlikely to interfere with natural ecosystem functions and was known to be free of highly sensitive ecosystem value such as endangered species, migration corridors or unique habitat elements. The South Branch Wind Farm project area was screened, with the use of the Natural Heritage Information Centre database, Ontario Breeding Bird Atlas, Christmas Bird Counts, the Breeding Bird Survey, and other sources that provided baseline historical information. This screening process was followed by scientifically designed field surveys that were tailored to provide detailed data on potentially sensitive features identified in the screening process. Comments and suggestions from EC and MNR were also incorporated into the study protocols.

The results of all aspects of the field program support the initial screening conclusion that the South Branch Wind Farm is unlikely to cause significant impact. The area was shown to not be one of concentrated migration movements during the fall period, a period when there is most concern for migrating birds. The winter landscape was shown to be one of low diversity of species and not likely to result in significant harm to any bird species. Bat diversity was found to be relatively low. Both RADAR and acoustical surveys show that the project area is not a concentration area for either migrating or breeding bats and that there are no known bat hibernacula areas nearby.

Prowind recognizes the importance of follow-up programs to ensure that pre-construction predictions can be verified. Results detailed in the bird study and the bat study reports indicate that the South Branch Wind Farm project area is unlikely to present a high degree of risk to birds or bats. The project is small in size and is located within an intensively farmed area of row crops. All turbines are to be placed within cropland. Therefore it is proposed that a comprehensive carcass searching program will be sufficient to monitor post-construction effects of the project and meet the requirements of MNR for post-construction bird and bat monitoring. The post-construction monitoring plan is included as Appendix I of the *Natural Heritage Assessment Report*.

The post-construction program was developed according to MNR's latest guidelines. The program will consist of carcass searching for birds and bats for three years post-construction. Monitoring occurs continuously between May 1st and Oct 31st for birds and bats, extended to Nov 30th for raptor species.

Searching will be conducted following the recommended frequency and methodology of agency guidelines – approximately every third day during that period pending acceptable weather conditions. Of the maximum 14 turbines that will be built, a representative subset of 10 turbines will be selected for post-construction monitoring and will be searched on each survey day. Searching will be conducted as indicated for the first two years. If the number of bird and bat mortalities is below the mortality thresholds during the first two years, which is outlined by the MNR and detailed in the Post-Construction Monitoring Plan: Birds and Bats, the third year of searching will be only for bats and will be conducted every third day between mid May and late October.

The carcass searching program will be accompanied by scavenger removal and searcher efficiency trials, as recommended in the MNR guidelines. Data from those trials will be used to provide corrected mortality rate estimates as per standard guideline methods.

Interim reports will be prepared at the end of each year of the program and submitted to both EC and MNR. A final bird report will be prepared and submitted by December after the second year of monitoring and a final bat report will be prepared and submitted by December of the third year of monitoring. Mortality frequency will be reported as per the recommendations in the MNR guideline documents and in the end, will be expressed as birds or bats per turbine per year, corrected for the effect of scavenger rates, searcher efficiency, and area surveyed.

Should significant mortality events be detected during the program, EC and MNR will be notified within 24 hours. Such an event will be considered to be of ten bats or thirty-three bird mortalities detected during any single day of searching (or as otherwise defined by EC or MNR).

Mitigation plans, if they become necessary, are to be developed cooperatively in consultation with MNR and EC. Mitigation measures may include alteration of the "cut-in" wind speeds for turbines during the high-risk period, temporary shutdown of turbines during high-risk periods if said periods can be precisely and accurately defined, or other methods such as noise or visual deterrents, that become independently proven to be effective mitigation measures. Communication with EC and MNR will be a priority should mitigation measures become necessary.

## 4.2. WATER QUALITY MONITORING

Water quality monitoring will be conducted for those surface watercourses within the project area where there is a potential for impact from construction activities. As discussed in the *Water Assessment Report*, the South Branch of the South Nation River and its tributaries are intersected in five separate locations within the project area.

The purpose of surface water monitoring is to assess the impacts of construction and decommissioning activities on surface water quality due to potential increased sedimentation and contamination.

The water will be tested both before and after construction and decommissioning activities for suspended solids and F1-F4 hydrocarbons (this encompasses all oils, fuels

and lubricants likely to be used onsite). The samples will be taken to a recognized water analysis centre for testing. Results will be recorded and submitted to MNR and South Nation Conservation (SNC) for their records.

Water samples will be taken prior to construction and decommissioning activities over two days and preferably immediately after a large rain event to better assess the average water quality. Baseline water samples will be taken within the weeks leading up to construction to ensure up to date information is gathered for later comparison. Samples will be taken again at the end of the construction period, once it is ensured that all risks of soil disruption and contamination are removed from the site.

Sample locations were chosen based on downstream locations of major activity points. This method will better facilitate the identification of a problem location, if a problem is found. Four locations have been identified either near to or downstream of watercourse crossings and downstream of major construction areas, namely where turbines or groups of turbines are proposed. This entire area is part of the same South Nation River subwatershed, so all tributaries and small drainage ditches eventually flow to the South Nation River; all watercourses in the project area flow north and east, generally. Any contaminants or sediments from project construction activities will flow past the selected water sample locations. Locations of water sample collection points are identified in Figure 12.

A water quality monitoring report will be prepared upon completion of the construction activities and water monitoring analysis and again after the decommissioning period. This report will be submitted to MNR Kemptville Branch and SNC.

If results indicate that water quality has been impacted by the construction or decommissioning of the South Branch Wind Farm, a mitigation and rehabilitation plan will be developed in consultation with the MNR and SNC.

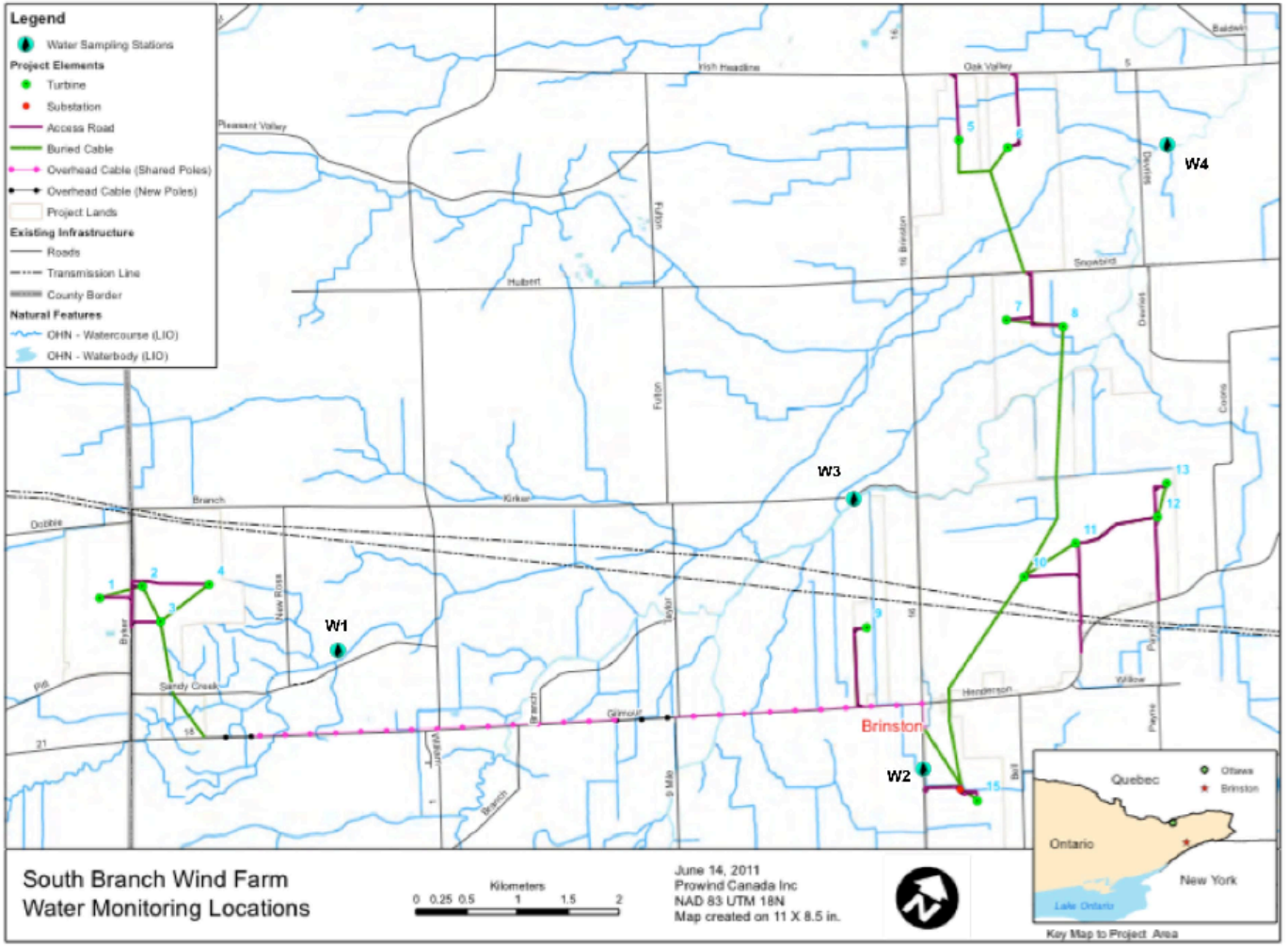



FIGURE 12 WATER MONITORING LOCATIONS

## 4.3. NOISE COMPLAINT MONITORING

A website will be established for the wind farm in order to receive potential complaints from the public regarding noise from the wind turbines. The website will list an email address and a mailing address for the receipt of potential noise complaints. The communication options covered in Section 3.5.2 are also a suitable avenue for reporting noise complaints.

Any noise complaints will be compared with climatic and operational conditions at the referenced time of the complaint and will be kept on record in an electronic file stored in the proponent's database for the duration of the project lifetime. As a minimum, the information recorded from the sender will include name, address, telephone number, time and date of the complaint, and details of the complaint as well the fields listed in the Noise Complaint Form attached as Appendix A to the MOE document *"Compliance Protocol for Wind Turbine Noise"*. The proponent will also add meteorological and project operational conditions to the complaint information.

Consultation with MOE and potential future MOE protocols will determine what courses of action and timelines for action are subsequently required. Mitigation and contingency measures are outlined in the sections below.

### 4.3.1. Mitigation Measures

The wind farm is designed to comply with the MOE October 2008 "*Noise Guidelines for Wind Farms*" at all wind speeds while operating at the maximum sound power level of any turbine under consideration for the site. This approach to project design and the low density of turbines is expected to result in a project with very few noise complaints, particularly given the likelihood that the turbine model installed will have a lower sound power level than what is used in the Noise Assessment Report.

Meteorological conditions and forecasting will be monitored by operations and maintenance staff to ensure that turbines are not operated in weather that could damage the turbines and cause increased sound emission.

Aerodynamic performance and vibration monitoring will be conducted on an ongoing basis by operations and maintenance staff to identify at an early stage potential issues that may increase sound emission.

Regular turbine maintenance including lubrication monitoring of moving parts will be performed.

### 4.3.2. Monitoring and Contingency Measures

Options for contingency actions to resolve noise complaints are specified below.

1. The MOE document *"Compliance Protocol for Wind Turbine Noise*" will be followed in addressing noise complaints. Should the result indicate that there is an issue with non-compliance to sound regulations, the one or more contingency measures listed in items 2-3 will be enacted.

2. Turbine components such as rotor blades, bearings, gearboxes etc, will be evaluated for wear or damage that causes increased sound emission. An example of this process involves inspecting rotor blades for inconsistencies that could have been caused by damage during construction, a lightning strike, avian impact, or wear from operation. Timing of repair or replacement of worn or damaged components will be evaluated together with option 3 below to determine the most cost effective course of action to reduce sound emission.
3. Turbines can be programmed and controlled to operate in a manner which emits less sound (and produces less power) during certain times of day and/or certain meteorological conditions as appropriate. This course of action may be used on a temporary or permanent basis to reduce sound emission and correct an issue with non-compliance to sound regulations. As an example, a turbine can be controlled to limit operational intensity during night-time hours, or when the wind is blowing from a direction that correlates to a measured noise issue. An operating regime will be developed such that turbines conform to noise regulations.

## 4.4. TV Reception Complaint Monitoring

Over-the-air TV reception may be impacted by the presence of wind turbines. A study was commissioned by Communication Engineering firm Yves R. Hamel and Associates Inc. The study examined the potential (theoretical) impact of the project turbines on over-the-air digital TV signals belonging to the Canadian Broadcast Corporation. The study is attached as Appendix E.

The study concluded the following:

> *"The detailed analysis of the potential deterioration of the quality of reception of the digital CBOFT-DT, CBOT-DT and CKWS-DT-2 television broadcast stations allowed to establish that there is no significant risk of interference and only a few dwellings are at risk to experience this type of interference in dynamic mode in the case of CBOT-DT.*
>
> *"These households will most probably be able to eliminate this risk by using a good quality reception antenna, which will permit discrimination between the direct signal from the TV transmitter and the reflected signals from the wind turbines. All calculations for the study were done using the antenna mask proposed by Industry Canada in the BPR-10. However, many good quality antennas on the market are more directional than the proposed mask and will therefore discriminate better between wanted and unwanted signals.*
>
> *"Based on available information showing the approximate location of buildings in the region, we did not identify any wind turbine that could possibly have an impact on the reception of Direct Broadcast Satellite services."*

Based on the potential for impact, a website will be established for the wind farm in order to receive potential complaints from the public regarding TV reception from the

wind turbines. The communication options covered in Section 3.5.2 are also a suitable avenue for reporting reception complaints. Any complaints will be compared with climatic and operational conditions at the referenced time of the complaint and will be kept on record in an electronic file that will be stored in the proponent's electronic database for the duration of the project. The information recorded from the sender will include name, address, telephone number; time and date of the complaint, and details of the complaint.

A site visit will be conducted by a representative of the proponent to verify negative impacts at locations from which a complaint is received.

Measures available to restore degraded TV reception (where the degraded station isn't available on another unaffected channel) are outlined in Appendix E and include the proponent purchasing a high quality directional antenna, purchasing a cable TV subscription, or purchasing a direct-to-home satellite TV subscription as deemed appropriate on a case-by-case basis.

## 4.5. RADIO COMMUNICATION, RADAR, AND SEISMO-ACOUSTIC COMPLAINTS MONITORING

A study was conducted according to the Radio Advisory Board of Canada's "*Technical Information On The Assessment of the Potential Impact Of Wind Turbines On Radio Communication, Radar And Seismoacoustic Systems*" in order to screen potential impacts. The report is attached as Appendix F.

Impact screening and consultation suggests that impacts to Radio Communication (other than as outlined in Section 2.6 of the Appendix), Radar and Seismo-Acoustic systems are predicted to be either non-existent or within acceptable levels to system operators.

In any case, a website will be established for the wind farm in order to receive any complaints from radio communication, radar and seismo-acoustic system operators. Any complaints will be compared with climatic and operational conditions at the referenced time of the complaint and will be kept on record in an electronic file that will be stored in the proponent's electronic database for the duration of the project. The information recorded from the sender will include name, address and the telephone number; time and date of the complaint, and details of the complaint.

Complaints received will be addressed in consultation with the system operator and any corresponding Provincial or Federal agencies. As these types of complaints can be very specific to a given technology or electromagnetic frequency, mitigation and contingency measures will require analysis and development by specialized consultants if and when an issue is brought to the proponent's attention.

## 4.6. NATURAL HERITAGE RESOURCES

Natural heritage in the area surrounding the South Branch Wind Farm is discussed in detail in the *Natural Heritage Assessment Report* (NHAR). Section 2.10 of this report and the NHAR detail the significant natural features located within 120 m of the project

location. Additional natural features determined not to be significant are also located in proximity to the project location; details of these features can be found in the NHAR. Natural heritage features discussed in the NHAR include woodlands, wetlands, wildlife habitat and floodplain.

No direct impacts are planned within any of the existing natural features in the project location. Potential impacts include bird and bat mortality, fish habitat disturbance and indirect impacts such as siltation. Impacts and mitigation measures are summarized in the tables below, taken from the NHAR.

TABLE 12 SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES TO SIGNIFICANT WOODLANDS (TABLE 16 OF NHAR)

| Project Component | Features within 120 m of project component (distance) | Phase | Impacts | Performance Objectives |
|---|---|---|---|---|
| Turbines | WO1 (33 m)<br>WO2 (24 m)<br>WO13 (83 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| | | Operation | Bird and bat interference from rotating blades | Avoid harm to bird and bat species |
| Access Roads | WO1 (90 m)<br>WO2 (33 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| Buried Electrical Cable | WO1 (90 m)<br>WO2 (55 m)<br>WO12 (5 m)<br>WO14 (5 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| Overhead Electrical Cable | WO3-WO10 (5 m-90 m) | Construction | Siltation from soil disruption at pole installation points | Avoid increase to surface water turbidity |

TABLE 13 SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES TO SIGNIFICANT WETLANDS (TABLE 17 OF NHAR)

| Project Component | Features within 120 m of project component (distance) | Phase | Impacts | Performance Objectives |
|---|---|---|---|---|
| Turbines | WE6 (24 m)<br>WE38 (83 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| | | Operation | Bird and bat interference from rotating blades | Avoid harm to bird and bat species |
| Access Roads | WE6 (33 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| Buried Electrical Cable | WE6 (55 m)<br>WE8 (78 m)<br>WE34-35 (5m)<br>WE39-40 (5m)<br>WE36 (20 m)<br>WE37 (40 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| Overhead Electrical Cable | WE10-33 (5-115 m) | Construction/ Decommissioning | Siltation from soil disruption at pole installation points | Avoid increase to surface water turbidity |
| Drilled Electrical Cable | WE9 (0 m)<br>WE35 (10 m) | Construction/ Decommissioning | Risk of surface and groundwater contamination from frac-out | Avoid increase to surface water hydrocarbon contaminants |

TABLE 14 SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES TO SIGNIFICANT WILDLIFE HABITAT (TABLE 18 OF NHAR)

| **Project Component** | **Features within 120 m of project component** (distance) | **Phase** | **Impacts** | **Mitigation** |
|---|---|---|---|---|
| Turbines | WHF1 (49 m)<br>WHF2 (36 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| | | Construction | Siltation due to erosion due to dewatering of turbine foundation | Avoid increase to surface water turbidity |
| Access Roads | WHF1 (110 m)<br>WHF2 (31 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| Buried Electrical Cable | WHF1 (110 m)<br>WHF2 (53 m) | Construction/ Decommissioning | Siltation from loose soil stockpiled on site | Avoid increase to surface water turbidity |
| Overhead Electrical Cable | WHL2 (0 m) | Construction | Siltation from soil disruption at pole installation points<br><br>Disruption of Snapping Turtle nests | Avoid increase to surface water turbidity<br><br>Avoid harm to wildlife |

TABLE 15 ENVIRONMENTAL EFFECTS MONITORING PLAN FOR ALL IDENTIFIED POTENTIAL NEGATIVE ENVIRONMENTAL EFFECTS

| Performance Objectives | Mitigation Measures | Monitoring Program | Contingency Plan |
|---|---|---|---|
| Avoid increase to surface water turbidity | • Silt fencing placed adjacent to construction to slow and filter any overland flow<br>• Soil stockpiles placed in low-lying windrows outside of the floodplain to limit soil loss to wind and rain<br>• Cable trenching and backfilling conducted within a short time frame to limit the exposure of loose soil<br>• Any water flow will be directed away from surface water courses to prevent soil erosion | Water quality monitoring for turbidity | If surface water turbidity is found to have increased overall compared to the pre construction figures, MNR, SNC and surface water consultants will be engaged and appropriate steps will be taken to attempt to reduce surface water turbidity levels to that of pre construction levels. |
| Avoid increase to ground and surface water hydrocarbon contaminants | • Construction equipment will be operated with care<br>• Emergency Frac-out Plan will be prepared to address any potential impacts<br>• Spills kit will be available on site | Water quality monitoring F1-F4 hydrocarbons | If surface water turbidity is found to have increased overall compared to the pre construction figures, MNR, SNC and surface water consultants will be engaged and appropriate steps will be taken to attempt to reduce surface water turbidity levels to that of pre construction levels. |
| Avoid harm to wildlife | • Pole installation conducted outside Snapping Turtle nesting and hatching period<br>• Post construction monitoring to determine level of impact to birds and bats<br>• Directional drilling under watercourses conducted outside of sensitive fish spawning/rearing season | Bird and Bat post-construction monitoring plan.<br><br>Water quality monitoring for impacts to fish habitat by way of increased turbidity and F1-F4 hydrocarbons. | If a significant number of bird and bat carcasses are found during post-construction monitoring, contingency measures will be put into place as outline in the Bird and Bat Post-Construction Monitoring Plan.<br><br>If surface water hydrocarbon levels are found to have increased overall compared to the pre construction figures, MNR, SNC and surface water consultants will be engaged and appropriate steps will be taken to attempt to reduce surface water hydrocarbon levels to that of pre construction levels. |

## 4.7. ARCHAEOLOGY AND CULTURAL HERITAGE

Archaeology and cultural heritage in the area surrounding the South Branch Wind Farm will be discussed in detail in the *Archaeology and Cultural Heritage Resources Assessment Report*. Extensive pre-construction surveys will be conducted to determine any archaeological or cultural heritage importance within proximity to the project area.

Impacts are expected to be concentrated during the Construction Phase of the Project. No impacts are expected during project operation and therefore no additional mitigation or monitoring is necessary.

## 4.8. AIR QUALITY AND DUST

Potential air quality and dust impacts from project activities are discussed in the *Project Description Report* and the *Construction Plan Report*. Vehicles and machinery used on-site will be kept in good repair to minimize emissions. When heavy traffic is expected at the site during dry and dusty conditions, a water truck will be used to spray access roads and crane pads as required to suppress dust. Dust levels from road traffic will be monitored by the Site Supervisor during all project phases.

## 4.9. LAND USE

The South Branch Wind Farm was designed according to surrounding land uses. All setbacks meet Provincial requirements, agricultural land will remain in production, and potential new buildings on vacant lots have been accounted for when proposing turbine locations. Existing farm roads and road entrances have been used for turbine access to the greatest extent possible. Electrical cabling in agricultural fields will be buried below tile drainage to minimize impact on productive land. Further land use impact and mitigation are addressed in the *Project Description Report*.

## 4.10. PROVINCIAL AND LOCAL INFRASTRUCTURE

Impact mitigation to Provincial and Local Infrastructure are outlined in the *Project Description Report*, the *Construction Plan Report*, and Section 2 of this report. All setbacks, clearances, and load restrictions on Provincial and local infrastructure will be observed in the construction, operation, and decommissioning of the project.

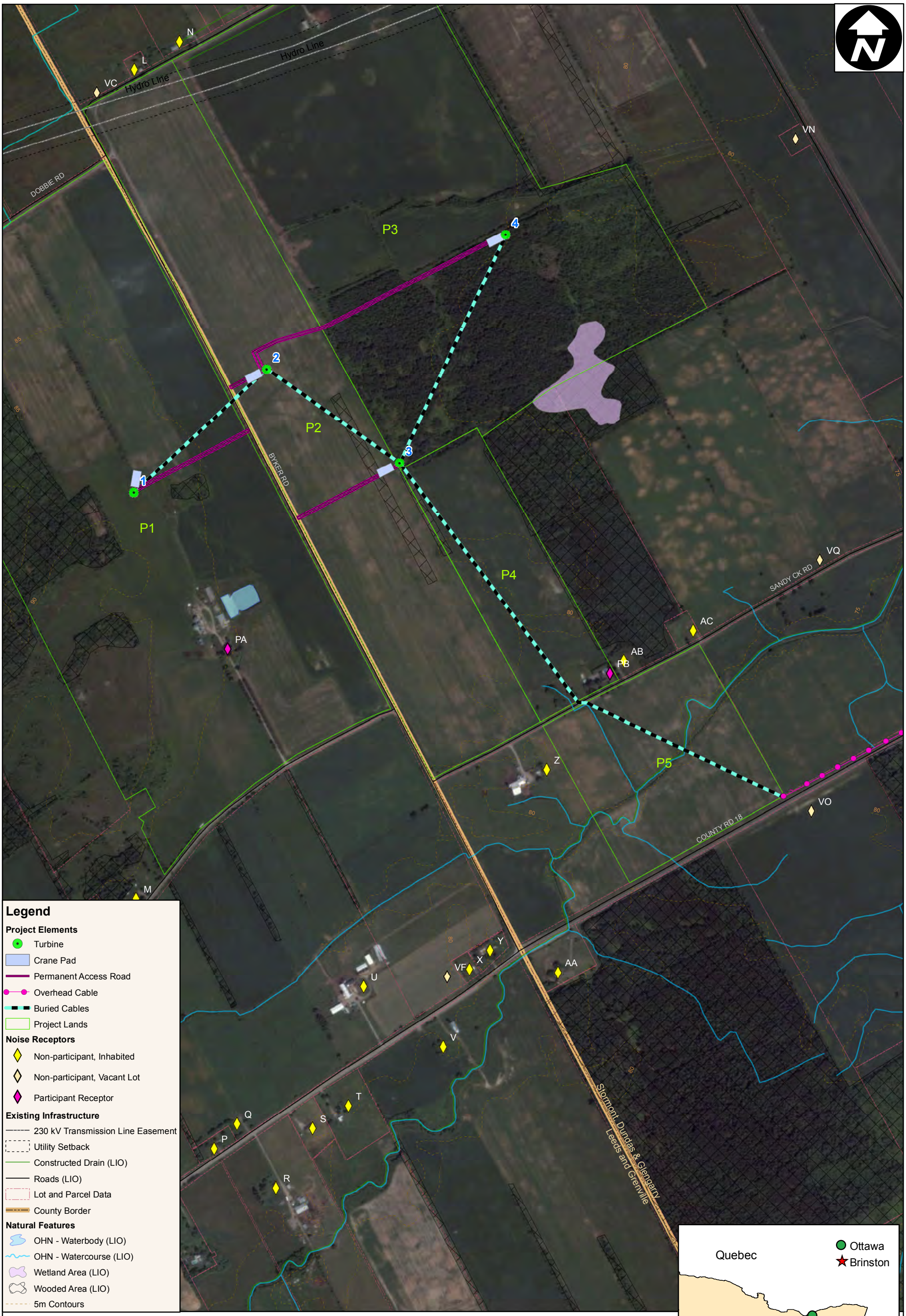
## 4.11. GENERAL COMPLAINTS MONITORING

A website will be established for the wind farm in order to receive any complaints from the public regarding topics not outlined in Sections 4.1 – 4.10. Any complaints will be compared with climatic and operational conditions at the referenced time of the complaint and will be kept on record in an electronic file. The information recorded from the sender will include name, address and the telephone number; time and date of the complaint, and details of the complaint actions taken to remediate the cause of the complaint; and proposed actions to be taken to prevent reoccurrence in the future.

# APPENDIX A

## SITE PLAN DIAGRAM

# South Branch Wind Farm - Operational Site Plan




## Legend

**Project Elements**
- Turbine
- Crane Pad
- Permanent Access Road
- Overhead Cable
- Buried Cables
- Project Lands

**Noise Receptors**
- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

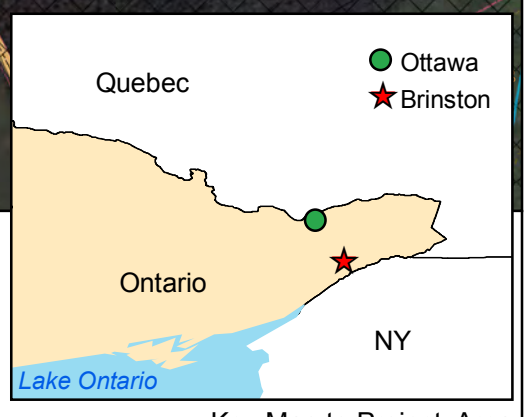
**Existing Infrastructure**
- 230 kV Transmission Line Easement
- Utility Setback
- Constructed Drain (LIO)
- Roads (LIO)
- Lot and Parcel Data
- County Border

**Natural Features**
- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- 5m Contours

Kilometers
0 0.1 0.2 0.3 0.4

1:8,000

Aerial Imagery: June 21, 2011
Company: TerraServer Prowind Canada Inc
Image Date: 10/20/2004 NAD 83 UTM 18N
Horizontal Accuracy: 45cm +/- Map created on 11.x 17 in.
Resolution: 0.6 m All distances in metres




Key Map to Project Area

## Legend

**Project Elements**
- Turbine
- Crane Pad
- Permanent Access Road
- Buried Cables
- Project Lands

**Noise Receptors**
- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

**Existing Infrastructure**
- Lot and Parcel Data
- Constructed Drain (LIO)
- Roads (LIO)

**Natural Features**
- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- 5m Contours

WD WH BF WJ COUNTY RD 5 P6 P7 5 6 P8 WG BI BL BJ BN BK BM BO BP BR P9 BS WL BU PD CI WV WW WN BW SNOWBIRD RD BV WO BX P13 P14 P15 Hulbert BRINSTON RD WP WQ 7 8 P16 P10 P11 P12 P35 P36

# South Branch Wind Farm - Operational Site Plan Turbines 5-8

Kilometers
0 0.1 0.2 0.3 0.4

1:8,000

Aerial Imagery: June 21, 2011
Company: TerraServer Prowind Canada Inc
Image Date: 10/20/2004 NAD 83 UTM 18N
Horizontal Accuracy: 45cm +/- Map created on 11.x 17 in.
Resolution: 0.6 m All distances in metres

Key Map to Project Area

## Legend

**Project Elements**
- Turbine
- Crane Pad
- Substation
- Permanent Access Road
- Overhead Cable
- Buried Cables
- Operations Building

**Note**
- 1

**Noise Receptors**
- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

**Existing Infrastructure**
- 230 kV Transmission Line Easement
- Telephone Easement (Former)
- Utility Setback
- Lot and Parcel Data
- Constructed Drain (LIO)
- Roads (LIO)

**Natural Features**
- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- 5m Contours

# South Branch Wind Farm - Operational Site Plan Turbines 9-15

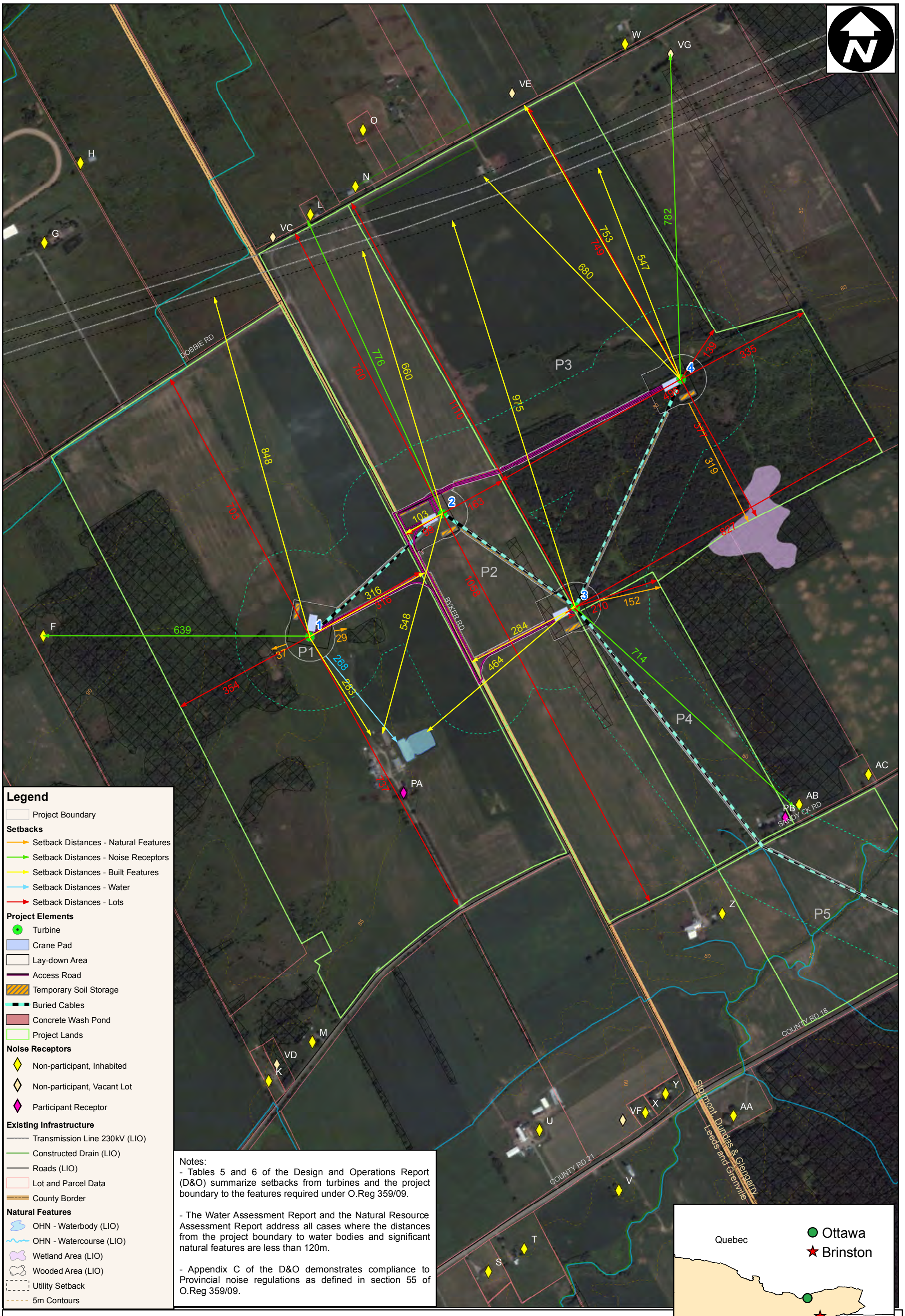
Kilometers
0 0.1 0.2 0.3 0.4

1:12,000

Aerial Imagery: October 20, 2011
Company: TerraServer Prowind Canada Inc
Image Date: 10/20/2004 NAD 83 UTM 18N
Horizontal Accuracy: 45cm +/- Map created on 11.x 17 in.
Resolution: 0.6 m All distances in metres

Key Map to Project Area

# South Branch Wind Farm - Setback Site Plan




## Legend

- Project Boundary

**Setbacks**

- Setback Distances - Natural Features
- Setback Distances - Noise Receptors
- Setback Distances - Built Features
- Setback Distances - Water
- Setback Distances - Lots

**Project Elements**

- Turbine
- Crane Pad
- Lay-down Area
- Access Road
- Temporary Soil Storage
- Buried Cables
- Concrete Wash Pond
- Project Lands

**Noise Receptors**

- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

**Existing Infrastructure**

- Transmission Line 230kV (LIO)
- Constructed Drain (LIO)
- Roads (LIO)
- Lot and Parcel Data
- County Border

**Natural Features**

- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- Utility Setback
- 5m Contours

Notes:

- Tables 5 and 6 of the Design and Operations Report (D&O) summarize setbacks from turbines and the project boundary to the features required under O.Reg 359/09.

- The Water Assessment Report and the Natural Resource Assessment Report address all cases where the distances from the project boundary to water bodies and significant natural features are less than 120m.

- Appendix C of the D&O demonstrates compliance to Provincial noise regulations as defined in section 55 of O.Reg 359/09.

Key Map to Project Area

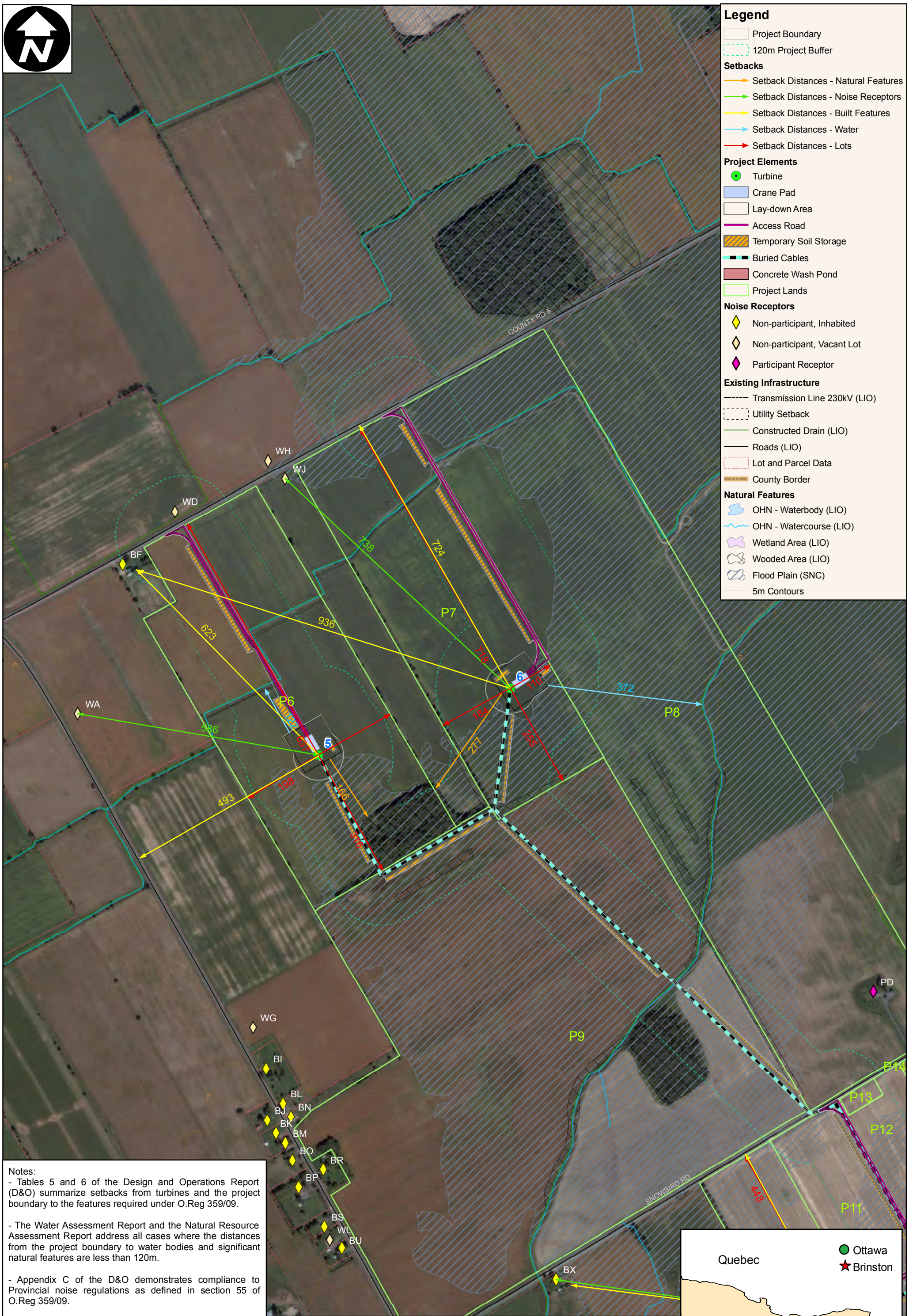
Kilometers

0 0.1 0.2 0.3 0.4

1:8,000

Aerial Imagery:
Company: TerraServer
Image Date: 10/20/2004
Horizontal Accuracy: 45cm +/-
Resolution: 0.6 m

June 14, 2011
Prowind Canada Inc
NAD 83 UTM 18N
Map created on 25 x 30 in.




Notes:
- Tables 5 and 6 of the Design and Operations Report (D&O) summarize setbacks from turbines and the project boundary to the features required under O.Reg 359/09.

- The Water Assessment Report and the Natural Resource Assessment Report address all cases where the distances from the project boundary to water bodies and significant natural features are less than 120m.

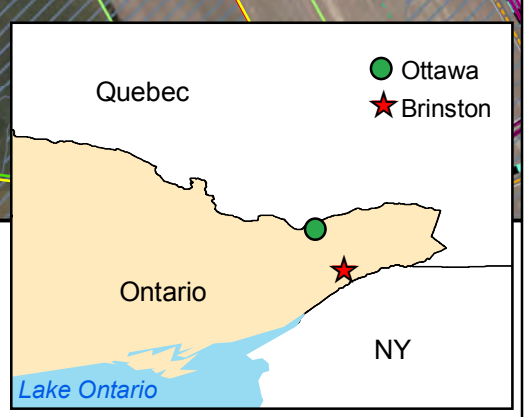
- Appendix C of the D&O demonstrates compliance to Provincial noise regulations as defined in section 55 of O.Reg 359/09.

# South Branch Wind Farm - Setback Site Plan - Turbines 5 & 6

Kilometers
0 0.1 0.2 0.3 0.4

1:8,000

Aerial Imagery: June 21, 2011
Company: TerraServer Prowind Canada Inc
Image Date: 10/20/2004 NAD 83 UTM 18N
Horizontal Accuracy: 45cm +/- Map created on 11.x 17 in.
Resolution: 0.6 m All distances in metres




Key Map to Project Area

## Legend

- Project Boundary
- 120m Project Buffer

**Setbacks**

- Setback Distances - Natural Features
- Setback Distances - Noise Receptors
- Setback Distances - Built Features
- Setback Distances - Water
- Setback Distances - Lots

**Project Elements**

- Turbine
- Crane Pad
- Lay-down Area
- Access Road
- Temporary Soil Storage
- Buried Cables
- Concrete Wash Pond
- Project Lands

**Noise Receptors**

- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

**Existing Infrastructure**

- Transmission Line 230kV (LIO)
- Utility Setback
- Constructed Drain (LIO)
- Roads (LIO)
- Lot and Parcel Data
- County Border

**Natural Features**

- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- Flood Plain (SNC)
- 5m Contours

Notes:
- Tables 5 and 6 of the Design and Operations Report (D&O) summarize setbacks from turbines and the project boundary to the features required under O.Reg 359/09.

- The Water Assessment Report and the Natural Resource Assessment Report address all cases where the distances from the project boundary to water bodies and significant natural features are less than 120m.

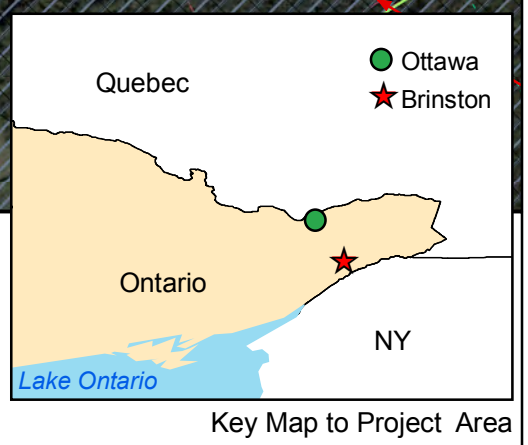
- Appendix C of the D&O demonstrates compliance to Provincial noise regulations as defined in section 55 of O.Reg 359/09.

# South Branch Wind Farm - Setback Site Plan - Turbines 7 & 8

Kilometers
0 0.1 0.2 0.3 0.4

1:8,000

Aerial Imagery: June 21, 2011
Company: TerraServer Prowind Canada Inc
Image Date: 10/20/2004 NAD 83 UTM 18N
Horizontal Accuracy: 45cm +/- Map created on 11.x 17 in.
Resolution: 0.6 m All distances in metres




Key Map to Project Area

Notes:
- Tables 5 and 6 of the Design and Operations Report (D&O) summarize setbacks from turbines and the project boundary to the features required under O.Reg 359/09.

- The Water Assessment Report and the Natural Resource Assessment Report address all cases where the distances from the project boundary to water bodies and significant natural features are less than 120m.

- Appendix C of the D&O demonstrates compliance to Provincial noise regulations as defined in section 55 of O.Reg 359/09.

## Legend

- Project Boundary
- 120m Project Buffer

**Setbacks**
- Setback Distances - Natural Features
- Setback Distances - Noise Receptors
- Setback Distances - Built Features
- Setback Distances - Water
- Setback Distances - Lots

**Noise Receptors**
- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

**Existing Infrastructure**
- 230 kV Transmission Line Easement
- Telephone Easement (Former)
- Utility Setback
- Constructed Drain (LIO)
- Road
- Lot and Parcel Data

**Project Elements**
- Turbine
- Crane Pad
- Lay-down Area
- Substation
- Access Road
- Overhead Cable (Shared Poles)
- Overhead Cable (New Poles)
- Buried Cables
- Temporary Soil Storage
- Storage Shed
- Operations Building
- Project Lands

**Natural Features**
- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- Flood Plain (SNC)
- 5m Contours

# South Branch Wind Farm - Setback Site Plan - Turbines 9 & 15

Kilometers
0 0.1 0.2 0.3 0.4

1:8,000

Aerial Imagery:
Company: TerraServer
Image Date: 10/20/2004
Horizontal Accuracy: 45cm +/-
Resolution: 0.6 m

October 20, 2011
Prowind Canada Inc
NAD 83 UTM 18N
Map created on 11.x 17 in.
All distances in metres

Key Map to Project Area

## Legend

- Project Boundary
- 120m Project Buffer

**Setbacks**

- Setback Distances - Natural Features
- Setback Distances - Noise Receptors
- Setback Distances - Built Features
- Setback Distances - Water
- Setback Distances - Lots

**Project Elements**

- Turbine
- Crane Pad
- Lay-down Area
- Access Road
- Temporary Soil Storage
- Buried Cables
- Concrete Wash Pond
- Operations Building
- Project Lands

**Noise Receptors**

- Non-participant, Inhabited
- Non-participant, Vacant Lot
- Participant Receptor

**Existing Infrastructure**

- Transmission Line 230kV
- Telephone Easement (Former)
- Utility Setback
- Constructed Drain (LIO)
- Road
- Lot and Parcel Data

**Natural Features**

- OHN - Waterbody (LIO)
- OHN - Watercourse (LIO)
- Wetland Area (LIO)
- Wooded Area (LIO)
- Flood Plain (SNC)
- 5m Contours

Notes:
- Tables 5 and 6 of the Design and Operations Report (D&O) summarize setbacks from turbines and the project boundary to the features required under O.Reg 359/09.

- The Water Assessment Report and the Natural Resource Assessment Report address all cases where the distances from the project boundary to water bodies and significant natural features are less than 120m.

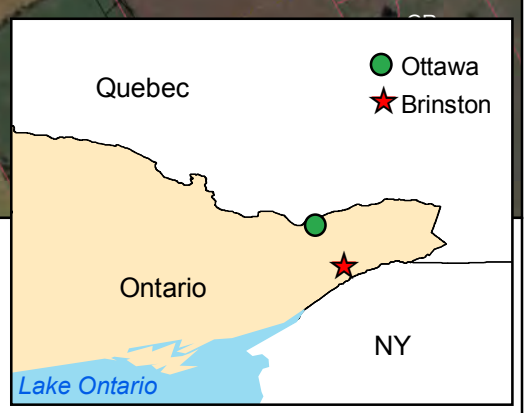
- Appendix C of the D&O demonstrates compliance to Provincial noise regulations as defined in section 55 of O.Reg 359/09.

# South Branch Wind Farm - Setback Site Plan - Turbines 10 to 13

Kilometers
0 0.075 0.15 0.225 0.3

1:8,000

Aerial Imagery: June 21, 2011
Company: TerraServer Prowind Canada Inc
Image Date: 10/20/2004 NAD 83 UTM 18N
Horizontal Accuracy: 45cm +/- Map created on 11.x 17 in.
Resolution: 0.6 m All distances in metres




Key Map to Project Area

# APPENDIX B

## TURBINE SPECIFICATIONS

# SOUTH BRANCH WIND FARM

## *WIND SPECIFICATIONS REPORT, WIND FACILITY (NOT CLASS 2)*

June 2012

GL Garrad Hassan

GL Garrad Hassan

# SOUTH BRANCH WIND FARM, ONTARIO

# WIND SPECIFICATIONS REPORT, WIND FACILITY (NOT CLASS 2)

| | |
|---|---|
| Client | South Branch Windfarm Inc. |
| Contact | Kenneth Little |
| Document No | 800194-CAMO-R-02 |
| Issue | C |
| Status | Final |
| Classification | Client's Discretion |
| Date | 8 June 2012 |

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# REVISION HISTORY

| Issue | Issue Date | Summary |
|---|---|---|
| A | 30 May 2012 | Initial version |
| B | 1 June 2012 | Revised as per client comments |
| C | 8 June 2012 | Addition of appendix B |

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# 1 INTRODUCTION

**GL Garrad Hassan Canada, Inc.** ("**GL GH**") was retained by **South Branch Windfarm Inc.** ("**Client**" or "**SBW**") to prepare a Specifications Report, Wind Facility (Not Class 2) for the **South Branch Wind** Farm ("**Project**")

The proposed South Branch Wind Farm is located in eastern Ontario. The site is located approximately 50 km south of Ottawa, Ontario within the Townships of South Dundas in the United Counties of Stormont, Dundas and Glengarry, as well as within the Township of Edwardsburg-Cardinal in the United Counties of Leeds and Grenville.

The South Branch Wind Farm is a Class 4 Wind Facility consisting of ten (10) Siemens SWT-3.0-113 (3.0 MW) turbines for a total installed capacity of up to 30 MW, although fourteen (14) sitting locations will be permitted.

This Specifications Report, Wind Facility (Not Class 2) has been prepared to satisfy the requirements outlined in *Ontario Regulation 359/09 (O. Reg. 359/09)*, the regulation governing renewable energy projects in Ontario and the Technical Guide to Renewable Energy Approvals [3]. The following sections outline the specifications of the turbine technology selected for this Project.

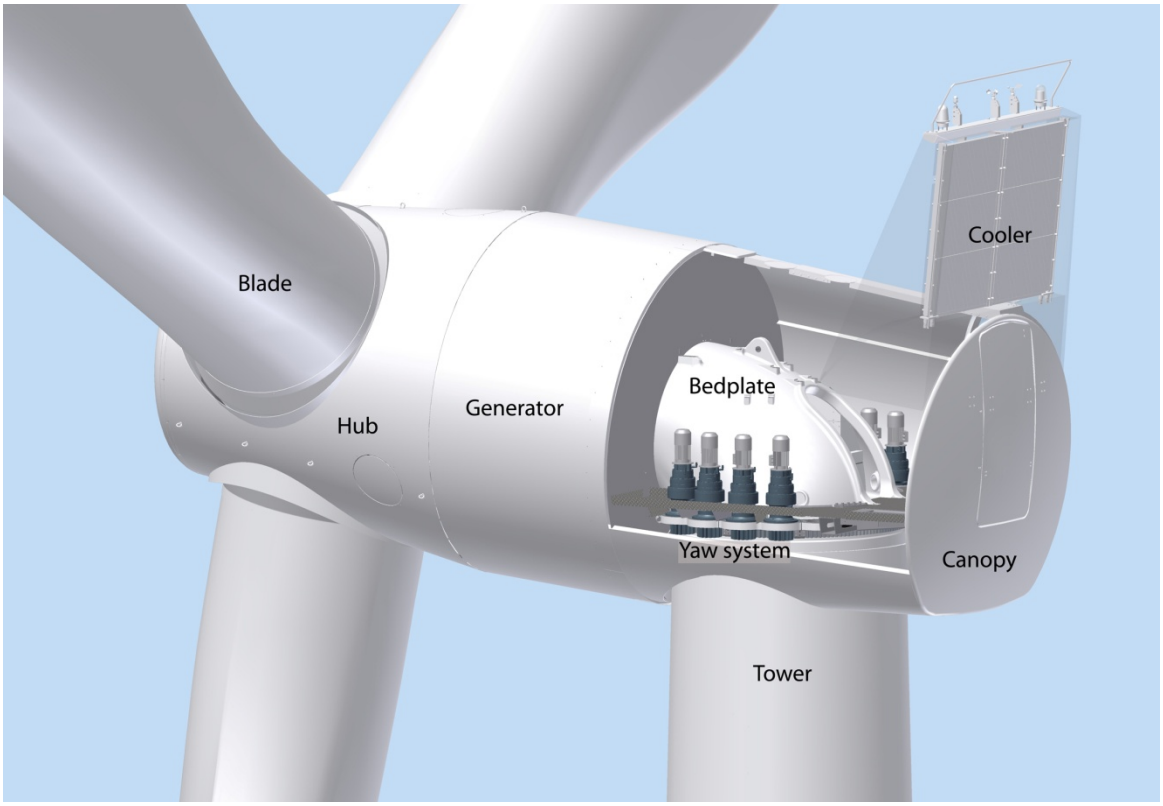
# 2 TECHNICAL SPECIFICATIONS

The proposed Siemens SWT-3.0-113 turbine is a three-bladed, upwind, horizontal-axis turbine. A summary of technical specifications is provided in Table 2-1.

**Table 2-1: Technical specifications, Siemens SWT-3.0-113**

| Parameter | Value |
|---|---|
| Make and model | Siemens SWT-3.0-113 |
| Name plate capacity | 3.0 MW |
| Hub height above grade | 99.5 m |
| Rotational speeds | 6-13 rpm* |
| Rotor diameter | 113 m |
| Swept area | 10,029 $m^2$ |

* Based on similar technology (Siemens 2.3-113). To be confirmed




Source: Siemens website (Ref: soere20091205-01)

**Figure 2-1: Siemens SWT-3.0-113 wind turbine nacelle layout**

Additional technical information on the Siemens SWT-3.0-113 is attached as Appendix A.

# 3 ACOUSTIC EMISSIONS DATA

The maximum overall sound power level of the Siemens SWT-3.0-113 is 106 dBA. The acoustic emissions data, in accordance with standard CAN/CSA-C61400-11-07, "Wind Turbine Generator Systems Part 11: Acoustic Noise Measurement Techniques"[4] are summarized below including:

- Measurement uncertainty value;
- Octave-band sound power levels (A weighted); and
- Tonality and tonal audibility.

**Table 3-1: Normal Operation calculated apparent sound power level (10 m/s), A-weighted**

| Wind Speed [m/s] at 10 m agl / Frequency [Hz] | Octave Band Sound Power Level [dBA]* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Manufacturer's Emission Level | | | | | Adjusted Emission Level | | | | |
| | 6 | 7 | 8 | 9 | 10 | 6 | 7 | 8 | 9 | 10 |
| **63** | 85.2 | NA | 86.9 | NA | NA | 86.9 | 86.9 | 86.9 | 86.9 | 86.9 |
| **125** | 91.5 | NA | 94.8 | NA | NA | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 |
| **250** | 97.2 | NA | 99.1 | NA | NA | 99.1 | 99.1 | 99.1 | 99.1 | 99.1 |
| **500** | 99.3 | NA | 100.0 | NA | NA | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| **1000** | 100.1 | NA | 99.6 | NA | NA | 99.6 | 99.6 | 99.6 | 99.6 | 99.6 |
| **2000** | 95.7 | NA | 98.6 | NA | NA | 98.6 | 98.6 | 98.6 | 98.6 | 98.6 |
| **4000** | 85.3 | NA | 91.5 | NA | NA | 91.5 | 91.5 | 91.5 | 91.5 | 91.5 |
| **8000** | 67.9 | NA | 75.1 | NA | NA | 75.1 | 75.1 | 75.1 | 75.1 | 75.1 |
| **A-Weighted** | 104.7 | 105.8 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 |

* Octave band spectra not warranted
NA: Not available

## 3.1 Uncertainty Levels

Specifications are currently unavailable.

## 3.2 Tonal Audibility

Specifications are currently unavailable. However, Siemens is confident, based on preliminary results and experience, that the noise emissions from the SWT-3.0-113 turbine will not display tonal characteristics. See communication in appendix B.

# 4 REFERENCES

[1] Ontario Regulation 359/09, made under the *Environmental Protection Act*, Renewable Energy Approvals under Part 1.0 of the Act.

[2] Ontario Regulation 521/10, made under the *Environmental Protection Act*, Renewable Energy Approvals under Part 1.0 of the Act.

[3] Technical Guide to Renewable Energy Approvals, Ontario Ministry of the Environment, July 2011.

[4] CAN/CSA-C61400-11-07, "Wind Turbine Generator Systems – Part II: Acoustic Noise Measurement Techniques", October 2007.

# APPENDIX A SIEMENS SWT-3.0-113 ACOUSTIC EMISSIONS SPECIFICATIONS

SIEMENS

Contract Acoustic Emission, SWT-3.0-113, Hub Height 99.5 m
Document ID: E W EN OEN DES TLS-10-0009-371-00
HST, JES / 2012.05.17
Conveyed confidentially as a trade secret

# SWT-3.0-113
# Acoustic Emission, Hub Height 99.5 m

**Sound Power Levels**

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels ($L_{WA}$) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

| Wind speed [m/s] | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Up to cut-out |
|---|---|---|---|---|---|---|---|---|---|---|
| Sound power level | 96.6 | 102.6 | 104.7 | 105.8 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 |

*Table 1: Noise emission, $L_{WA}$ [dB(A) re 1 pW]*

**Typical Octave Band**

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

| Octave band, centre frequency [Hz] | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|
| Sound power level | 85.2 | 91.5 | 97.2 | 99.3 | 100.1 | 95.7 | 85.3 | 67.8 |

*Table 2: Typical octave band for 6 m/s, $L_{WA}$ [dB(A) re 1 pW]*

| Octave band, centre frequency [Hz] | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|
| Sound power level | 86.9 | 94.8 | 99.1 | 100.0 | 99.6 | 98.6 | 91.5 | 75.1 |

*Table 3: Typical octave band for 8 m/s, $L_{WA}$ [dB(A) re 1 pW]*



Siemens Wind Power A/S
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# APPENDIX B COMMUNICATION FROM SIEMENS

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**Cc:** "Hackman, Holly L (NAM RC-US E P-S CEN GFC)" <holly.hackman@siemens.com>, "Outten, Mike" <Mike.Outten@edpr.com>, "Brown, Ryan" <ryan.brown@edpr.com>, "Barrington, Tawanna M (E W AM ON US S PE)" <tawanna.barrington@siemens.com>, "Kushner, Brian A (E W AM S)" <brian.kushner@siemens.com>, "Cague, Tom" <Tom.Cague@edpr.com>, "Fenz, Caton" <Caton.Fenz@edpr.com>
**Subject: RE: SWT3.0-113 Specs**

Ken,

As discussed on the phone earlier today. Also attached is the referenced measurement report.

The Sound Level test report for the SWT 3.0-113 wind turbine generator is not yet available. Siemens will provide a copy of this report on a confidential basis to EDPR once it is available. Siemens currently has 30 Direct Drive turbines in operation world wide and has not seen any problems with tones. The tonal characteristics in this Direct Drive wind turbine generator with no gearbox should only be slightly different as compared to the Siemens geared 2.3MW wind turbine generators, of which Siemens has produced more than 4,000 units. See the attached measurement report from Windtest on a Siemens 2.3-93 wind turbine generator that has shown no puretones as per the Ontario guidelines.

Siemens has preliminary information from one of its 3.0-101 Direct Drive turbine generators, and based upon this information is not expecting any tones on the SWT 3.0-113 unit that will result in tonal audibility above the threshold determined in accordance with IEC 61400-11 and according to the Compliance Protocol for Wind Turbine Noise, issued by Ministry Of Environment in 2011.

Regards,

Michael Bell

Technical Sales Manager
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# APPENDIX C

## NOISE IMPACT ASSESSMENT REPORT

# SOUTH BRANCH WIND FARM

## *NOISE IMPACT ASSESSMENT*

June 2012

GL Garrad Hassan

GL Garrad Hassan

# SOUTH BRANCH WIND FARM, ONTARIO

# NOISE IMPACT ASSESSMENT

| | |
|---|---|
| Client | South Branch Windfarm Inc. |
| Contact | Kenneth Little |
| Document No | 800194-CAMO-R-01 |
| Issue | D |
| Status | Final |
| Classification | Client's Discretion |
| Date | 7 June 2012 |

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# REVISION HISTORY

| Issue | Issue date | Summary |
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| A | 30 May 2012 | Original Release (electronic version only) |
| B | 1 June 2012 | Revised as per client comments and addition of engineer's signature |
| C | 6 June 2012 | Revised as per client comments |
| D | 7 June 2012 | Correction to participant receptor list |

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# 1 INTRODUCTION

**GL Garrad Hassan Canada, Inc.** ("**GL GH**") was retained by **South Branch Windfarm Inc.** ("**Client**" or "**SBW**") to prepare a Noise Impact Assessment (NIA) of the **South Branch Wind Farm** ("**Project**") in accordance with the Ontario Regulation 359/09 (Renewable Energy Approvals (REA) under Part V.0.1 of the Ontario Environmental Protection Act (EPA)) .

The proposed Project is located in eastern Ontario. The layout being evaluated is comprised of fourteen (14) turbine locations, although only ten (10) Siemens SWT-3.0-113 (3 MW) turbines will be installed for a total nameplate capacity of 30 MW. The substation transformer location has been determined and has 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;

2. Predict the noise levels generated by the Project at all Points of Reception, Vacant Lot Receptors and Participating receptors within 1,500 m of the turbines.

# 2 GENERAL DESCRIPTION OF PROJECT SITE

## 2.1 General Characteristics

The proposed South Branch Wind Farmis located in eastern Ontario. The site is located approximately 50 km south of Ottawa, Ontario within the Townships of South Dundas in the United Counties of Stormont, Dundas and Glengarry, as well as within the Township of Edwardsburg-Cardinal in the United Counties of Leeds and Grenville (Figure 2-1). Project components will be installed on privately-owned agricultural lots within this area.

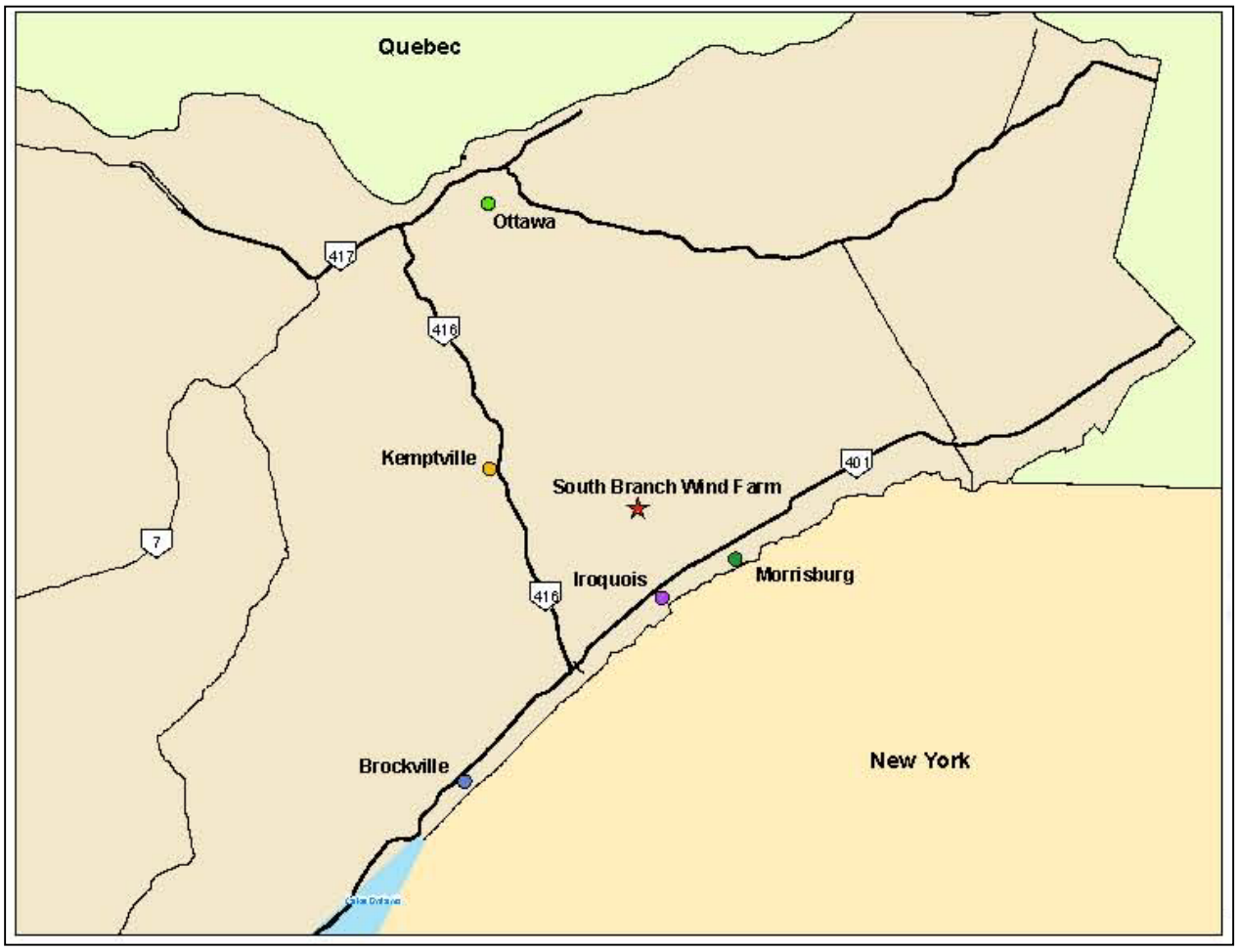


**Figure 2-1: Approximate location of the South Branch Wind Farm**

The Project has been configured with 14 turbine sites, although only 10 Siemens SWT-3.0-113 (3.0 MW) turbines will be installed. The wind turbines have been strategically sited on lands that the Client holds under lease options. It is anticipated that the Project's collector system may be partially located on public Right of Ways.

## 2.2 Land Use Description

The Project lies on predominantly flat, open, agricultural lands that include various natural features such as waterbodies/watercourses and wooded areas, as well as built features. The development pattern is typical of most rural areas in southern Ontario with dwellings built near the roadways. The Project Area is dotted with residential farm houses and related buildings. A few small urban centers exist in proximity to the Project, the two largest being Brinston and Hainesville. Figure 2-2 presents typical views of the land and features of the study area.

**Figure 2-2: Land features of the South Branch Wind Farm Project Area**

## 2.3 Points of Reception

All Points of Reception (PoR), as defined by MOE Noise Guidelines[1], were considered in this NIA. The guidelines generally define a 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. PoRs can also include locations on vacant lots that have residences as a permitted use; in this case GL GH has placed a Vacant Lot Receptor (VLR) on such lots in a location consistent with the building pattern in the area, as per the O. Reg. 359/09 and the Ontario MOE Noise Guidelines.

A residence located on the same premises as a wind turbine or other Project infrastructure is not a PoR as defined by the MOE Noise Guidelines, and considered a "Participating Receptor".

A cluster of buildings is treated as one receptor, the assumption being that each cluster represents one residence with adjacent garage, barns and/or outbuildings, and that the sound level will be similar for buildings in close proximity to each other.

Coordinates of the PoRs for the Project were provided by the Client and according to the Client's instructions, are validated. The height of each PoR - taken to be 4.5 m for one-storey and two-storey buildings and 7.5 m for three-storey buildings - was also provided by the Client and considered validated. The default height of a VLR is 4.5 m. The coordinates of all PoRs, including VLRs and Participating Receptors are listed in Appendix C and Appendix D, respectively.

[1] Ministry of the Environment, October 2008. Noise Guidelines for Wind Farms, Interpretation for applying MOE NPC Publications to Wind Power Generation Facilities, October 2008.

# 3 DESCRIPTION OF RECEPTORS

There is a total of 317 PoRs located within a radius 1,500 m of a wind turbine or the substation, among which 91 are VLRs and 218 are dwellings or other sensitive receptors such as churches and cemeteries. There are 8 dwellings considered as Participating Receptors.

## 3.1 Receptor Classes

The MOE 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 night time 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 concession and side roads, some of which are gravel roads;
- Occasional sounds due to agricultural activities;
- 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 MOE guidelines, the noise limits for a wind farm are set according to the existing MOE 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 by the MOE Interpretation 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 dB(A); 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 MOE as summarized below in Table 3-1. A sample calculation of how noise modeling was determined for each receptor appears in Appendix B where intermediate and cumulative A-weighted sound pressure levels from each turbine are provided.

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

| **Wind Turbine Noise Criterion (NPC-232 and Guideline) [dB(A)]** | **Wind Speed [m/s]** | | | | |
|---|---|---|---|---|---|
| | **6** | **7** | **8** | **9** | **10** |
| | 40 | 43 | 45 | 49 | 51 |

# 4 DESCRIPTION OF SOURCES

## 4.1 Turbines

The proposed Siemens SWT-3.0-113 turbine is a 3-bladed, upwind, horizontal-axis turbine. The total rotor diameter of the turbine is 113 m, resulting in a swept area of 10,029 $m^2$. The turbine rotor and nacelle are mounted on top of a 99.5 m tubular tower which is manufactured in sections from steel plate. Each turbine is mounted on a steel reinforced concrete foundation.

Table 4-1 presents the general specifications of the wind turbine.

**Table 4-1: Turbine specifications – Siemens SWT-3.0-113**

| **Model** | **Siemens SWT-3.0-113** |
|---|---|
| Design | Steel, tubular, white; 3 sections |
| Rated power | 3.0 MW |
| Hub height | 99.5 m |
| Rotor diameter | 113 m |
| Rotor swept area | 10.029 $m^2$ |
| Operational interval | 6 - 13 rpm* |
| Number of blades | 3 |
| Cut-in wind speed | 3 m/s* |
| Cut-out wind speed | 25 m/s* |
| Nominal wind speed | 12 - 13 m/s* |

* Based on similar technology (Siemens 2.3-113). To be confirmed.

Full noise specifications as provided by the manufacturer can be found in Appendix E. Coordinates of all turbines are listed in Appendix F.

The layout being evaluated consists of 14 turbine sites, although only 10 turbines will be installed.

## 4.2 Substation

The Project comprises one 33 MVA substation located on the Project Area and in close proximity to the turbines. The substation includes one transformer that will elevate the Project's collector system voltage to 44 kV.

## 4.3 Other Wind Farms

GL GH has reviewed readily and publicly available information relating to wind farms in Ontario and has not identified existing or planned wind farms with publicly disclosed site plans within 5 km from this Project.

# 5 NOISE EMISSION RATINGS

## 5.1 Turbines

Broadband sound power levels and octave band sound power levels of the Siemens SWT-3.0-113 wind turbine were provided by the manufacturer and are shown in Appendix E. Measurements were made in accordance with the IEC 61400 – 11 Ed. 2.1 method using standardized wind speeds at 10-m height. The values corresponding to the maximum sound power level of the turbine were retained for the purpose of the noise impact assessment to account for summer night-time shear.

The octave band sound power levels used for the simulation in this NIA are those stated for each octave band centre frequency, for a 10m height wind speed of 8 m/s, in Table 5-1.

**Table 5-1: Siemens SWT-3.0-113 wind turbine acoustic emission summary**

| **Siemens SWT-3.0-113** | **Octave Band Sound Power Level (dBA)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Frequency (Hz)** | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | Broadband |
| **PWL (dBA)** | 86.9 | 94.8 | 99.1 | 100.0 | 99.6 | 98.6 | 91.5 | 75.1 | 106.0 |

## 5.2 Substation Transformer

The cumulative effect that the substation would have on nearby residents has been considered in this analysis.

Noise emission from the substation mainly originates from one (1) high-voltage 33 MVA, 44 kV transformer. The equipment proposed for the substation will be compliant with applicable standards (CAN/CSA-C88-M90). The substation coordinates, as provided by the client, are included in Appendix F.

The Broadband Sound Power Level for the noise modelling calculations was conservatively assumed to be 96.8 dB(A), based on worst-case sound pressure value from standard CAN/CSA-C88-M90, and converted to sound power level using methodology outlined in Handbook of Acoustics[2], for utility scale transformers. The 96.8 dB(A) includes a 5 dB(A) tonal penalty, as prescribed in Publication NPC-104.

Table 5-2 provides the octave band sound power levels of the substation transformer, using a typical transformer octave band sound distribution for a large transformer[2]. It was conservatively modelled at a height of 3 m agl.

**Table 5-2: South Branch Wind Farm substation transformer sound power level**

| **Transformer** | **Octave Band Sound Power Level* (dBA)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Frequency (Hz)** | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | Broadband |
| **PWL (dBA)** | 73.2 | 85.3 | 87.8 | 93.2 | 90.4 | 86.6 | 81.4 | 72.3 | 96.8 |

* Includes 5 dBA penalty to account for tonality

[2] "Handbook of Acoustics". Malcolm J. Crocker. 1998.

# 6 NOISE IMPACT ASSESSMENT

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

The ISO 9613 standard provides a prediction of the equivalent continuous A-weighted sound pressure level at a distance from one or more point sources under meteorological conditions favourable 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: 0.7;
- Middle ground factor: 0.7;
- Receptor ground factor: 0.7;

The effect of topography was included.

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 noise emission ratings used for each octave band were those specified in Table 5-1 and Table 5-2. The noise impact was calculated for each PoR and Participating Receptor located within 1,500 m of at least one turbine or the substation, and the calculated noise level was then compared with the applicable noise limit for each receptor as stated in Table 3-1.

To be conservative, noise levels were calculated at 4.5 m a.g.l for 1-story and 2-storey Points of Reception/Participating Receptors and at 7.5 m a.g.l for 3-storey Points of Reception/Participating Receptors

# 7 WIND TURBINE NOISE IMPACT ASSESSMENT SUMMARY TABLE

## 7.1 Results

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

- The distance to the closest wind turbine or substation;
- For receptors at 4.5 m or 7.5 m a.g.l., the sound pressure level presented for wind speeds from 6 m/s to 10 m/s is the noise level at the receptor location at its respective height;
- The sound level limit for that receptor according to the MOE 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 receptor comply with the MOE guidelines (for continued reference, compliance is confirmed for all receptors).

The closest distance between a wind turbine and a PoR for this project is 582 m between turbine 15 and R_317, and 585 m between turbine 5 and VLR_251. The closest PoR to the substation is R_139 at 460m, while the closest VLR is V_276 at 429m.

The highest calculated noise level for a PoR is 39.3 dB(A) for R_6 (existing dwelling) and 39.5 dB(A) for VLR_260.

**The results show that the South Branch Wind Farm complies with the applicable MOE 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 South Branch Wind Farm are shown in Appendix A.

Similarly, the maximum noise level at each Participating receptor within 1,500 m of any turbine or substation is tabulated in Table 7-2.

**Table 7-1: Wind turbine noise impact assessment summary**

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_1 | 4.5 | 1318 | 1 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_2 | 4.5 | 1284 | 1 | 33.0 | 33.0 | 33.0 | 33.0 | 33.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_3 | 4.5 | 1092 | 1 | 34.7 | 34.7 | 34.7 | 34.7 | 34.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_4 | 4.5 | 1061 | 1 | 35.2 | 35.2 | 35.2 | 35.2 | 35.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_5 | 4.5 | 1022 | 1 | 35.7 | 35.7 | 35.7 | 35.7 | 35.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_6 | 4.5 | 642 | 1 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_7 | 4.5 | 1142 | 1 | 35.6 | 35.6 | 35.6 | 35.6 | 35.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_8 | 4.5 | 1212 | 2 | 35.1 | 35.1 | 35.1 | 35.1 | 35.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_9 | 4.5 | 1381 | 1 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_10 | 4.5 | 1433 | 1 | 32.4 | 32.4 | 32.4 | 32.4 | 32.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_11 | 4.5 | 1075 | 1 | 35.2 | 35.2 | 35.2 | 35.2 | 35.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_12 | 4.5 | 786 | 2 | 39.1 | 39.1 | 39.1 | 39.1 | 39.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_13 | 4.5 | 976 | 1 | 36.3 | 36.3 | 36.3 | 36.3 | 36.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_14 | 4.5 | 815 | 2 | 39.0 | 39.0 | 39.0 | 39.0 | 39.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_15 | 4.5 | 943 | 2 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_16 | 4.5 | 1588 | 1 | 31.9 | 31.9 | 31.9 | 31.9 | 31.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_17 | 4.5 | 1537 | 1 | 32.3 | 32.3 | 32.3 | 32.3 | 32.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_18 | 4.5 | 1705 | 1 | 31.3 | 31.3 | 31.3 | 31.3 | 31.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_19 | 4.5 | 1587 | 1 | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_20 | 4.5 | 1549 | 3 | 32.6 | 32.6 | 32.6 | 32.6 | 32.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_21 | 4.5 | 1261 | 3 | 34.6 | 34.6 | 34.6 | 34.6 | 34.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_22 | 4.5 | 1407 | 3 | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_23 | 4.5 | 818 | 4 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_24 | 4.5 | 1228 | 3 | 34.5 | 34.5 | 34.5 | 34.5 | 34.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_25 | 7.5 | 1191 | 3 | 34.8 | 34.8 | 34.8 | 34.8 | 34.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_26 | 4.5 | 817 | 3 | 37.9 | 37.9 | 37.9 | 37.9 | 37.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_27 | 4.5 | 1282 | 3 | 33.9 | 33.9 | 33.9 | 33.9 | 33.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_28 | 4.5 | 718 | 3 | 39.0 | 39.0 | 39.0 | 39.0 | 39.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_29 | 4.5 | 812 | 3 | 38.1 | 38.1 | 38.1 | 38.1 | 38.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_30 | 4.5 | 1274 | 4 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_31 | 4.5 | 1488 | 4 | 31.2 | 31.2 | 31.2 | 31.2 | 31.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_32 | 4.5 | 1733 | 4 | 29.7 | 29.7 | 29.7 | 29.7 | 29.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_33 | 4.5 | 1567 | 4 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_34 | 4.5 | 1089 | 4 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_35 | 4.5 | 1170 | 4 | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_36 | 4.5 | 1527 | 3 | 32.3 | 32.3 | 32.3 | 32.3 | 32.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_37 | 4.5 | 1262 | 4 | 33.9 | 33.9 | 33.9 | 33.9 | 33.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_38 | 4.5 | 1837 | 4 | 29.2 | 29.2 | 29.2 | 29.2 | 29.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_39 | 4.5 | 1872 | 4 | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_40 | 4.5 | 1889 | 4 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_41 | 4.5 | 2022 | 4 | 28.2 | 28.2 | 28.2 | 28.2 | 28.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_42 | 4.5 | 1406 | 4 | 32.4 | 32.4 | 32.4 | 32.4 | 32.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_43 | 4.5 | 1762 | 3 | 30.9 | 30.9 | 30.9 | 30.9 | 30.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_44 | 4.5 | 1365 | 5 | 31.3 | 31.3 | 31.3 | 31.3 | 31.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_45 | 4.5 | 1309 | 5 | 31.7 | 31.7 | 31.7 | 31.7 | 31.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_46 | 4.5 | 1138 | 5 | 33.1 | 33.1 | 33.1 | 33.1 | 33.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_47 | 4.5 | 2426 | 9 | 26.7 | 26.7 | 26.7 | 26.7 | 26.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_48 | 4.5 | 1047 | 5 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_49 | 4.5 | 2380 | 9 | 27.2 | 27.2 | 27.2 | 27.2 | 27.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_50 | 4.5 | 898 | 5 | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_51 | 4.5 | 2238 | 7 | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_52 | 4.5 | 2270 | 9 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_53 | 4.5 | 2234 | 9 | 27.6 | 27.6 | 27.6 | 27.6 | 27.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_54 | 4.5 | 2167 | 9 | 27.9 | 27.9 | 27.9 | 27.9 | 27.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_55 | 4.5 | 2154 | 9 | 28.1 | 28.1 | 28.1 | 28.1 | 28.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_56 | 4.5 | 2044 | 7 | 30.2 | 30.2 | 30.2 | 30.2 | 30.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_57 | 4.5 | 2033 | 9 | 28.3 | 28.3 | 28.3 | 28.3 | 28.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_58 | 4.5 | 655 | 5 | 38.6 | 38.6 | 38.6 | 38.6 | 38.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_59 | 4.5 | 1682 | 9 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_60 | 4.5 | 1690 | 9 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_61 | 4.5 | 761 | 5 | 37.9 | 37.9 | 37.9 | 37.9 | 37.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_62 | 4.5 | 884 | 5 | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_63 | 4.5 | 911 | 5 | 36.7 | 36.7 | 36.7 | 36.7 | 36.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_64 | 4.5 | 838 | 5 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_65 | 4.5 | 932 | 5 | 36.6 | 36.6 | 36.6 | 36.6 | 36.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_66 | 4.5 | 869 | 5 | 37.1 | 37.1 | 37.1 | 37.1 | 37.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_67 | 4.5 | 973 | 5 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_68 | 4.5 | 1036 | 5 | 36.1 | 36.1 | 36.1 | 36.1 | 36.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_69 | 4.5 | 1285 | 7 | 34.7 | 34.7 | 34.7 | 34.7 | 34.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_70 | 4.5 | 993 | 5 | 36.5 | 36.5 | 36.5 | 36.5 | 36.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_71 | 4.5 | 1129 | 5 | 35.9 | 35.9 | 35.9 | 35.9 | 35.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_72 | 4.5 | 1564 | 9 | 30.8 | 30.8 | 30.8 | 30.8 | 30.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_73 | 4.5 | 1181 | 5 | 35.8 | 35.8 | 35.8 | 35.8 | 35.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_74 | 4.5 | 1046 | 7 | 35.6 | 35.6 | 35.6 | 35.6 | 35.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_75 | 4.5 | 1009 | 7 | 36.1 | 36.1 | 36.1 | 36.1 | 36.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_76 | 4.5 | 679 | 7 | 38.8 | 38.8 | 38.8 | 38.8 | 38.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_77 | 4.5 | 1212 | 9 | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_78 | 4.5 | 1168 | 9 | 32.6 | 32.6 | 32.6 | 32.6 | 32.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_79 | 4.5 | 1089 | 9 | 33.2 | 33.2 | 33.2 | 33.2 | 33.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_80 | 4.5 | 1113 | 9 | 33.1 | 33.1 | 33.1 | 33.1 | 33.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_81 | 4.5 | 1367 | 10 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_82 | 4.5 | 941 | 9 | 34.6 | 34.6 | 34.6 | 34.6 | 34.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_83 | 4.5 | 911 | 9 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_84 | 4.5 | 907 | 9 | 35.2 | 35.2 | 35.2 | 35.2 | 35.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_85 | 4.5 | 873 | 9 | 35.6 | 35.6 | 35.6 | 35.6 | 35.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_86 | 4.5 | 783 | 9 | 36.5 | 36.5 | 36.5 | 36.5 | 36.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_87 | 4.5 | 662 | 8 | 39.2 | 39.2 | 39.2 | 39.2 | 39.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_88 | 4.5 | 703 | 8 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_89 | 4.5 | 760 | 9 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_90 | 4.5 | 820 | 9 | 36.5 | 36.5 | 36.5 | 36.5 | 36.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_91 | 4.5 | 836 | 9 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_92 | 4.5 | 834 | 9 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_93 | 4.5 | 979 | Subs | 35.8 | 35.8 | 35.8 | 35.8 | 35.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_94 | 4.5 | 794 | 9 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_95 | 4.5 | 851 | 9 | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_96 | 4.5 | 714 | 9 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_97 | 4.5 | 836 | 9 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_98 | 4.5 | 881 | 9 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_99 | 4.5 | 849 | 9 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_100 | 7.5 | 769 | 9 | 37.6 | 37.6 | 37.6 | 37.6 | 37.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_101 | 4.5 | 883 | 9 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_102 | 4.5 | 863 | 9 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_103 | 4.5 | 788 | 9 | 37.5 | 37.5 | 37.5 | 37.5 | 37.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_104 | 4.5 | 877 | 9 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_105 | 4.5 | 829 | 9 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_106 | 7.5 | 910 | 9 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_107 | 4.5 | 820 | 9 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_108 | 4.5 | 842 | 9 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_109 | 4.5 | 851 | 9 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_110 | 4.5 | 887 | 9 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_111 | 4.5 | 864 | 9 | 37.1 | 37.1 | 37.1 | 37.1 | 37.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_112 | 7.5 | 922 | 9 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_113 | 4.5 | 921 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_114 | 4.5 | 913 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_115 | 4.5 | 894 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_116 | 4.5 | 852 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_117 | 4.5 | 894 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_118 | 4.5 | 834 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_119 | 4.5 | 866 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_120 | 4.5 | 805 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_121 | 4.5 | 761 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_122 | 4.5 | 743 | Subs | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_123 | 4.5 | 721 | Subs | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_124 | 4.5 | 698 | Subs | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_125 | 4.5 | 744 | Subs | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_126 | 4.5 | 909 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_127 | 4.5 | 677 | Subs | 37.1 | 37.1 | 37.1 | 37.1 | 37.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_128 | 4.5 | 676 | Subs | 37.1 | 37.1 | 37.1 | 37.1 | 37.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_129 | 4.5 | 649 | Subs | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_130 | 4.5 | 913 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_131 | 4.5 | 577 | Subs | 37.7 | 37.7 | 37.7 | 37.7 | 37.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_132 | 4.5 | 845 | Subs | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_133 | 4.5 | 543 | Subs | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_134 | 4.5 | 514 | Subs | 38.3 | 38.3 | 38.3 | 38.3 | 38.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_135 | 4.5 | 893 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_136 | 4.5 | 916 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_137 | 4.5 | 498 | Subs | 38.4 | 38.4 | 38.4 | 38.4 | 38.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_138 | 4.5 | 500 | Subs | 38.4 | 38.4 | 38.4 | 38.4 | 38.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_139 | 4.5 | 460 | Subs | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_140 | 4.5 | 896 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_141 | 4.5 | 840 | Subs | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_142 | 4.5 | 889 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_143 | 4.5 | 723 | Subs | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_144 | 4.5 | 876 | Subs | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_145 | 4.5 | 965 | Subs | 36.6 | 36.6 | 36.6 | 36.6 | 36.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_146 | 4.5 | 976 | Subs | 36.6 | 36.6 | 36.6 | 36.6 | 36.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_147 | 4.5 | 895 | Subs | 36.7 | 36.7 | 36.7 | 36.7 | 36.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_148 | 4.5 | 999 | Subs | 36.6 | 36.6 | 36.6 | 36.6 | 36.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_149 | 4.5 | 1018 | Subs | 36.5 | 36.5 | 36.5 | 36.5 | 36.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_150 | 4.5 | 1265 | 15 | 31.4 | 31.4 | 31.4 | 31.4 | 31.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_151 | 4.5 | 1095 | Subs | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_152 | 4.5 | 977 | 15 | 33.9 | 33.9 | 33.9 | 33.9 | 33.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_153 | 4.5 | 1234 | 15 | 31.6 | 31.6 | 31.6 | 31.6 | 31.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_154 | 4.5 | 997 | 15 | 33.7 | 33.7 | 33.7 | 33.7 | 33.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_155 | 4.5 | 1259 | 15 | 31.4 | 31.4 | 31.4 | 31.4 | 31.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_156 | 4.5 | 1204 | 13 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_157 | 4.5 | 1194 | 15 | 31.9 | 31.9 | 31.9 | 31.9 | 31.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_158 | 4.5 | 1019 | 15 | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_159 | 4.5 | 1175 | 15 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_160 | 4.5 | 1131 | 15 | 32.4 | 32.4 | 32.4 | 32.4 | 32.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_161 | 4.5 | 1173 | 15 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_162 | 4.5 | 1130 | 10 | 36.1 | 36.1 | 36.1 | 36.1 | 36.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_163 | 4.5 | 1159 | 15 | 32.2 | 32.2 | 32.2 | 32.2 | 32.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_164 | 4.5 | 1228 | 15 | 31.6 | 31.6 | 31.6 | 31.6 | 31.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_165 | 4.5 | 1134 | 10 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_166 | 4.5 | 1278 | 15 | 31.2 | 31.2 | 31.2 | 31.2 | 31.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_167 | 4.5 | 1271 | 13 | 34.5 | 34.5 | 34.5 | 34.5 | 34.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_168 | 4.5 | 1189 | 10 | 35.9 | 35.9 | 35.9 | 35.9 | 35.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_169 | 4.5 | 1211 | 15 | 31.8 | 31.8 | 31.8 | 31.8 | 31.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_170 | 4.5 | 1128 | 15 | 32.4 | 32.4 | 32.4 | 32.4 | 32.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_171 | 4.5 | 1198 | 15 | 31.9 | 31.9 | 31.9 | 31.9 | 31.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_172 | 4.5 | 1111 | 15 | 32.6 | 32.6 | 32.6 | 32.6 | 32.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_173 | 4.5 | 808 | 10 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_174 | 4.5 | 1167 | 15 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_175 | 4.5 | 1236 | 15 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_176 | 4.5 | 1098 | 15 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_177 | 4.5 | 1074 | 15 | 32.9 | 32.9 | 32.9 | 32.9 | 32.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_178 | 4.5 | 1151 | 10 | 35.8 | 35.8 | 35.8 | 35.8 | 35.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_179 | 4.5 | 1089 | 10 | 36.1 | 36.1 | 36.1 | 36.1 | 36.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_180 | 4.5 | 1439 | 15 | 29.9 | 29.9 | 29.9 | 29.9 | 29.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_181 | 4.5 | 977 | 10 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_182 | 4.5 | 1017 | 10 | 36.7 | 36.7 | 36.7 | 36.7 | 36.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_183 | 4.5 | 1117 | 15 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_184 | 4.5 | 1109 | 15 | 32.6 | 32.6 | 32.6 | 32.6 | 32.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_185 | 4.5 | 1028 | 15 | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_186 | 4.5 | 1023 | 15 | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_187 | 4.5 | 808 | 11 | 39.1 | 39.1 | 39.1 | 39.1 | 39.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_188 | 4.5 | 940 | 15 | 34.1 | 34.1 | 34.1 | 34.1 | 34.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_189 | 4.5 | 629 | 15 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_190 | 4.5 | 701 | 15 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_191 | 4.5 | 662 | 15 | 37.5 | 37.5 | 37.5 | 37.5 | 37.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_192 | 4.5 | 614 | 15 | 38.3 | 38.3 | 38.3 | 38.3 | 38.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_193 | 4.5 | 905 | 15 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_194 | 4.5 | 814 | 12 | 38.8 | 38.8 | 38.8 | 38.8 | 38.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_195 | 4.5 | 711 | 13 | 38.6 | 38.6 | 38.6 | 38.6 | 38.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_196 | 4.5 | 1121 | 15 | 33.9 | 33.9 | 33.9 | 33.9 | 33.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_197 | 4.5 | 770 | 12 | 38.5 | 38.5 | 38.5 | 38.5 | 38.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_198 | 4.5 | 1511 | 11 | 34.1 | 34.1 | 34.1 | 34.1 | 34.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_199 | 4.5 | 1618 | 15 | 33.0 | 33.0 | 33.0 | 33.0 | 33.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_200 | 4.5 | 821 | 12 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_201 | 4.5 | 1300 | 15 | 32.9 | 32.9 | 32.9 | 32.9 | 32.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |



GL Garrad Hassan

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| R_202 | 4.5 | 694 | 12 | 39.2 | 39.2 | 39.2 | 39.2 | 39.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_203 | 4.5 | 746 | 12 | 38.5 | 38.5 | 38.5 | 38.5 | 38.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_204 | 4.5 | 876 | 12 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_205 | 4.5 | 918 | 12 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_206 | 4.5 | 1585 | 15 | 31.8 | 31.8 | 31.8 | 31.8 | 31.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_207 | 4.5 | 1682 | 15 | 31.4 | 31.4 | 31.4 | 31.4 | 31.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_208 | 4.5 | 1085 | 12 | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_209 | 4.5 | 1778 | 15 | 31.2 | 31.2 | 31.2 | 31.2 | 31.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_210 | 4.5 | 1115 | 12 | 35.1 | 35.1 | 35.1 | 35.1 | 35.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_211 | 4.5 | 1871 | 15 | 30.8 | 30.8 | 30.8 | 30.8 | 30.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_212 | 4.5 | 1204 | 12 | 34.5 | 34.5 | 34.5 | 34.5 | 34.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_213 | 4.5 | 1859 | 15 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_214 | 4.5 | 1251 | 12 | 34.2 | 34.2 | 34.2 | 34.2 | 34.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_215 | 4.5 | 1327 | 13 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_216 | 4.5 | 1921 | 15 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_316 | 4.5 | 585 | 15 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| R_317 | 4.5 | 582 | 15 | 38.8 | 38.8 | 38.8 | 38.8 | 38.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_225 | 4.5 | 933 | 1 | 36.1 | 36.1 | 36.1 | 36.1 | 36.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_226 | 4.5 | 1371 | 1 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_227 | 4.5 | 780 | 2 | 39.1 | 39.1 | 39.1 | 39.1 | 39.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_228 | 4.5 | 1032 | 1 | 35.6 | 35.6 | 35.6 | 35.6 | 35.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_229 | 4.5 | 799 | 4 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_230 | 4.5 | 1240 | 3 | 34.5 | 34.5 | 34.5 | 34.5 | 34.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_231 | 4.5 | 782 | 4 | 37.5 | 37.5 | 37.5 | 37.5 | 37.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_232 | 4.5 | 1003 | 4 | 35.1 | 35.1 | 35.1 | 35.1 | 35.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_233 | 4.5 | 959 | 4 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_234 | 4.5 | 1101 | 4 | 34.2 | 34.2 | 34.2 | 34.2 | 34.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_235 | 4.5 | 1113 | 4 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_236 | 4.5 | 1203 | 4 | 33.3 | 33.3 | 33.3 | 33.3 | 33.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| V_237 | 4.5 | 1285 | 4 | 32.6 | 32.6 | 32.6 | 32.6 | 32.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_238 | 4.5 | 732 | 4 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_239 | 4.5 | 1294 | 3 | 33.7 | 33.7 | 33.7 | 33.7 | 33.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_240 | 4.5 | 1440 | 4 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_241 | 4.5 | 1035 | 3 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_242 | 4.5 | 1468 | 4 | 31.3 | 31.3 | 31.3 | 31.3 | 31.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_243 | 4.5 | 1045 | 4 | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_244 | 4.5 | 1470 | 3 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_245 | 4.5 | 1260 | 4 | 33.8 | 33.8 | 33.8 | 33.8 | 33.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_246 | 4.5 | 1161 | 5 | 32.9 | 32.9 | 32.9 | 32.9 | 32.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_247 | 4.5 | 1393 | 5 | 31.3 | 31.3 | 31.3 | 31.3 | 31.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_248 | 4.5 | 2430 | 9 | 27.1 | 27.1 | 27.1 | 27.1 | 27.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_249 | 4.5 | 919 | 5 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_250 | 4.5 | 2168 | 9 | 27.8 | 27.8 | 27.8 | 27.8 | 27.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_251 | 4.5 | 585 | 5 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_252 | 4.5 | 2171 | 5 | 27.4 | 27.4 | 27.4 | 27.4 | 27.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_253 | 4.5 | 1945 | 9 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_254 | 4.5 | 678 | 5 | 38.6 | 38.6 | 38.6 | 38.6 | 38.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_255 | 4.5 | 1838 | 9 | 29.2 | 29.2 | 29.2 | 29.2 | 29.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_256 | 4.5 | 1749 | 9 | 29.6 | 29.6 | 29.6 | 29.6 | 29.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_257 | 4.5 | 672 | 5 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_258 | 4.5 | 716 | 5 | 38.8 | 38.8 | 38.8 | 38.8 | 38.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_259 | 4.5 | 1657 | 9 | 30.3 | 30.3 | 30.3 | 30.3 | 30.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_260 | 4.5 | 667 | 5 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_261 | 4.5 | 1345 | 7 | 33.7 | 33.7 | 33.7 | 33.7 | 33.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_262 | 4.5 | 1161 | 5 | 35.8 | 35.8 | 35.8 | 35.8 | 35.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_263 | 4.5 | 1147 | 7 | 34.9 | 34.9 | 34.9 | 34.9 | 34.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_264 | 4.5 | 1076 | 7 | 35.6 | 35.6 | 35.6 | 35.6 | 35.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_265 | 4.5 | 986 | 7 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| V_266 | 4.5 | 962 | 7 | 35.7 | 35.7 | 35.7 | 35.7 | 35.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_267 | 4.5 | 879 | 7 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_268 | 4.5 | 1217 | 9 | 32.3 | 32.3 | 32.3 | 32.3 | 32.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_269 | 4.5 | 1024 | 9 | 33.8 | 33.8 | 33.8 | 33.8 | 33.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_270 | 4.5 | 1041 | 9 | 33.8 | 33.8 | 33.8 | 33.8 | 33.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_271 | 4.5 | 951 | 9 | 34.7 | 34.7 | 34.7 | 34.7 | 34.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_272 | 4.5 | 661 | 8 | 39.1 | 39.1 | 39.1 | 39.1 | 39.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_273 | 4.5 | 779 | 8 | 37.7 | 37.7 | 37.7 | 37.7 | 37.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_274 | 4.5 | 685 | 9 | 38.3 | 38.3 | 38.3 | 38.3 | 38.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_275 | 4.5 | 899 | 9 | 36.9 | 36.9 | 36.9 | 36.9 | 36.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_276 | 4.5 | 429 | Subs | 39.4 | 39.4 | 39.4 | 39.4 | 39.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_277 | 4.5 | 1517 | Subs | 29.6 | 29.6 | 29.6 | 29.6 | 29.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_278 | 4.5 | 538 | Subs | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_279 | 4.5 | 818 | 15 | 35.7 | 35.7 | 35.7 | 35.7 | 35.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_280 | 4.5 | 1297 | 15 | 31.2 | 31.2 | 31.2 | 31.2 | 31.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_281 | 4.5 | 1002 | Subs | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_282 | 4.5 | 1019 | 15 | 33.5 | 33.5 | 33.5 | 33.5 | 33.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_283 | 4.5 | 1329 | 15 | 30.8 | 30.8 | 30.8 | 30.8 | 30.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_284 | 4.5 | 1408 | 15 | 30.2 | 30.2 | 30.2 | 30.2 | 30.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_285 | 4.5 | 600 | 15 | 39.1 | 39.1 | 39.1 | 39.1 | 39.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_286 | 4.5 | 1142 | 15 | 32.3 | 32.3 | 32.3 | 32.3 | 32.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_287 | 4.5 | 1127 | 15 | 32.4 | 32.4 | 32.4 | 32.4 | 32.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_288 | 4.5 | 626 | 15 | 38.5 | 38.5 | 38.5 | 38.5 | 38.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_289 | 4.5 | 790 | 15 | 36.6 | 36.6 | 36.6 | 36.6 | 36.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_290 | 4.5 | 728 | 13 | 38.3 | 38.3 | 38.3 | 38.3 | 38.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_291 | 4.5 | 922 | 12 | 38.1 | 38.1 | 38.1 | 38.1 | 38.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_292 | 4.5 | 1358 | 10 | 34.7 | 34.7 | 34.7 | 34.7 | 34.7 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_293 | 4.5 | 835 | 12 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_294 | 4.5 | 1047 | 15 | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

| Point of Reception ID | PoR height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [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 | Compliance With Limit (Yes/No) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6 or < | 7 | 8 | 9 | 10 | 6 or < | 7 | 8 | 9 | 10 | NPC 232 (C 3) | |
| V_295 | 4.5 | 1499 | 10 | 34.1 | 34.1 | 34.1 | 34.1 | 34.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_296 | 4.5 | 1077 | 15 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_297 | 4.5 | 1138 | 15 | 32.3 | 32.3 | 32.3 | 32.3 | 32.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_298 | 4.5 | 714 | 12 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_299 | 4.5 | 1171 | 15 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_300 | 4.5 | 767 | 12 | 38.3 | 38.3 | 38.3 | 38.3 | 38.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_301 | 4.5 | 1167 | 15 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_302 | 4.5 | 1345 | 15 | 32.6 | 32.6 | 32.6 | 32.6 | 32.6 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_303 | 4.5 | 1398 | 15 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_304 | 4.5 | 1167 | 13 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_305 | 4.5 | 1289 | 15 | 31.1 | 31.1 | 31.1 | 31.1 | 31.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_306 | 4.5 | 1528 | 15 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_307 | 4.5 | 1275 | 15 | 31.3 | 31.3 | 31.3 | 31.3 | 31.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_308 | 4.5 | 1522 | 15 | 31.9 | 31.9 | 31.9 | 31.9 | 31.9 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_309 | 4.5 | 1660 | 15 | 31.4 | 31.4 | 31.4 | 31.4 | 31.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_310 | 4.5 | 1404 | 15 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_311 | 4.5 | 1448 | 15 | 30.1 | 30.1 | 30.1 | 30.1 | 30.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_312 | 4.5 | 1784 | 15 | 31.0 | 31.0 | 31.0 | 31.0 | 31.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_313 | 4.5 | 1243 | 13 | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_314 | 4.5 | 1287 | 13 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |
| V_315 | 4.5 | 1398 | 13 | 33.1 | 33.1 | 33.1 | 33.1 | 33.1 | 40 | 43 | 45 | 49 | 51 | 40 | Yes |

**Table 7-2: Wind turbine noise impact assessment summary – Participating receptors**

| Participating receptor ID | Height [m] | Distance to Nearest Turbine [m] | Nearest Turbine [ID] | Calculated Sound Pressure Level at Dwelling [dB(A)] |
|---|---|---|---|---|
| P_217 | 4.5 | 438 | 1 | 43.8 |
| P_218 | 4.5 | 715 | 3 | 39.0 |
| P_219 | 4.5 | 1888 | 7 | 32.0 |
| P_220 | 4.5 | 726 | 8 | 39.8 |
| P_221 | 4.5 | 1131 | 10 | 36.2 |
| P_222 | 4.5 | 778 | 11 | 39.3 |
| P_223 | 4.5 | 771 | 11 | 39.5 |
| P_224 | 4.5 | 760 | 12 | 38.9 |

# 8 CONCLUSION

Based on the approach presented in this NIA, the South Branch Wind Farm is compliant with the MOE noise limits at all Points of Reception and Vacant Lot Receptors within 1,500 m of the Project's noise sources, for wind speeds of 6, 7, 8, 9 and 10 m/s. It should be noted that additional potential attenuation from foliage was not taken into account 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 Point of Reception.

# APPENDIX A NOISE ISO-CONTOUR MAPS

462000 464000 466000 468000 470000 472000 474000 476000

4982000 4980000 4978000 4976000 4974000 4972000

TOWNSHIP OF NORTH DUNDAS
TOWNSHIP OF SOUTH DUNDAS
TOWNSHIP OF EDWARDSBURGH/CARDINAL

South Mountain
Pleasant Valley
Hulbert
Toyes Hill
Straders Hill
Brinston
Dundela
Dixons Corners
Glen Stewart
Hainsville

NELSON RD
SANDY ROW
COUNTY ROAD 16 BRINSTON RD
COUNTY RD 5
DEVRIES RD
SNOWBIRD RD
IRISH HEADLINE RD
COUNTY RD 3
NATION RIVER RD
COONS RD
HERITAGE RD
HULBERT RD
FULTON RD
COUNTY RD 16
HENDERSON RD
SMAIL RD
BOUNDARY RD
KIRKER RD
TAYLOR RD
S BRANCH RD
GILMOUR RD
COUNTY RD 18
RIDGE RD
COUNTY RD 1
DOBBIE RD
SANDY CK RD
9 MILE RD
HANESVILLE RD
SEIBERT RD
COUNTY RD 21

1 2 3 4 5 6 7 8 9 10 11 12 13 15

## Legend

**Project Components**

- Wind Turbine (14)
- Participating Receptor
- 2-Storey Receptor
- Vacant Lot Receptor
- Substation
- Signed Lot

**Other Components**

- Other Building
- Transmission Line
- Arterial / Collector Road
- Local Road / Street
- Permanent Watercourse
- Intermittent Watercourse
- Contour (Interval: 5 m)
- Lot Line
- Municipality Boundary
- Urban Area
- Pit or Quarry
- Wetland
- Waterbody
- Wooded Area

Noise Iso-contours:

- 40 dBA for 4.5 m receptors
- 45 dBA for 4.5 m receptors

0 0.5 1 2 kilometres

edp renewables

*South Branch Wind Project*

**SIMULATED NOISE ISO-CONTOURS (NOISE LEVEL 0F 106.0 dBA)**

GL Garrad Hassan

800194-004-120530-001-CC

May 30, 2012

Projection: UTM Zone 18, NAD83

Sources: CanVec 50k, Geobase, Google Earth, OBM and ORN

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# APPENDIX B SAMPLE CALCULATION FOR NOISE MODELING

**Resulting A-weighted sound pressure level at Receptors R_6 and VLR V_260**

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 for the worst impacted dwelling (R_6) and VLR (V_260). The following conditions were used:

- Turbine locations (Appendix F);
- Receptor locations (Appendix C).

Turbine characteristics and modelling parameters:

- Hub-heights: 99.5 m (Siemens SWT-3.0-113);
- Ambient air temperature: 10ºC;
- Ambient barometric pressure: 101.32 kPa;
- Relative humidity: 70%;
- Source ground factor: 0.7 (soft ground);
- Middle ground factor: 0.7; and
- Receptor ground factor: 0.7
- Tonal penalty for turbine: 0.0 dB(A);
- Tonal penalty for transformer: 5.0 dB(A);
- See Table 5-1 for broadband and octave band sound power level;

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 net result, the A-weighted sound pressure level at the example receptors PoR R_6 and VLR V_260 for all bands and all noise sources within 5000 m of the example receptor is 39.3 and 39.5 dB(A) respectively.

## Sample Calculations

### Sound Pressure Levels at PoR R_6

| Turbine ID | Distance* [m] | Octave Band Sound Pressure Levels [dB(A)] | | | | | | | | Total A-Weighted Sound Pressure Level by Turbine and for all Octave Bands [dB(A)] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | 8000 Hz | |
| 1 | 649 | 22.6 | 25.7 | 31.1 | 32.4 | 30.9 | 26.0 | 3.9 | -67.1 | 37.2 |
| 2 | 1009 | 18.7 | 21.6 | 26.9 | 27.9 | 25.7 | 18.7 | -11.8 | -113.1 | 32.5 |
| 3 | 1285 | 16.6 | 19.3 | 24.5 | 25.2 | 22.6 | 13.9 | -22.9 | -147.4 | 29.8 |
| 4 | 1657 | 14.3 | 17.0 | 21.9 | 22.3 | 19.1 | 8.1 | -37.3 | -193.1 | 26.9 |
| **Total A-Weighted Sound Pressure Level** | | | | | | | | | | **39.3** |

* Includes the heights of noise sources and receptors

### Sound Pressure Levels at VLR V_260

| Turbine ID | Distance* [m] | Octave Band Sound Pressure Levels [dB(A)] | | | | | | | | Total A-Weighted Sound Pressure Level by Turbine and for all Octave Bands [dB(A)] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | 8000 Hz | |
| 5 | 674 | 22.3 | 25.4 | 30.8 | 32.0 | 30.5 | 25.4 | 2.8 | -70.3 | 36.8 |
| 6 | 743 | 21.4 | 24.4 | 29.8 | 31.0 | 29.4 | 23.9 | -0.4 | -79.3 | 35.7 |
| 7 | 2410 | 11.0 | 13.4 | 17.9 | 17.6 | 13.0 | -2.4 | -65.2 | -284.4 | 22.4 |
| 8 | 2586 | 10.3 | 12.7 | 17.1 | 16.7 | 11.8 | -4.7 | -71.6 | -305.5 | 21.5 |
| 13 | 4388 | 6.4 | 7.6 | 10.9 | 8.9 | 0.9 | -26.5 | -135.0 | -520.5 | 14.9 |
| 12 | 4668 | 5.9 | 7.0 | 10.1 | 7.8 | -0.7 | -29.7 | -144.6 | -553.6 | 14.2 |
| 11 | 4683 | 5.9 | 7.0 | 10.0 | 7.8 | -0.7 | -29.9 | -145.2 | -555.5 | 14.1 |
| 10 | 4939 | 5.5 | 6.5 | 9.3 | 6.8 | -2.1 | -32.8 | -154.0 | -585.8 | 13.4 |
| **Total A-Weighted Sound Pressure Level** | | | | | | | | | | **39.5** |

* Includes the heights of noise sources and receptors.

# APPENDIX C COORDINATES OF POINTS OF RECEPTION

Coordinates of all modeled Points of Reception and Vacant Lot Receptors for the South Branch Wind Farm (UTM17-NAD83 projection) are given in the tables below:

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| R_1 | 462637 | 4973448 |
| R_2 | 462673 | 4973383 |
| R_3 | 462882 | 4973652 |
| R_4 | 462979 | 4973868 |
| R_5 | 463067 | 4973956 |
| R_6 | 463313 | 4973453 |
| R_7 | 463316 | 4974398 |
| R_8 | 463403 | 4974590 |
| R_9 | 463651 | 4972104 |
| R_10 | 463701 | 4972041 |
| R_11 | 463855 | 4972381 |
| R_12 | 463956 | 4974466 |
| R_13 | 463960 | 4972475 |
| R_14 | 464064 | 4974534 |
| R_15 | 464082 | 4974670 |
| R_16 | 464147 | 4971875 |
| R_17 | 464202 | 4971934 |
| R_18 | 464296 | 4971780 |
| R_19 | 464384 | 4971923 |
| R_20 | 464470 | 4971978 |
| R_21 | 464506 | 4972264 |
| R_22 | 464697 | 4972119 |
| R_23 | 464712 | 4974877 |
| R_24 | 464761 | 4972306 |
| R_25 | 464810 | 4972351 |
| R_26 | 464946 | 4972785 |
| R_27 | 464973 | 4972298 |
| R_28 | 465131 | 4973047 |
| R_29 | 465298 | 4973119 |
| R_30 | 465358 | 4975238 |
| R_31 | 465653 | 4975322 |
| R_32 | 465689 | 4975585 |
| R_33 | 465785 | 4975326 |
| R_34 | 465881 | 4973724 |
| R_35 | 465979 | 4973770 |
| R_36 | 465984 | 4972892 |
| R_37 | 465998 | 4973550 |
| R_38 | 466004 | 4975498 |
| R_39 | 466052 | 4975503 |
| R_40 | 466084 | 4975499 |
| R_41 | 466182 | 4975589 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| R_42 | 466232 | 4973820 |
| R_43 | 466264 | 4972963 |
| R_44 | 467967 | 4981323 |
| R_45 | 468030 | 4981525 |
| R_46 | 468195 | 4981451 |
| R_47 | 468344 | 4976875 |
| R_48 | 468391 | 4981844 |
| R_49 | 468399 | 4976973 |
| R_50 | 468460 | 4981602 |
| R_51 | 468481 | 4979233 |
| R_52 | 468504 | 4976914 |
| R_53 | 468543 | 4976949 |
| R_54 | 468616 | 4976994 |
| R_55 | 468654 | 4977145 |
| R_56 | 468657 | 4979317 |
| R_57 | 468747 | 4976965 |
| R_58 | 468862 | 4981840 |
| R_59 | 469160 | 4977220 |
| R_60 | 469176 | 4977292 |
| R_61 | 469206 | 4980632 |
| R_62 | 469208 | 4980508 |
| R_63 | 469229 | 4980478 |
| R_64 | 469246 | 4980549 |
| R_65 | 469252 | 4980454 |
| R_66 | 469265 | 4980517 |
| R_67 | 469269 | 4980412 |
| R_68 | 469283 | 4980348 |
| R_69 | 469287 | 4979997 |
| R_70 | 469342 | 4980390 |
| R_71 | 469345 | 4980254 |
| R_72 | 469355 | 4977394 |
| R_73 | 469387 | 4980203 |
| R_74 | 469533 | 4979914 |
| R_75 | 469563 | 4980002 |
| R_76 | 469900 | 4980127 |
| R_77 | 470296 | 4975599 |
| R_78 | 470374 | 4975616 |
| R_79 | 470434 | 4975679 |
| R_80 | 470548 | 4975625 |
| R_81 | 470552 | 4978085 |
| R_82 | 470657 | 4975782 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| R_83 | 470734 | 4975807 |
| R_84 | 470852 | 4975814 |
| R_85 | 470967 | 4975868 |
| R_86 | 470997 | 4975969 |
| R_87 | 471072 | 4980896 |
| R_88 | 471126 | 4980936 |
| R_89 | 471140 | 4976056 |
| R_90 | 471175 | 4976007 |
| R_91 | 471344 | 4976114 |
| R_92 | 471370 | 4976143 |
| R_93 | 471375 | 4975915 |
| R_94 | 471407 | 4976250 |
| R_95 | 471420 | 4976174 |
| R_96 | 471444 | 4976497 |
| R_97 | 471446 | 4976232 |
| R_98 | 471475 | 4976195 |
| R_99 | 471477 | 4976255 |
| R_100 | 471488 | 4976455 |
| R_101 | 471492 | 4976216 |
| R_102 | 471501 | 4976266 |
| R_103 | 471520 | 4976490 |
| R_104 | 471528 | 4976284 |
| R_105 | 471529 | 4976394 |
| R_106 | 471537 | 4976235 |
| R_107 | 471541 | 4976453 |
| R_108 | 471558 | 4976435 |
| R_109 | 471560 | 4976414 |
| R_110 | 471567 | 4976337 |
| R_111 | 471567 | 4976396 |
| R_112 | 471568 | 4976264 |
| R_113 | 471582 | 4976271 |
| R_114 | 471598 | 4976280 |
| R_115 | 471608 | 4976262 |
| R_116 | 471626 | 4976213 |
| R_117 | 471633 | 4976296 |
| R_118 | 471639 | 4976200 |
| R_119 | 471646 | 4976266 |
| R_120 | 471652 | 4976167 |
| R_121 | 471676 | 4976121 |
| R_122 | 471689 | 4976107 |
| R_123 | 471699 | 4976079 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| R_124 | 471715 | 4976060 |
| R_125 | 471715 | 4976153 |
| R_126 | 471717 | 4976410 |
| R_127 | 471717 | 4976015 |
| R_128 | 471727 | 4976034 |
| R_129 | 471734 | 4975983 |
| R_130 | 471750 | 4976445 |
| R_131 | 471784 | 4975904 |
| R_132 | 471794 | 4976393 |
| R_133 | 471808 | 4975859 |
| R_134 | 471831 | 4975822 |
| R_135 | 471834 | 4976484 |
| R_136 | 471838 | 4976514 |
| R_137 | 471841 | 4975747 |
| R_138 | 471841 | 4975792 |
| R_139 | 471880 | 4975721 |
| R_140 | 471883 | 4976518 |
| R_141 | 471919 | 4976474 |
| R_142 | 471928 | 4976535 |
| R_143 | 471940 | 4976350 |
| R_144 | 472083 | 4976585 |
| R_145 | 472093 | 4976680 |
| R_146 | 472119 | 4976698 |
| R_147 | 472131 | 4976618 |
| R_148 | 472156 | 4976729 |
| R_149 | 472251 | 4976761 |
| R_150 | 472380 | 4974458 |
| R_151 | 472382 | 4976841 |
| R_152 | 472430 | 4974743 |
| R_153 | 472444 | 4974484 |
| R_154 | 472459 | 4974720 |
| R_155 | 472468 | 4974457 |
| R_156 | 472470 | 4980529 |
| R_157 | 472477 | 4974522 |
| R_158 | 472520 | 4974696 |
| R_159 | 472539 | 4974540 |
| R_160 | 472551 | 4974584 |
| R_161 | 472566 | 4974543 |
| R_162 | 472570 | 4976967 |
| R_163 | 472591 | 4974558 |
| R_164 | 472595 | 4974489 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| R_165 | 472601 | 4976985 |
| R_166 | 472605 | 4974439 |
| R_167 | 472611 | 4980617 |
| R_168 | 472614 | 4976926 |
| R_169 | 472626 | 4974508 |
| R_170 | 472633 | 4974592 |
| R_171 | 472645 | 4974523 |
| R_172 | 472653 | 4974611 |
| R_173 | 472676 | 4977641 |
| R_174 | 472677 | 4974558 |
| R_175 | 472680 | 4974489 |
| R_176 | 472683 | 4974628 |
| R_177 | 472712 | 4974657 |
| R_178 | 472729 | 4977077 |
| R_179 | 472765 | 4977213 |
| R_180 | 472781 | 4974299 |
| R_181 | 472789 | 4977465 |
| R_182 | 472806 | 4977411 |
| R_183 | 472817 | 4974637 |
| R_184 | 472843 | 4974652 |
| R_185 | 472865 | 4974745 |
| R_186 | 472931 | 4974776 |
| R_187 | 472934 | 4978075 |
| R_188 | 473008 | 4974908 |
| R_189 | 473060 | 4975383 |
| R_190 | 473050 | 4975250 |
| R_191 | 473111 | 4975405 |
| R_192 | 473132 | 4975616 |
| R_193 | 473135 | 4976385 |
| R_194 | 473139 | 4978271 |
| R_195 | 473195 | 4979873 |
| R_196 | 473320 | 4976506 |
| R_197 | 473354 | 4978480 |
| R_198 | 473377 | 4977462 |
| R_199 | 473446 | 4977046 |
| R_200 | 473463 | 4978531 |
| R_201 | 473484 | 4976594 |
| R_202 | 473489 | 4978989 |
| R_203 | 473521 | 4978836 |
| R_204 | 473667 | 4978925 |
| R_205 | 473712 | 4978961 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| R_206 | 473717 | 4976761 |
| R_207 | 473804 | 4976808 |
| R_208 | 473878 | 4979079 |
| R_209 | 473882 | 4976865 |
| R_210 | 473909 | 4979049 |
| R_211 | 473969 | 4976906 |
| R_212 | 473985 | 4979194 |
| R_213 | 473988 | 4976863 |
| R_214 | 473993 | 4979371 |
| R_215 | 474007 | 4979644 |
| R_216 | 474049 | 4976886 |
| R_316 | 473032 | 4975421 |
| R_317 | 473105 | 4975653 |
| V_225 | 463040 | 4973633 |
| V_226 | 463738 | 4972097 |
| V_227 | 463866 | 4974412 |
| V_228 | 463875 | 4972422 |
| V_229 | 464441 | 4974758 |
| V_230 | 464707 | 4972287 |
| V_231 | 464822 | 4974852 |
| V_232 | 465053 | 4975052 |
| V_233 | 465084 | 4974999 |
| V_234 | 465166 | 4975124 |
| V_235 | 465273 | 4975099 |
| V_236 | 465294 | 4975187 |
| V_237 | 465460 | 4975200 |
| V_238 | 465543 | 4974301 |
| V_239 | 465581 | 4972686 |
| V_240 | 465586 | 4975306 |
| V_241 | 465601 | 4973288 |
| V_242 | 465618 | 4975320 |
| V_243 | 465850 | 4973774 |
| V_244 | 465970 | 4973008 |
| V_245 | 466027 | 4973625 |
| V_246 | 468179 | 4981525 |
| V_247 | 468210 | 4982210 |
| V_248 | 468356 | 4977039 |
| V_249 | 468487 | 4981746 |
| V_250 | 468607 | 4976926 |
| V_251 | 468754 | 4981482 |
| V_252 | 468823 | 4983494 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| V_253 | 468851 | 4977061 |
| V_254 | 468987 | 4981967 |
| V_255 | 468992 | 4977202 |
| V_256 | 469075 | 4977168 |
| V_257 | 469174 | 4980730 |
| V_258 | 469210 | 4982089 |
| V_259 | 469231 | 4977343 |
| V_260 | 469251 | 4982045 |
| V_261 | 469262 | 4979726 |
| V_262 | 469358 | 4980222 |
| V_263 | 469440 | 4979846 |
| V_264 | 469499 | 4979955 |
| V_265 | 469591 | 4979935 |
| V_266 | 469746 | 4979537 |
| V_267 | 469881 | 4979487 |
| V_268 | 470411 | 4975553 |
| V_269 | 470574 | 4975711 |
| V_270 | 470634 | 4975684 |
| V_271 | 470774 | 4975766 |
| V_272 | 471153 | 4980892 |
| V_273 | 471315 | 4980981 |
| V_274 | 471432 | 4976560 |
| V_275 | 471565 | 4976307 |
| V_276 | 471920 | 4975655 |
| V_277 | 472052 | 4974257 |
| V_278 | 472154 | 4975242 |
| V_279 | 472327 | 4974922 |
| V_280 | 472337 | 4974432 |
| V_281 | 472363 | 4976749 |
| V_282 | 472486 | 4974697 |
| V_283 | 472646 | 4974391 |
| V_284 | 472673 | 4974315 |
| V_285 | 472676 | 4976296 |
| V_286 | 472709 | 4974588 |
| V_287 | 472769 | 4974614 |
| V_288 | 472874 | 4976235 |
| V_289 | 473030 | 4976323 |
| V_290 | 473096 | 4979969 |
| V_291 | 473150 | 4978158 |
| V_292 | 473152 | 4977344 |
| V_293 | 473286 | 4978333 |

| Point of Reception ID | Easting [m] | Northing [m] |
|---|---|---|
| V_294 | 473298 | 4976423 |
| V_295 | 473312 | 4977366 |
| V_296 | 473349 | 4975020 |
| V_297 | 473362 | 4974943 |
| V_298 | 473430 | 4978682 |
| V_299 | 473443 | 4974987 |
| V_300 | 473497 | 4978701 |
| V_301 | 473525 | 4975111 |
| V_302 | 473553 | 4976584 |
| V_303 | 473563 | 4976652 |
| V_304 | 473611 | 4980096 |
| V_305 | 473661 | 4975104 |
| V_306 | 473673 | 4976725 |
| V_307 | 473695 | 4975206 |
| V_308 | 473700 | 4976683 |
| V_309 | 473817 | 4976758 |
| V_310 | 473870 | 4975308 |
| V_311 | 473896 | 4975246 |
| V_312 | 473922 | 4976825 |
| V_313 | 473939 | 4979555 |
| V_314 | 473987 | 4979532 |
| V_315 | 474070 | 4979686 |

# APPENDIX D COORDINATES OF PARTICIPATING RECEPTORS

Coordinates of all modeled participating receptors for the South Branch Wind Farm (UTM17-NAD83 projection) are given in the table below:

| Participating receptor ID | Easting [m] | Northing [m] |
|---|---|---|
| P_217 | 464180 | 4973075 |
| P_218 | 465098 | 4973016 |
| P_219 | 469700 | 4978356 |
| P_220 | 470660 | 4980816 |
| P_221 | 472500 | 4976919 |
| P_222 | 472860 | 4977999 |
| P_223 | 472903 | 4978098 |
| P_224 | 473231 | 4978386 |

# APPENDIX E TURBINE ACOUSTIC EMISSION SPECIFICATIONS

# SWT-3.0-113
# Acoustic Emission, Hub Height 99.5 m

**Sound Power Levels**

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels ($L_{WA}$) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

| **Wind speed [m/s]** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **Up to cut-out** |
|---|---|---|---|---|---|---|---|---|---|---|
| Sound power level | 96.6 | 102.6 | 104.7 | 105.8 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 | 106.0 |

*Table 1: Noise emission, $L_{WA}$ [dB(A) re 1 pW]*

**Typical Octave Band**

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

| **Octave band, centre frequency [Hz]** | **63** | **125** | **250** | **500** | **1000** | **2000** | **4000** | **8000** |
|---|---|---|---|---|---|---|---|---|
| Sound power level | 85.2 | 91.5 | 97.2 | 99.3 | 100.1 | 95.7 | 85.3 | 67.8 |

*Table 2: Typical octave band for 6 m/s, $L_{WA}$ [dB(A) re 1 pW]*

| **Octave band, centre frequency [Hz]** | **63** | **125** | **250** | **500** | **1000** | **2000** | **4000** | **8000** |
|---|---|---|---|---|---|---|---|---|
| Sound power level | 86.9 | 94.8 | 99.1 | 100.0 | 99.6 | 98.6 | 91.5 | 75.1 |

*Table 3: Typical octave band for 8 m/s, $L_{WA}$ [dB(A) re 1 pW]*



**Siemens Wind Power A/S**
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# APPENDIX F COORDINATES OF TURBINES

Coordinates of turbines to be installed in the South Branch Wind Farm are listed below in UTM17-NAD83 projection:

| Turbine ID | Easting [m] | Northing [m] |
|---|---|---|
| 1 | 463955 | 4973451 |
| 2 | 464274 | 4973747 |
| 3 | 464593 | 4973522 |
| 4 | 464848 | 4974070 |
| 5 | 469331 | 4981383 |
| 6 | 469791 | 4981543 |
| 7 | 470572 | 4980031 |
| 8 | 471094 | 4980234 |
| 9 | 470765 | 4976717 |
| 10 | 471904 | 4977880 |
| 11 | 472196 | 4978405 |
| 12 | 472795 | 4979009 |
| 13 | 472713 | 4979350 |
| 15 | 472526 | 4975715 |
| Substation | 472339 | 4975747 |

# APPENDIX D

## EMERGENCY PREPAREDNESS AND FIRE PREVENTION PLAN TEMPLATE

*GE Energy, Power Generation*
*Projects and Services*

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Revision 1

# Element 11
# Emergency Preparedness and Fire Prevention

**Revision History**

| Revision | Date | Author | Reason For Change |
|---|---|---|---|
| 1 | 9/5/2006 | D. Olson | Updated as a Global procedure for Power Generation Projects and Services group. |
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**EMERGENCY PREPAREDNESS AND FIRE PREVENTION**

## 1.0 Purpose and Scope

1.1 The purpose of this document is to provide guidance to the site in establishing an Emergency Preparedness Plan. This procedure outlines the course of action associated with emergencies, evacuations, and fire prevention. The site must assess each type of potential incident in order to thoroughly identify equipment requirements, on-site response needs, and outside emergency resources. The attachments provided with this plan are intended to assist site management in documenting these procedures. This instruction applies to all personnel doing business at any GE Energy, Power Generation, Projects and Services sites or customer locations.

1.2 The procedure includes activities at the service center as well as work carried out on the Projects and Services site.

1.3 The EHS Manager conducts a review of the overall emergency response plan on an annual basis. Site-specific plan elements are reviewed during site audits. The Site EHS Representative shall conduct a periodic (quarterly drill) assessment of the plan at the site level to ensure that changes in the site are accounted for in the plan.

## 2.0 Definitions

2.1 **Emergency Coordinator**-The Area Manager or designated alternate who will be the GE Energy, Power Generations, Projects and Services person in charge during any site emergencies.

2.2 **Emergency Escape Equipment (EEE) –** The bag containing the rope and braking system used in case of an emergency escape from the top of the WTG tower.

2.3 **Evacuation Meeting Location**- A designated area where all employees will assemble during a site evacuation emergency.

2.4 **Fire Detection System** – An outside firm or a site monitoring system that detects and sends out a warning in the event of a fire.

2.5 **Fuel/Ignition Sources** – Any material, chemical, etc. that has the potential to increase the size, or possibly start, a fire (i.e. boxes, skids, rags, oil, fuel, paint, etc.).

2.6 **Hazardous Materials**– Any chemical meeting the hazardous criteria of being toxic, flammable, or corrosive defined by country regulations.

2.7 **Highly Combustible Materials** – Any material or chemical that will readily catch fire (i.e. fuel, oily rags, etc.).

2.8 **Reportable Quantity (RQ)** – A designated quantity of a chemical that is reportable to a regulatory agency.

2.9 **Small Spill** – A spill of less than 20L (5 gallons), which can be completely cleaned and contained using a Spill Kit.

2.10 **Tornado Shelter Location** – Any area/location specifically designed or identified for protection from severe weather/tornadoes. An interior room without windows that is designated as a safe haven during tornadoes is considered a tornado shelter.

2.11 **Tornado Warning** - A tornado has been sighted, take cover immediately.

2.12 **Tornado Watch** - Conditions are favorable for a tornado.

**3.0 Procedure**

3.1 **Develop a Site Emergency Preparedness and Fire Prevention Plan** for all sites and field operations utilizing the Site-Specific Template and instructions located in **Appendix A.**

3.1.1 This plan is required to be reviewed any time changes are made to the facility/site, when there are personnel changes that affect the plan or at a minimum, on an annual basis.

3.2 **Develop a Emergency Contact Information Rooster** using the Site-Specific Template in **Appendix B.**

3.2.1 Post the Emergency Contact Information near all site telephones and communicate its location to all site personnel.

3.3 **Complete the Site-Specific Service Area/Center Specific Information** in **Appendix C** and develop a site emergency equipment, evacuation and rally point map**.**

3.3.1 Post the Site Map in prominent areas of the Service Center as well as on evacuation routes.

3.4 Each site must communicate the Site Emergency Preparedness and Fire Prevention Plan to all affected personnel upon initial work date and upon each change to the plan or procedure.

3.4.1 A copy of the plan must also be shared with the local Fire Department and local Emergency Response Committee (and any other emergency response agency that is expected to respond) if required. This should be documented on who and when the plan was shared.

3.4.2 All visitors and contractors must be informed of the emergency alarms, evacuation routes and rally points, and who to contact in case of an emergency using information located in **Appendix B and C** of this Plan.

3.5 Each site must evaluate their need for emergency equipment, i.e., fire extinguishers, 1st aid kits, emergency lighting, etc. and assure that the proper resources are available at the site.

**4.0 Training**

4.1 All GE Energy, Power Generation, Projects and Services employees must be trained in the site's Emergency Preparedness and Fire Prevention Procedure. (EHS Procedure No. HS7: EHS Training).

4.2 Designated GE Energy, Power Generation, Projects and Services employees shall be trained on Oil Spill Prevention and the site-specific spill plans, and/or portable fire extinguishers (where applicable).

4.3 GE Energy, Power Generation, Projects and Services personnel involved with climbing and working in the wind turbine towers must receive training in the emergency escape equipment (EEE) and procedures to escape from the towers, including how to prevent fires while working inside the towers.

## 5.0 Recordkeeping

5.1 All associated paper files and documentation shall be kept in the GE Energy, Power Generation, Projects and Services EHS Filing System. Additional non-paper type files will be located on the EHS Web Measurements Reporting Website, Training Tracker, GE Energy, Power Generation, Projects and Services EHS Homepage, EHS Services, Support Central, local site server and/or the Web Compliance Center or data base.

## 6.0 Auditing

6.1 This procedure will be reviewed annually by completing the CEP Health and Safety Framework element 11 "Emergency preparedness" and updating the procedure accordingly.

## 7.0 Responsibilities

7.1 **Service Site/Region/Area Managers** shall:

7.1.1 Ensure overall procedure implementation and coordination,

7.1.2 Ensure GE Energy, Power Generation, Projects and Services EHS Headquarters is contacted in the event of an injury, fire, chemical spill, or major emergency,

7.1.3 Determine when an evacuation should take place, and

7.1.4 Account for every employee during an evacuation.

7.1.5 Ensure adequate emergency response/escape equipment is available at the site/towers.

7.2 **EHS Manager/Coordinator** shall:

7.2.1 Be responsible for assisting the Site/Region/Area Manager with coordination of response activities, as necessary, and assisting with follow up activities including incident investigation and corrective actions.

7.2.2 Identify the proper emergency escape equipment to be used by Services personnel and visitors.

7.2.3 Determine if a reportable quantity has been spilled and contact the applicable regulatory agencies, as necessary.

7.2.4 Determine if an emergency spill response team should be deployed.

7.2.5 Complete, and update annually, the site specific information listed in **Appendices B and C** and track via EHS Compliance Calendar,

7.2.6 Review this procedure annually,

7.2.7 Ensure all inspections and associated recordkeeping are completed,

7.2.8 Ensure all fire drills and associated recordkeeping are completed,

7.2.9 Ensure all evacuation drills and associated recordkeeping are completed,

7.2.10 Ensure all training and associated recordkeeping is completed, and

7.2.11 Enter all events/incidents into the EHS Measurements Reporting Website.

7.2.12 Develop business specific procedures, which address all types of emergencies possible at the site and operation level. Include these procedures as attachments to this document and review with all site personnel.

7.3 GE Energy, Power Generation, Projects and Services **Employees** shall:

7.3.1 Follow the emergency procedures listed in **Appendix A,**

7.3.2 Notify the Site/Region/Area Manager immediately of any possible emergency,

7.3.3 Control fuel and ignition sources,

7.3.4 Contact the appropriate response personnel in the event of an emergency (ambulance, fire department, police department, etc.).

**8.0 References -** None

**9.0 Appendices**

9.1 Appendix A Emergency Preparedness and Fire Prevention Plan

9.2 Appendix B Site Contacts

9.3 Appendix C Site Specific Information

9.4 Appendix D On-Site Emergency Response Personnel

9.5 Appendix E Bloodborne Pathogen Program

**APPENDIX A**

## GE Energy, Power Generation, Projects and Services
## *Emergency Preparedness and Fire Prevention Plan*

In accordance with the provisions of the General Electric Corporate Policy 20.3 and in support of the Company-wide emphasis on full environmental compliance and minimizing risks to employee health and safety, the GE Energy, Power Generation, Projects and Services Site/Service Center, located in _____ _____ has adopted this Emergency Preparedness and Fire Prevention Plan.

This plan has been completed, reviewed, and approved for implementation by the following individuals:

| *Title, Name and Signature* | *Site Location* | *Date* |
|---|---|---|
| **Region / Area Manager:** | | |
| **EHS Manager / EHS Coordinator:** | | |
| **Other1:** | | |
| **Other 2:** | | |

## 1.0 Site Description

1.1 See Site Description in **Appendix C**.

## 2.0 Location of Copies of the Emergency Preparedness and Fire Prevention Plan

2.1 A copy of the Emergency Preparedness and Fire Prevention Plan will be located at each GE Energy, Power Generation, Projects and Services service site, in the office of the Region/Site Manager, EHS Manager/Coordinator, and in a common area so each employee has access to it.

2.2 Additionally, a copy of the plan will be sent to the local Fire Department and local Emergency Response Committee (and any other emergency response agency that is expected to respond) if required.

## 3.0 Chemical Use & Storage

3.1 The following chemicals may typically be expected to be found at this service site:

***(Enter a list of chemicals typically used at specific sites.)***

3.2 The storage locations of these materials can be found on the Site Map located in **Appendix C**. All containers will be marked or labeled to identify the contents of the container.

## 4.0 Chemical/Hazardous Waste Storage

4.1 Typical chemical wastes that are generated at this site are:

***(Enter a list of chemical wastes generated at specific sites.)***

4.2 Wastes may be accumulated in small quantities at the point of generation. If designated waste accumulation areas (or satellite storage areas) have been established, they can be found on the Site Map in **Appendix C**.

4.3 Wastes are typically accumulated in 200 L (55-gallon) drums that are stored within a secondary containment. As these containers are filled, they are moved to the designated hazardous waste storage area as identified in the Site Map.

4.4 The chemical and hazardous waste storage areas are inspected weekly to prevent releases, explosions, and fires. (EHS Procedure HS16, Chemical Management/HAZCOM).

## 5.0 Potential Emergencies

5.1 The Service Region/Area Manager will be designated as the Emergency Coordinator unless otherwise specified in **Appendix B**. The Service Region/Area Manager will be notified immediately in the event of an emergency. If the emergency is within the capabilities of site personnel, the Emergency Coordinator will coordinate response activities. If the emergency is beyond the capabilities of site personnel, appropriate outside agencies and emergency responders will be notified. These agencies and their corresponding phone numbers are listed in **Appendix B.**

5.1.1 **Post the Emergency Contact Information, Appendix B,** near all site telephones and communicate its location and content to all site personnel.

5.2 Every effort should be made to identify the most suitable ambulance and medical facilities location near the site. These resources, and the services they may provide, include:

5.2.1 Medical Services

5.2.1.1 Hospital: Multiple or severe injury treatments.

5.2.1.2 Ambulance Service/Medical Technicians: Medical response and transport.

5.2.2 Emergency Services

5.2.2.1 Fire Department: Fire response, pre-fire planning, confined space rescue.

5.2.2.2 Hazardous Material Response/Cleanup Groups: Spill response.

5.2.2.3 Local Emergency Planning Commission (where applicable): Community warning/evacuation.

5.2.2.4 Police Department: Strikes, bomb threats, community evacuation, traffic diversion.

5.2.2.5 Neighboring Facilities: Capabilities available through written agreements, fire brigade, hazardous material response team.

5.2.2.6 Other Emergency Services: Severe weather (e.g., hurricane, tornado, severe storm warnings).

5.2.2.7 Local Media: Radio and television stations, coordination with local emergency response agencies on emergency broadcast capability.

5.2.2.8 Local emergency response authorities - authorization of community evacuations and traffic diversion.

5.2.2.9 Information gathered on each outside medical and emergency service providers used should include: address, contact person, telephone number, means of contact, response time and capabilities of the emergency resource. The need for backup or secondary resources should be identified as part of the assessment. Gathering and verifying this information is essential to the proper preplanning and coordination for an emergency. The name, address, and phone number of these agencies must be included on the Emergency Contact List (Appendix B: Emergency Contacts List). This list must be posted at the site.

5.2.2.10 Once the emergency resources are identified, the Site EHS Representative and/or Site Manager should coordinate with these resources to effectively prepare for potential emergency situations. Coordination should include, as necessary:

5.2.2.10.1 Providing documentation of plans, procedures and/or maps of the site to the fire department or other responders;
5.2.2.10.2 Site tours for fire and medical response emergency resources;
5.2.2.10.3 Training sessions, emergency drills or simulations with fire, medical, and confined space rescue providers.

5.2.2.11 If external emergency response capabilities are not available to the degree needed by the site, then the site must develop internal resources and internal response capability, i.e., fire, medical and spill response capabilities.

5.2.3 Training

5.2.3.1 All site employees must be trained on site-specific emergency procedures. This training should be done as part of site orientation training and shall include the following areas:

5.2.3.1.1 Alarms and other emergency communications used both at the site and at the customer/host facility as applicable.
5.2.3.1.2 Evacuation procedures including routes and assembly areas to be used.
5.2.3.1.3 Accident reporting procedures.
5.2.3.1.4 Location of first-aid kits and identification of first-aid providers.
5.2.3.1.5 Chemical spill on-site reporting procedures.

5.2.3.2 The site should review each of its emergency response procedures to determine which response actions on-site personnel will perform. Because of the intensive training requirements for certain emergency response functions development and use of on-site responders should only be considered if outside emergency response capabilities are not available. The On-Site Emergency Response Personnel (Appendix D On-Site Emergency Response Personnel) list provided shall be completed for all on-site first aid trained personnel; spill responders, and members of a confined space rescue team or fire brigade as applicable. Personnel who will be performing emergency response activities require additional training. Training requirements for emergency response personnel include:

5.2.3.2.1 Chemical Spill Responders 40 hours of HAZMAT Response Training plus 8 hours of annual refresher training.
5.2.3.2.2 Fire Brigades Training equivalent to that received at Fire Fighting Training Schools, refresher training must be on a quarterly basis.
5.2.3.2.3 Use of Fire Extinguishers. Annual refresher training on the use fire extinguishers.
5.2.3.2.4 Confined Space Rescue Training in CPR and First Aid, use of personnel protective equipment including SCBAs, use of rescue equipment, and practice confined space rescue on an annual basis.
5.2.3.2.5 The EHS Manager/Coordinator must approve all On-Site Emergency Response Personnel.

5.2.4 Emergency Equipment

5.2.4.1 The site must have readily available the correct equipment to effectively respond to emergency situations. Emergency equipment must be maintained through preventive maintenance procedures (inspection and testing) in accordance with the manufacturer's recommendation to ensure that equipment is in ready condition for use. The location of Emergency Equipment is provided as (Appendix C - Service Area/Center Specific Information – Site Map). The type of emergency equipment available on site should be reviewed periodically to reflect changing site conditions.

5.2.4.2 Equipment inspections should be tracked using the Compliance Calendar.

5.2.5 Alarm and Communication Systems

5.2.5.1 An alarm or other system (e.g., public address, sirens, lights) is needed at the site to notify site personnel in the event of an emergency or that an evacuation is required. The evacuation notification system should be recognizable by all personnel and distinguishable from signals, warnings, buzzers, bells or lights used at the site for other purposes. Communication systems (e.g., telephone, radio and PA systems) are often used as part of the emergency response procedures. An inexpensive air horn is a practical alternative to installing permanent alarm systems at the site. All alarms and communication equipment should be periodically inspected and tested as applicable to ensure proper functioning.

5.2.5.2 Field Technicians are required to always have a form of communication with the service center.

**ATTACHMENT 1**

## Fire and Explosion

### 1.0 Potential for Fire & Safe Operating Procedures

1.1 Potential ignition sources at this GE Energy, Power Generation, Projects and Services service site are:
*(Insert potential ignition sources at your site here)*

1.2 It is required that all fuel and ignition sources (flammable materials) be removed from the site or reduced as much as practically possible.

1.3 Smoking is only allowed in designated areas as identified in **Appendix C**.

### 2.0 Control of Fuel Sources

2.1 All trash must be placed in designated containers.

2.2 Flammable liquids must be stored in approved containers and placed in flammable liquid storage cabinets when not in use.

2.3 Accumulations of paper, cardboard, or other highly combustible materials should be kept to a minimum.

2.4 Areas around fire extinguishers, exits, and electrical panels must be kept clear and unobstructed.

2.5 Combustible material should always be stored away from any ignition sources.

2.6 When transferring flammable liquids from one container to another, always ground and bond the containers to prevent a static electricity spark.

### 3.0 Control of Ignition Sources

3.1 Do not use equipment that has exposed wiring, cracked or damaged switch plates.

3.2 Use only approved extension cords for temporary wiring.

3.3 Never use extension cords in place of permanent wiring.

3.4 Do not use cords that are damaged or frayed.

3.5 Do not load motors beyond their capacity.

3.6 Smoking is allowed in designated areas only and all butts must be disposed of in designated containers.

3.7 If smoke or smoldering is detected, disconnect the power supply.

3.8 When performing welding, cutting or open flame operations outside a designated weld area, a special hot work permit is required (see GE Energy, Power Generation, Projects and Services EHS Procedure No. HS13.4 – Hotwork).

## 4.0 Fire Fighting Equipment

4.1 Fire extinguishers are portable extinguishing equipment for persons to respond to small-scale fires (incipient stage). Where fire extinguishers will be used, appropriate provision should be in place for the proper selection, placement and maintenance (inspection and testing) of these units. The following provisions should be used to satisfy these requirements:

4.1.1 Selection - Fire extinguishers should be selected according to the class of workplace hazards and their severity. The fire classes include: Class A - Ordinary Combustibles; Class B - Flammable Liquids; Class C - Electrical Equipment; and Class D - Combustible Metals. Fire extinguisher size and capacity should be representative of the hazard severity.

4.1.2 Placement - Fire extinguishers should be identifiable (e.g., readily recognizable) in an accessible location to personnel. In general extinguishers should be placed at the entrances to areas where fire risks are present, but should not be placed immediately adjacent to the fire source, where they would be inaccessible in a fire. Within large areas where fire risks are present, fire extinguishers should be located within 16.6 meters (50 feet) of fire sources to facilitate prompt response. The location of the extinguishers should be marked with clearly visible signs, and parked vehicles or stored materials must not obstruct access to the extinguishers.

4.1.3 Maintenance (Inspection and Testing) - Portable fire extinguishers should be visually inspected on a monthly basis for pressure, physical condition of activation pin and handles, and clear access to verify their use status. Fire extinguishers should receive a maintenance check and hydrostatic testing on a defined schedule according to the type of extinguisher.

4.1.4 Training – All site personnel who are expected to use Fire Extinguishers should be trained to use them.

## 5.0 Inspections

5.1 The following inspections of Fire Protection Equipment must be completed. All inspections are to be tracked via the region's Compliance Calendar.

5.1.1 Automatic Sprinkler System requires annual inspections by a qualified person.

5.1.2 Emergency Lighting requires semi annual inspections – verify that the emergency lighting will engage during an emergency situation.

5.1.3 Fire Detection Systems require annual inspections – verify that the detection systems will engage in the event of a real emergency. This inspection is usually completed by a detection company.

5.1.4 Fixed Extinguishing Systems require annual inspections – these include standpipes, etc. Ensure all systems are in complete working order.

5.1.5 Portable Fire Extinguishers in the service centers require monthly inspections– verify all extinguishers have the required charge, are in the correct locations and properly marked.

5.1.6 Portable Fire Extinguishers also require an periodic maintenance inspection based on the country specific regulations by a qualified person, as well as periodic hydrostatic testing depending on the type of extinguisher.

5.1.7 Fire extinguishers in the WTG will be inspected each time the turbines are maintenanced according to country specific regulations

## 6.0 Response to A Fire

### 6.1 Response to a Fire in the Service Center

6.1.1 The first employee discovering a fire shall pull the nearest fire alarm and/or dial the site emergency number as listed in **Appendix B**. If the employee has the appropriate fire extinguisher training, and the fire is incipient, the employee can try to fight the fire.

6.1.2 Evacuate the immediate area.

6.1.3 Notify the Region/Area Manager, who will direct the fire department to the proper location.

6.1.4 The Region/Area Manager and designated personnel will ensure the evacuation of personnel has been successfully completed and that all personnel are accounted for.

6.1.5 People should assemble at the designated Evacuation Meeting Location as described in **Appendix C.**

6.1.6 The Service Region/Area Manager will also ensure that equipment is shutdown as necessary.

6.1.7 The local fire department and the Site Manager will determine when normal operations can be resumed.

### 6.2 Response to a Fire at Substation / Transformer:

6.2.1 Call the site emergency number immediately. Fire department must be called immediately to contain this type of fire.

6.2.2 Do not try to extinguish the fire due to high voltage hazards. Cannot use conventional fire extinguishers.

6.2.3 Site to report the fire to Customer representative and appropriate utility company.

### 6.3 Respond to fire which is out of control

6.3.1 Barricade hazardous area.

6.3.2 Fires which cannot be extinguished by an employee using a fire extinguisher must be fought by an external fire department. As a general rule, if there is not a fire department, which can reach the site within 20 minutes, the site should have a fire brigade, or access to a fire brigade through mutual aid agreements.

**7.0 Emergency Drills**

7.1 The service center will **conduct at least one emergency drill per quarter**. This also enables the local fire department to get a chance to become familiar with our site and be more prepared in the event of an actual emergency. Most fire departments are more than willing to help out with emergency drills. The following four types of drills must be conducted during the year;

7.1.1 Rescue

7.1.2 Emergency Services – Medical

7.1.3 Severe Weather

7.1.4 Fire Drill –Site Grounds or Service Center

7.2 Each drill above must be performed at least once during the calendar year with a drill being conducted each quarter. Multiple drills may be conducted at one time but a drill must be conducted each quarter.

7.3 Conducting a emergency drill involves the following steps:

7.3.1 Plan the drill.

7.3.2 Coordinate with the local fire department and fire detection company if conducting a fire drill.

7.3.3 Conduct the drill.

7.3.4 Ensure the appropriate evacuation takes place.

7.3.5 Time the evacuation.

7.3.6 Check the site for people who did not leave, areas where the alarm can't be heard, or other potential problems.

7.3.7 Give employees the OK to come back inside.

7.3.8 Critique the drill with the local fire department if they are present.

7.3.9 Write up a brief report of how the drill went and keep it in your site EHS files.

**8.0 Emergency Evacuation**

8.1 **Evacuation from the Site/Service Center:**

8.1.1 A site evacuation map must be posted in commonly used locations inside the service center. (lunch rooms, offices, bathrooms, etc).

8.1.2 A designated Evacuation Meeting Location must be identified for each service center. A Back-Up Evacuation Meeting Location must also be identified in case the primary Evacuation Meeting Location is affected by the emergency (i.e.—wind direction during a fire makes the original Evacuation Meeting Location unusable.)

8.1.3 All service center personnel must receive training of the site's emergency evacuation procedures within the first week of employment at the Service Site.

8.2 **During an evacuation the designated Emergency Coordinator** shall:

8.2.1 Keep exits marked, clear and accessible at all times.

8.2.2 Instruct employees not to try to fight any fire (unless incipient), but simply to report it immediately.

8.2.3 Notify employees of any evacuation and then verify that all employees are safely at the Evacuation Meeting Location.

8.2.4 Comply with any instructions from the Fire Department.

8.2.5 Consult with the Fire Department / EHS as the situation permits and/or warrants.

8.2.6 Consult with the Fire Department to determine the extent of any evacuation necessary.

8.2.7 Supervise any evacuation that is ordered.

8.2.8 Respond to direction from the Fire Department / EHS and maintain communication with others.

8.2.9 Verify that isolated areas are checked for personnel.

8.2.10 Conduct head count to ensure everyone is accounted for. The designated Emergency Coordinator will notify the fire department if any persons are thought to be inside the building.

8.2.11 The local fire department Fire Chief and the designated Emergency Coordinator will determine when normal operations can be resumed.

8.3 **During an evacuation Employees** shall:

8.3.1 Evacuate the building from the nearest exit.

8.3.2 Report to the designated site Evacuation Meeting Location outside of the building as listed in **Appendix C**.

8.4 **Evacuation from the Site/Service Center:**

8.4.1 Drills from the Service Center shall be conducted quarterly

These drills shall be scheduled and entered into the region's Compliance Calendar.

**ATTACHMENT 2**

## Medical Emergency

### 1.0 Emergency Injury or Illness in the Site/Service Center:

1.1 All facilities should have basic first aid supplies available at the site and a person trained to provide first aid and cardiopulmonary resuscitation (CPR) in the absence of an infirmary, clinic or hospital in the near proximity. It is recommended that all locations, particularly those with unacceptable emergency response times, have at least two persons per shift who are trained to administer basic first aid and cardiopulmonary resuscitation. In areas where accidents resulting in suffocation, severe bleeding, or other life threatening injury or illness can reasonably be expected, a 3 to 4 minute response time, from time of injury to time of administering first aid, is required. In other circumstances, i.e., where a life-threatening injury is an unlikely outcome of an accident, a 15-minute response time is acceptable. If site personnel are trained and expected to provide first aid, the appropriate personal protective equipment and precautions to prevent exposure to blood borne pathogens should be provided as shown in (Appendix E Blood borne Pathogen Program).

1.2 If emergency medical attention is required for an employee, call the local emergency medical services as listed in **Appendix B.**

1.3 Notify the Site Manager or EHS Coordinator of the injury/illness.

1.4 An ambulance shall be used to transport the victim to the appropriate hospital emergency room.

1.5 The Site Manager or injured employees Manager shall fill out an accident investigation report and the employee, if able, shall fill out an Employee First Notice of Injury (GE Energy, Power Generation, Projects and Services EHS Procedure No. HS6: Accident Reporting & Investigation).

1.6 All accident investigation reports will be sent to the service region EHS Manager where the determination shall be made as to whether or not the accident will be an OSHA Recordable.

1.7 The incident will then be appropriately entered into the EHS Measurements Reporting Website within 24 hours.

### 2.0 Non-emergency Injury or Illness

2.1.1 If the employee needs attention by a doctor on a non-emergency basis, the Site Manager or EHS Coordinator will ask the employee if he/she wants to see a doctor.

2.1.2 The Site Manager or EHS Coordinator will arrange transportation and designate someone to accompany the employee to the doctor.

2.1.3 If the nature of the injury permits, the Site Manager or EHS Coordinator shall call a designated cab company to transport the employee to the doctor.

2.1.4 GE Energy, Power Generation, Projects and Services EHS Headquarters must be called immediately.

2.1.5 The Site Manager or injured employee's Manager shall fill out an accident investigation report and the employee, if able, shall fill out an Employee First Notice of Injury (GE

Energy, Power Generation, Projects and Services EHS Procedure No. HS6: Accident Reporting & Investigation).

2.1.6 All accident investigation reports will be sent to the service region EHS Manager where the determination shall be made as to whether or not the accident will be an OSHA Recordable.

2.1.7 Within 24 hours of the non-emergency injury or illness, the incident will be appropriately entered into the EHS Measurements Reporting Website by the site.

**ATTACHMENT 3**

## Chemical Spill or Leak

**1.0 Response to a Chemical Spill at the Site/Service Center:**

1.1 The Service Area Manager or EHS Coordinator should be notified immediately.

1.2 Every effort will be made to prevent spills from entering the sewer system and local waterways. Personnel working with chemicals or responding to a spill shall wear proper personal protective equipment, such as safety goggles, gloves, etc.

1.3 Only trained personnel in spill response shall respond to a chemical spill or leak. All others must notify the Region / Area Manager immediately or the EHS Manager/Coordinator.

1.4 For larger spills, additional assistance will be obtained from outside emergency responders or spill cleanup contractors. Spill response materials are kept at the site for small spills. The locations of these spill kits are identified on the Site Map in **Appendix C**.

**2.0 SWIM**

2.1 **Stop the Spill**—Up-righting a container, closing a valve, or shutting down the equipment.

2.2 **Warn Others**—to stay clear of the area.

2.3 **Isolate the spill area**—Keep personnel out of the area.

2.4 **Minimize** exposure and the spread of the spill. Place absorbent materials around the spill to contain its spread. Do not stand in the spilled material while doing this.

**3.0 The primary concerns for responding to chemical spill emergencies** are:

3.1 Ensure the safety of all employees.

3.2 Notify appropriate emergency organizations to properly respond to the emergency. (i.e., fire department, ambulance).

3.3 Get emergency assistance to anyone who has been exposed to the hazardous chemicals.

3.4 Prevent any spills from entering the sanitary and storm sewers.

3.5 Minimize site personnel exposure to the hazardous chemicals by only allowing qualified personnel to respond to the emergency.

3.6 Investigate to determine the cause, effect and damage, if any, and take steps to correct.

3.7 Arrange for timely clean up of the chemical spill to minimize the potential of contaminating the environment or further contamination of the site.

**4.0 Notifications**

4.1 **The Region/Area Manager must:**

4.1.1 Immediately notify the service region EHS manager to provide all necessary information to establish the extent of the emergency, including:

4.1.2 Amount spilled/leaked,

4.1.3 Chemical(s) involved,

4.1.4 Time spill/leak occurred, and

4.1.5 Where spill/leak occurred.

4.1.6 If a spill impacted soil, water, etc.

4.1.7 Person responding to spill/leak.

4.1.8 The Fire Department shall be notified should a spill occur that is not controllable by the employees in the immediate area and requires the evacuation of the building.

4.1.9 Should the spill occur in the site and evacuation is necessary, all employees shall immediately evacuate the building to the designated Evacuation Meeting Location.

4.2 **Reportable Quantities**

4.2.1 If a reportable quantity has been released, GE Energy, Power Generation, Projects and Services region EHS Manager or Customer will notify the appropriate regulatory agencies, as applicable:

4.2.1.1 U.S.

- The National Response Center
- The State Emergency Response Commission
- The Local Emergency Planning Committee

5.2.1.2 Europe/Asia

- Follow country specific regulations

4.2.2 Once the extent of the chemical spill has been determined, GE Energy, Power Generation, Projects and Services service region EHS Manager, the Site Manager and Customer will make the decision as to the appropriate emergency spill response team.

4.3 **Spills that reach the sewer system**

4.3.1 The Customer representative shall contact the applicable Sewer District. This notification must be followed by a detailed written statement describing the causes of the discharge and the measures being taken to prevent future occurrence.

## ATTACHMENT 4

## Hurricane (US only)

**1.0** Hurricanes involve high winds and heavy rains which often result in power failures, inaccessible roads and structural damage to buildings. Hurricanes generally occur from August through October.

**2.0** **To prepare for a hurricane**, the following must be completed:

2.1 Cover all large windows with shutters or plywood.

2.2 Clear out important paperwork from desk drawers, wrap them in plastic, and store on a high shelf.

2.3 Cover affected equipment, such as

2.3.1 Computers and related Equipment (Printers, Monitors, etc.)
2.3.2 Fax Machines
2.3.3 Photocopiers
2.3.4 Electrical devices (Strip Plugs, Power or Extension Cords, etc.)

2.4 Unplug all affected equipment from wall.

2.5 Move the affected equipment away from any unprotected windows or doors.

2.6 Cover affected equipment with Vizqueen or Plastic Bags.

2.7 Move the affected equipment that is on the ground to the top of desks if possible.

2.8 Backup all data from your Computer and take backup media off site, the data you save on the network drives will be protected.

**3.0** In the event of a possible Hurricane in the US, connect to the FEMA Website at http://www.fema.gov/fema/trop.htm. This site will be active during the Hurricane season and will have up-to-the-minute hurricane information. The GE Energy, Power Generation, Projects and Services Site Manager will determine if evacuation is necessary.

3.1 The National Weather Service will issue a hurricane watch when there is a threat to coastal areas of hurricane conditions within 24-36 hours. To assure the safety of all GE Energy, Power Generation, Projects and Services service site personnel the Site Manager may call for the immediate evacuate or closure of the site when a hurricane watch has been issued or the site is positioned within the greatest potential path of the storm.

3.1.1 Site Evacuation

3.1.1.1 When calling for the evacuation of the site the site manager must assure that all personnel on site are accounted for and all off site personnel are made aware of the site evacuation/closure.

3.1.1.2 A list of contact information for all site personnel shall be collected by the site manager for the purpose of recall once the danger has passed.

**ATTACHMENT 5**

## Tornado (US Only)

***1.0*** *Tornadoes involve highly localized, extremely destructive high winds. Tornadoes generally travel from southwest to northeast. Tornado warnings and watches may only be forecast within hours of a tornado actually occurring. However, tornadoes may touch down with little warning, and therefore, preparation time may be minimal.*

1.1 *Each site must have a radio and a designated person who is responsible for monitoring the radio during inclement weather for tornado announcements, where geographically applicable.*

1.2 *The bulletin will then be identified as a tornado "watch" or a tornado "warning" (severe thunderstorms and other weather conditions are also announced).*

1.2.1 ***Watch****: Continue to monitor the radio closely.*

1.2.2 ***Warning****: In the event of a tornado warning proceed immediately to the site specific gathering location. Take the weather alert radio to the tornado shelter area, and continue to monitor it until the warning is over.*

***2.0 During a Tornado Warning, all Employees*** *shall:*

2.1 *Clear off important paperwork and remove from the top of desks and store in a secure spot.*

2.2 *Turn off equipment and machines.*

2.3 *Move affected equipment away from any unprotected windows or doors.*

2.3.1 *Computers and related Equipment (Printers, Monitors, etc.)*
2.3.2 *Fax Machines*
2.3.3 *Photocopiers*
2.3.4 *Electrical Devices (Strip Plugs, Power or Extension Cords, etc.)*

2.4 *Avoid elevators and extinguish open flames. If you are at a location that has an elevator, do not use it during an emergency.*

2.5 *Meet at the Tornado Shelter Location.*

2.6 *Monitor the weather radio that should be located in each site.*

2.7 *Crouch down and cover yourself from falling debris. Use either a jacket or cushion.*

2.8 *Take a look around for equipment that may fall or tip over in the area and stay clear.*

2.9 *Do not evacuate the building until told to do so.*

2.10 *Once building is evacuated, don't smoke anywhere near the premises.*

***When designating a Tornado Shelter Location please consider the following:***

- *Interior rooms and halls on the lowest floor are the safest,*
- *Stay away from glass enclosed places or areas with wide-span roofs such as auditoriums, theaters, and warehouses,*
- *A corner would be safer than the middle of the wall, and*
- *A bathroom, closet, office, or maintenance room with short walls would be the safest area, especially if it was on the north or east side of the building.*

**ATTACHMENT 6**

## Earthquake

**1.0** In the event of an earthquake the following shall occur:

1.1 Take cover to protect yourself from injury.

1.2 If there is overhead glass in the area, cover yourself from falling debris.

1.3 Take a look around for equipment that may fall or tip over in the area and stay clear.

1.4 Do not run from buildings during an earthquake. Most injuries occur outside from flying debris, falling objects or from downed high-voltage wires.

1.5 Avoid elevators and extinguish open flames. If you are at a location that has an elevator, do not use it during an emergency.

1.6 DO NOT smoke or light a match/lighter, as there may be ruptured gas lines.

1.7 Once the initial shock is over, calmly walk out of the building to the site's Evacuation Meeting Location. Do not reenter the building until the structural damage has been assessed.

**When designating an Earthquake Shelter Location please consider the following:**

- Safe areas include: doorways, under doorsills, or beside heavy upright beams
- Try to get under the nearest heavy table, desk, bench or machine.

**ATTACHMENT 7**

## Flood

**1.0** Flooding can occur as a result of either long-term, sustained precipitation or short-term intense weather events. Monitoring of emergency broadcasts are important to ensure proper preparation for such events.

**2.0** Prepare for a flood by:

2.1 Secure work area and turn off equipment and machines.

2.2 Cover all large window with shutters or plywood.

2.3 Clear out important paperwork from desk drawers wrap them in plastic and store on a high shelf. Affected equipment during a flood are:

2.3.1 Computers and related Equipment (Printers, Monitors, etc.)
2.3.2 Fax Machines
2.3.3 Photocopiers
2.3.4 Electrical Devices (Strip Plugs, Power or Extension Cords, etc.)

2.4 Unplug all affected equipment from wall.

2.5 Cover affected equipment with Vizqueen or Plastic Bags.

2.6 Backup all data from your Computer and take backup media off site, the data you save on the network drives will be protected.

## ATTACHMENT 8

## Bomb Threat

**Note:**
**All bomb threats must be taken seriously!!!**

**0.0 The person receiving the call** shall:

0.1 Notify the Service Region/Area Manager immediately.

0.2 Listen very carefully, assisted, if possible, by another person who will take careful notes to ensure getting the exact language of the message. Pay special attention to if the caller is a man or a woman, any distinguishing accents, and any background noises that might be heard (children, traffic, etc.).

0.3 See if another person can get the call traced, by contacting the police department, while the caller is kept on the phone.

0.4 Attempt to get the caller to repeat the message several times to elicit further information as to:

0.4.1 Who the caller is

0.4.2 Location of the calling party

0.4.3 Where the device may be hidden

0.4.4 When it is scheduled to detonate

0.4.5 Why GE Energy, Power Generation, Projects and Services is being bombed

The following phone script can also assist in information gathering and should be available to personnel answering the site phone.

**1.0 The Area / Site Manager** shall:

1.1 Evacuate the site immediately.

1.2 Contact the Police Department listed in **Appendix B**.

## ATTACHMENT 9

### SECURITY

These guidelines are designed to provide a handy reference on security procedures that might be implemented to protect property, personnel, material, and sites against terrorist and illegal or criminal acts. Security is not a one size fits all discipline. The appropriate level of security should be determined based on the prevailing threat level where a particular site is located. For additional guidance on developing site-specific security procedures please reference the GE Energy Security Guidelines web site.

### 9.1 SUSPICIOUS MAIL PACKAGES (HANDLING OF)

All employees who handle mail have a responsibility to consistently follow the established safety procedures. One of these procedures is to maintain caution and follow directives when dealing with suspicious mail in terms of explosives and biochemical threats. The goal of this procedure is to provide the steps that you must follow in order to protect yourself and all other personnel in the site. We must be ready to act in the event any of us come across a piece of suspicious mail. Be aware that explosive or biohazard material can be enclosed in either a package or an envelope.

1.1 What makes a piece of mail or parcel suspicious?

- 1.1.1 Has protruding wires, strange odors or stains
- 1.1.2 Lopsided, oddly shaped
- 1.1.3 Has an unusual weight, given its size
- 1.1.4 Shows a city or state in the postmark that doesn't match the return address
- 1.1.5 No return address or an addressed that cannot be verified
- 1.1.6 Addressed to someone no longer at your location or is outdated in any way
- 1.1.7 Marked with restrictive statements, such as "Personal" or "Confidential"
- 1.1.8 Mail may have distorted handwriting or the name and address may be prepared with homemade labels or cut and pasted lettering
- 1.1.9 Mail bombs may have excessive postage. Letter bombs may feel rigid or appear uneven or lopsided
- 1.1.10 Package may be unprofessionally wrapped, several combinations of tape used to secure the package
- 1.1.11 Package may be endorsed " Fragile - Handle With Care" or "Rush - Do Not Delay"
- 1.1.12 Package bombs may make a sloshing sound, but generally do not tick or buzz

**THE SITE WILL NOT DELIVER ANY MAIL AND/OR PACKAGE IF DETERMINED SUSPICIOUS**

1.2 Use of Gloves for Handling of Mail

- 1.2.1 As a general rule, gloves are not required to handle mail. However, if a person desires to use gloves it is recommended that N-dex nitrile type (not latex) gloves be used since these are less likely to cause an allergic reaction. Employees are recommended to use gloves if he/she has

open cuts or sores until these injuries heal. Mailrooms are expected to maintain a supply of gloves for employee use.

1.2.2 Employees who wear gloves to handle and deliver mail are to discard the gloves by traditional means (garbage) upon completion of a shift or a work period. For instance, if an employee handles mail in the morning and leaves the work area for lunch, the gloves would be discarded and a new pair would be made available to the employee for the afternoon work period.

**Plastic sealing or Zip Lock bags will be available in each site for containment of any suspicious substances.**

1.3 What should I do if I receive a suspicious package in the mail?

1.3.1 Do not try to open the package or envelope.

1.3.2 Isolate the parcel or letter, place it is a plastic bag or other container, and do not move it further.

1.3.3 Evacuate the immediate area.

1.3.4 Wash hands with soap and warm water

1.3.5 Make a list of all the people who had contact with the package or envelope, include contact information, and provide the list to the emergency responders.

1.3.6 Emergency response personnel will take the parcel away, assess the situation and coordinate with officials, and report back to you with information.

1.3.7 Contact the following personnel immediately:

- Site manager, site EHS coordinator, and site medical personnel (if present)
- Energy HQ Security, EHS, Medical and Facilities, as applicable
- Local police

1.4 What should I do if I am exposed to a substance that I suspect may be a dangerous substance?

1.4.1 DO NOT try to CLEAN UP the powder. COVER the spilled contents immediately with anything (e.g., clothing, paper, trash can, etc.) and do not remove this cover!

1.4.2 Then LEAVE the room and CLOSE the door, or section off the area to prevent others from entering (i.e., keep others away).

1.4.3 Report the incident to your supervisor immediately who should notify the above PS personnel, building security and police.

1.4.4 Ensure everyone who had contact with the piece of mail washes his or her hands with soap and water.

1.4.5 Make a list of all the people who had contact with the package or envelope, include contact information, and provide the list to the emergency responders.

1.4.6 Place all items worn in contact with the suspicious mail in plastic bags or other container and present them to emergency response personnel.

1.4.7 Emergency response personnel will take the parcel away, assess the situation and coordinate with officials, and report back to you with information.

1.4.8 SHOWER with soap and water as soon as possible.

1.4.9 **The Supervisor or Site Manager is to ensure that the following take place:**

1.4.9.1 Notify PS security, EHS, Medical and Facilities.

1.4.9.2 Notify the local police and the Postal Inspector.

1.4.9.3 Notify local, county, and state health departments.

1.4.9.4 Ensure that all persons who have touched the letter wash their hands with soap and water.

1.4.9.5 List all persons who have touched the letter and/or envelope. Include contact information. Provide the list to the emergency responders.

1.4.9.6 Place all items worn when in contact with the suspected mail piece in plastic bags and keep them wherever you change your clothes and have them available for law enforcement agents.

1.4.9.7 If prescribed medication by medical personnel, take it until otherwise instructed or it runs out.

1.5 POSSIBLE ROOM CONTAMINATION BY AEROSOLIZATION:

1.5.1 Turn off local fans or ventilation units in the area.

1.5.2 LEAVE area immediately.

1.5.3 CLOSE the door, or section off the area to prevent others from entering (i.e., keep others away).

1.5.4 Report the incident to your supervisor immediately who should notify the police & building security

1.5.5 SHUT down air handling system in the building, if possible.

1.5.6 List all people who were in the room or area. Give this list to both the local public health authorities so that proper instructions can be given for medical follow-up and to law enforcement officials for further investigation.

A copy of these guidelines can be found on the EHS Support Central for posting. Additionally, a Suspicious Package/Letter/Materials Emergency Procedures will help with information gathering in case of such an event.

## ATTACHMENT 10

### OTHER EMERGENCIES

**1.0 Power Outage**

1.1 Employees should notify the Site Manager, if the outage is not immediately apparent.

1.2 The employees involved should take immediate steps to:

1.2.1 Ensure the safety of personnel.
1.2.2 Restore service.
1.2.3 Investigate to determine cause, effect and damage, if any, and take steps to correct.
1.2.4 If required, call the local utility company. The site-specific utility company is listed in **Appendix A**.

**2.0 Demonstrations or Civil Disturbances (Including Picketing)**

2.1 Any employee seeing evidence of a demonstration within the immediate area of the site shall inform the Site Manager who will in turn notify the co-located business' GE Manager (if applicable).
2.2 In the event of an act of civil disturbance or other security threat such as assaults, the local police department shall be notified immediately. Attempts to handle potentially violent employees shall not be made by on-site personnel including security with out the support of the police.

**3.0 Media Requests**

3.1 In the event of an EHS incident that gains media attention, **NO ONE** at the site shall have any contact with the media before contacting the Customer and GE Energy, Power Generation, Projects and Services service region EHS Manager.

**APPENDIX B**

## Emergency Contact Information

**Site Emergency Number**

| | **Phone Number/Business** |
|---|---|
| Emergency Number(at site): | |

**Site Specific Contacts**

| Title | Contact | Phone Number |
|---|---|---|
| Area / Site Manager | | **Work:**<br>**Mobile:** |
| EHS Coordinator | | **Work:**<br>**Mobile:** |
| Site Emergency Coordinator | | **Work:**<br>**Mobile:** |
| Service region EHS Manager | | **Work:**<br>**Mobile:** |
| Customer Representative | | **Work:**<br>**Mobile:** |

**Emergency Contacts**

| Agency | Contact | Phone Number |
|---|---|---|
| Fire Department | | |
| Police Department | | |
| Ambulance Service | | |
| Hospital | | |
| Electric Utility Company | | |
| Spill Response Team | | |
| Sewer District | | |
| State Emergency Response Com. (US only) | | |
| Local Emergency Planning Com. (US only) | | |
| National Response Center (US only) | NA | 1-800-424-8802 |

APPENDIX C

**Service Area/Center Specific Information**

The GE Energy, Power Generation, Projects and Services area/center is located at ***(name and location of service area/center)***. The service area/center employees approximately ***(insert number)*** people working in ***(insert number)*** shifts. The site, a drawing of which is included, encompasses ***(insert number)*** square meters.

**Work at the service area/center includes:**

***(Provide a description of the type of work performed at the site)***

The site is co-located with _____. The co-located site performs the following type of work (if applicable): _____

_____

_____

Site/Service Center Evacuation Meeting Location: ***(list)***

Alternate Evacuation Meeting Location: ***(list)***

Tornado Shelter Location: ***(list)***

Earthquake Shelter Location: ***(list)***

Fire Protection Equipment

Site/Service Center Specific Fire Detection System(s):

- ☐ Pull Box to Fire Department
- ☐ Automatic to Site Alarm
- ☐ None

Site/Service Center Specific Fire Alarm System(s):

- ☐ Manual Activation
- ☐ Automatic Activation
- ☐ None

Site/Service Center Specific Fire Suppression System(s):

- ☐ Portable A,B,C Fire Extinguishers
- ☐ Sprinkler System – Office
- ☐ Sprinkler System – Shop
- ☐ Sprinkler System – Other_____
- ☐ Emergency Lighting – Office
- ☐ Emergency Lighting – Shop
- ☐ Illuminated Exit Signs
- ☐ None

Portable fire extinguishers, emergency eyewashes, safety showers, emergency first aid kits, and emergency spill response kits are located throughout the site. The location of this equipment is identified on the service center map.

**Insert Site Map as next page and indicate the following:**

| | | |
|---|---|---|
| Hazardous Waste Storage Areas | Spill Kit Locations | AED |
| Chemical Storage Locations | Emergency Eyewashes | Safety Showers |
| Portable Fire Extinguishers | First Aid Kits | Fire Alarms |

Information Completed By: _____ Date: _____

**APPENDIX C (cont)**

Service Area/Center Specific Information

# Attach Site Map

Appendix D
On-Site Emergency Response Personnel

## *On-Site 1st Aid/CPR Personnel*

| *Contractor* | *Individuals Name* | *Training Up-to-Date (yes/no)* |
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## *On-Site HAZMAT Personnel*

| *Contractor* | *Individuals Name* | *Training Up-to-Date (yes/no)* |
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Appendix D (cont)
On-Site Emergency Response Personnel

## *On-Site Confined Space Rescue*

| *Contractor* | *Individuals Name* | *Training Up-to-Date (yes/no)* |
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## *On-Site Fire Brigade*

| *Contractor* | *Individuals Name* | *Training Up-to-Date (yes/no)* |
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**Appendix E**
**Bloodborne Pathogen Program**

## 1.0 Purpose

1.1 An infection control plan must be prepared for all persons who handle, store, use, process, or disposes of infectious medical wastes. The plan includes requirements for personal protective equipment, housekeeping, training, and a procedure for reporting exposures.

## 2.0 Responsibilities

2.1 The EHS Manager will conduct the Bloodborne Pathogen Program and maintain records of training and inspections for this program.
2.2 Management will ensure proper conduct of the program though inspections, record keeping and periodic audit.

## 3.0 Definitions

3.1 **Biological Hazard.** The term biological hazard or biohazard is taken to mean any viable infectious agent that presents a risk, or a potential risk, to the well being of humans.
3.2 **Medical Wastes/Infectious Wastes.** All waste emanating from human or animal tissues, blood or blood products or fluids. This includes used first aid bandages, syringes, needles, sharps, material used in spill cleanup and contaminated PPE or clothing.
3.3 **Universal Precautions.** Refers to a system of infectious disease control that assumes that every direct contact with body fluids is infectious and requires every employee exposed to be protected as though such body fluids were infected with blood-borne pathogens. All infectious/medical material must be handled according to Universal Precautions.

## 4.0 Hazards

4.1 Unprotected exposure to body fluids presents the possible risk of infection from a number of bloodborne pathogens notably Hepatitis and HIV.

## 5.0 Hazard Control

5.1 Engineering Controls **-** prevention of exposure to bloodborne pathogens engineering controls include proper storage facilities and containers, syringes designed to prevent accidental needle sticks, autoclaves and disinfectant equipment.

5.2 Administrative Controls - prevention of exposure to bloodborne pathogen administrative controls include universal precautions, assignment of PPE, employee training, use of spill Kits specifically designed for blood and body fluids, restricted access to waste collection points and waste disposal procedures.

## 6.0 Reporting and Record Keeping

6.1 Any reports required by OCCUPATIONAL HEALTH AND SAFETY ACT will be maintained by the Occupational Health Department. All reports (Training Certificates, Notice of HBV Vaccinations, exposure reports) will be maintained for 30 years.

## 7.0 Training

7.1 All personnel assigned duties as First Aid Station Staff, HAZMAT responders, Custodial Employees (those that clean rest rooms, etc.) will receive initial and annual training by a qualified person on the Bloodborne Pathogen Program. Additionally, personnel trained in First Aid shall be offered this annual training.

7.2 All new and current affected Employees will be trained initially and annually thereafter as part of the first aid/CPR training. The content of the training program will include:

- 7.2.1 Types and transmission of Blood-Borne Pathogens
- 7.2.2 General Safety Rules
- 7.2.3 Universal Precautions
- 7.2.4 Use of Personal Protective Equipment
- 7.2.5 Medical Waste Disposal Procedures
- 7.2.6 Post Exposure Treatment and Procedures
- 7.2.7 HBV Vaccinations

7.3 Documentation of training will be by *Training Certificate*

7.4 All Employees not affected by this Program will receive an overview of the program requirements during scheduled Safety Meetings with documentation by Safety Meeting Minutes Form.

**8.0 Hepatitis-B Virus (HBV) Vaccinations**

8.1 Those required to provide first aid or emergency response duties on a routine basis will be offered Hepatitis-B Virus (HBV) Vaccinations at Company expense.

8.2 The choice for HBV vaccination is not mandatory. If an affected Employee chooses not to have the vaccination at the initial offering, they will have the opportunity to be vaccinated when they are ready. The Company will document the offer, acceptance or declination, and vaccination dates with the Notice of HBV Vaccinations Form.

**9.0 Post Exposure Treatment**

9.1 Should an affected Employee or an Employee acting as a "Good Samaritan" be occupationally exposed to HIV/HAV/HBV the affected Employee will report the exposure to the Schenectady Medical Center. The Company will provide for the Employee to be tested for HIV/HAV/HBV at Company expense. Following the initial blood test at time of exposure, employees will be retested at 6 weeks, 12 weeks and 6 months to determine if transmission has occurred. During this period, the Employee will follow the recommendations provided by the Physician.

9.2 An "occupational exposure" is defined as blood or body fluid contact from an injured or ill Employee to the affected Employee or injury by a contaminated sharp object.

9.3 Following the report of exposure, the Company Doctor will contact the exposure source and request that person be tested for HIV/HAV/HBV at Company expense. The request is not mandatory and if refused will not effect that Employee's future employment.

9.4 The source individual's blood is tested as soon as possible and after consent is obtained to determine HBV and HIV infectivity. (Hepatitis B surface Antigen, Hepatitis C Antibody and HIV Screen).

9.5 The exposed employee's blood shall be collected as soon as feasible and tested for HBV (Hepatitis Bs Antibody, Hepatitis C Antibody) and HIV serological status after consent is obtained (Employee Consent for HIV Antibody Testing).

9.6 During all phases of Post Exposure, the confidentiality of the affected Employee and exposure source will be maintained on a "need to know basis". The Blood-Borne Pathogens Exposure and Treatment form is used to document the exposure and offer of medical assistance to the affected Employee and use the Medical Consent for Blood-Borne Pathogens Testing form for the exposure source. The results of any HIV/HAV/HBV tests conducted will be provided to the exposed and source

Employees within 5 business days of receipt.

## 10.0 General Procedures

10.1 Personnel when faced with a potential exposure must follow the following procedures.

- 10.1.1 Pocket masks must be provided to eliminate the need for direct mouth-to-mouth contact in groups where resuscitation is a part of their responsibilities.
- 10.1.2 Gloves must be made of appropriate disposable material, usually intact latex or vinyl. They must be used in the following circumstances:
  - 10.1.2.1 When the employee has cuts, abraded skin, chapped hands, dermatitis, or similar conditions.
  - 10.1.2.2 When examining abraded or non-intact skin of a patient with active bleeding.
- 10.1.3 Employees must wash their hands immediately, or as soon as possible, after removal of gloves or other personal protective equipment and after hand contact with blood or other potentially infectious materials.
- 10.1.4 All personal protective equipment must be removed immediately upon leaving the work area, and if this equipment is overtly contaminated, it must be placed in an appropriate area or container for storage, washing, decontamination, or disposal.
- 10.1.5 All procedures involving blood or other potentially infectious agents must be performed in a manner that will minimize splashing, spraying, and aerosolization.

## 11.0 Medical Waste

11.1 Medical/infectious waste must be segregated from other waste at the point of origin.

11.2 Medical/infectious waste, except for sharps (i.e., razor blades, broken glass, needles, etc.) capable of puncturing or cutting, must be contained in double disposable red bags conspicuously labeled with the words "INFECTIOUS WASTE" and "BIOHAZARD."

11.3 Used needles or other sharps (razor blades, broken glass, scalpels, etc.) must not be sheared, bent, or broken.

11.4 Infectious sharps must be contained for disposal in leak-proof, rigid puncture-resistant containers. Infectious waste contained as described above must be placed in reusable or disposable leak-proof bins or barrels that are conspicuously labeled with the words "INFECTIOUS WASTE" and "BIOHAZARD".

11.5 All employees exposed to human blood and blood products must report to the Company Medical Center for information and possible inclusion in the Hepatitis B Immunization Program.

## 12.0 Infection Control Plan

12.1 The purpose of the Infection Control Plan is to protect the health and safety of the persons directly involved in handling the materials, Company personnel and the general public by ensuring the safe handling, storage, use, processing, and disposal of infectious medical waste.

12.2 Universal precautions: Refers to a system of infectious disease control, which assumes that every direct contact with body fluids is infectious and requires every employee exposed to be protected as though such body fluids were infected with blood-borne pathogens. All infectious/medical material must be handled according to Universal Precautions

- 12.2.1 The following universal precautions must be taken:
  - 12.2.1.1 Gloves must be made of appropriate disposable material, usually intact latex or vinyl. They must be used:
    - **12.2.1.1.1** when the employee has cuts, abraded skin, chapped hands, dermatitis, or the like.
    - **12.2.1.1.2** when examining abraded or non-intact skin of a patient with

active bleeding.

12.2.1.2 Mask and eye protection are required when contact of mucosal membranes (eyes, mouth or nose) with body fluids is likely to occur (e.g. splashes or aerosolization).

12.2.1.3 Resuscitation equipment, pocket masks, or other ventilation equipment must be provided to eliminate the need for direct mouth-to-mouth contact.

**13.0 Waste Disposal Plan**

13.1 Medical/Infectious waste must be segregated from other waste at the point of origin.

13.2 Medical/Infectious waste, except for sharps (e.g. razor blades, broken glass, needles, etc.) capable of puncturing or cutting must be contained in double disposable red bags conspicuously labeled with the words, "INFECTIOUS WASTE -- BIOHAZARD."

13.3 Infectious sharps must be contained for disposal in leak-proof, rigid puncture resistant containers.

13.4 Infectious waste thus contained as described in procedures 2 and 3 above must be placed in reusable or disposable leak-proof bins or barrels which must be conspicuously labeled with the words, "INFECTIOUS WASTE – BIOHAZARD."

13.5 Spills/Disinfectants: a solution of sodium hypo chlorite (household bleach) diluted 1:9 with water must be used to disinfect, following initial cleanup of a spill with a chemical germicide approved as a hospital disinfectant. Spills must be cleaned up immediately.

13.6 After removing gloves, and/or after contact with body fluids, hands and other skin surfaces must be washed thoroughly and immediately with soap or other disinfectant in hot water.

## *Personal Protective Equipment for Worker Protection*

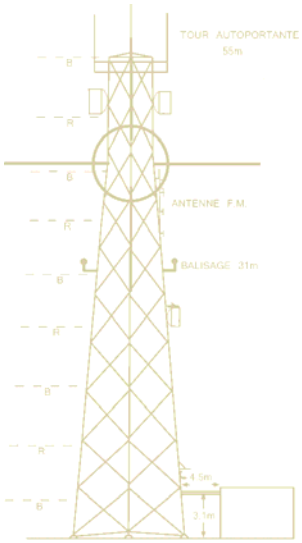
## *Against HIV and HBV Transmission*

| TASK | GLOVES | APRON | MASK | EYEWEAR |
|---|---|---|---|---|
| Control of Bleeding w/ spurting blood | X | X | X | X |
| Bleeding control with minimal bleeding | X | | | |
| Cleaning Bio Spills (blood, vomit, etc...) | X | | | |

The examples provided in this table are based on application of universal precautions. Universal precautions are intended to supplement rather than replace recommendation for routine infection control, such as hand washing and using gloves to prevent gross microbial contamination of hands (e.g., contact with urine or feces) .

# APPENDIX E

## CBC TV POTENTIAL IMPACT ASSESSMENT REPORT




# DEPLOYMENT OF A WIND FARM

# IN THE AREA OF SOUTH BRANCH

## IMPACT STUDY
## ON CBC TV BROADCASTING

Prepared for

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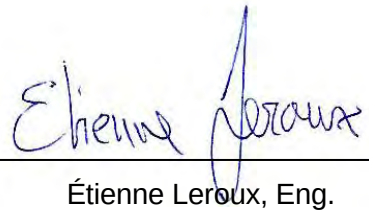
**SOUTH BRANCH WIND FARM PROJECT**

**IMPACT STUDY**

**ON CBC TV BROADCASTING**

**Team members in charge of the preparation of this document**



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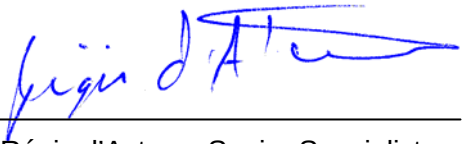
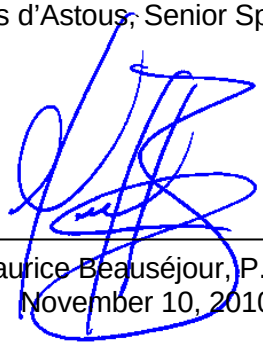


Régis d'Astous, Senior Specialist



Maurice Beauséjour, P.Eng.
November 10, 2010

**Note:** This document is written according to a mandate given to Yves R. Hamel et Associés Inc. by Prowind Canada Inc. This document is based on data obtained mainly from the database of Industry Canada and third parties, for which no field validation was made. Consequently, the information and conclusions presented in this document are strictly informative. Yves R. Hamel et Associés Inc. as well as the people acting on their account cannot be held responsible for any direct or indirect damage connected to the contents of this document.

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# 1 Introduction

Yves R. Hamel et Associés Inc., telecommunication and broadcasting consultants, have been mandated by Prowind Canada Inc. to verify the impact of a wind farm on CBC TV broadcasting systems in the region of South Branch, Ontario. This region is located half way between Cornwall and Brockville, Ontario.

This report addresses the issues of the impact of the wind farm on CBC television broadcast signals in the region and presents the results of a detailed analysis on the quality of received signals from the following television stations: CBOFT (CBC French), CBOT (CBC English), and CKWS-2 (CBC English - Affiliate).

As the final selection of the wind turbine manufacturer is not completed yet, this study is based on some conservative assumptions. The largest possible wind turbine model, the Vestas V112, has been used, along with the highest possible hub height at 140 m.

Annex 1 presents an overview of the wind farm area and of the surrounding analysis zone, extending up to 10 km from the closest wind turbine. The details of the location of the individual wind turbines are also included in Table 1.

Table 1- List of the wind turbine locations analyzed, layout of September 1st, 2010

| WIND TURBINE | EASTING (UTM NAD83 ZONE 18) (m) | NORTHING (UTM NAD83 ZONE 18) (m) |
|---|---|---|
| 1 | 463 956 | 4 973 451 |
| 2 | 464 274 | 4 973 747 |
| 3 | 464 593 | 4 973 523 |
| 4 | 464 849 | 4 974 070 |
| 5 | 469 347 | 4 981 388 |
| 6 | 469 791 | 4 981 543 |
| 7 | 470 573 | 4 980 031 |
| 8 | 471 093 | 4 980 202 |
| 9 | 470 765 | 4 976 717 |
| 10 | 471 894 | 4 977 876 |
| 11 | 472 196 | 4 978 405 |
| 12 | 472 785 | 4 979 016 |
| 13 | 472 724 | 4 979 355 |
| 14 | 469 381 | 4 978 015 |
| 15 | 472 475 | 4 975 541 |

# 2 CBC Television Broadcast Stations

Regarding the impact on the quality of reception of television signals, a preliminary study has identified three CBC broadcast television stations covering the region of the wind farm and its surroundings. This section and the following section provide a detailed study of the quality of reception of the signals from these stations, including a description of the methodology and a presentation of the results.

## *2.1 NTSC to ATSC transition*

The television industry is currently in transition from analog television, according to the NTSC standard, to digital broadcasting, following to the ATSC standard. This transition, which is currently being implemented, must be completed before August 31, 2011.

The ATSC standard is applicable in all North America. The transition therof has now been completed since June 12, 2009 in the United States, which means that since that date, all full power NTSC analog stations have been switched off. This transition is presently underway in Canada and must be coordinated with the American transition, since it is necessary in the border area to coordinate the use of frequency spectrum between the two countries so that the simultaneous operation of analog and digital systems can be done only on a transitional basis for a temporary period.

On May 17, 2007, the CRTC (Canadian Radio-television and Telecommunications Commission) issued the Public Notice CRTC 2007-53, making public some of CRTC's decisions, including the following:

*Television licensees will be authorized to broadcast only digital OTA signals after 31 August 2011, although exceptions may be made in northern and remote communities where analog transmissions will not cause interference.*

A new policy of the CRTC, CRTC 2010-167, released March 22, 2010, indicates that in some small markets where there is only one local television station, the broadcaster will be allowed to broadcast with analog technology for some period of time, as long as the the

station does not disturb the analog to digital conversion of the other broadcasters in the region and meets the technical requirements of Industry Canada, including the coordination of U.S. and Canada frequency plans within an area of 360 km on both sides of the border.

The effect of this transition to digital television (DTV) on the impact of wind farm projects on telecommunications systems is significant. The need to include a detailed study of the impact on the quality of reception of analog television signals would no longer be required for wind farm projects with a commissioning date scheduled after August 31, 2011. As it is the case for this South Branch project, this detailed study is focused on the quality of reception of digital television signals.

## *2.2 Quality of reception of digital television signals*

As the reception of analog television signals is probably the type of system most likely to be affected by the implantation of a wind farm, it is recognized by the broadcasting industry that the digital system is much more reliable. However, it might still be possible that wind turbines cause some reception degradation at close proximity or in some cases where signal reception is already marginal. This degradation would generally appear on screen as a random pixelization of the picture, which in extreme cases could be generalized to the entire picture or the complete loss of it when the signal reception was previously marginal.

There is no simple rule to determine the minimum separation, between wind turbines and TV transmitter or receiver, ensuring interference free operation. The topographic information and the relative positions of the sites are important parameters. With analog reception, interference free operation have been encountered in some cases at relatively close distances of less than a kilometre, while unacceptable interference have been experienced at distances sometimes exceeding 10 km. The impact of wind turbines on DTV reception is still not clearly defined, however it is well accepted that the impact on DTV reception would be limited to the close proximity of wind turbines or to areas where DTV signal level is marginal. Each case needs to be evaluated separately, in order to consider the actual field conditions. This study presents the results of a detailed analysis concerning the area of the proposed wind farm.

The regulation of the television broadcasting allows each station a protected service contour within which no interference from other stations is allowed. The installation of wind turbines within the protected service contour of a station may have an impact on the quality of the received signal in the vicinity of the wind turbine. The goal of this study is therefore to establish, as precisely as possible, for every station involved, the extent of the realistic service contours and the location of the inhabited areas within these contours where significant received signal degradation is most likely to occur.

This analysis will involve two aspects: the analysis of static multipath signals due mainly to the presence of the wind turbine support tower and the analysis of the dynamic multipath signals, due to the rotation of the wind turbine blades. A similar methodology is used for each analysis, but the parameters used and the interpretation of the results are different in each case.

# 3 Analysis of CBC television broadcast systems

## *3.1 Overview*

### *3.1.1 Operating Parameters of the stations*

The operating parameters shown in Table 2 are those published by Industry Canada for the post-transition digital TV systems. These stations have not yet completed their planning of the conversion to the digital technology, hence their final digital operating parameters are not yet known. In most case, the objective of the digital transition for each station is at least to replicate with this new technology the same coverage that they currently have with the analog technology. However, the CBC have confirmed to us that they will operate CBOT-DT with its maximum parameters and to consider CBOFT-DT with its maximum parameters eventhough it is not confirmed in their planning. In the case of CKWS-DT-2, the maximum parameters are also considered even if the affiliate station is not planning to proceed with its transition in the short term.

Table 2- List of the TV stations analyzed with their operating parameters.

| Call Sign | Channel | Effective Radiated Power (W) | Ground elevation (m) | Antenna height AGL (m) | Coordinates NAD 83 |
|---|---|---|---|---|---|
| CBOT-DT Ottawa | 25 | 480 000 | 350.5 | 121.9 | 45°30'11'' N 75°51'01'' W |
| CBOFT-DT Ottawa | 9 | 3500 | 350.5 | 214.0 | 45°30'11'' N 75°51'01'' W |
| CKWS-DT-2 Prescott | 48 | 220 | 97.2 | 112.8 | 44°49'55'' N 75°31'16'' W |

The operating parameters presented in the previous table are obtained from the Industry Canada's broadcast database. In one case, the radiation pattern of the station was obtained from the information on file with Industry Canada.

In order to determine the real extent of the coverage of each station, the realistic service contour of each station was generated using the dBPlanner software and the propagation algorithm CRC-Predict V2.0. The realistic service contours are included in Annex 2 for the three stations covering partially or entirely the proposed wind farm area.

### *3.1.2 Wind turbine specifications*

The type of wind turbine used and its physical and geometric characteristics are all important parameters enabling us to determine the risk and the severity of potential interference on the quality of the received television signal. As the final selection of the wind turbine model to be implemented on this project is not yet completed, the wind turbine model used in the present study is the Vestas V112, using a tapered cylindrical steel support tower placing the hub height at 140 meters. This approach is representing the largest wind turbine and highest possible hub height, hence the worst possible case of TV reception degradation. The main characteristics are listed below.

**Rotor**

| | |
|---|---|
| Diameter: | 112 m |
| Axis tilt: | N/A |
| Blades Coning: | N/A |
| Number of blades: | 3 |

**Blades**

| | |
|---|---|
| Material: | Glass and carbon fiber reinforced |
| Length: | 54.6 m |
| Projected area of a blade: | 131 m² (estimated) |
| Twist angle (anchor point to blade tip): | 15° |

**Tower**

| Section | Length | Maximum Diameter | Minimum Diameter |
|---|---|---|---|
| Top | 40.0 m | 4.2 m | 2.3 m |
| Bottom | 100.0 m | 4.2 m | 4.2 m |

One of the most important parameters concerning the wind turbines is the reflection efficiency which allows us to determine how effectively the blades will reflect the incident signal. This parameter depends on the type of material used in the blades and on the geometry of the blades. As stated in several publications, this factor can be estimated as follows:

$$\eta_S = \eta_A \, \eta_M \, \exp^{(-2.30 \, \Delta\beta)}$$

Where $\eta_S$ is the efficiency coefficient of a wind turbine blade in the horizontal axis;
$\eta_A$ is the airfoil coefficient of the blade;
$\eta_M$ is the coefficient of the material;
$\Delta\beta$ is the twist angle of the blade from the base to the tip (rad).

Based on the results of measurements performed by Sengupta and Senior, the following factors are suggested for the airfoil and material coefficient:

$\eta_A$ = 0.80
$\eta_M$ = 1.00 for metallic blades
0.41 for non-metallic blades

It was however observed that non-metallic blades equipped with lightning arresters at the tip of the blade and connected to the grounding system by conductive cables will present a higher material factor than non-metallic blades, sometimes approaching the value for metallic blades. In our case, a material factor of 1 was used because of some carbon fiber content, representing the equivalent of a fully metallic blade. Based on this, an efficiency factor of 0.44 was obtained. This parameter will be used in the analysis to obtain the reflection factor which in turn will allows us to determine the equivalent power reradiated by the wind turbine rotor.

## *3.2 Analysis methodology*

The two types of analysis performed in this study are the dynamic analysis, focusing on the reflections caused by the rotating wind turbine blades, and a static analysis, focusing mainly on the impact of the supporting tower. Both of these approaches seek to establish if, at a given location, the quality of the received signal reaches the quality threshold recommended by the regulations.

### *3.2.1 Picture Quality Evaluation*

In digital mode, we can almost say that the picture will be perfect or there will be no picture at all. The information received is binary, which is composed of '0' and '1'. In normal operation, the receiver decodes these 0 and 1 without any error, which in digital television produces a perfect picture quality. When the received signal level is dropping to the point of the receiver noise threshold, its ability to recognize the 0's and 1's without error is reduced and the receiver can no longer always recognize the 0's and 1's, hence no longer able to produce a perfect picture. In fact, when the received signal level decreases and approaches the receiver noise threshold, the picture quality remains almost perfect until the threshold. If a small additional reduction of signal level occurs, the picture quality will deteriorate very quickly, showing initialy random pixelization of the picture, indicating an operation at the level of the receiver noise threshold. With another slight reduction, the receiver can no longer produce picture at all. In other words, a variation of more than 70 dB of the received signal level above the receiver noise threshold has no effect on image quality, which will remain perfect. A simple variation of less than 1 dB near the receiver noise threshold will initially reduce the picture quality, with the apparition of isolated pixelization to a frozen pixelized picture and finally to no picture at all (blue screen). It will be the same for the quality of the audio portion of the signal that is transmitted within the same binary frame; the audio signal will begin by breaking up and ultimately turn to silence.

The presence of a wind turbine or any other structure or building has no impact on the receiver noise threshold, so should not affect the reception quality. At worst, these structures might cause a slight weakening of the signal at short distance behind the wind turbine, which could cause difficulties, for receivers which were already operating near the receiver noise threshold, to decode the received signal. For most of these receivers located in marginal received signal level areas, reception quality will already be subject to occasional reception impairments or outages due to atmospheric conditions variations. However, these structures, whether buildings, metallic surfaces, hills or wind turbines, will produce signal reflections which will be received at the receivers with different delays and levels, potentially causing difficulties for the receiver to recognize without error the 0's and 1's of the digital frame. Fortunately, special circuits, called equalizers, are integrated in the receivers which serve to manage this kind of situation. Unfortunately, these equalizers, despite their processing power and their impressive performance, may not necessarily mitigate all of the possible causes.

Upon reception of the signal by the digital receiver, these equalizers allow, in addition to processing the direct signal received from the TV transmitter, to process each of the different signals reflected from various structures, independently from each other, and retain only the most important signal by eliminating sources of interference that may be caused by other received signals which have traveled different paths.

During the development of the North American ATSC digital television standard, the standards committee defined the minimum ATSC receiver performance and in particular, a standard for the equalizer minimum performance. The standard equalizer performance specification represents the performance of the prototype equalizers available in 2004. However, the equalizers embedded in digital receivers sold today are much more efficient than the current minimum standard. The mask shown in Figure 3 shows the minimum performance that any equalizer embedded in a DTV receiver must meet, according to the standard of the ATSC A74 specification.

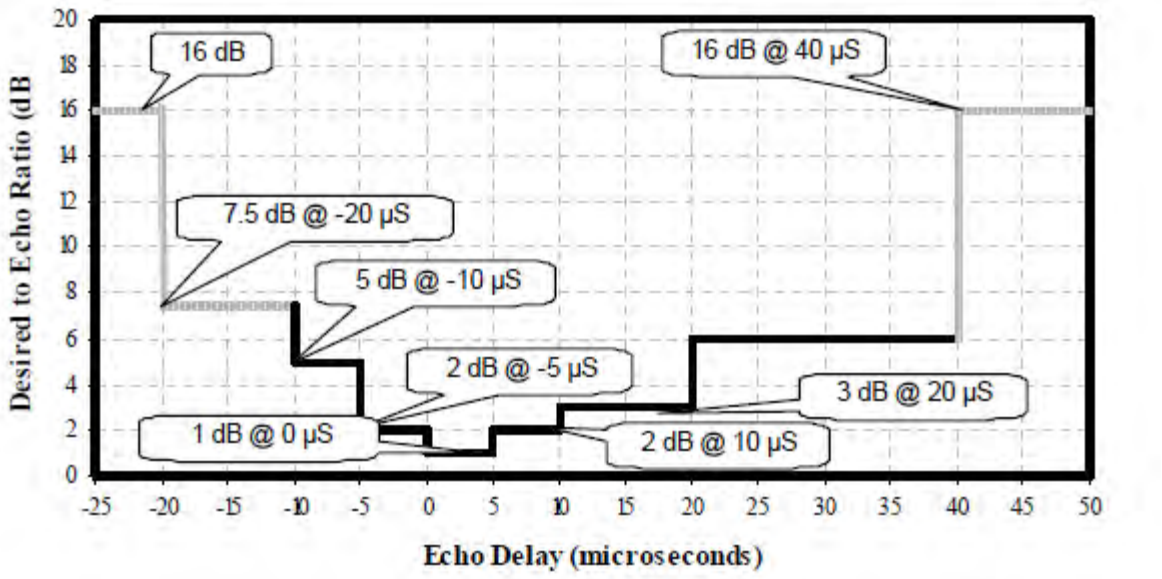


Figure 1 - Minimum equalizer performance specified by the ATSC A74 standard applicable since 2004.

The interpretation of the equalizer minimum performance curve is as follow. When the ratio of the desired signal level, usually the direct signal from the television station transmitter, to the undesired (Echo) signal level, usually the signal reflected by the wind turbine or other structure, is higher than the mask value for a given delay, which is based on the path length

difference, the receiver can perform adequately. This situation is applicable to the right portion of the mask, where the values of the delay are positives. In some particular cases, when the direct signal is attenuated by an obstacle, while the reflected signal from the structures would be in line-of-sight, the latter may become more powerful than the direct signal and would be seen by the equalizer as the desired signal. The left portion of the mask, where the values of the delay are negatives, would then be applicable and the receiver could still perform adequately.

Generally speaking, the cases where a deterioration of the quality of reception of the digital television signal is more likely to occur are:

1- Close to the wind turbine, where the delay is very low, a few microseconds or less, and where the direct and the reflected signals are potentially equal or close to. This is typically possible on a very limited area located a few hundred meters only from the wind turbine; where there is typically no residence, given the usual restrictions used for residence protection.

2- At the limit of the coverage area of the TV broadcasting station, where the direct and reflected signals are both low and at the limit of the detection capabilities of the receiver. It is likely that at these locations, reliability of a good quality of reception would be relatively low, even in the absence of wind turbines.

Even if the majority of the ATSC receivers now available on the market have better performance than those required by the standard, this performance curve will be used in the digital TV analysis, as it represents the worst possible case for receivers commercially available.

### *3.2.2 Image Quality Prediction*

Through the years, Yves R. Hamel et Associés Inc. (YRH), in collaboration with various broadcast industry players has developed proprietary simulation software for predicting the impact of wind farms on the quality of the received television signal within the wind farm area. This software partially uses the approach developed by Dr. Sengupta and Senior in the 70s

and early 80s, as well as the conclusion of latest report on this subject from the International Telecommunication Union (ITU), the report BT- 2142.

In the case of the static analysis the simulation software can be used, within the area surrounding the wind farm, to estimate the number of wind turbine, mainly their support tower, that are likely to produce multipath at any given location on a 90 m terrain grid. Each wind turbine is analyzed separately and the results are compiled to show the impact of the entire wind farm.

The same process is applied to the dynamic analysis but since the dynamic multipath is caused by the wind turbine rotor blades motion, it depends on the orientation of the blades, and therefore on the strength and the direction of the wind. The analysis must then be complemented by a statistical analysis which includes the speed and direction of the prevailing winds. The probability of any given location being affected by dynamic multipath is the sum of the probabilities for each of the individual wind turbine. The result of the analysis is therefore not the number of wind turbines likely to affect a given location but rather a percentage of time that a given location is likely to be affected by dynamic multipath due to the rotation of the wind turbine blades.

The mask of the equalizer minimum performance is used for both analyses, to determine the ability of the digital receivers to maintain the required performance in presence of multipath signals at its input.

### *3.2.3 Dynamic Analysis*

The method used for dynamic analysis is to evaluate, at each location, the level of signal received directly from the TV transmitter, as well as the level of signal received as a result of reflection on the blades of each wind turbine. The ratio of the two signals field strength and the delay between the reception of the direct and the reflected signals are used to establish if the limit of the equalizer performance is reached at a given location.

The evaluation of the equivalent power radiated by the wind turbine is partially based on the method proposed by MM. Sengupta and Senior and on the ITU BT-2142 report. The

radiation patterns of the wind turbine, in static and dynamic modes, are based on the conclusions of the ITU BT-2142 report.

The evaluation of the signal received directly from the transmitter is accomplished using the published digital station parameters and antenna radiation pattern on file within the database of Industry Canada. It should be noted again that it is assumed that the upcoming DTV station's coverage will use their maximum allocated parameters. The dBPlanner version 2.5 propagation software, along with the CRC-Predict version 2.0 algorithms, are used for the prediction. The topographical data is taken from a digital database with a resolution of 3 arcseconds resampled at 90 m. The field strength at the TV receiver is predicted with an antenna height of 10 m above ground, as stated by Industry Canada in BPR-10, while the field strength at the wind turbines is predicted at a height of 140 m above ground, corresponding to the wind turbine axis height.

Dynamic analysis is accomplished by using the projected area of the blades and an equivalent number of blades of two per rotor, as suggested by MM. Sengupta and Senior. The rotor axis tilt and the coning angle of the rotor blades were not considered in this approach, making it a pessimistic evaluation.

Annex 3 presents the results obtained for the three stations previously identified. Since it is not applicable to define an exclusion zone concerning the impact on the quality of reception of television signal, it is preferable to represent the impact at each potential reception location and estimate if the resulting risk of potential impact is acceptable for that location. Yellow and red colored areas represent locations where a possibility of interference exists, due to one or several wind turbines. For each 90 m X 90 m section of terrain, the color indicates the total probability that for this terrain grid element, a standard digital receiver would not properly decode the received signals coming simultaneously directly from the DTV transmitter and from the reflections on the wind turbine blades.

The analysis was limited to the area within the realistic service contour, obtained from the CRC-Predict algorithm. Therefore, wherever the map background is visible, either the signal level is below the minimum service level or there is no significant wind turbine interference at that location.

It is recognized that dynamic interference produced by a wind turbine at a specific point will not be permanent, but will be present only when a particular geometry is in place, mainly based on the orientation of the wind turbine, therefore on the direction of the wind. As suggested by Sengupta and Senior in reference 9, the multipath produced in dynamic mode is mainly caused by reflections on the surface of the blades, similar to a mirror reflection. This type of reflection is very directional (specular) and would impact only a sector of a few degrees from the point of reflection on the blade. From a statistical point of view, Sengupta and Senior suggest considering a wind distribution sector of 5° to estimate the probability of dynamic interference. As it is not possible without extensive calculation to determine exactly the location where interference, caused by a reflection on a blade with a specific angular position of the rotor compounded to the blade pitch angle under certain precise conditions of wind will occur, it is preferable to consider the phenomenon with a statistical approach.

The analysis of the wind distribution in the area of South Branch, according to the database of Environment Canada, allows us to establish, by interpolation, that the probability of the wind coming from any sector of 5° varies between 0.26% and 3.60%. Considering that the wind turbine does not operate when the wind speed is lower than 3.0 m/s and stops operating for a wind speed higher than 25 m/s, these minimum and maximum probabilities for any 5° sector become 0.23% and 3.10% with an average of 1.19%. This average value could be used as is, but it is proposed to consider the sector of the prevailing winds without necessarily using the worst possible case. The value of 2.24%, corresponding to the average of all 5° sectors within the quadrant of 90° centered on the prevailing wind direction, is considered as representative of the prevailing wind probability without being excessively pessimistic.

Based on this probability of 2.24%, when more than 4 wind turbines can cause interference at a specific point, the probability of interference at this point is considered to exceed the threshold of 10% of the time. This threshold of 10% of the time is the maximum considered to be acceptable by Industry Canada, according to the BPR-10, with regard to the interference from another TV station operating on the same channel. Although no Canadian standard is defined with regard to the interference caused by the wind turbines, this threshold could also be used when considering the interference on same channel originating from one or several wind turbines.

According to the BPR-10, when populated areas are submitted to a risk of interference for more than 10% of the time, the operator of the TV station causing the interference must take corrective measures to eliminate or reduce this interference, only if the interference cause greater than 0.5% additional population service loss to a previously approved primary or secondary DTV assigment. When this interference is occurring within unpopulated areas, it can generally be accepted.

### *3.2.4 Static Analysis*

The static analysis uses the same approach as the dynamic analysis, generally considering the whole surface of the support tower. The height above ground used for the calculation of the received field is 70 meters for a 140 meter tower, corresponding to the center of the support tower. The radiation pattern used for the supporting tower is based on the conclusion of the ITU BT-2142 report.

One of the main differences between dynamic and static methodologies is in the vertical pattern of radiation of the tower. As shown in a study published by the British Department of Trade and Industry (DTI) in reference 4, evaluating the effect of wind turbines on the operation of radars, the measurements and modelings done demonstrate that the vertical opening of the radar response is very narrow.

Although these models were done at higher frequencies than those used in television, it is reasonable to claim that the opening angle of the vertical radiation pattern of the tower represents only a few degrees, which practically matches the opinion of Industry Canada expressed in the TB-5. The modeling of the tower shows that in the S band (3.0 GHz), a conical tower of 80 meters with a tapering angle of 0.5° has a vertical opening of approximately 0.03° centered around the 0.5° elevation plane, while in the L band (1 GHz) the vertical opening is approximately of 0.09°, also centered at 0.5° elevation. The conicity of the tower is then an important parameter to consider for the reflectivity of the tower.

At TV frequencies, approximately 500 MHz for the UHF band, 200 MHz for the H-VHF band and 60 MHz for the L-VHF band, the vertical pattern opening could be approximately 0.2°, 0.5° and 2° respectively, and because the conicity of the tower is approximately 0.4$^{o}$, these vertical patterns would be uptilted approximately 0.8° over the horizon, assuming that the incident signal is arriving horizontaly. Since the TB-5 suggests openings of a few degrees, up

to approximately 10° for telecommunication lattice towers, it is reasonable to believe that the values mentioned previously are realistic for cylindrical or conical towers. To consider the potential reflections on the elements contained in the nacelle and also on the blades when the wind turbine is not in operation, openings of 1° for UHF, 2° for H-VHF and 5° for L-VHFwill be used, however no uptilt angle will be considered for calculations, since the most important part of the support tower is not conical but cylindrical, which represent a worst case scenario.

The Annex 4 presents the results of the static analysis for the three stations covering the zone of analysis of the South Branch wind farm.

### *3.2.5 Quantitative evaluation of the impact of the wind farm*

The most practical method to evaluate the real impact of the wind farm on the surrounding population is probably to estimate the number of household which could suffer a potential degradation of the quality of reception of the DTV signal. To do so, the number of dwellings enumerated during the census of 2006 in each census dissemination area was used and the geographical distribution of the households was considered proportional to the distribution of the buildings found in each of these census subdivisions.

The comparative analysis of the areas where a possible degradation of the quality of reception is expected and the distribution of the households as previously described, are presented in Table 3 and Table 4. Table 3 presents the approximate number of households potentially impacted by the dynamic multipath for each analyzed TV station, while Table 4 presents similar results for the static multipath.

The total number of dwellings included in the zone of analysis is estimated at 3540 on the basis of the data from the 2006 census and other database.

These estimates were produced by using the receive antenna masks suggested by Industry Canada in BPR-10. These masks roughly represent the response of an average receive antenna. Most good quality TV reception antennas are more directional than the suggested mask, which would make it possible to reduce the number of dwellings affected, without however eliminating all possibilities.

Table 3- Estimated number of dwellings potentially suffering dynamic multipath.

| TV Station | Dwellings Within Realistic Service Contour | Dwellings without dynamic multipath | Dwellings with multipath probability between 0% and 5% of the time | Dwellings with multipath probability between 5% and 10% of the time | Dwellings with multipath probability more than 10% of the time |
|---|---|---|---|---|---|
| CBOFT-DT | 3540 (100%) | 3540 | 0 | 0 | 0 |
| CBOT-DT | 3540 (100%) | 3538 | 2 | 0 | 0 |
| CKWS-DT-2 | 3540 (100%) | 3540 | 0 | 0 | 0 |

Table 4- Estimated number of dwellings potentially suffering static multipath.

| TV Station | Dwellings Within Realistic Service Contour | Dwellings without static multipath | Dwellings potentially suffering static multipath from 1 or 2 wind turbines | Dwellings potentially suffering static multipath from 3 or 4 wind turbines | Dwellings potentially suffering static multipath from 5 or more wind turbines |
|---|---|---|---|---|---|
| CBOFT-DT | 3540 (100%) | 3540 | 0 | 0 | 0 |
| CBOT-DT | 3540 (100%) | 3540 | 0 | 0 | 0 |
| CKWS-DT-2 | 3540 (100%) | 3540 | 0 | 0 | 0 |

The results of the analysis presented in Table 3 and 4 consider that the future digital station will cover an area equivalent to the area covered by the analog station. It is possible that the final operating parameters of these new digital stations provide more or less coverage compared to the analog stations they replace. However, it will not affect the risk of interference caused by wind turbines, but only the ability of the receiver to detect adequately or not the signal of a station, in the presence of wind turbines or without it.

Finally, it was not possible to obtain precise figures on the rate of penetration of cable television in the various agglomerations of the area, but it is generally agreed that a significant number of these dwellings receive their television signals via a cable TV operator or some Direct Broadcast Satellite services.

### *3.2.6 Reception of Direct Broadcast Satellite*

As mentioned previously, the Direct Broadcast Satellite services are increasingly popular in these rural areas and the positioning of wind turbines in the line-of-sight between the antenna

of a satellite receiver and the satellite providing the service would have an impact on the quality of service offered to this household. The Canadian operators offering this type of service are Bell TV and Shaw Direct. They use, in the case of Bell TV, the Nimiq 1 (91°W) and Nimiq 4 (82°W) satellites, while Shaw Direct uses the Anik F1R (107.3°W) and Anik F2 (111.1°W) satellites, all located on the geostationary orbit at the longitudes indicated within brackets. For the area of South Branch, the applicable satellite look angles for the reception of these satellite signals are indicated in the following Table.

Table 5- Canadian DBS operators satellite look angles.

| Operator | Satellite | Program type | Azimuth | Elevation |
|---|---|---|---|---|
| Bell TV | Nimiq 1 | NTSC | 201.6° | 27.5° |
| Bell TV | Nimiq 4 | HDTV | 189.3° | 38.0° |
| Shaw Direct | Anik F1R | English | 221.5° | 29.5° |
| Shaw Direct | Anik F2 | French | 225.6° | 27.5° |

Over a flat land region, the minimal horizontal distance required for a satellite link having an elevation angle of 30° to clear a 125m overall height wind turbine is approximately 275m. This distance is raised to approximately 400m for a satellite link having an elevation angle of 20°. However, wind turbines are often located near the top of hills and mountains. The difference of elevation between building and wind turbine must be taken into account.

A simple rule to prevent any difficulty is simply adding, for a satellite whose elevation angle is 30 degrees, the double of the difference of elevation between the building and the wind turbine to the minimum distance of 275m mentioned above. As an example, instead of 275m if the ground was flat, a minimum distance of 475m must be satisfied for a difference of ground elevation of 100m between a wind turbine located on hill top and a building located in a valley. In the case of a satellite whose elevation angle is 20 degrees, three times the difference in ground elevation between the building and the wind turbine location, added to the minimum distance of 400m mentioned earlier ensure there is adequate clearance over a wind turbine which would be located exactly in the same azimuth as the satellite, as seen from the residence.

Based on available information showing the approximate location of buildings in the region, we have not identified any wind turbine that could possibly have an impact on the reception of the Direct Broadcast Satellite services.

# 4 Conclusion

The detailed analysis of the potential deterioration of the quality of reception of the digital stations CBOFT-DT, CBOT-DT and CKWS-DT-2 television broadcast stations allowed to estalish that there is no significant risk of interference and only a few dwellings are at risk to experience this type of interference in dynamic mode in the case of CBOT-DT.

These households will most probably be able to eliminate this risk by using a good quality reception antenna, which will permit discrimination between the direct signal from the TV transmitter and the reflected signals from the wind turbines. All calculations for the study were done using the antenna mask proposed by Industry Canada in the BPR-10. However, many good quality antennas on the market are more directional than the proposed mask and will therefore discriminate better between wanted and unwanted signals.

Based on available information showing the approximate location of buildings in the region, we did not identify any wind turbine that could possibly have an impact on the reception of Direct Broadcast Satellite services.

## Reference:


1- Dipak L. Sengupta, Thomas B. A. Senior, “Electromagnetic Interference from Wind Turbines” in Wind Turbine Technology : Chapter 9, David A. Spera (Ed), ASME Press, 1994.

2- David F. Bacon, “Fixed-link Wind-Turbine exclusion zone method”, D.F. Bacon, 2002.

3- Thomas B. A. Senior, Dipak L. Sengupta, “Large wind turbine sitting handbook: Television interference assessment” Technical report No.4, University of Michigan, 1981.

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6- Thomas B. A. Senior, Dipak L. Sengupta, “Wind turbine generator sitting handbook” Technical report No.2, University of Michigan, 1979.

7- Industry Canada TB-5 “Report on predicting television ghosting interference and picture quality”, Issue 2, July 1989

8- Industry Canada BPR “Part IV: Application Procedures and Rules for Television Broadcasting Undertakings”, April 1997

9- Dipak L. Sengupta, Thomas B. A. Senior, “Wind turbine generator interference to electromagnetic systems” Final report, University of Michigan, 1979.

10- Canadian Radio-television and Telecommunications Commission, ‘’ Broadcasting Public Notice CRTC 2007-53’’, 17 May 2007.

11- Industry Canada BPR “Part X: Application Procedures and Rules for Digital Television (DTV)”, Provisional issue, August 2009

12- RABC/CANWEA “Technical Information on the Assessment of the Potential Impact Of Wind Turbines on Radio Communication, Radar and Seismoacoustic Systems”, April 2007.

13- ITU Report BT.2142 “The effect of the scattering of digital television signals from a wind turbine”, ITU-R BT.2142, April 2009.

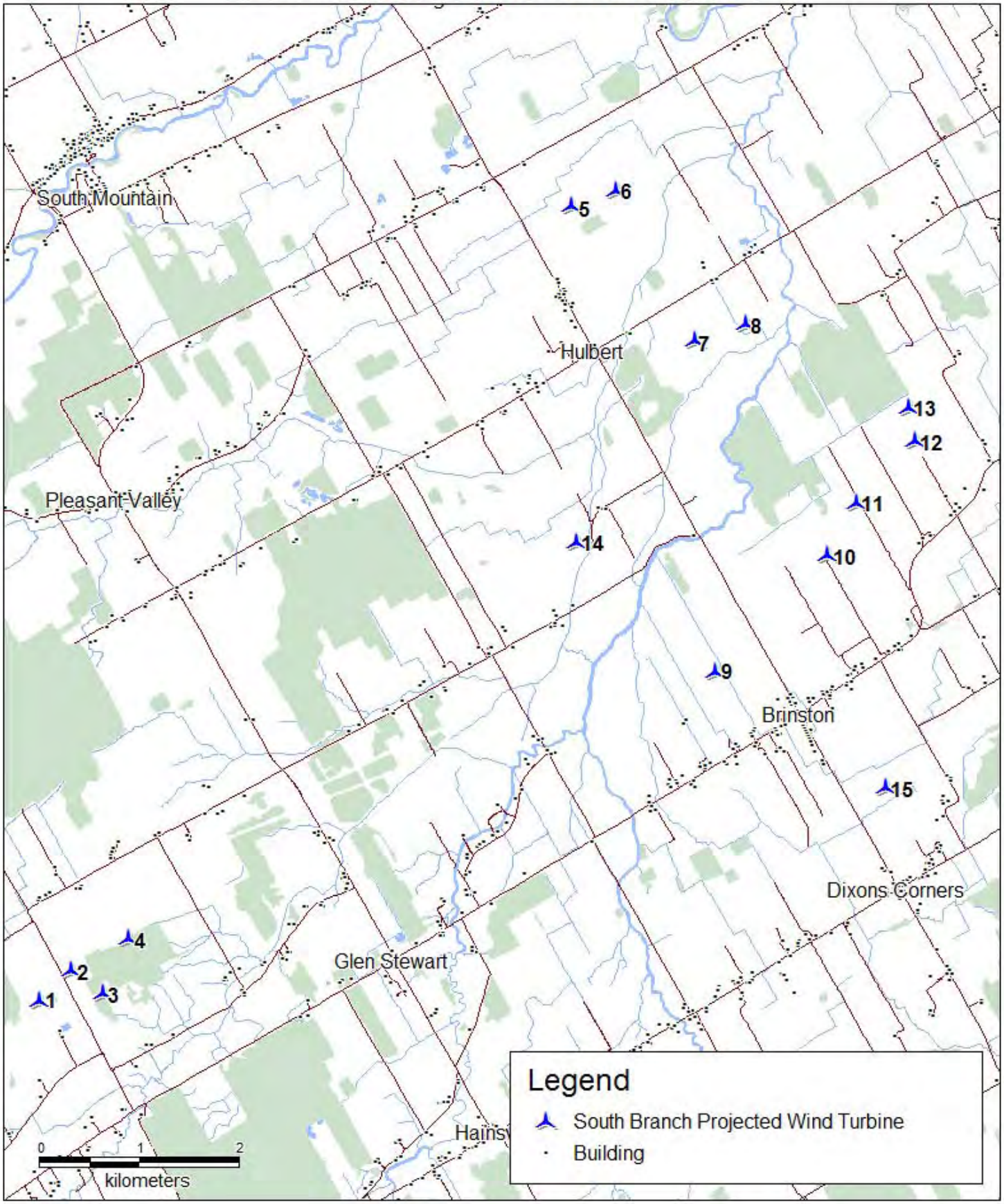
14- ATSC Standard, ‘’ATSC Recommended Practice: Receiver Performance Guidelines’’, Document A/74, June 2004 with corrigendum July 2007.

# ANNEX 1

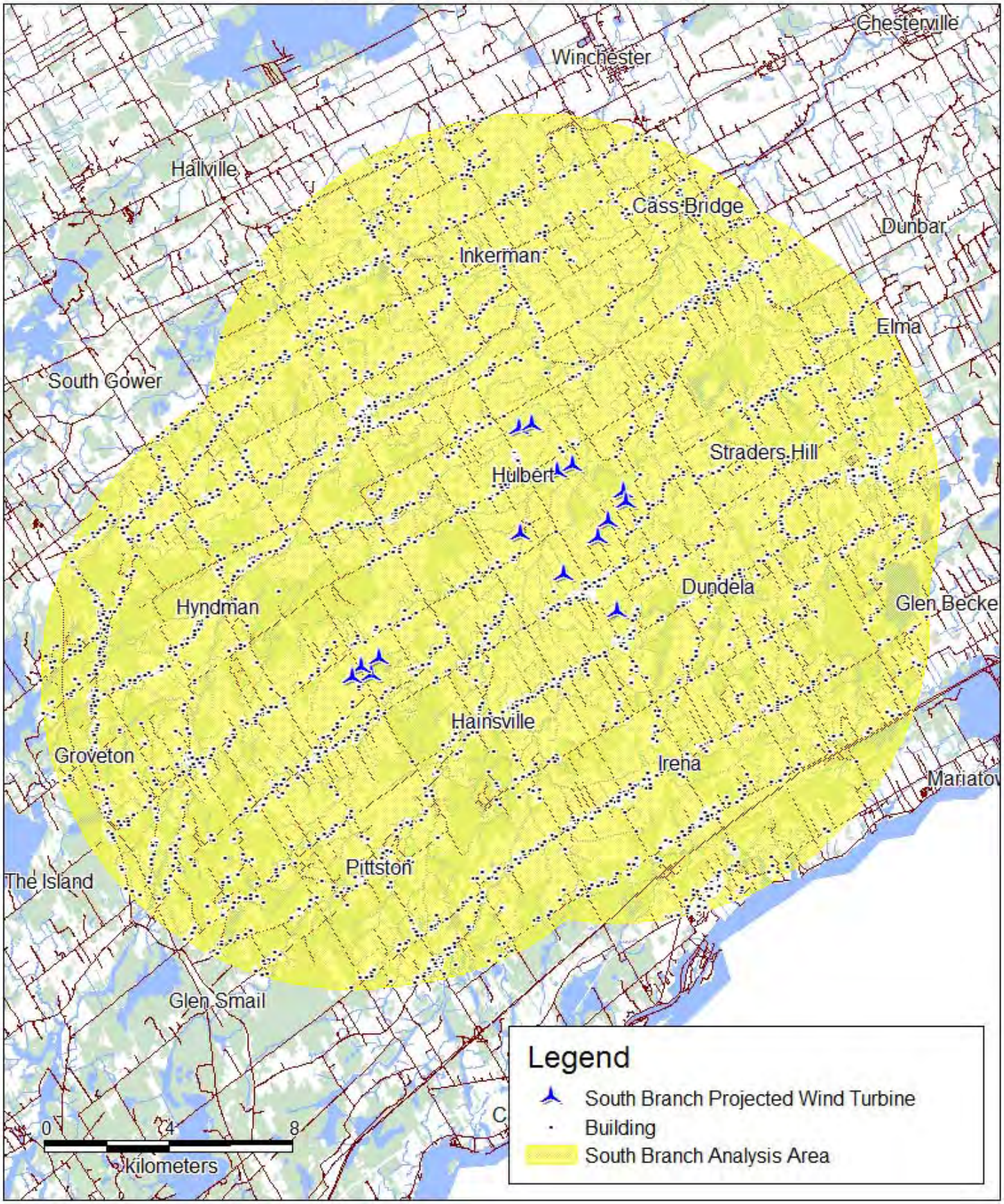
## Global View and Analysis Zone

## South Branch Wind Farm

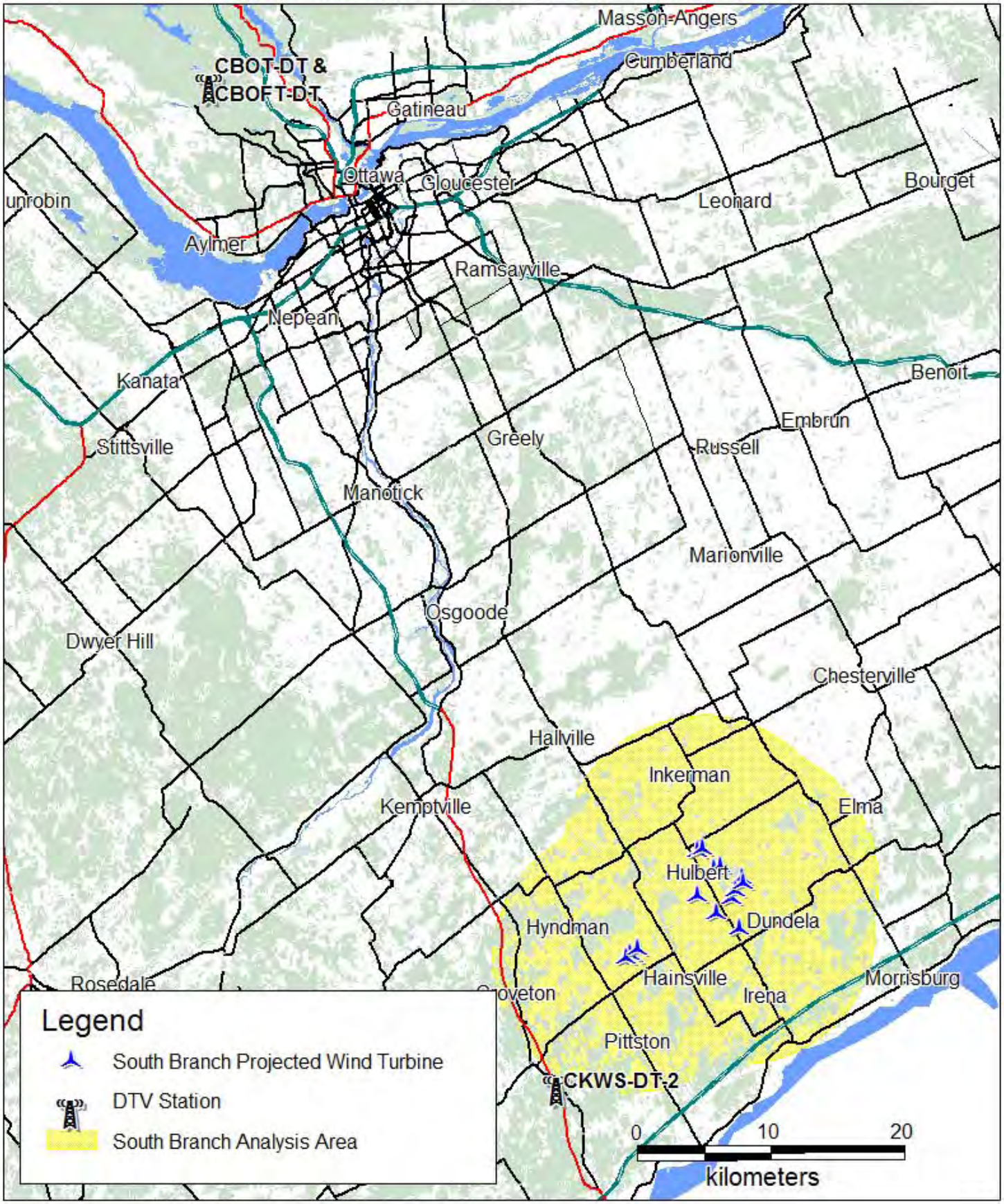
# SOUTH BRANCH WIND FARM LAYOUT



# GLOBAL VIEW OF THE SOUTH BRANCH WIND FARM AND THE ANALYSIS AREA



# OVERVIEW OF THE SOUTH BRANCH WIND FARM AND THE ANALYZED DTV STATIONS

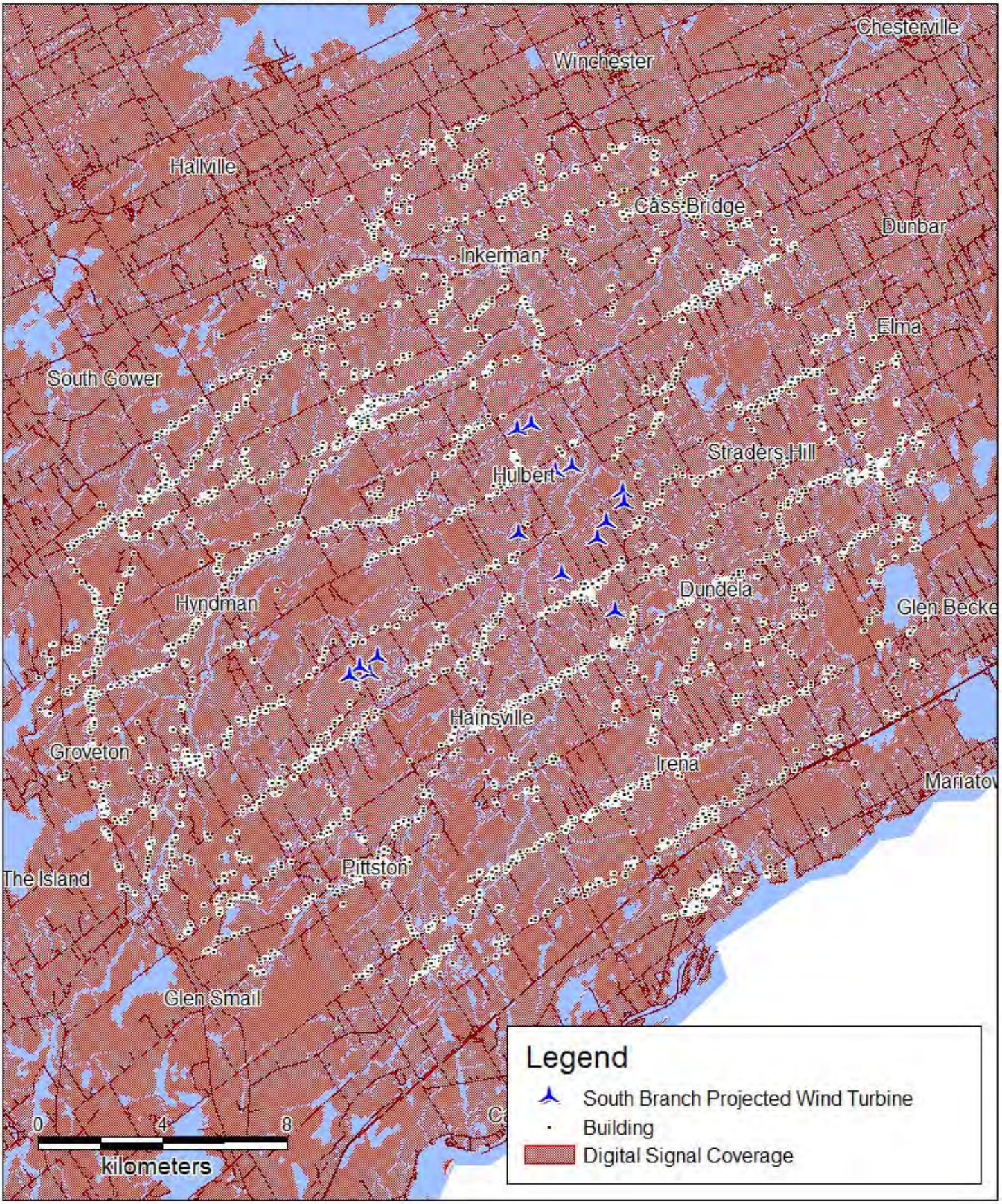


# ANNEX 2

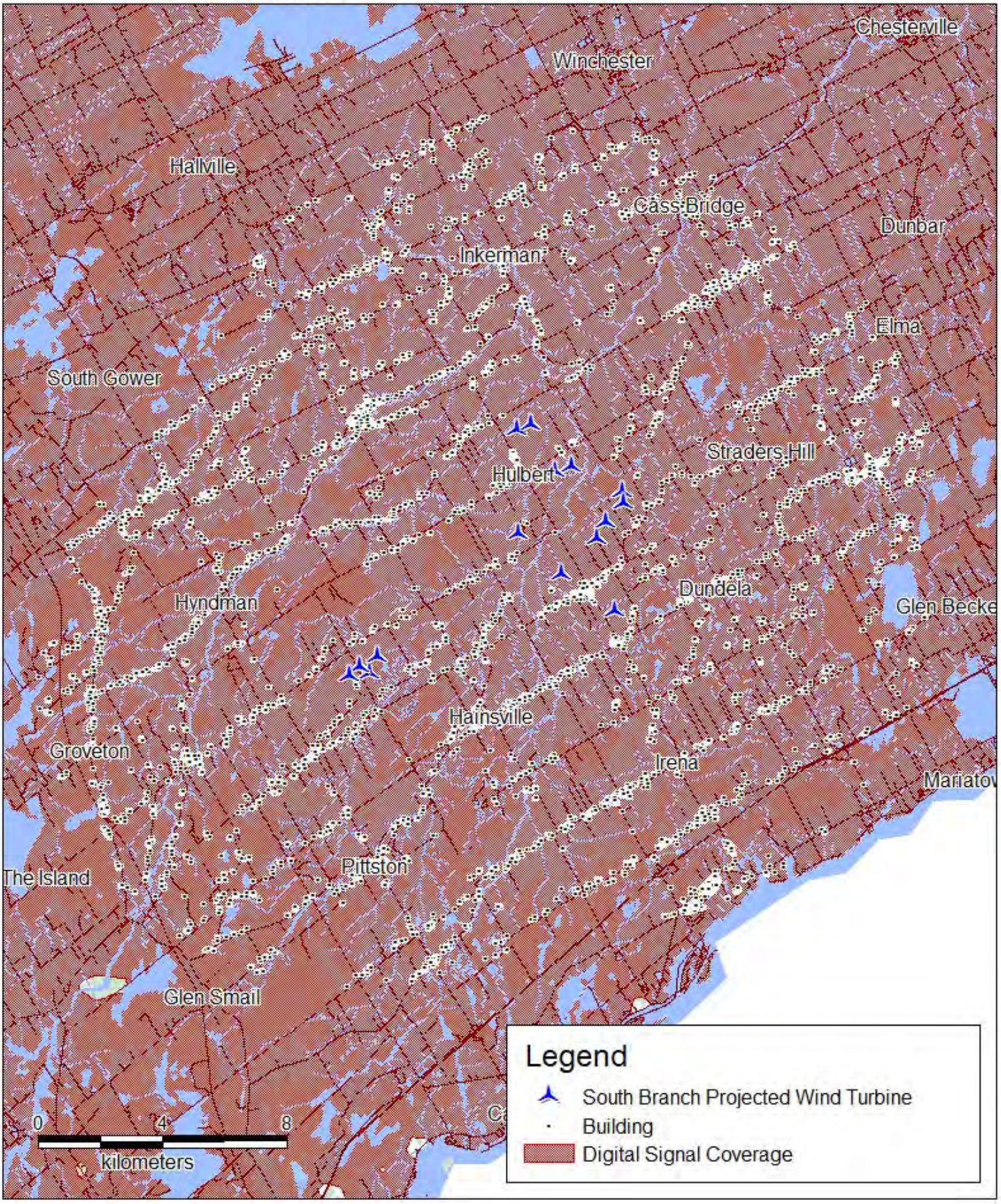
## Realistic Coverage
## of DTV Stations

## South Branch Wind Farm

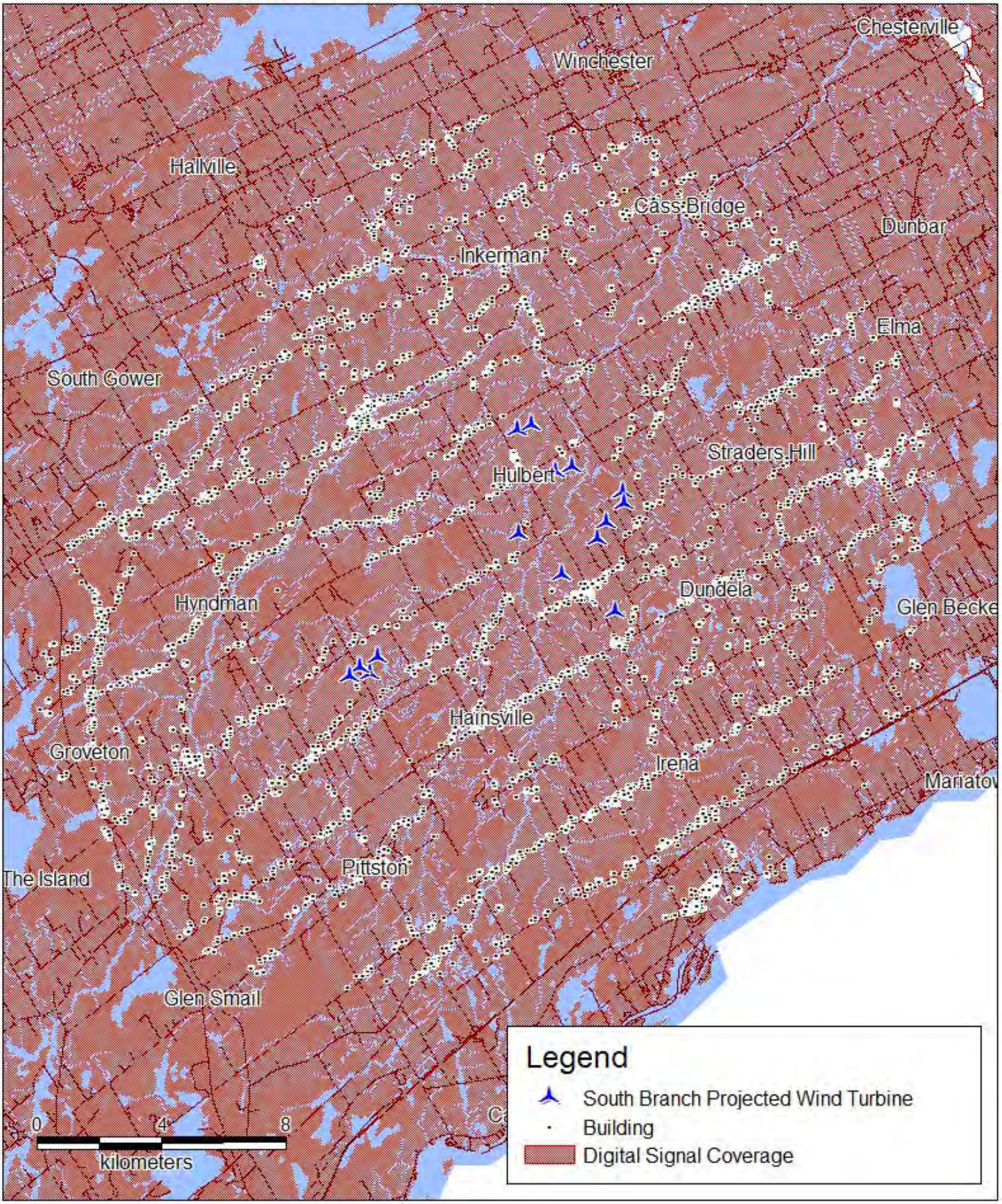
# SOUTH BRANCH WIND FARM CBOT-DT COVERAGE



# SOUTH BRANCH WIND FARM CBOFT-DT COVERAGE



# SOUTH BRANCH WIND FARM CKWS-DT-2 COVERAGE

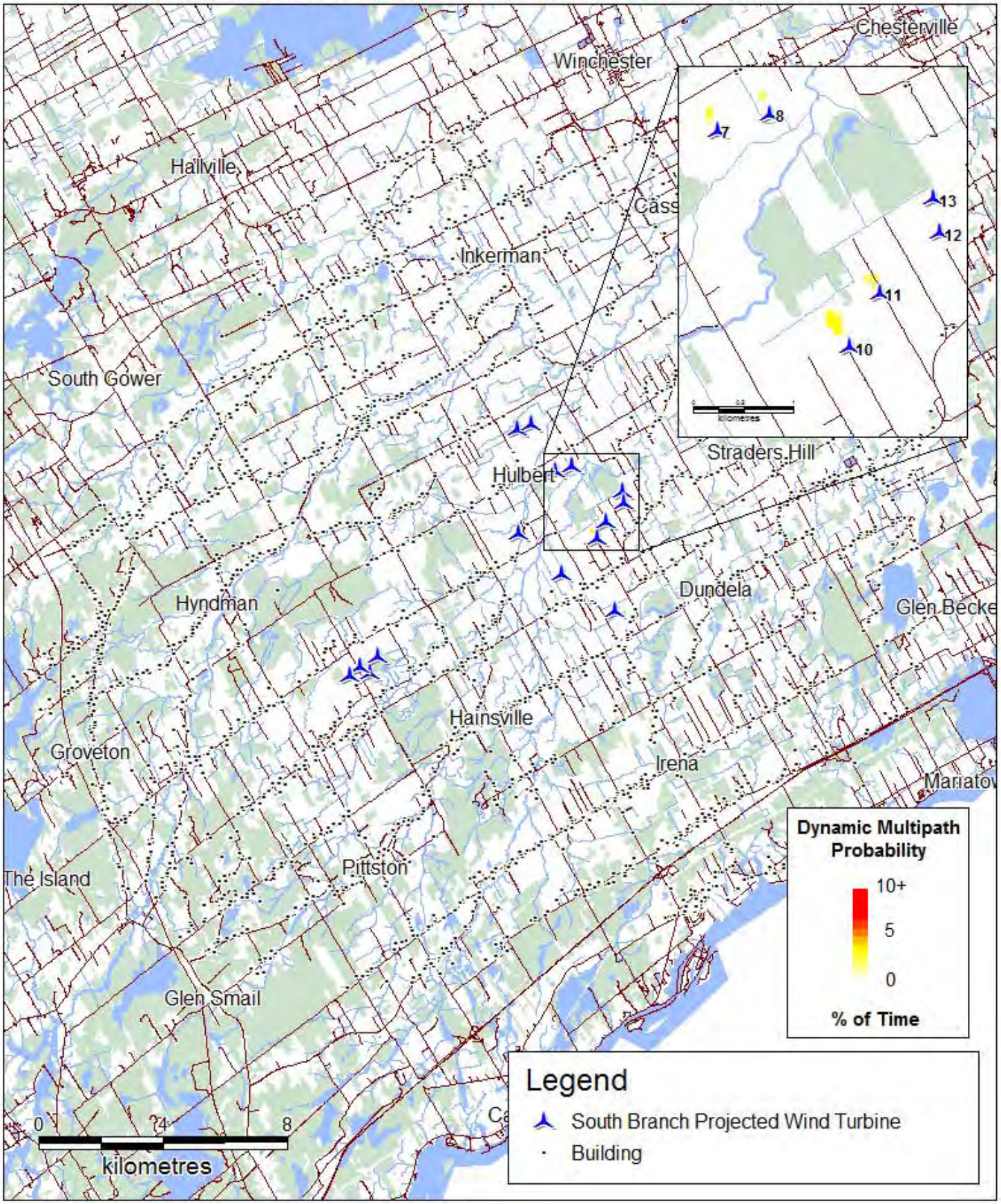


# ANNEX 3

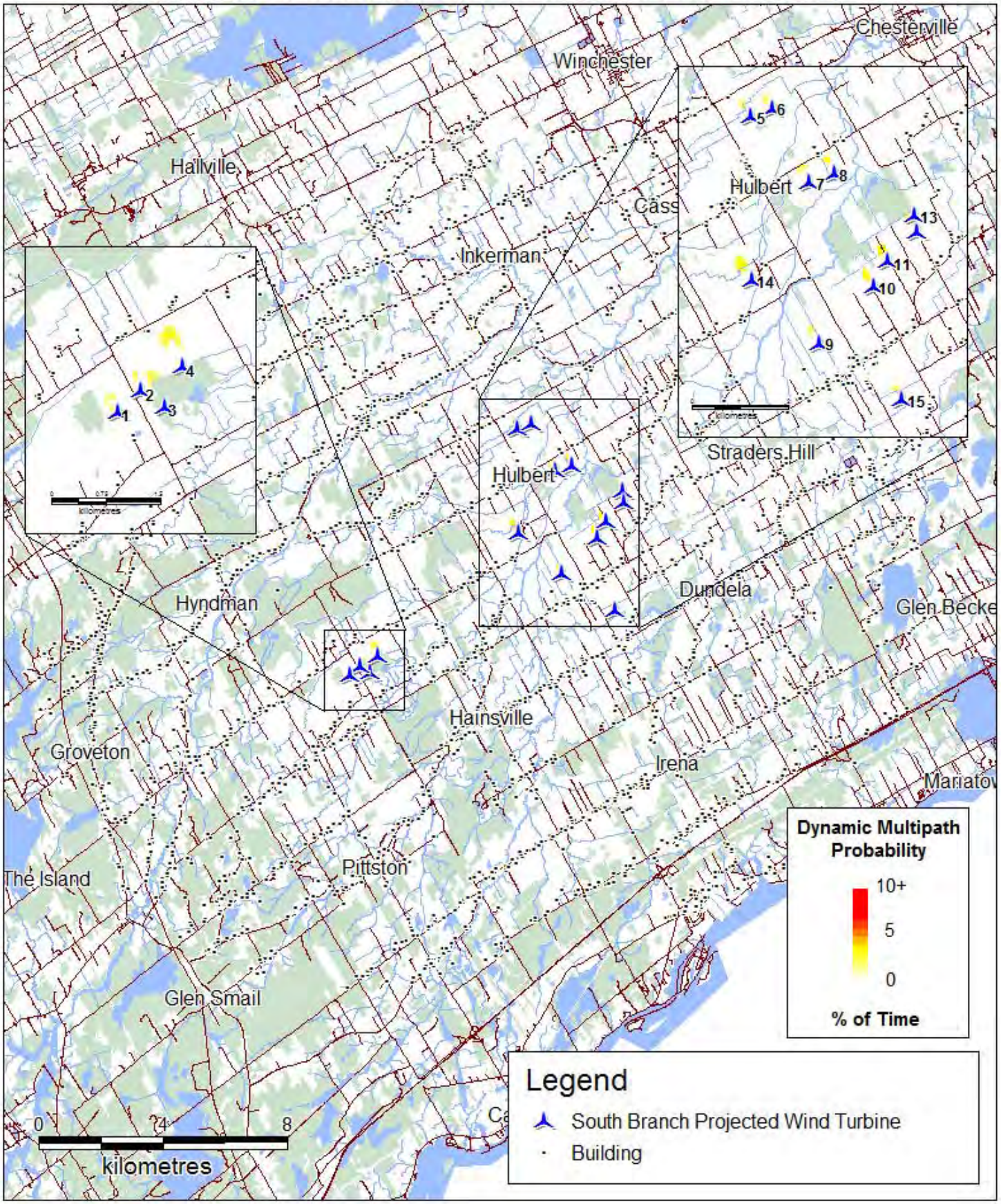
## Dynamic Interference
## Analysis Results

## South Branch Wind Farm

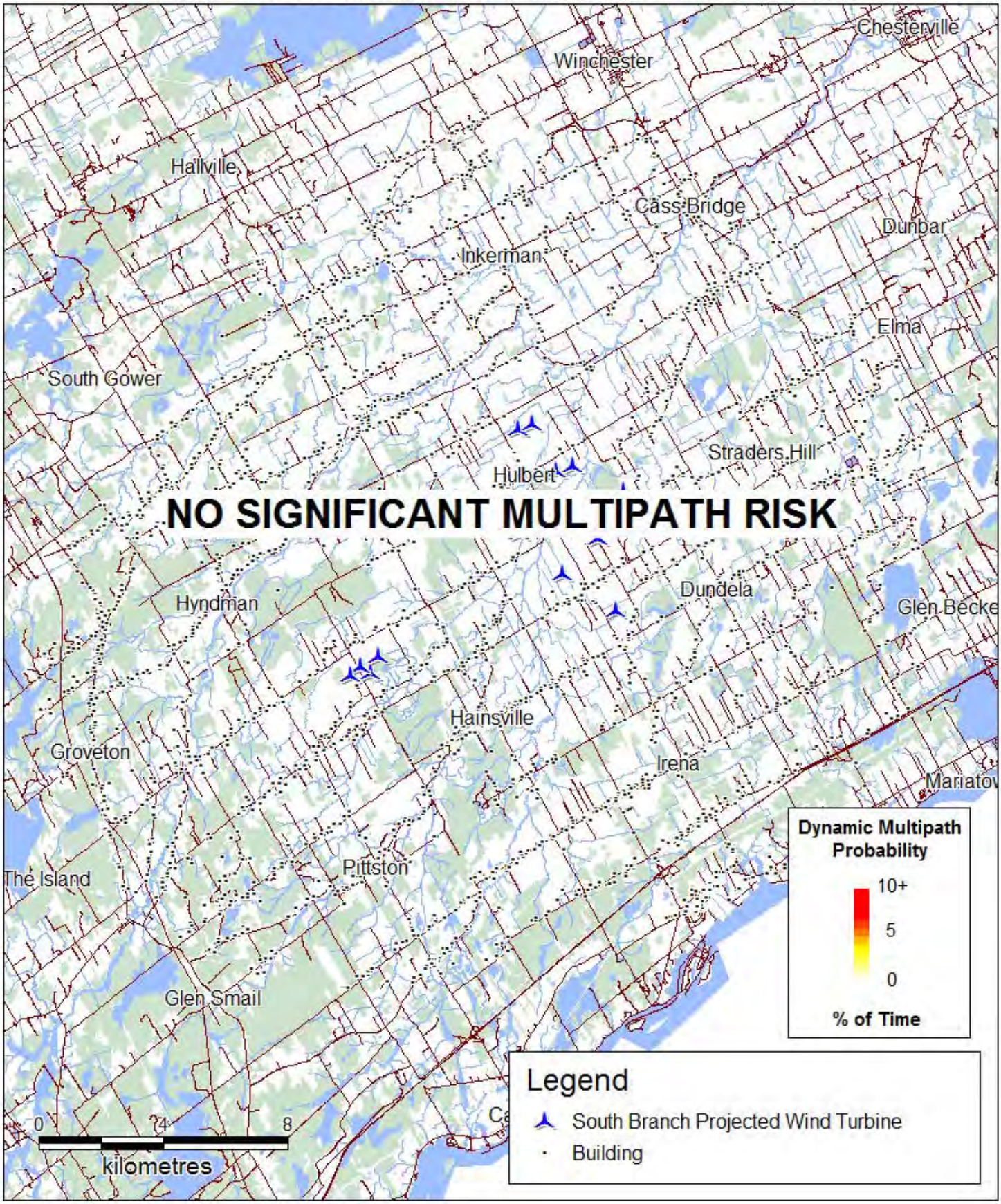
# SOUTH BRANCH WIND FARM
# CBOFT-DT DYNAMIC MULTIPATH PROBABILITY



# SOUTH BRANCH WIND FARM
# CBOT-DT DYNAMIC MULTIPATH PROBABILITY



# SOUTH BRANCH WIND FARM
# CKWS-DT-2 DYNAMIC MULTIPATH PROBABILITY

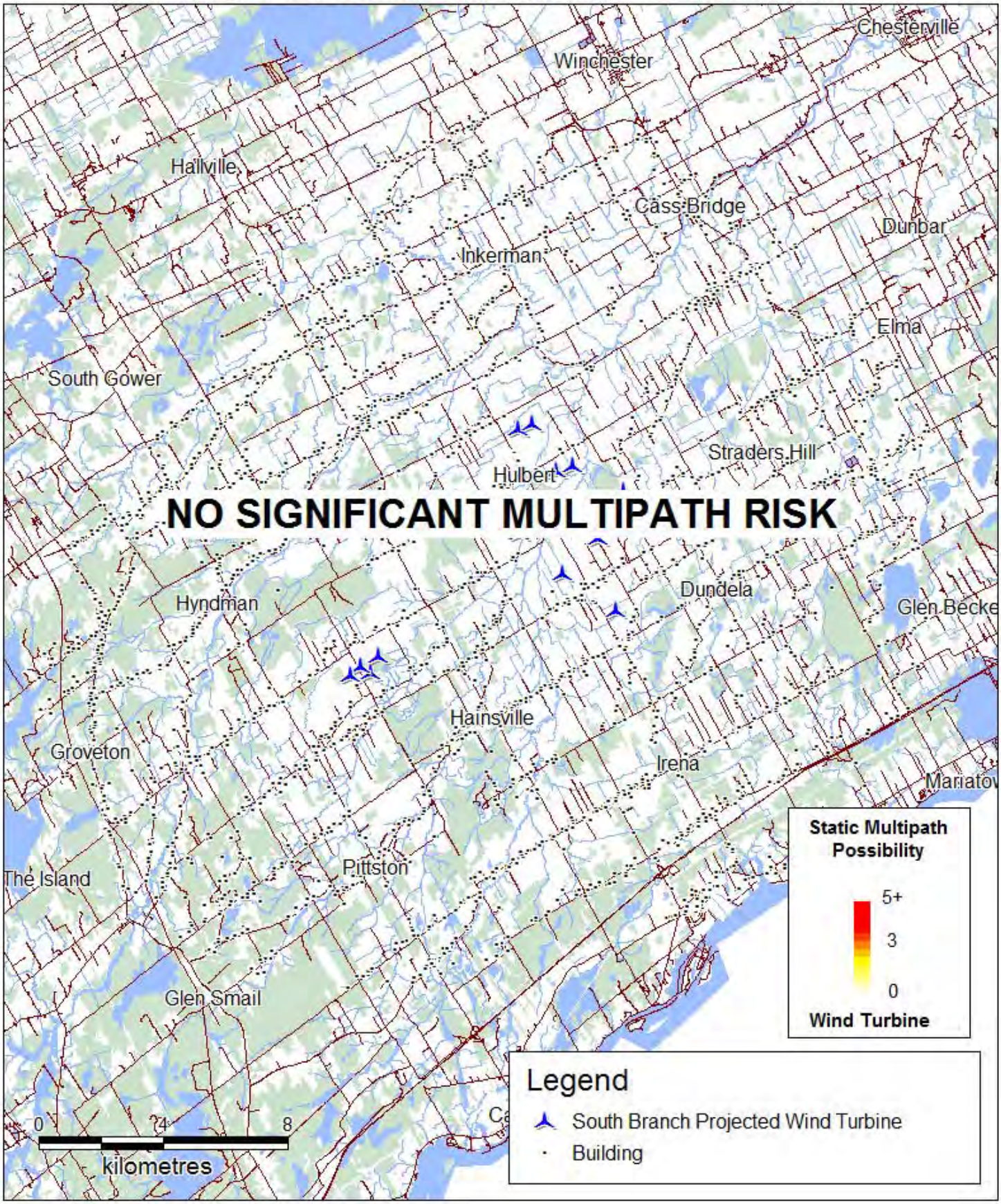


# ANNEX 4

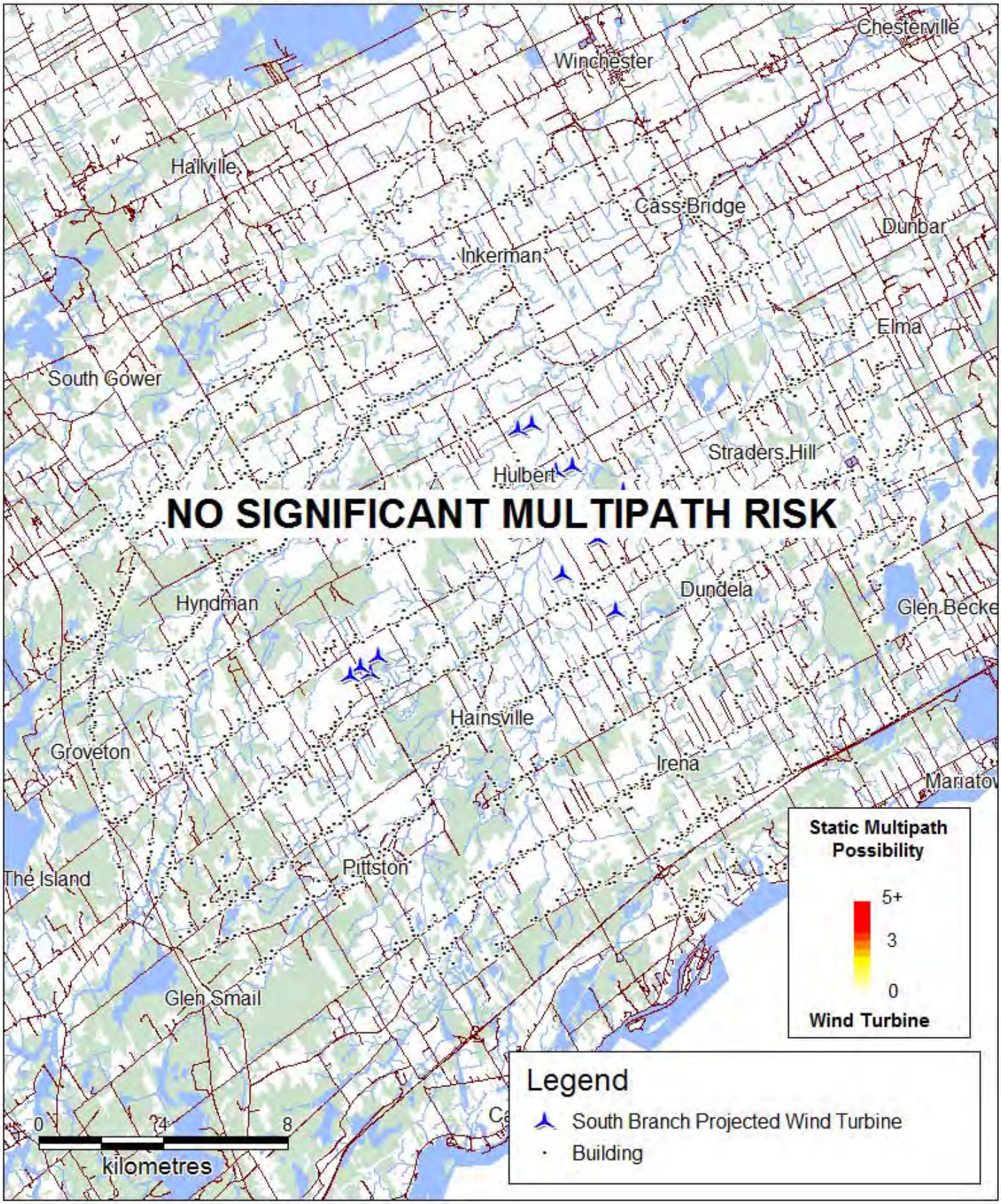
## Static Interference
## Analysis Results

## South Branch Wind Farm

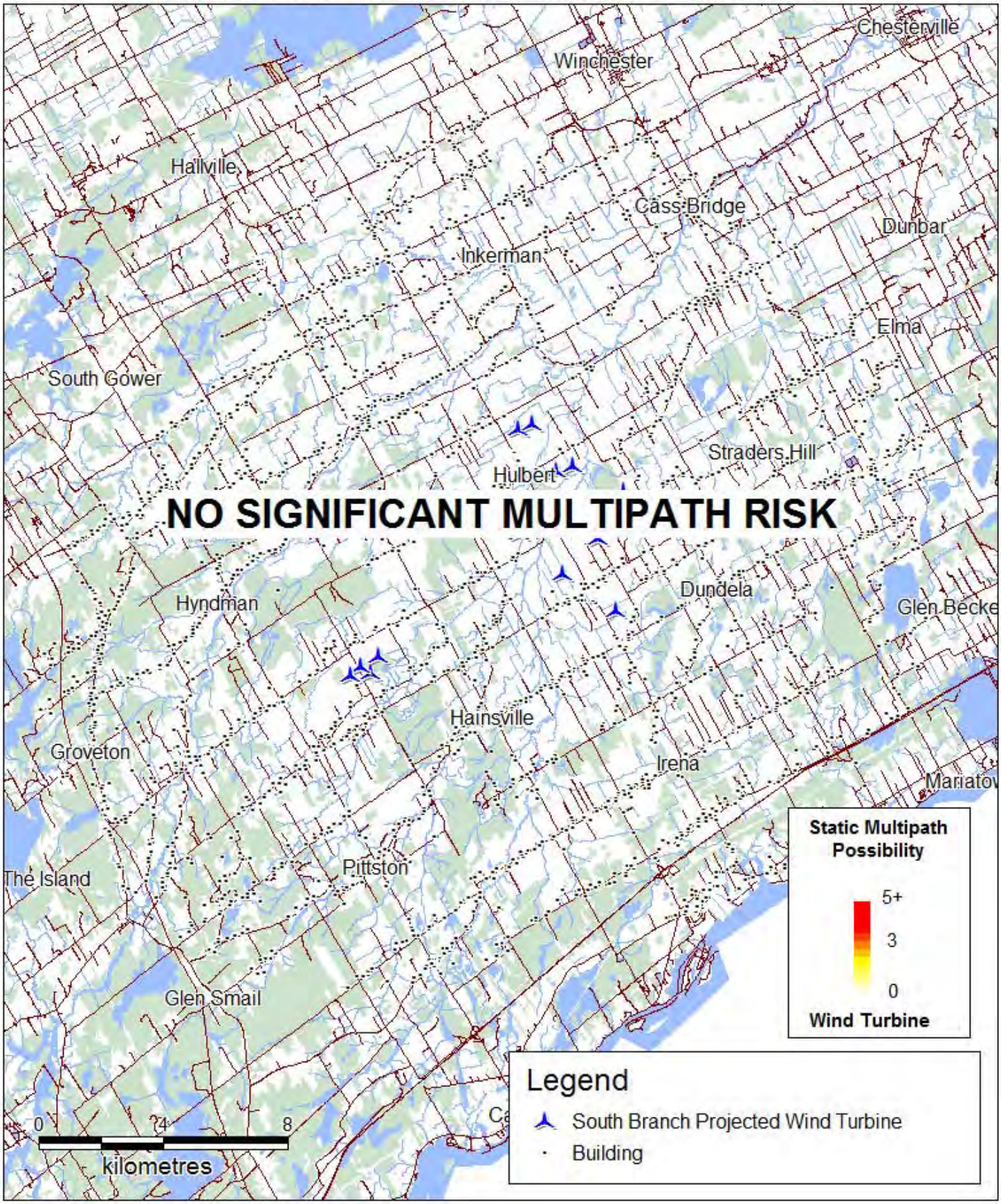
# SOUTH BRANCH WIND FARM
# CBOFT-DT STATIC MULTIPATH POSSIBILITY



# SOUTH BRANCH WIND FARM
# CBOT-DT STATIC MULTIPATH POSSIBILITY



# SOUTH BRANCH WIND FARM
# CKWS-DT-2 STATIC MULTIPATH POSSIBILITY



# APPENDIX F

## RADIO COMMUNICATION, RADAR AND SEISMO-ACOUSTIC POTENTIAL IMPACT ASSESSMENT REPORT

# SOUTH BRANCH WIND FARM

## POTENTIAL CUMULATIVE IMPACTS ON RADIO COMMUNICATION, RADAR AND SEISMO-ACOUSTIC SYSTEMS

June 30, 2011

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# 1. INTRODUCTION

## 1.1. POTENTIAL IMPACT GUIDELINES

Wind turbines have potential impacts on certain radio communication, radar and seismo-acoustic systems. In order to screen a wind project for these potential impacts, the Canadian Wind Energy Association and the Radio Advisory Board of Canada (RABC) have consulted with a range of stakeholders and have produced a document titled "*Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radio Communication, Radar and Seismoacoustic Systems*" (the RABC Guidelines Document), Version 8.0.

The RABC Guidelines Document defines consultation zones near Radio Communication, Radar and Seismoacoustic Systems and forms the basis of all analysis in this report.

## 1.2. PROJECT LOCATION AND SIZE

Prowind Inc. has proposed the South Branch Wind Farm near Brinston, ON, approximately 8 km northwest of Williamsburg, Ontario. The project is primarily located within South Dundas Township, in the United Counties of Stormont, Dundas and Glengarry, with a small portion extending into the neighbouring Edwardsburgh/Cardinal Township in Leeds and Grenville County. Figure 1 presents the project location to illustrate the project area; Figure 2 presents the proposed turbine locations and project layout.

The South Branch Wind Farm project is proposed to be 30 MW in total nameplate capacity and will consist of up to 14 turbines, each rated at no more than 3 MW. Proposed turbine coordinates are listed in Table 1. These wind turbines will have a hub height of up to 140 m and a rotor diameter of up to 118 m. More information on the turbine is included in the *Turbine Specification Report*.

The project is proposed on privately owned, agricultural land as well as municipal easements surrounding the Town of Brinston, Ontario. The project turbines are located in two main areas. The western area is defined by properties directly on each side of Byker Rd, between Dobbie Rd and Branch Rd to the north and Pitt Rd and Sandy Creek Rd to the south. Turbines in the eastern area lie on either side of Brinston Rd/County Rd 16 between Oak Valley Rd to the north and Cook Rd to the south.

FIGURE 1 SOUTH BRANCH WIND FARM PROJECT LOCATION

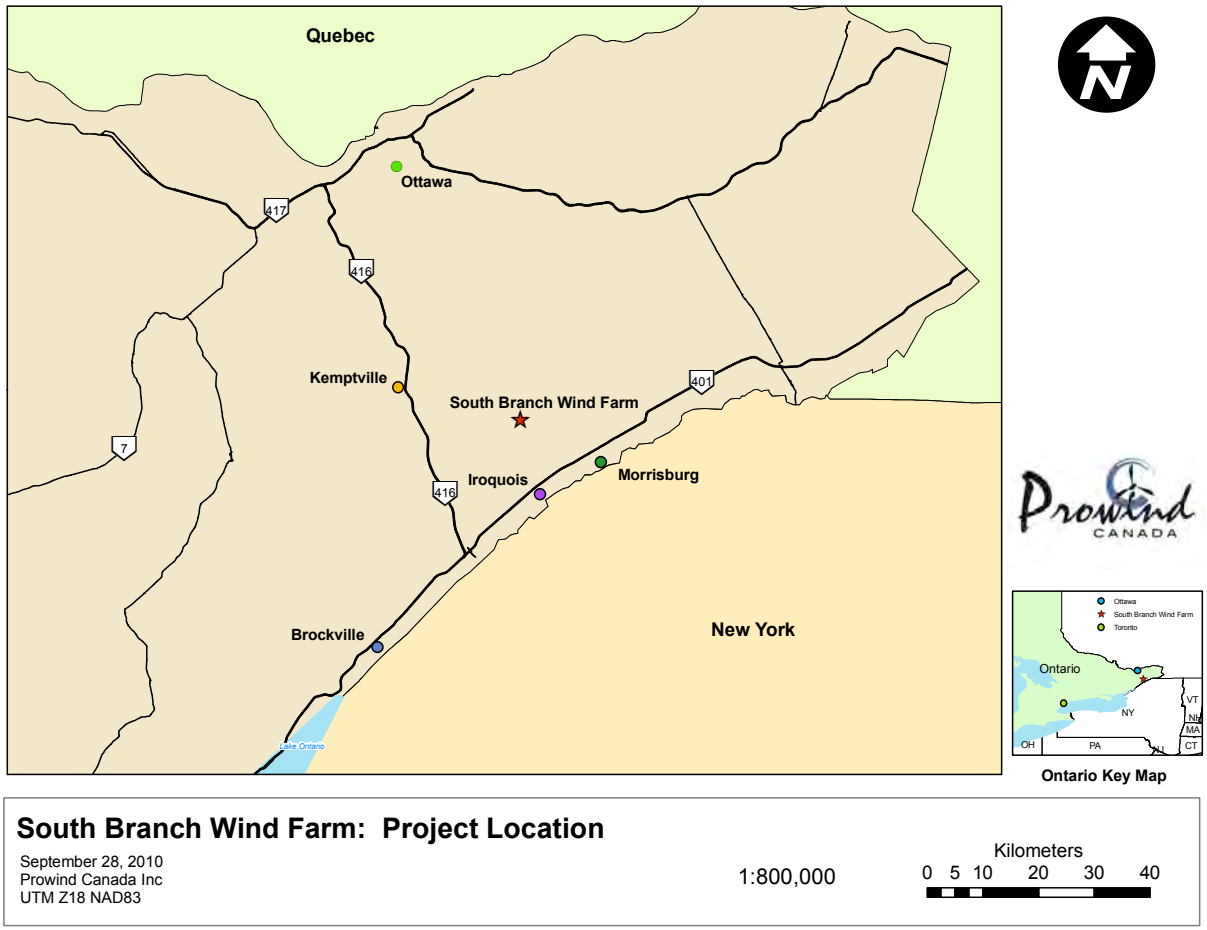


TABLE 1 SOUTH BRANCH WIND FARM TURBINE LOCATIONS

| Identifier | UTM NAD 83 Zone 18N Coordinates | | |
|---|---|---|---|
| | Easting | Northing | Elevation (m) |
| 1 | 463,955 | 4,973,451 | 87.8 |
| 2 | 464,274 | 4,973,747 | 83.0 |
| 3 | 464,593 | 4,973,522 | 80.8 |
| 4 | 464,848 | 4,974,070 | 80.0 |
| 5 | 469,331 | 4,981,383 | 72.6 |
| 6 | 469,791 | 4,981,543 | 71.1 |
| 7 | 470,572 | 4,980,031 | 74.5 |
| 8 | 471,094 | 4,980,234 | 72.1 |
| 9 | 470,765 | 4,976,717 | 73.1 |
| 10 | 471,904 | 4,977,880 | 72.6 |
| 11 | 472,196 | 4,978,405 | 72.4 |
| 12 | 472,795 | 4,979,009 | 74.3 |
| 13 | 472,713 | 4,979,350 | 73.7 |
| 15[1] | 472,526 | 4,975,715 | 75.0 |

[1] Earlier versions of this report included details for a Turbine 14. Turbine 14 was removed from the project design in early 2011, but other turbine identifiers have been unchanged.

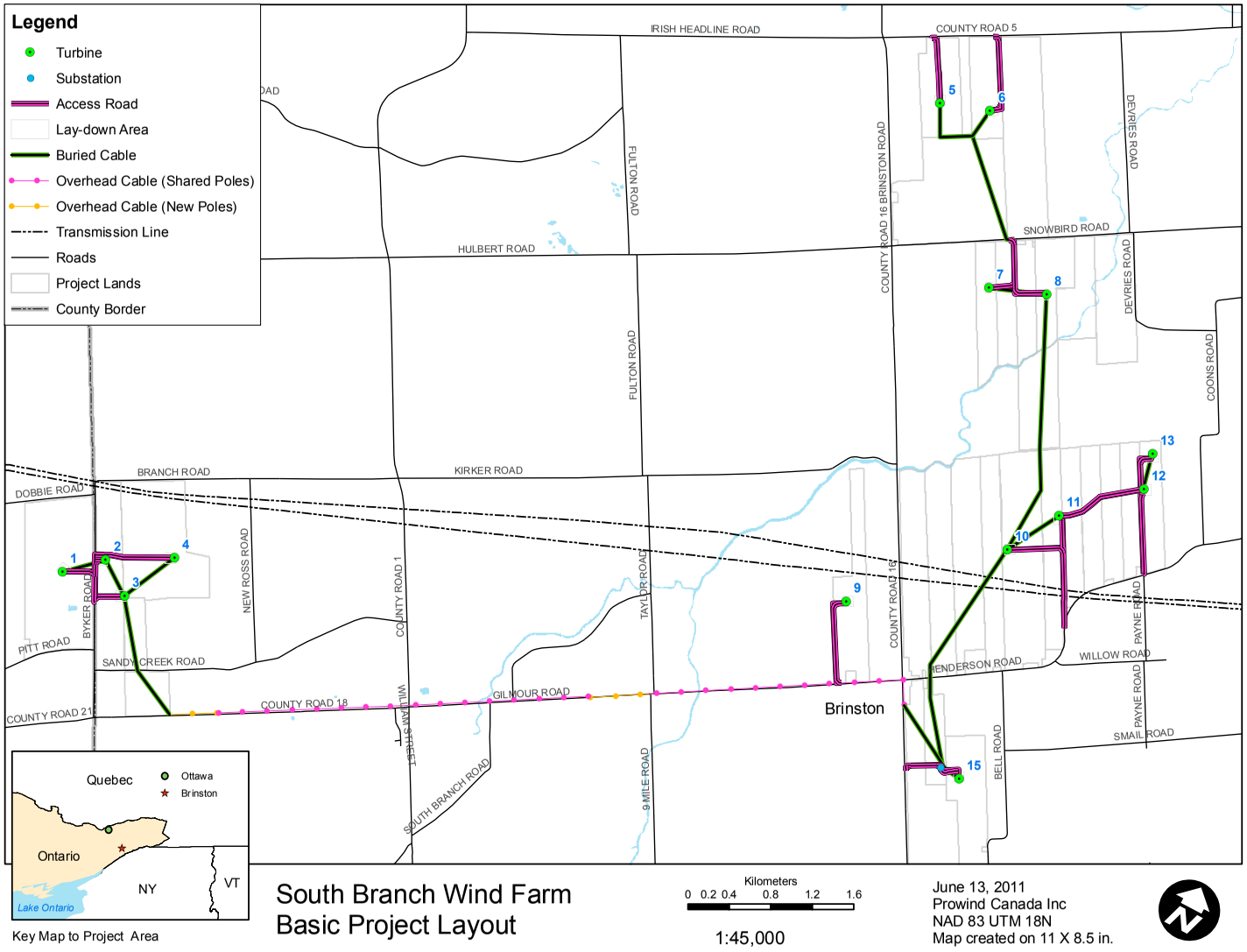



FIGURE 2 SOUTH BRANCH WIND FARM PROJECT LAYOUT

## 1.3. PROJECT EQUIPMENT

Table 2 presents the turbine characteristics for the projects. This information was used, where applicable, in the calculation of consultation zones as suggested by the RABC Guidelines Document.

The final turbine selection has not yet been made; however, the analysis summarized in this report incorporates the maximum dimensions of all turbines under consideration to ensure that no matter what turbine is ultimately selected, its impact on the communication systems will be less than or equal to the assumptions that were studied.

TABLE 2 TURBINE SPECIFICATIONS

| | |
|---|---|
| **Make and Model** | Generic Turbine (Reflecting Maximum Size and Operational Parameters Being Considered) |
| **Maximum Electrical Output Rating** | 3.0 MW |
| **Hub Height** | Up to 140 m |
| **Rotor Diameter** | Up to 118 m |
| **Range of Rotational Speeds** | Up to approximately 20 RPM |
| **Mode of Operation** | Horizontal Axis, Upwind, Pitch Controlled |
| **Diameter of Turbine Base** | Approximately 9.2 m maximum |
| **Approximate Foundation Diameter** | 22 m – depending on soil conditions |
| **Approximate Volume of Concrete Foundation** | 575 $m^3$ but may be as high as 815 $m^3$ if buoyancy forces are present |

# 2. IMPACT ON RADIO COMMUNICATION SYSTEMS

A search of Industry Canada's Spectrum Direct listings was performed. The search radius was 30 km centred at the project and included frequencies between 0.1 MHz – 99999 MHz. 521 results were returned.

Consultation with Industry Canada confirmed that the search parameters should be sufficient to identify point-to-point systems, cellular and mobile systems, and over-the-air broadcast systems that could be impacted by the project. The search results are interpreted in the following sections and follow the order presented in the RABC Guidelines Document.

## 2.1. EMERGENCY SERVICES COMMUNICATIONS

The potential for impact on emergency services communications, including, but not limited to fire, police and ambulance services have been addressed within this section.

Specifically in regards to communications networks for Federal services, consultation with the RCMP, Department of Defence, Environment Canada, Navigation Canada and Transport Canada has been completed with results summarized below.

At a provincial level, and as presented in Section 0 below, consultation with Government Mobile Communications Offices (GMCO) was completed. The GMCO confirmed their responsibility for the Provincial Government's Public Safety Radio network, used by various Ministries. In the Counties of SD&G and Leeds & Grenville, this includes the Ministry of Community Safety and Correctional Services (OPP and Corrections), Ministry of Transportation (highway operations and enforcement), Ministry of Health and Long-Term Care (land ambulance) and Ministry of Natural Resources (fire management and conservation enforcement). None of these groups reported a likelihood of detrimental impact due to the proposed wind farm.

Also within the Counties of SD&G and L&G, both municipal and commercial radio communications have been thoroughly investigated. All transmit or receive stations networks registered on the Industry Canada's Spectrum Direct website within 30 km of the project area were investigated to ensure that any potential for signal disruption was identified and reviewed. This survey included fixed point and mobile communications networks that make up the local emergency services, such as fire, ambulance, hospital, County and Township communication systems. As presented in Section 2.5, there are no land mobile networks within the defined consultation zone. A full list of the reviewed frequencies is available upon request.

## 2.2. POINT-TO-POINT SYSTEMS

Point-to-point systems and beam paths were mapped using "link call sign" information from spectrum direct. The RABC Guidelines Document states: "*the radius of the consultation zone around both the transmit and receive locations should be at least 1 km.*" The nearest transmit or receive station is approximately 11 km from the centre of the project.

The consultation zone surrounding point-to-point beam path is a cylinder defined in the RABC Guidelines Document as follows:

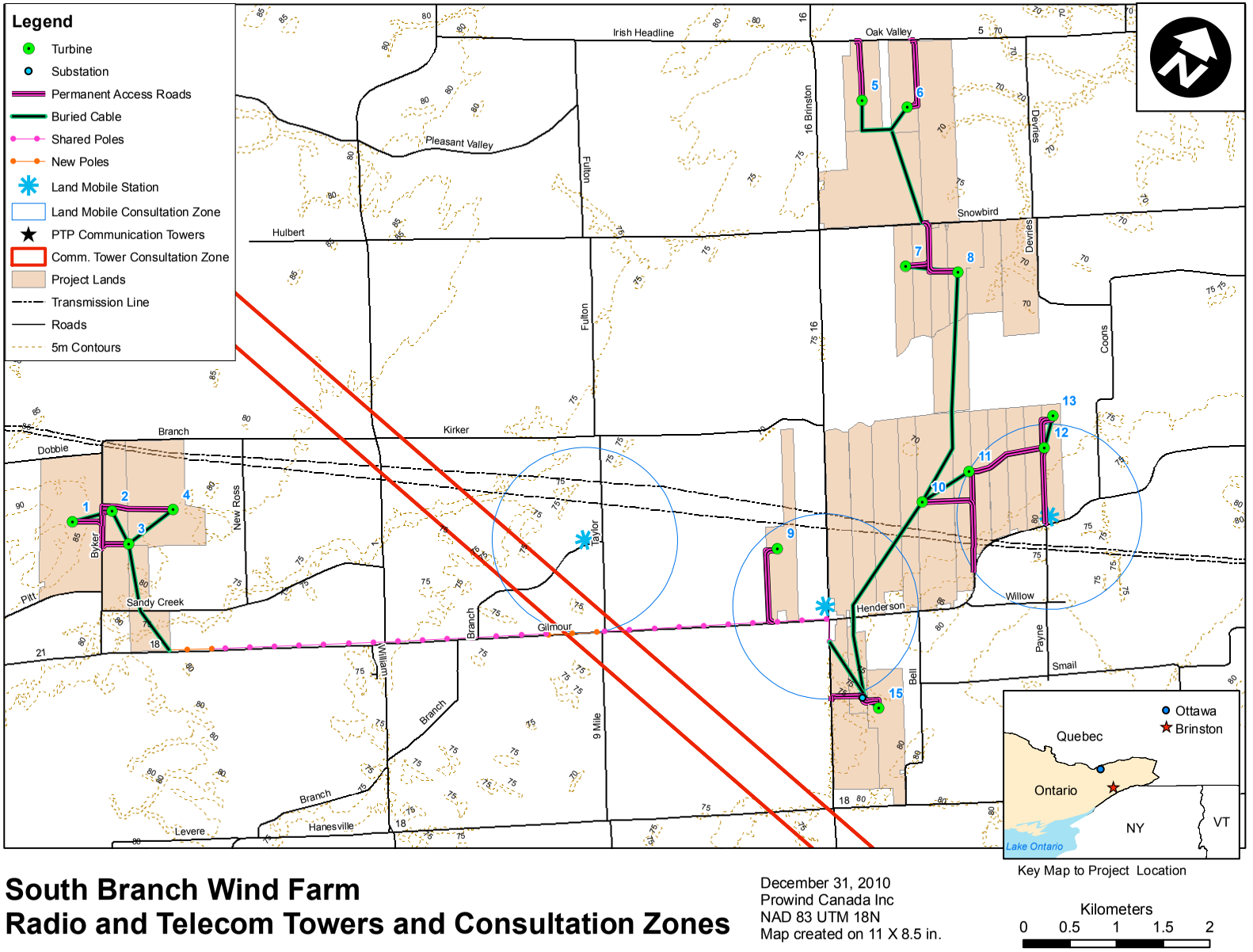
$$L_{c(m)} = 52\left(\frac{D_{(km)}}{F_{(GHz)}}\right)^{1/2} + 2B$$

Where:

***L*** $_c$ = Diameter of the cylinder in meters
***D*** = Transmit to receive path length in kilometres
***F*** = Frequency in GHz
***B*** = Length of one wind turbine blade in meters

Point-to-point beam path and tower consultation zones are shown in Figure 3. Although there is a cellular telecom communication path that crosses diagonally through the centre of the project area, no turbines at the South Branch Wind Farm are located within the consultation zone as defined within the RABC Guidelines Document.

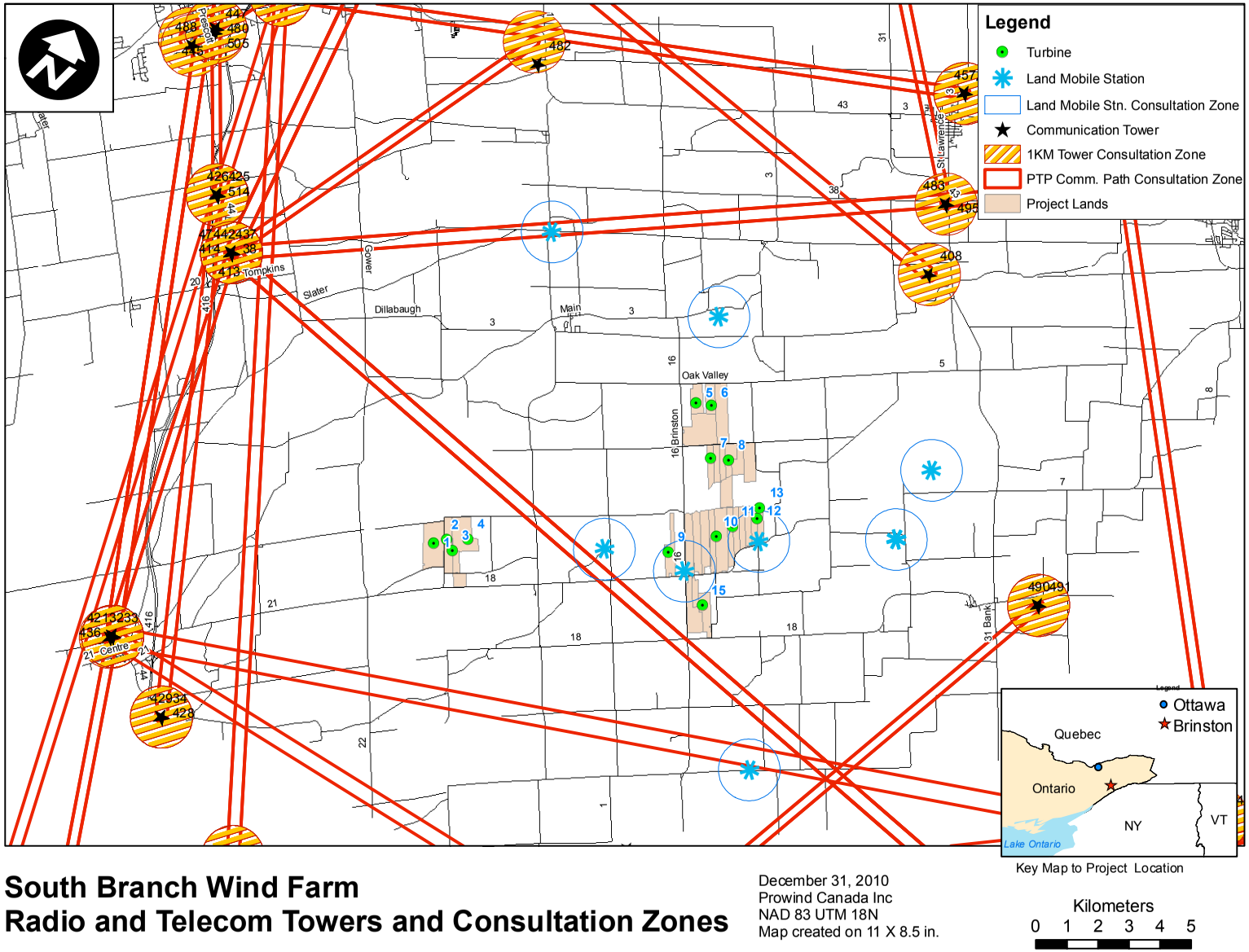
Figure 4 presents the same point-to-point and radio communication consultation zones, but with a larger scale. This is presented only to show the complexity of systems in the area neighbouring the wind farm.




**South Branch Wind Farm**
**Radio and Telecom Towers and Consultation Zones**

December 31, 2010
Prowind Canada Inc
NAD 83 UTM 18N
Map created on 11 X 8.5 in.

FIGURE 3 POINT-TO-POINT AND RADIO TRANSMISSION STATION CONSULTATION ZONES




**South Branch Wind Farm**
**Radio and Telecom Towers and Consultation Zones**

December 31, 2010
Prowind Canada Inc
NAD 83 UTM 18N
Map created on 11 X 8.5 in.

FIGURE 4 POINT-TO-POINT AND RADIO TRANSMISSION STATION CONSULTATION ZONES NEAR PROJECT

## 2.3. OVER-THE-AIR BROADCAST AND RECEPTION

### 2.3.1. AM Radio Broadcast

No AM radio broadcasters were found within the 30km radius search area. No further consultation is required.

### 2.3.2. FM Radio Broadcast

No FM broadcasters are within 30 km of the project area. No consultation with FM broadcasters is necessary.

### 2.3.3. TV Broadcast

There are no TV broadcast antennae within 30km of the project. Since the nearest lies beyond the 10km consultation zone, further consultation with TV broadcasters regarding impacts on broadcast systems is not required.

### 2.3.4. TV Reception

The RABC Guidelines Document states that TV broadcast signal receivers may be impacted within a worst-case consultation zone with radius, R, defined as follows:

$$R = 0.051 * B * (T)^{½}$$

Where:

***R*** = the radius, in kilometres, of the consultation zone from the geographic centre of the wind farm

***B*** = the length, in metres, of a single wind turbine blade

***T*** = the number of turbines in the wind farm

For the South Branch Wind Farm B <= 59 m, and T <= 14. This results in a maximum consultation zone radius, **R, of 11.26** km. There are expected to be a few hundred households within this distance of each of our turbines. A portion of these households is expected to receive over-the-air broadcasts of TV signals as their primary source of TV signals.

Consultation with broadcast stakeholders in the area was initiated in June 2009 with communications between Prowind Canada and the Canadian Broadcast Corporation (CBC). In a telephone conference Ms. Julie Bergeron, noted that the CBC will typically request that an impact assessment study be performed for all projects if there are any receivers within the consultation zone. This would apply to South Branch Wind Farm as noted in the preceding paragraph.

Ms. Bergeron provided the guidelines for preparing and submitting a report on pre-construction assessment of potential impacts. Prowind is continuing with arrangements to contract out the recommended pre-construction surveys so as to identify and where possible, mitigate any potential for problems.

In August 2010, Prowind contracted Yves R. Hamel et Associés inc. (YRH) to perform a detailed investigation of potential impacts to television reception in the vicinity of the wind farm. The full

report from YRH is included in Appendix F of the *Design and Operation Report*. Pertinent excerpts from their conclusions are presented below.

> *"The detailed analysis of the potential deterioration of the quality of reception of the digital CBOFT-DT, CBOT-DT and CKWS-DT-2 television broadcast stations allowed to establish that there is no significant risk of interference and only a few dwellings are at risk to experience this type of interference in dynamic mode in the case of CBOT-DT.*
>
> *"These households will most probably be able to eliminate this risk by using a good quality reception antenna, which will permit discrimination between the direct signal from the TV transmitter and the reflected signals from the wind turbines. All calculations for the study were done using the antenna mask proposed by Industry Canada in the BPR-10. However, many good quality antennas on the market are more directional than the proposed mask and will therefore discriminate better between wanted and unwanted signals."*

In follow up to this report, Prowind has developed a mitigation strategy that details the planned responses to reported disruptions. This strategy is in line with the suggestion by YRH to provide alternate TV reception equipment or services, and is presented in Section 5.3 of the *Design and Operations Report*.

Results of the YRH study were provided to Ms. Bergeron at CBC to demonstrate Prowind's compliance with the requirement for an impact assessment study.

## 2.4. CELLULAR-TYPE NETWORK

The RABC Guidelines Document states: "*the radius of the consultation zone around a cellular tower should be at least 1 km*."

The nearest cellular tower is approximately 11 km from the centre of the project, located in Iroquois, Ontario. No consultation with cellular carriers is required.

## 2.5. SATELLITE SYSTEMS

The RABC Guidelines Document states: "*Satellite ground stations are locations where broadcasters either receive RF [radio frequency] signals from, or transmit signals to, geo-stationary orbiting satellites*." This includes direct-to-home receivers such as satellite TV or radio.

The consultation zones related to these systems are defined as:

a) a 500 m radius around the transmit and receive antennas, plus

b) A cone of width ***Lc*** defined as:

$$Lc = R + 104 * (D/F)^{½}$$

where

*D* = distance in km from the antenna

*F* = frequency in GHz of the transmission

*R* = rotor diameter of the turbines in metres

The regulated setback of 550 m from turbine base to noise receptor (e.g. residence, school, church) is sufficient to ensure that all satellite receptors of concern are beyond the 500 m consultation zone identified in point (a) above.

The investigation can therefore focus on whether the combination of satellite dish direction and turbine placement presents potential for interference. The television reception study conducted by Yves R. Hamel and Associates Inc., presented in Appendix G of the *Design and Operations Report* presents results of this investigation. Their conclusions were as follows:

> *"Based on available information showing the approximate location of buildings in the region, we did not identify any wind turbine that could possibly have an impact on the reception of Direct Broadcast Satellite services."*

The closest Satellite Ground Station is outside of the 10 km radius for mandatory consultation. Further investigation has demonstrated that there are no Satellite Ground Stations with beam paths that cross the project area.

## 2.6. LAND MOBILE NETWORKS

The RABC guidelines document states: "*the radius of the consultation zone around a land mobile radio tower site should be at least 1.0 km*."

There are two land mobile radio frequencies originating from within 1 km of a proposed turbine location. These are identified in Figure 2 with blue asterisks and are registered as follows:

Frank Ault – located within 1km of Turbine 9.

George Tibben - located within 1km of Turbines 11 and 12.

Both frequencies are located in close proximity to the village of Brinston. Proponent staff has contacted each of these operators to relay information about the proposed wind farm and determine the extent to which mitigation measures must be initiated.

Both George Tibben and Frank Ault have confirmed in conversations with Prowind staff that the identified land mobile networks are no longer operational.

Industry Canada's Spectrum Direct listings include only partial information for mobile land networks. Police frequencies are not included in Spectrum Direct listings due to confidentiality concerns. Consultation with the RCMP has confirmed that there are no concerns with the proposed project. Upon review of the project areas for South Branch Wind Farm, Alex Beckstead, Radio Spectrum Engineer for the RCMP Mobile Communication Services has stated:

> *"I've reviewed to proposed South Branch Wind Project and I do not foresee this development causing any radio communications issues to our systems. Should the locations of any of the turbines change (over 1km), please keep us informed."*

In addition, Prowind has communicated a description of the full project area with the Ontario Government Mobile Communications Office (GMCO) and the response received was as follows:

> *"Please accept this Email as written confirmation that the wind turbines deployment at the proposed locations indicated in the attachment to your Aug 13, 2010 Email are not likely to affect the operation of Ontario's Public Safety Radio network."*

No further follow up with the GMCO or RCMP is required.

# 3. Impact on Seismo-acoustic Monitoring Equipment

The RABC guidelines document states: "*The radius of the consultation zone around a Natural Resources Canada monitoring array should be at least 50 km, and at least 10 km around a single monitoring station.*"

As suggested in the RABC guideline document, the following website was consulted in order to determine the proximity of the projects to seismo-acoustic monitoring equipment: http://earthquakescanada.nrcan.gc.ca/stnsdata/cnsn/stn_book/?tpl_sorting=map

Figure 3 illustrates seismo-acoustic station locations near the project. The nearest station is Williamsburg, ON (site name WBO), which is less than 10 km from the project center and certainly within the 100km consultation zone.

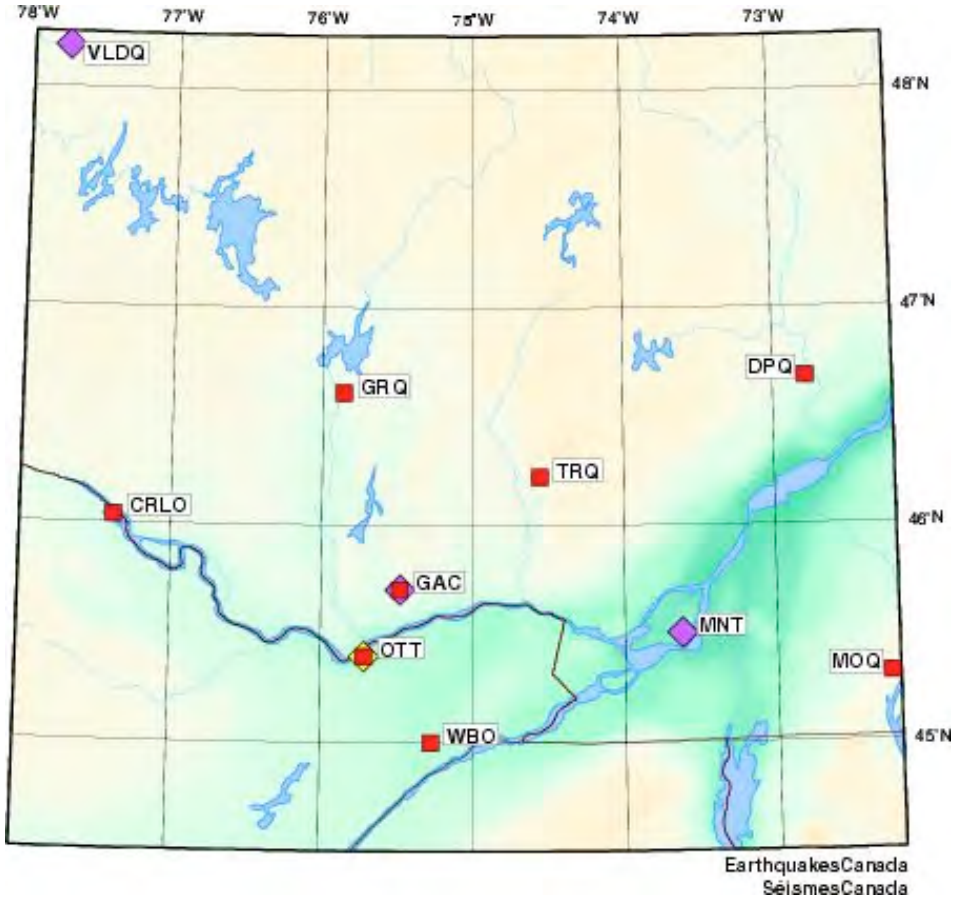



FIGURE 5 SEISMO-ACOUSTIC STATIONS IN PROXIMITY TO THE PROJECTS

The Ministry of Natural Resources (MNR) has confirmed that they will not object to the proposed South Branch Wind Farm development. Mr. Jim Lyons, Leader, Infrastructure and Development Group stated:

> *"It appears that the centre of the South Branch wind farm is located 8.3 km from our WBO installation, and the centre of the Brinston wind farm is 8.5 km from WBO. At this distance, it is possible that the facility may generate sufficient seismoacoustic noise to have a degrading effect on our monitoring capabilities at this site.*
>
> *Further monitoring will continue, however, at this time we do not intend to raise an objection to this proposal."*

Subsequent discussion occurred after the amalgamation of South Branch, Brinston and Boundary projects as a single 30 MW project. Upon review of the updated layout and project areas, Ms. Janet Drysdale, Seismologist for NRCan stated:

> *"The added lands to the west will be farther away as you state. Our initial assessment that at this time we do not intend to raise an objection to this proposal still stands."*

# 4. Impact on Air Defence, Vessel Traffic and Air Traffic Control Radars

Several government stakeholders have been contacted in regards to the proposed South Branch Wind Farm to scrutinize any potential for impacts to the air defence, vessel traffic or air traffic control (ATC) radar systems.

The Department of National Defence (DND) has confirmed that the South Branch Wind Farm poses no concerns for either their ATC or Air Defence Radars, as stated by J. Andrew Risk:

> *"We have completed the initial analysis of the proposed South Branch wind turbine site.*
>
> *"The assessment has revealed no impact to the Department of National Defence; Air Traffic Control, Air Defence Radars. Therefore with respect to these sites as well as DND airports and NAVAIDS we have no objections with your project as submitted. Should there be any changes to the site please re-submit the proposal for another assessment."*

Mr. Mario Lavoie, also of DND, further confirmed that there are no concerns in regards to radiocommunication systems:

> *"I reviewed your proposal in respect to DND radiocommunication systems, and I have no objections, or concerns."*

Prowind applied for a Land Use Assessment with Nav Canada. Included in the application package were turbine coordinates for the South Branch Wind Farm. On March 7, 2011, Prowind staff met with Mr. Jeff MacDonald to discuss the details of the proposed South Branch Wind Farm in relation to Nav Canada interests in the area. In a letter dated March 18, 2011, Nav Canada provided a letter to Prowind (Appendix A) stating the following:

> *"We have evaluated the captioned proposal and NAV CANADA has the following comments regarding the project:*
>
> - *All fifteen proposed wind turbines are predicted to be within line-of-sight to*

*NAV CANADA's Primary Surveillance RADAR (PSR) site in Ottawa, ON;*

- *Wind turbines within line-of-sight to PSR installations are known to interfere with operation of RADAR and cause:*
  - *Large numbers of false primary radar targets in the wind farm geographical limits and their immediate vicinities;*
  - *Significant reductions to our capability to identify and track primary surveillance targets in the subject area;*
  - *Limitations in our ability to provide full traffic information to our customers when a primary surveillance target(s) is in this area;*
  - *A decrease in flight safety for aircraft operating in these areas;*
  - *A potential overload condition in our radar data processing systems; and*
  - *A potential requirement to desensitize our primary radar to eliminate false targets and consequently eliminating legitimate aircraft targets;*

- *Due to the nature and significance of the possible negative impact on our capabilities and services for aircraft operating in and out of the Ottawa airport and other surrounding smaller airports, NAV CANADA objects to the development as proposed.*

*As discussed at our meeting on 7 March 2011, we advised you that if technical mitigations are required to address the impact on our radar, then the cost to implement the mitigations would be the responsibility of Prowind Canada Inc. A letter indicating your concurrence with this condition, would allow us to remove our objection."*

Prowind has responded in turn with a letter (Appendix A) indicating concurrence with this condition. Prowind will ensure the project is re-evaluated for compliance at least once every 12 months until commissioning per Nav Canada's written request. At this time, no further follow up is required.

Mr. Lee Goldberg, P.Eng of Department of Fisheries and Oceans reviewed the project proposal and on behalf of the Canadian Coast Guard had the following response in June 2009 based on the initial layout of the South Branch and Brinston projects:

*"Based on the information provided to Fernando Mojica of the Canadian Coast Guard, there are no radar or other Coast Guard communication installations in that area. Therefore, we do not foresee any problems with the proposed installation"*

Further, after an updated set of coordinates was provided on August 15, 2010, Mr. Goldberg again confirmed his position on this project:

*"I have reviewed the information provided by you. The combined wind farm locations are still not near Coast Guard communication sites to be of any concern."*

# 5. Impact on Weather Radar Systems

The RABC guidelines document states: "*the radius of the consultation zone around an Environment Canada Weather Radar should be at least 80 km*."

The closest weather radar station is at Franktown, ON. This location is within 80 km of the project and so consultation with the Meteorological Service of Canada, a division of Environment Canada was initiated by Prowind.

Upon review of the project details, the following response was provided by Ms. Lillian Yao on behalf of the Meteorological Service of Canada:

> *"Our preliminary assessment of the information you provided to us via your recent email indicates that any interference that may be created by your project will be minimal. As a consequence, we have no concerns at this time."*

Prowind will ensure that any updates to the layout or project area are appropriately communicated to the Meteorological Service of Canada.

# 6. Summary

The South Branch Wind Farm has been screened for potential impacts on radio communication systems, radar, and seismo-acoustic systems based on the guidelines outlined in the *Technical Information and Guidelines on the Assessment of Potential Impact of Wind Turbines on Radio communication, Radar and Seismoacoustic Systems* document published by the Canadian Wind Energy Association and the Radio Advisory Board of Canada, Version 8.0.

All stakeholders identified in this guideline document have been provided details of the proposed characteristics of the project. There have been no concerns identified by any of these groups.

The wind farm poses potential impacts to analog television reception in the immediate vicinity of the project area. Prowind has developed a comprehensive mitigation strategy for any residents who are detrimentally impacted by the wind farm. This strategy is presented in detail in sections 4.4 and 4.5 of the *Design and Operations Report*.

The wind farm also poses a possible negative impact on the capabilities and services for aircraft operating in and out of the Ottawa airport and other surrounding smaller airports, as identified by NAV CANADA. Prowind Canada has accepted responsibility for any costs associated with technical mitigations of these potential impacts and will continue to work with NAV CANADA to ensure all impacts are identified and resolved.

# APPENDIX A

## NAV CANADA CORRESPONDENCE

March 18, 2011

Your file
South Branch Wind Farm, Brinston
Our file
10-2290

Ms. Cathy Weston
Prowind Canada Inc.
P.O. Box 1678
Kemptville, ON
K0G 1J0

**RE: Wind Farm: 15 turbines (N44° 58' 28.6" W75° 21' 59.6") - Brinston, ON**

Dear Ms. Weston,

We have evaluated the captioned proposal and NAV CANADA has the following comments regarding the project:

- All fifteen proposed wind turbines are predicted to be within line-of-sight to NAV CANADA's Primary Surveillance RADAR (PSR) site in Ottawa, ON;
- Wind turbines within line-of-sight to PSR installations are known to interfere with operation of RADAR and cause:
  - Large numbers of false primary radar targets in the wind farm geographical limits and their immediate vicinities;
  - Significant reductions to our capability to identify and track primary surveillance targets in the subject area;
  - Limitations in our ability to provide full traffic information to our customers when a primary surveillance target(s) is in this area;
  - A decrease in flight safety for aircraft operating in these areas;
  - A potential overload condition in our radar data processing systems; and
  - A potential requirement to desensitize our primary radar to eliminate false targets and consequently eliminating legitimate aircraft targets;
- Due to the nature and significance of the possible negative impact on our capabilities and services for aircraft operating in and out of the Ottawa airport and other surrounding smaller airports, NAV CANADA objects to the development as proposed.

As discussed at our meeting on 7 March 2011, we advised you that if technical mitigations are required to address the impact on our radar, then the cost to implement the mitigations would be the responsibility of Prowind Canada Inc. A letter indicating your concurrence with this condition, would allow us to remove our objection.

We kindly request that you inform us regarding your intentions for this project so we may proceed accordingly. If you have any questions, contact the Land Use Department by telephone at 1-866-577-0247 or e-mail at landuse@navcanada.ca.

1601 Tom Roberts, P.O. Box 9824 Stn T, Ottawa, ON, K1G 6R2
Telephone: +1 (866) 577-0247, Fax: +1 (613) 248-4094

1601 Tom Roberts, C.P.9824 Succursale T, Ottawa, Ontario, K1G 6R2
Téléphone: +1 (866) 577-0247, Télécopieur: +1 (613) 248-4094

NAV CANADA's land use evaluation is valid for a period of 12 months. Our assessment is limited to the impact of the proposed physical structure on the air navigation system and installations; it neither constitutes nor replaces any approvals or permits required by Transport Canada, Industry Canada, other Federal Government departments, Provincial or Municipal land use authorities or any other agency from which approval is required. Industry Canada addresses any spectrum management issues that may arise from your proposal and consults with NAV CANADA Engineering as deemed necessary.

Yours truly,

Chris Csatlos

Christopher Csatlos
for
Tom Hollinger
Manager, Data Collection
Aeronautical Information Services

cc CNA8 – Winchester airport
Aerodromes & Air Navigation – Ontario Region, Transport Canada
Michelle Bishop, Manager – Government and Public Affairs, NAV CANADA
Jeff MacDonald, Director – Operations Planning and Programs, NAV CANADA
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Email: info@prowind.ca

March 21, 2011

Mr. Tom Hollinger
Manager, Data Collection
NAV CANADA
1601 Tom Roberts
PO Box 9824 Station T
Ottawa, Ontario K1G 6R2

Re: South Branch Wind Farm – 15 turbines, Brinston, Ontario

Dear Sir:

Thank you for your letter dated March 18, 2011, presenting your comments on the proposed 15-turbine wind farm to be located near Brinston, Ontario and for opportunity to meet with Mr. Jeff MacDonald at Nav Canada offices on March 7th.

As indicated during the March 7th meeting, Prowind is willing to accept responsibility for cost to implement any technical solutions that are deemed necessary to mitigate negative impacts created by the construction or operation of the South Branch Wind Farm.

I trust this letter provides sufficient detail for you to proceed with the processing of this land use application. Please contact me directly with any questions or requests for further information. We will continue to keep you informed of the status and timelines of our projects.

Sincerely,

Cathy Weston
President, Prowind Canada Inc.

Cc Jeff MacDonald, Director – Operations Planning and Programs NAV CANADA

# APPENDIX G

## ICE THROW REPORT

# South Branch Wind Farm

## ICE THROW REPORT

**Revision 2**

For


Zephyr North Ltd.

850 LEGION ROAD UNIT 20
BURLINGTON ON L7S 1T5
CANADA

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*Fax: 905-335-0119*
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By


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J.R. Salmon


2012 January 23


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# 1 BACKGROUND

## 1.1 Purpose

This report provides estimates of the distance and quantity of prospective ice throw from operating turbines in the South Branch Wind Farm. Based on a series of assumptions with respect to ice throw from the turbines, the results are presented in terms of probabilities for ice to land at any specific location surrounding each of the turbines, including the cumulative effect around multiple turbines.

## 1.2 Revision 0

Revision 0 of this report used Zephyr North's ice throw trajectory model for specified wind turbine characteristics, plus ice fragment estimates comparable to those in a similar report (Leblanc, 2007) written for Ontario wind and freezing precipitation conditions. These are coupled with site specific wind and freezing rain data for a nearby location, and are used as a basis for predicting and mapping potential ice throw from the turbines planned for deployment in the South Branch Wind Farm.

## 1.3 Revision 1

Revision 1 included an additional section with cumulative estimates of ice fragment strikes for two specific areas – Byker Road and Property D.

## 1.4 Revision 2

This revision (Revision 2) includes additional discussion with respect to the probability of an ice particle striking a travelling vehicle on Byker Road. It also includes a number of minor formatting changes, minor corrections and a discussion of computations of ice fall from a stationary turbine.

## 1.5 Theory and Modelling

Safety risks associated with icing on wind turbine blades have long been recognized as a cause for concern in cold climates. Reports such as those by Morgan *et al.* (1998) and Seifert *et al.* (2003) review the problem, and describe ice fragment trajectory models. The report prepared by Garrad Hassan & Partners (Leblanc,

2007) for the Canadian Wind Energy Association (hereinafter referred to as GHP) presents specific recommendations for risk assessment in Ontario.

In this report, Zephyr North's ice throw trajectory model uses the same basic trajectory equations as the model used in the GHP report but allows wind speed to vary more realistically with height according to the usual logarithmic profile. It is based on work described in Biswas *et al.* (2011). This latter paper explores a wide range of particle, wind, and turbine parameters and also presents some sample computations with lift as well as drag forces on the ice fragments.

While the authors are not aware of any reports of personal injury or significant property damage caused by ice falling or thrown from wind turbines in Ontario, there have been reports of ice falling from turbines as documented for example in the GHP report. The biggest problem in assessing the risk of ice throw and its dependence on position relative to a turbine is the serious lack of quantitative data related to these rare occurrences.

## 1.6 Application and Recommendation

It is important to appreciate that in almost all icing situations, these conditions will be predicted or detected and turbine operation will be terminated — automatically, or by the operator. Ice falling from the tower and blades would remain a problem but would be limited to the immediate vicinity of the turbine, and appropriate safety procedures can be implemented.

It should be emphasized that a prudent wind farm operator would shut down turbines in icing conditions for both safety considerations and to avoid potential damage to the turbine. The initial estimates of risk do not take this into account but in Section 6.4 computations of ice fall from a stationary turbine are discussed. With sufficiently strong winds (30 $ms^{-1}$) the model predicts that ice fragments falling from the tip of a vertically upward pointing blade could be blown about 180 m downwind but with hub height winds < 20 $ms^{-1}$ no fragments traveled more than 100 m downwind.

# 2 ICING CONDITIONS OBSERVATIONS IN ONTARIO

Both freezing rain/drizzle or extensive hoar frost deposition due to ice fog or cloud can lead to a buildup of ice on turbine blades but in southern Ontario the occasional occurrence of freezing rain is probably the only cause of significant icing. A climatology of the frequency of occurrence of icing conditions is required in order to determine the number of occasions on which there is potential for ice build-up. Fortunately, in Ontario such climatologies exist. (See, for example, http://ontario.hazards.ca/maps/intro5-e.html.)

However, details of the likely size and number of falling or thrown ice fragments must be determined from other sources. Unfortunately, there are very few of these other sources.

The Environment Canada web site http://ontario.hazards.ca/maps/intro5-e.html provides maps of the number of days and number of hours with freezing precipitation in Ontario. See http://ontario.hazards.ca/docs/Klaassen_et_al,_2003-e.pdf for more detail from Klaassen *et al.* (2003).

The closest location to the South Branch Wind Farm reporting icing data appears to be the Meteorological Service of Canada Ottawa International Airport observing station at an elevation of 114 m above sea level (a.s.l.). This station has an average of 9.7 days with freezing rain per year (between November and April). This is the highest frequency of those sites in south central Ontario and bordering U.S. locations reported in the Klaassen *et al.* report. Freezing rain duration was reported, on average, for 36.6 hours during the 9.7 days. The maximum duration for the study period 1953/1954 to 2000/2001 appears to be near 25 days, and the standard deviation appears to be about 3 days. These values have been taken from the plot presented in the report. There was no significant trend.

Based on the Klaassen *et al.* report, and noting that Ottawa Airport has the highest frequency in the region and is at a slightly higher elevation than South Branch (at 76 m a.s.l.), it is estimated that nine days of icing per year are possible for the South Branch Wind Farm area. These are days when freezing precipitation occurs. The GHP report for Ontario focuses on conditions with 5 icing days per year.

# 3 ICE THROW TRAJECTORY MODELS

## 3.1 Garrad-Hassan Report

The GHP report uses a trajectory model for a generic wind turbine with an 80 m hub height and 80 m rotor diameter. For that analysis, the rotor speed was set to 15 rpm. For each ice fragment, the mass (M) was taken to be 1 kg and assumed to have a frontal area (A) of 0.01 $m^2$. This would correspond to an ice fragment of dimensions 0.1 m x 0.1 m x 0.111 m with an ice density of 900 $kgm^{-3}$. The drag coefficient ($C_D$) was 1.0, aerodynamic lift was not included, and the assumed wind speed distribution was independent of height and had a mean value of 8 $ms^{-1}$. The basic calculation made in the ice throw model described in the GHP report to the Canadian Wind Energy Association is of the number of ice strikes per square metre of area (on the ground) per fragment release, ISPR(r), as a function of r, the radial distance from the base of the turbine. This value is then multiplied by the estimated number of ice fragments released per ice day and by the number of ice days per year to obtain ISPY(r), the number of ice strikes per square metre per year (strikes/$m^2$/year). In GHP, these are reported as averages for circles surrounding the turbine and do not take into account the preferred wind directions during periods when ice may be present, and shed from the turbine. Figure 1 is copied from the GHP report and shows the radial variation of probability of ice strike per square metre per release of an ice fragment, ISPR(r), based on its assumed distributions of release position and wind speed. Trajectories were computed by GHP for randomized release points in a Monte Carlo numerical simulation involving 100,000 ice fragments.

At 100 m distance the probability is about 6 x $10^{-6}$ per $m^2$ per fragment release and at 200 m it drops to 5 x $10^{-7}$ per $m^2$. One assumption made by GHP is that the probability of ice detachment at the blade tip is three times greater than at the hub, with linear interpolation used for other radial positions. Blades are however broader near the hub and it can be argued that this offsets the increased relative airspeed and centrifugal effects near the tip. In the calculations to be presented with the Zephyr North model, the probability of fragment release is assumed to be independent of radial position.

Leblanc (2007) does not specify the number of releases per ice day assumed, but based on ratios extracted from that paper's Figures 3.2 and 3.4 for 50, 100 and 200 m, it is between 110 and 240. It is not clear why these values differ but it is assumed that the 110-120 values derived from 50 and 100 m ratios are more reliable.

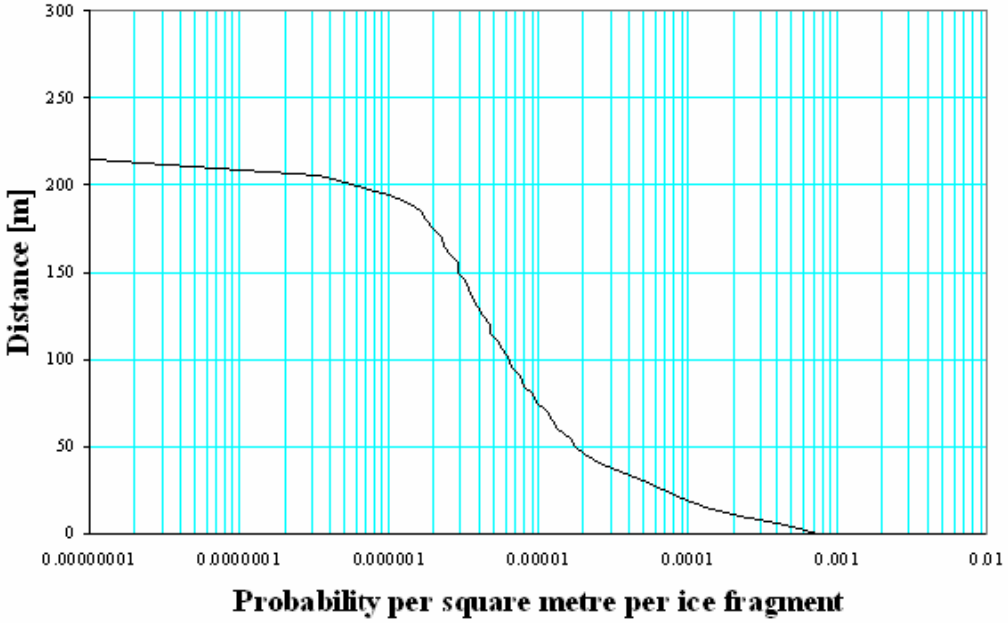


Figure 1: Distances corresponding to relative probability of ice fragment strikes for a single ice fragment release for a representative case for Ontario (from Leblanc 2007).

## 3.2 The Zephyr North Ice Throw Model

The Zephyr North ice throw model is based on the trajectory model described in the paper by Biswas *et al.* (2011). For the present study, it was applied with specified turbine characteristics and run for a range of wind speeds. Releases are for 100 points along the blade and for 360 angular blade positions. Twenty-five wind speeds (0.5 to 24.5 $ms^{-1}$) are used for a total of 900,000 different trajectory calculations. Ice fragments have mass of 1 kg, frontal area of 0.02 $m^2$, and a drag coefficient of 1.0. Sensitivity to these parameters is discussed in Biswas *et al.*

In these calculations, it is assumed that the terrain is flat with no variation in terrain elevation between the turbine and landing locations. Adjustments can be made for more complex terrain but were not considered necessary in this application.

The resulting fragment landing positions for all wind speeds, and with appropriate angular rotations, are coupled with a joint wind speed and direction distribution to produce a plot of the frequency of impacts per ice fragment release per unit area for the specified turbine and wind regime.

# 4 APPLICATION TO THE SOUTH BRANCH WIND FARM

## 4.1 Prospective Project Turbine Models

Several wind turbine types are under consideration for this project. Test ice throw trajectory computations were made with each of the prospective turbines' characteristics — hub height, rotor diameter, and rotation speed. Maximum ice throw distances were computed for a typical case — 1 kg ice fragment, 0.02m$^2$ fragment frontal area, and 10 ms$^{-1}$ hub height wind speed). All were similar and ranged from 175 to 195 m. The calculations to follow have been carried out for the REpower 3.2M114 since the maximum throw distance occurred for this turbine model. The hub height was set at 128 m, blade length at 57 m and rotation rate at 14.6 rpm, rotating clockwise when viewed from upwind of the turbine.

## 4.2 Single Turbine Modelling Results

Figure 2 shows results for a single turbine with the November-April wind speed and direction distribution computed from data supplied for the South Branch Wind Project. The joint frequency table is shown in Table 1. Landing frequency results are checked to ensure that the total integrates to 1.0. Because of interpolations between polar coordinate and Cartesian coordinate representations there are slight errors amounting to no more than 2%.

As revealed by the project's site climatology, the predominant moderate to strong winds are from the southwest which explains the slightly higher concentrations of impacts northeast of the turbine in Figure 2, while the higher values to the northwest are caused in part by fragments thrown laterally at lower wind speeds. Near the base of the turbine values are up to 1.2 x $10^{-4}$ per square metre but drop to below $10^{-5}$ per square metre within 100 m of the turbine base. Only 3.1% of the fragments travel beyond 100 m and 0.02% beyond 200 m.

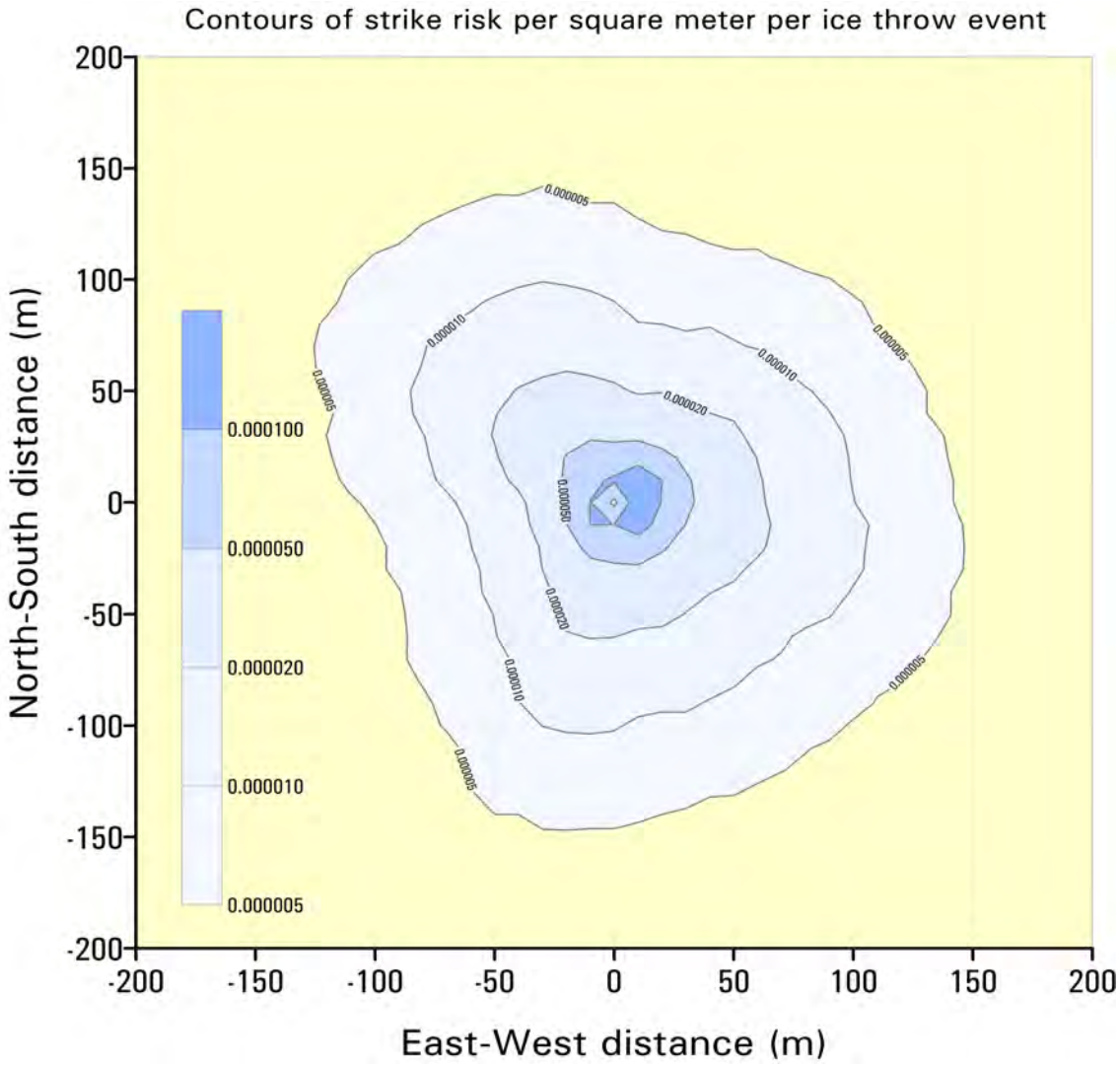


Figure 2: Ice strikes per square metre per release for a single turbine in the South Branch Wind Project. Meteorological data as in Table 1.

Table 1: Joint wind speed and direction frequency (%) table for South Branch Wind Project. Hub height winds, November to April inclusive.

| Joint Frequency Table, South Branch Wind Project: Hub Height Winds, November-April inclusive | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind Speed Bins (M/s) | | | Direction Sectors | | | | | | | | | | | | |
| | Lower | Upper | 345° - 15° | 15° - 45° | 45° - 75° | 75° - 105° | 105° - 135° | 135° - 165° | 165° - 195° | 195° - 225° | 225° - 255° | 255° - 285° | 285° - 315° | 315° - 345° | All Directions |
| 1.0 | 0.0 | 1.0 | 0.2040 | 0.2283 | 0.2747 | 0.1737 | 0.1825 | 0.2252 | 0.1430 | 0.1407 | 0.1825 | 0.1410 | 0.1567 | 0.1830 | 2.2352 |
| 2.0 | 1.0 | 2.0 | 0.5055 | 0.6272 | 0.7060 | 0.4013 | 0.3282 | 0.3565 | 0.3252 | 0.3090 | 0.2495 | 0.2077 | 0.2783 | 0.3047 | 4.5990 |
| 3.0 | 2.0 | 3.0 | 0.7813 | 1.0693 | 1.1365 | 0.9255 | 0.6363 | 0.3897 | 0.5463 | 0.5370 | 0.4257 | 0.4415 | 0.5698 | 0.5737 | 8.0327 |
| 4.0 | 3.0 | 4.0 | 0.8087 | 1.1893 | 1.3062 | 1.3663 | 0.9257 | 0.5955 | 0.6738 | 1.0388 | 0.8745 | 0.9463 | 1.1285 | 0.9315 | 11.7852 |
| 5.0 | 4.0 | 5.0 | 0.8960 | 0.9948 | 1.2320 | 1.5720 | 0.9038 | 0.6348 | 1.0428 | 2.0090 | 1.5598 | 1.5928 | 1.7988 | 1.2632 | 15.5000 |
| 6.0 | 5.0 | 6.0 | 0.8150 | 1.0068 | 1.1843 | 1.4402 | 0.5487 | 0.4710 | 1.3255 | 2.7188 | 1.8908 | 1.7340 | 2.3320 | 1.4152 | 16.8823 |
| 7.0 | 6.0 | 7.0 | 0.7313 | 0.6315 | 0.7673 | 1.2402 | 0.4270 | 0.2507 | 1.1093 | 2.6302 | 2.0193 | 1.4148 | 2.3012 | 1.2903 | 14.8132 |
| 8.0 | 7.0 | 8.0 | 0.4087 | 0.3050 | 0.4858 | 0.8633 | 0.2192 | 0.1500 | 0.7218 | 1.9713 | 1.3368 | 0.9115 | 1.4400 | 0.9578 | 9.7713 |
| 9.0 | 8.0 | 9.0 | 0.1547 | 0.1470 | 0.4008 | 0.5423 | 0.0563 | 0.1210 | 0.6500 | 1.1825 | 0.9960 | 0.6690 | 1.1338 | 0.5593 | 6.6128 |
| 10.0 | 9.0 | 10.0 | 0.0807 | 0.0627 | 0.2988 | 0.2267 | 0.0102 | 0.0390 | 0.5227 | 0.7000 | 0.6670 | 0.4593 | 0.6708 | 0.2557 | 3.9935 |
| 11.0 | 10.0 | 11.0 | 0.0438 | 0.0270 | 0.1473 | 0.0792 | 0.0010 | 0.0213 | 0.2908 | 0.4957 | 0.3920 | 0.2553 | 0.4517 | 0.1443 | 2.3495 |
| 12.0 | 11.0 | 12.0 | 0.0065 | 0.0152 | 0.0783 | 0.0442 | 0.0010 | 0.0288 | 0.1645 | 0.3718 | 0.3462 | 0.1457 | 0.2502 | 0.0627 | 1.5150 |
| 13.0 | 12.0 | 13.0 | 0.0000 | 0.0097 | 0.0187 | 0.0117 | 0.0000 | 0.0075 | 0.0702 | 0.2023 | 0.2185 | 0.1230 | 0.1535 | 0.0220 | 0.8370 |
| 14.0 | 13.0 | 14.0 | 0.0000 | 0.0065 | 0.0188 | 0.0022 | 0.0000 | 0.0030 | 0.0200 | 0.0842 | 0.1235 | 0.0712 | 0.0963 | 0.0213 | 0.4470 |
| 15.0 | 14.0 | 15.0 | 0.0000 | 0.0077 | 0.0193 | 0.0012 | 0.0000 | 0.0068 | 0.0032 | 0.0437 | 0.0852 | 0.0388 | 0.0383 | 0.0133 | 0.2575 |
| 16.0 | 15.0 | 16.0 | 0.0000 | 0.0000 | 0.0150 | 0.0000 | 0.0000 | 0.0030 | 0.0042 | 0.0170 | 0.0535 | 0.0268 | 0.0117 | 0.0055 | 0.1367 |
| 17.0 | 16.0 | 17.0 | 0.0000 | 0.0012 | 0.0037 | 0.0000 | 0.0000 | 0.0048 | 0.0048 | 0.0075 | 0.0435 | 0.0193 | 0.0080 | 0.0010 | 0.0938 |
| 18.0 | 17.0 | 18.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0030 | 0.0058 | 0.0170 | 0.0302 | 0.0055 | 0.0022 | 0.0000 | 0.0637 |
| 19.0 | 18.0 | 19.0 | 0.0000 | 0.0000 | 0.0043 | 0.0000 | 0.0000 | 0.0010 | 0.0020 | 0.0032 | 0.0240 | 0.0033 | 0.0010 | 0.0000 | 0.0388 |
| 20.0 | 19.0 | 20.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0020 | 0.0022 | 0.0123 | 0.0022 | 0.0000 | 0.0000 | 0.0197 |
| 21.0 | 20.0 | 21.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0020 | 0.0033 | 0.0022 | 0.0012 | 0.0000 | 0.0000 | 0.0087 |
| 22.0 | 21.0 | 22.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0012 | 0.0043 | 0.0000 | 0.0000 | 0.0000 | 0.0055 |
| 23.0 | 22.0 | 23.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0012 | 0.0000 | 0.0000 | 0.0000 | 0.0022 |
| 24.0 | 23.0 | 24.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 |
| 25.0 | 24.0 | 25.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0000 | 0.0000 | 0.0010 |

## 4.3 Cumulative Results

The results for single turbines can be combined by adding the impact probabilities for a number of turbines after specifying turbine locations. For the South Branch layout, however, the turbines are sufficiently well separated that there is minimal overlap between impacts from different turbines. There is also a considerable distance between turbine groups T1-to-T4 and T5-to-T15 so maps for each group are presented separately in Figure 3 and Figure 4 respectively. These show plots of the number of strikes per release, with one release per turbine. Values along Byker Road are less than 0.000005 per square metre. Ice thrown from turbines other than T2 is highly unlikely to reach Byker Road according to these model calculations.

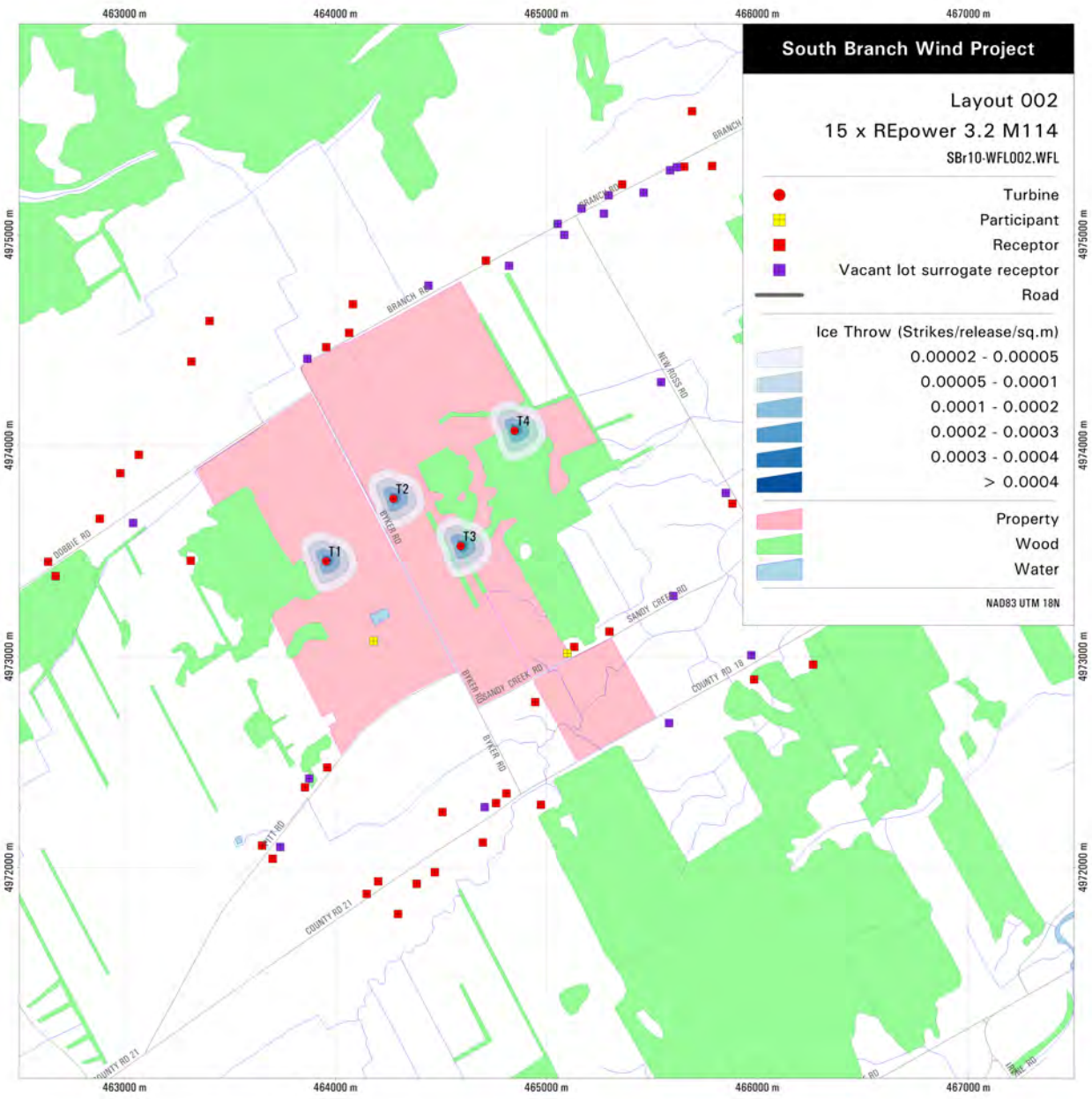


Figure 3: Ice throw landing probabilities for turbines T1 to T4. Contoured values of strikes per ice fragment release, one release per turbine.

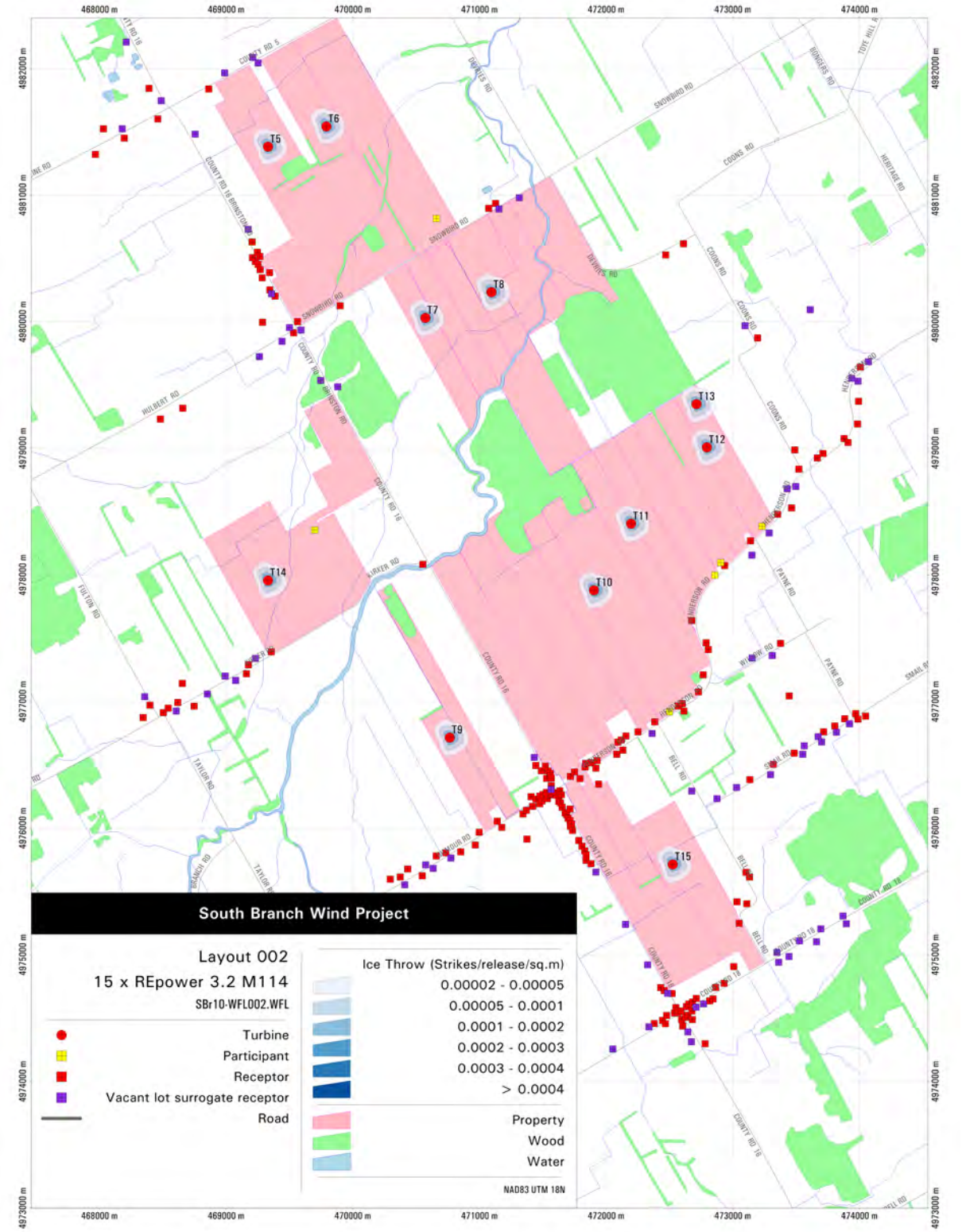


Figure 4: Ice throw landing probabilities for turbines T5 to T15. Contoured values of strikes per ice fragment release, one release per turbine.

## 4.4 Ice Days And Fragment Releases Per Year

There is considerable uncertainty regarding the amount of ice that could fall from the wind turbine blades. The inferred GHP assumption (Leblanc, 2007) of approximately 110 to 120 1-kg fragments of ice released per icing day is a plausible estimate but operating field experience and anecdotal evidence suggests that this estimate should be regarded as very conservatively high, possibly by a factor of ten. It would be very helpful if some quantitative certainty through field research were brought to bear on this factor.

Again, it is important to bear in mind that under normal operational protocol the turbines would generally have stopped operating in icing conditions, and ice fragments would simply fall, rather than be thrown, from the blades, and would land much closer to the turbine.

Based on 110 fragments per turbine per event and nine events per year the values in Figure 3 and Figure 4 should be multiplied by 1000 in order to estimate possible strikes per year. On this basis, the values at the outer edge of the pale blue regions around each turbine would correspond to one strike per square metre every 200 years.

## 4.5 Summary

Based on the calculations described above, the chance of an ice strike (per square metre) beyond about 150 m from an operating turbine with accumulated ice is less than 0.000005 per release, and with 1000 releases per year this is less than one strike in 200 years. Near the turbine, the possibility increases, but there is no reason for members of the public to be near a turbine (operating or not) when there is ice accretion on the blades.

# 5 BYKER ROAD AND PROPERTY D

Two areas of special interest are the section of Byker Road between turbines T1 and T2 and the property to the east of turbines T12 and T13 (Property D). For these sites, the risks per square meter shown in Figure 3 and Figure 4 can be integrated over the areas involved to estimate the total numbers of ice fragments that could potentially fall on Byker Road or on Property D.

## 5.1 Byker Road

### 5.1.1 Annual Impacts

Byker Road is relatively narrow, but to provide a conservative (*i.e.*, high) estimate, a total road width of 8 m is assumed. The segment of road potentially affected by ice fragments thrown from turbine T2 is about 200 m long. There is also a very remote possibility of impacts from turbines T1 and T3.

Integration of the impact frequencies over the Byker Road strip shown in Figure 5 gives 0.022 impacts if one fragment is released from each of turbines T1 to T4. With 1000 releases per year this could lead to 22 impacts by 1-kg fragments, but it must again be noted that this is very conservative. As a reference, note that 1 cm of freezing rain would deposit approximately 16,000 kg of ice directly on the 200 m section of Byker Road on each occasion.

### 5.1.2 Vehicle Impact

Although these ice throw and ice fall computations indicate the possibility of a number of ice fragments falling on the road each year, the likelihood of impacts on vehicles is much lower. No traffic information is available but for a relatively remote, unpaved, rural road such as Byker it is unlikely to exceed 100 vehicles per day in winter. Assuming that the road area potentially impacted by ice is 300 x 8 m then the area and exposure duration per day is 2,400 $m^2$ x 86,400 s. If vehicles travel at 15 $ms^{-1}$ (54 km/hr) they will be within the 300 m road length for 20 s and occupy about 6 $m^2$. With 100 vehicles per day, the likelihood of impact by an ice fragment falling on that section of road is then 6 x 20 x 100/(2,400 x 86,400) = 5.8 x $10^{-5}$ and with 22 ice fragments impacting the roadway, the annual likelihood of an ice-vehicle impact is 0.0013, *i.e.*, one impact every 785 years.

In a similar manner, the annual likelihood of vehicle impact with the turbine *stationary* during any icing events reduces to 0.0010, or one impact every 985 years.

## 5.2 Property D

### 5.2.1 Annual Impacts

Property D is shown in Figure 6. An integration analogous to that for the Byker Road case leads to 0.094 impacts when one fragment is released from all turbines, resulting in 94 per year if there were 1000 releases. Again this is a conservative estimate over a large area. Note that the fragments would not travel far enough to reach the southern portion of this property.

Figure 4 and Figure 6 show dwellings or "receptors" and a vacant lot surrogate receptor in Property D. The closest of these is 700 m from the nearest turbine and in model computations with the turbine rotating in a wind speed of 30 m/s, no ice fragments traveled beyond 335 m from the turbine. The maximum distance for a stationary turbine is 170 m.

Other receptors lie to the north-east of T13 at a distance of about 700 m. Again this is well beyond the computed ice throw range.

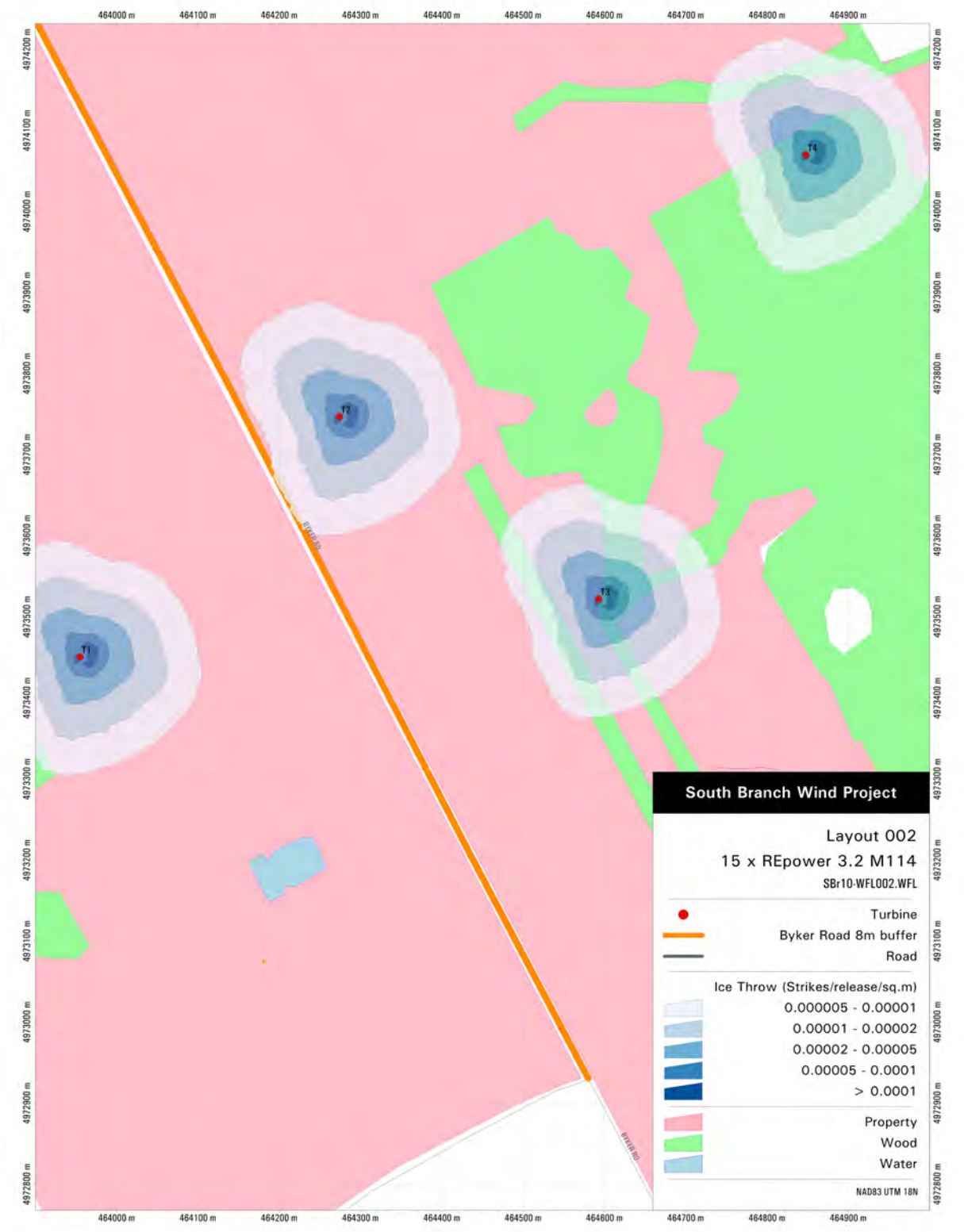


Figure 5: Location of Byker Road and turbines T1 to T4.

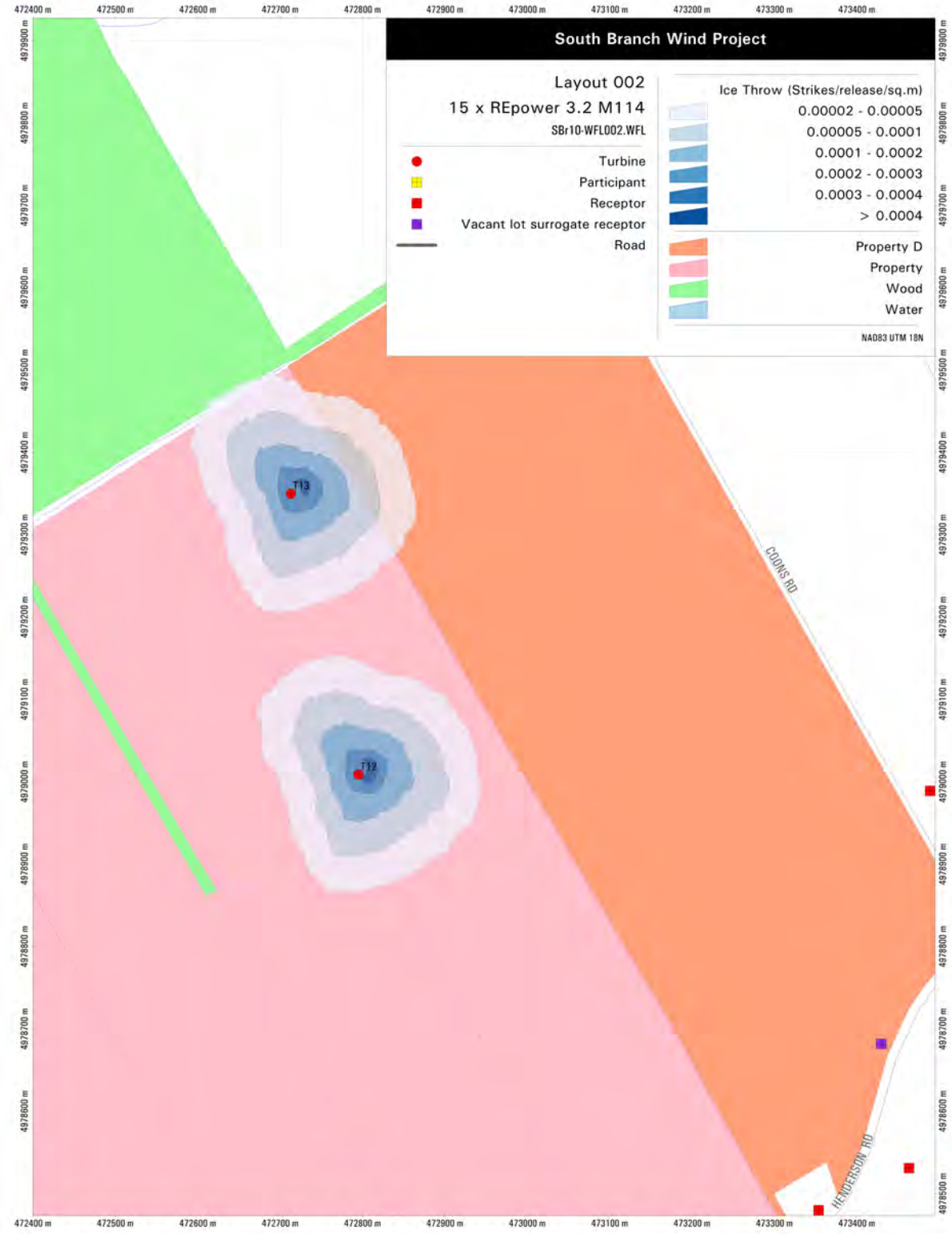


Figure 6: Location of Property D and turbines T12 and T13.

# 6 MITIGATION MEASURES

As described previously, the probability of an ice fragment thrown from an operating turbine striking a specific location is exceedingly small and decreases rapidly with distance from the turbine. Nevertheless, a number of ice throw mitigation measures can reasonably be applied in all circumstances. These will be described in the following sections.

It is important to note, though, that the primary ice-throw mitigation measure should be to cease operation of the turbines when there is a build-up of ice on the blades.

## 6.1 Operating Protocol

### 6.1.1 Ice Detection

The control system in a modern turbine can automatically shut down the turbine should it detect conditions resulting from icing of the blades.

While each manufacturer has its own protocol for detecting and responding to ice buildup, most use the correlation between power and wind speed. That is, if the measured power output is not equal to the expected power output based on the measured wind speed, the control system concludes that there is ice present, and shuts down the turbine. It should be noted that virtually all turbines designed for temperate climates use heated wind sensors to ensure that the correct wind speed is, indeed, being measured, even if an icing event is occurring. Once a specific turbine is chosen for the South Branch Wind Project, details of the icing protocol for that turbine can be provided.

The detection of vibrations (by a shaft vibration sensor) caused by rotor imbalance due to asymmetrical ice formation on the blades is another approach.

External freezing rain detectors are also available for deployment.

### 6.1.2 Ice Forecasting

Freezing rain generally occurs during winter warm frontal passages when surfaces are cold and water droplets, especially super-cooled water droplets, impact the surfaces and freeze. During such events, freezing rain forecasts are issued by the

Meteorological Service of Environment Canada. Wind farm operators should be trained to pay particular attention to these forecasts, and should then be prepared to effect a shut-down of the turbines once freezing precipitation is detected at the site.

### 6.1.3 Ice Prevention

Some turbine manufacturers (Enercon, as an example) offer blade heating devices that prevent ice accumulation in the first place. Obviously, this is a solution that renders the issue of ice throw moot.

## 6.2 Training

Once there has been a build-up of ice on the turbine blades and/or tower and the turbine has ceased operation, the risk of falling ice will be limited to the immediate vicinity of the turbine and slightly downwind. Clearly these areas should be avoided until the ice has melted, fallen or sublimated unless access to the turbine is absolutely essential.

There is very little, if any, reason to require a visit to an iced-up turbine, and avoiding any turbine in this condition should be a priority.

In the unlikely event that an individual is required to visit a turbine with ice, he or she should receive training to the effect that the turbine should only be approached from upwind and appropriate caution should be exercised, noting that ice can fall from any part of the turbine — blades, nacelle, tower. In addition, training should emphasize that the turbine should be shut down remotely (if not stopped already); the rotor should be yawed (if safe to do so) to the side of the tower away from the access door; and the turbine should be restarted remotely after personnel have vacated the site. As always, appropriate safety gear (hard hats, safety glasses, steel-toed boots, *etc.*) should be worn. If possible, approach should be made in a sturdy vehicle with protection for the roof. Alternatively, the vehicle should be parked at least 100 m from the turbine.

The same considerations that would apply to bridges, power lines or other elevated structures subject to icing are relevant to the case of wind turbines.

While it is highly unlikely during the winter/icing season, there is a possibility that the landowner (or employees, or sub-lessees) will require access to the property in the vicinity of the wind turbine. These individuals should be offered training in ice safety with respect to approaching any stopped or operating turbine with accumulated ice.

## 6.3 Signage

While the recommended operating protocol described above is to avoid turbine operation under any conditions that could result in the accumulation of ice on the turbine blades, there is a very small possibility that small pieces of ice could be blown onto a nearby roadway as noted above. As with rock falls on highways, the chance of being struck by falling ice is remote but there could be a potential hazard

from vehicles encountering ice fragments blown from the turbines in addition to the freezing precipitation that has already fallen on the road during the icing event. In this case it is proposed that drivers be warned of this (remote) possibility with signage along any affected roads bearing messages such as "Beware of Fallen Ice during Icing Conditions". Any stretch of road within 200 m of a turbine should be posted. This signage is analogous to the signs warning of fallen rock in areas subject to that hazard.

In addition to roadside signage, it is proposed that similar signage (*e.g.*, "Beware of Falling Ice from Wind Turbine during Icing Conditions") be posted along any possible driving or walking approach to a turbine. Signage would be posted at 200 m from the turbine and at blade-length+10m from the turbine. This latter distance corresponds to a safe perimeter around the turbine to avoid any ice fragments that drop off the turbine while it is stopped.

Again, it is emphasized here that there is virtually no reason why it would be necessary to approach a stopped (or operating) turbine with iced surfaces.

## 6.4 Ice Fall from Stationary turbines

Although ceasing turbine operation in icing conditions is highly recommended it will not eliminate the possibility of ice falling from the blades, nacelle or tower and being carried some distance by the wind. For hub height wind speeds less than 18 $ms^{-1}$ calculations show that, for the standard ice fragment size and conditions (as above), no fragments will travel more than 100m from the turbine base. At 30 $ms^{-1}$ the maximum range is 180 m implying that only ice from T2 could reach Byker Road since the maximum wind reported for this site was 25 $ms^{-1}$. The wind speed and direction distribution for the South Branch wind farm does however show that wind speeds exceed 17 $ms^{-1}$ for 0.23% of the time but that these winds come from the north to southeast sector (about 345 through 0 165° true) only 0.02% of the time. On these rare occasions ice fragments from T2 could reach Byker Road.

For this report revision, the ice throw model used for the initial set of computations has been re-run with the turbine rotation rate set equal to zero. Using the wind speed and direction distribution from Table 1, distributions analogous to those shown in Figure 6 show impact likelihood values of about $10^{-5}$ per fragment release per square metre on Byker Road at the closest points to T2. With 1000 fragment releases per year and assuming a potentially affected road area of about 8 x 200 m, this leads to 16 impacts per year. Detailed computations integrating impact likelihood values over an extended section of the road lead to 16.9 impacts per year.

# 7 REFERENCES

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**END**