

Kemptown Wind Project 2014

Archaeological Resource Impact Assessment

Heritage Research Permit A2014NS036

Davis MacIntyre & Associates Limited
109 John Stewart Drive, Dartmouth, NS B2W 4J7

Kempton Wind Project 2014

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Davis MacIntyre & Associates Limited
Project No.: 14-013.1RMS

Principal Investigator: Laura de Boer
Report Compiled by: Laura de Boer

Submitted to:

Affinity Wind LP
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-and-

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Cover Image: Detail of Ambrose Church's map of Colchester County, showing the approximate positions of the three proposed turbines and associated access roads.

Executive Summary

In May 2014, Davis MacIntyre & Associates Limited was contracted by Affinity Wind LP to conduct an archaeological resource impact assessment of the proposed Kemptown Wind Project. The wind farm had been previously considered in a location approximately 5km south of the present location, under Heritage Research Permit A2013NS088. The purpose of the assessment was to determine the potential for archaeological resources within the development zone and to provide any recommendations for further mitigation, if deemed necessary. The assessment consisted of a background study and a reconnaissance of the study area.

This impact assessment has indicated that stone features including a short wall and at least five stone piles exist in proximity to proposed turbine site 2, with part of the stone wall lying within 50m of the turbine's centre point. It is recommended that the stone wall and the area to the northwest of the wall be avoided by heavy equipment during turbine construction if possible. The area surrounding the remaining two turbines showed no signs of archaeological resources or areas of elevated archaeological potential.

If the turbine or access road layout is significantly altered, it is recommended that the new layout be reassessed by a qualified archaeologist in order to determine the potential for significant heritage resources within a new impact area.

In the unlikely event that any archaeological material is encountered during ground disturbance activities, all activity should cease and the Coordinator of Special Places, Sean Weseloh-McKeane (902-424-6475) should be contacted immediately to determine a suitable method of mitigation.

Table Of Contents

LIST OF FIGURES	III
LIST OF PLATES.....	III
1.0 INTRODUCTION.....	1
2.0 STUDY AREA	1
3.0 METHODOLOGY.....	4
3.1 MARITIME ARCHAEOLOGICAL RESOURCE INVENTORY	5
3.2 HISTORICAL BACKGROUND.....	6
3.2.1 The Precontact Period.....	6
3.2.2 European Settlement.....	7
3.3 FIELD RECONNAISSANCE.....	12
4.0 RESULTS AND DISCUSSION.....	15
5.0 RECOMMENDATIONS AND CONCLUSIONS.....	15
6.0 REFERENCES CITED.....	16
PLATES.....	17
APPENDIX A: HERITAGE RESEARCH PERMIT.....	22

LIST OF FIGURES

Figure 2.0-1: A map showing the proposed wind project and its surroundings. Turbine data courtesy Affinity Wind LP.....	2
Figure 2.0-2: A map showing the proposed turbine sites and access roads. Turbine data courtesy Affinity Wind LP.....	3
Figure 2.0-3: A map showing Natural Theme Region #572 – St. Mary’s Fault Block (highlighted). The study area is indicated in red. Map after Davis and Browne 1996.....	4
Figure 3.2-1: Map of the Mi’kmaq districts.	7
Figure 3.2-2: Detail of a georeferenced land grant map showing the three turbine sites along with modern roads.	8
Figure 3.2-3: Detail of Ambrose Church’s 1874 map of Colchester county, showing the approximate location of the proposed turbines and access roads in blue. ..	10
Figure 3.2-4: Detail of a 1902 geological survey map showing the study area overlaid on modern mapping. Modern roads and trails are shown as dotted lines.	11
Figure 3.3-1: The study area showing identified archaeological features.....	14

LIST OF PLATES

Plate 1: The site of turbine site 1, looking northwest.....	18
Plate 2: A mixed hardwood and softwood forest at the site of turbine 2. Looking west.....	18
Plate 3: The moss-covered stone wall near turbine 2, looking southwest.....	19
Plate 4: The largest of the stone mounds, looking south.....	19
Plate 5: The smallest of the stone mounds also includes a wooden beam or sill (near Irene Hart’s feet) suggesting a feature with more structure than a regular stone mound.....	20
Plate 6: The site of turbine 3, looking north.	20
Plate 7: Stephen Davis examines soil from a tree throw along the access road between turbine sites 2 and 3. Looking west.	21

1.0 Introduction

In May 2014, Davis MacIntyre & Associates Limited was contracted by Affinity Wind LP to conduct an archaeological resource impact assessment of the proposed Kemptown Wind Project. The wind farm had been previously considered in a location approximately 5km south of the present location, under Heritage Research Permit A2013NS088. The purpose of the assessment was to determine the potential for archaeological resources within the development zone and to provide any recommendations for further mitigation, if deemed necessary. The assessment consisted of a background study and a reconnaissance of the study area.

This assessment was completed under Category C Heritage Research Permit A2014NS036 issued by the Nova Scotia Culture and Heritage Development Division. This report conforms to the standards required by the Department of Communities, Culture and Heritage as specified under the guidelines of the Special Places Protection Act (*R.S., c. 438, s. 1.*).

2.0 Study Area

The proposed wind project is a 4.99MW wind farm between Kemptown and Upper Kemptown on a logging and quarrying road, branching off the unpaved Kemptown Road (Figures 2.0-1 and 2.0-2). The site is north of the Colchester Municipal Waste Management Facility. The proposed project includes three turbine sites connected by a single east-west access road, to be constructed partially on existing roadways.

The study area is located in the St. Mary's Fault Block region (Natural Theme Region #572), which stretches in a narrow band across Nova Scotia from Salmon River Lake in the east to Economy in the west (Figure 2.0-3). This region is an area of coarse Horton sandstone lying in a graben, or "downfaulted block lying between two parallel faults." This narrow band is approximately 15km in width across central Nova Scotia, becoming more prominent when it extends east past the Eden Lake-Caledonia line. From the Trafalgar area westwards all drainage runs towards the St. Marys River at Melrose. The East River St. Marys branch lines up with the Chedabucto Fault, while West River St. Marys drains along the St. Marys Fault line. The river's erosion has exposed the fault scarp, and the shape of these rivers forms a rectangle on the landscape.

The St. Mary's Watershed is one of three key watersheds in the region, along with the Calvary River system and a network of smaller rivers that drain into the Stewiacke River. Drainage consists of a trellis-like network of first-, second-, and third-order streams.

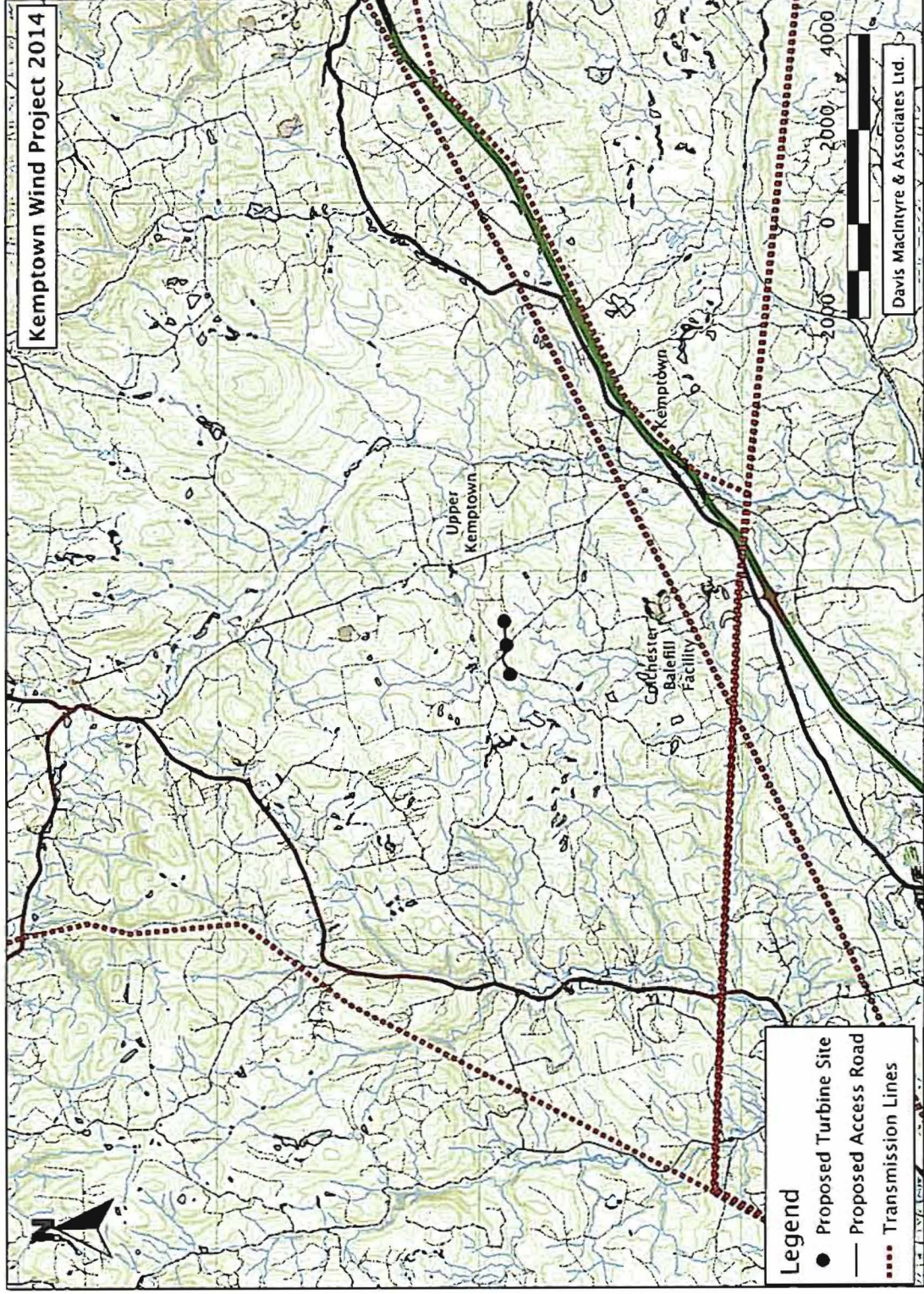


Figure 2.0-1: A map showing the proposed wind project and its surroundings. Turbine data courtesy Affinity Wind LP.

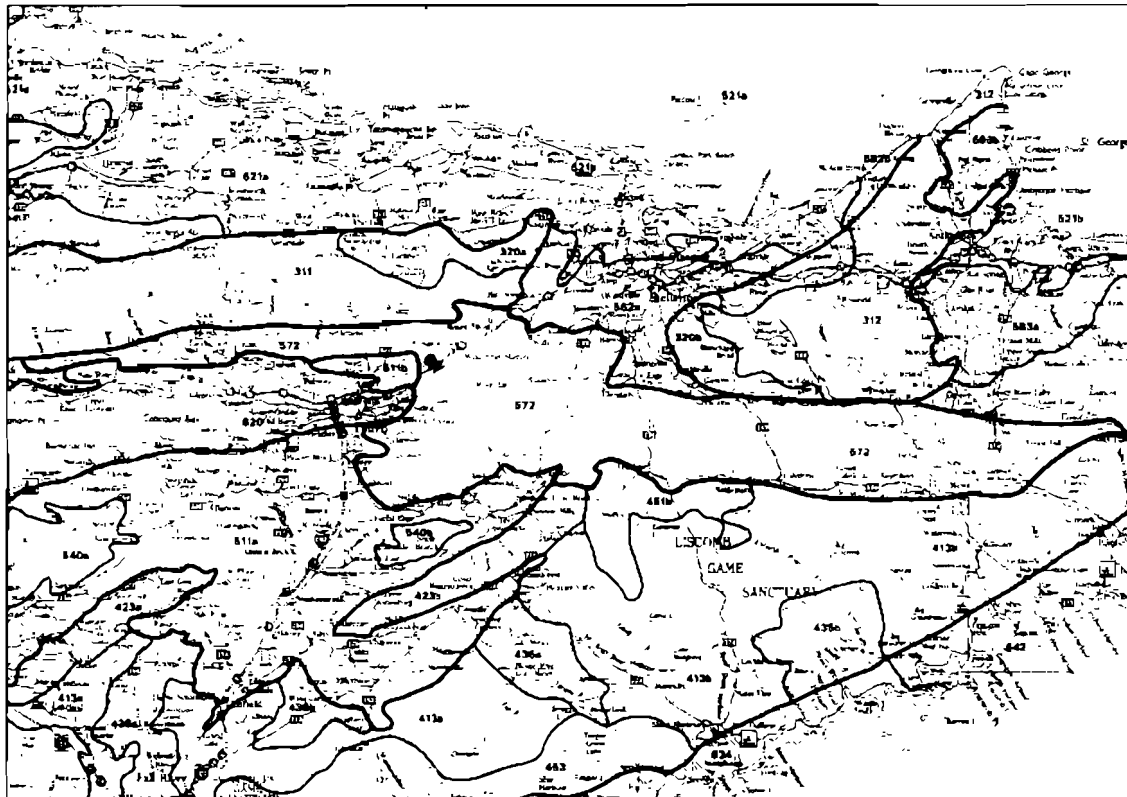


Figure 2.0-3: A map showing Natural Theme Region #572 – St. Mary's Fault Block (highlighted). The study area is indicated in red. Map after Davis and Browne 1996.

The till in the area is formed from a hard grey Horton sandstone, and the soil in the region derives from this till. There are areas of Halifax soils, which are sandy loams that drain well, and patches of Aspotogan peat and soil. Shulie soils, Springhill sandy loams, and gravelly Millbrook soils can also be found.

Vegetation in the area includes trees such as Balsam Fir, White Spruce, White Pine, Red Spruce, Eastern Hemlock, and Red Oak, most existing in poorly-drained and previously cleared areas. Mixed hardwoods can be found in the areas of better drainage. There are two small floodplains, one near Kemptown and one near Glencoe, both consisting of diverse and sometimes rare intervale flora.¹

3.0 Methodology

A historic background study was conducted to understand the area's history and topography. This included consultation of historic maps and manuscripts at the Nova Scotia Archives as well as online resources.

¹ Davis and Browne 1996:134-136.

A field reconnaissance of the proposed impact areas (proposed access roads and turbine sites) was conducted by Stephen Davis and Laura de Boer May 2014, accompanied by co-op students Travis Crowell and Irene Hart. The survey was guided by a hand-held GPS unit. The terrain and vegetation changes within the study area were noted in the interest of recording negative evidence for historic cultural activity.

Table 1: Proposed turbine locations.

Proposed Turbine	Coordinates (UTM NAD83)
Turbine 1	20 T 489994 5037875
Turbine 2	20 T 490619 5037950
Turbine 3	20 T 491123 5037996

3.1 Maritime Archaeological Resource Inventory

Three historic sites representing domestic activity have been recorded less than a kilometer northeast of the study area, along Mingo Road at the site of the Colchester Waste Management Facility, also listed as Irishtown. The first is the remains of a small agricultural complex including stone piles resulting from field clearing as well as a stone foundation for a building, half-buried by soil and rock bulldozed from an adjacent road (BiCs-04). The second site consists of a small midden and two earthen or decayed wooden foundations, all most likely related to occupation in the 1930s or 1940s (BiCs-02). The final site is that of the W. Work House (originally registered as the J. Johnson House), consisting of a dry-laid stone foundation and cellar with stone piles marking the eastern perimeter of the site (BiCs-03).

A celt fragment was recovered as an isolated find in the Salmon River near Valley Station (BiCt-01), and a biface was also reported eroding from the bank of the same watercourse at Riversdale (BiCs-01). Another isolated find, a spurred end scraper, was recovered from Bible Hill at the site of the former Nova Scotia Agricultural College (now a branch of Dalhousie University) (BiCt-04). This find suggests the presence of a Palaeo-Indian site.

A general activity precontact site is known in Truro, near the shopping mall east of the Robie Street Cemetery (BiCt-02). A second general activity site has been identified on Churchill Street based upon a quartzite biface fragment and other detritus recovered from a garden plot (BiCt-03).

A mill and smithy complex is known in Bible Hill along Farnham brook, originating in the late eighteenth or early nineteenth century (BiCt-05).

3.2 Historical Background

3.2.1 The Precontact Period

The history of human occupation in Nova Scotia has been traced back approximately 11,000 years ago, to the Palaeo-Indian period or Sa'qewe'k L'nu'k (11,000 – 9,000 years BP). The only significant archaeological evidence of Palaeo-Indian settlement in the province exists at Debert/Belmont in Colchester County.

The Saqiwe'k Lnu'k period was followed by the Mu Awsami Kejikawe'k L'nu'k (Archaic period) (9,000 – 2,500 years BP), which included several traditions of subsistence strategy. The Maritime Archaic people exploited mainly marine resources while the Shield Archaic concentrated on interior resources such as caribou and salmon. The Laurentian Archaic is generally considered to be a more diverse hunting and gathering population.

The Archaic period was succeeded by the Woodland/Ceramic period or Kejikawek L'nu'k (2,500 – 500 years BP). Much of the Archaic way of subsistence remained although it was during this period that the first exploitation of marine molluscs is seen in the archaeological record. It was also during this time that ceramic technology was first introduced.

The Woodland period ended with the arrival of Europeans and the beginning of recorded history. The initial phase of contact between First Nations people and Europeans, known as the Protohistoric period, was met with various alliances particularly between the Mi'kmaq and French.

The Mi'kmaq inhabited the territory known as Mi'kma'ki or Megumaage, which included all of Nova Scotia including Cape Breton, Prince Edward Island, New Brunswick (north of the Saint John River), the Gaspé region of Quebec, part of Maine and southwestern Newfoundland. Halifax, Lunenburg, Kings, Hants and Colchester Counties were part of the district known as Sipekni'katik or "wild potato area" (Figure 3.2-1).

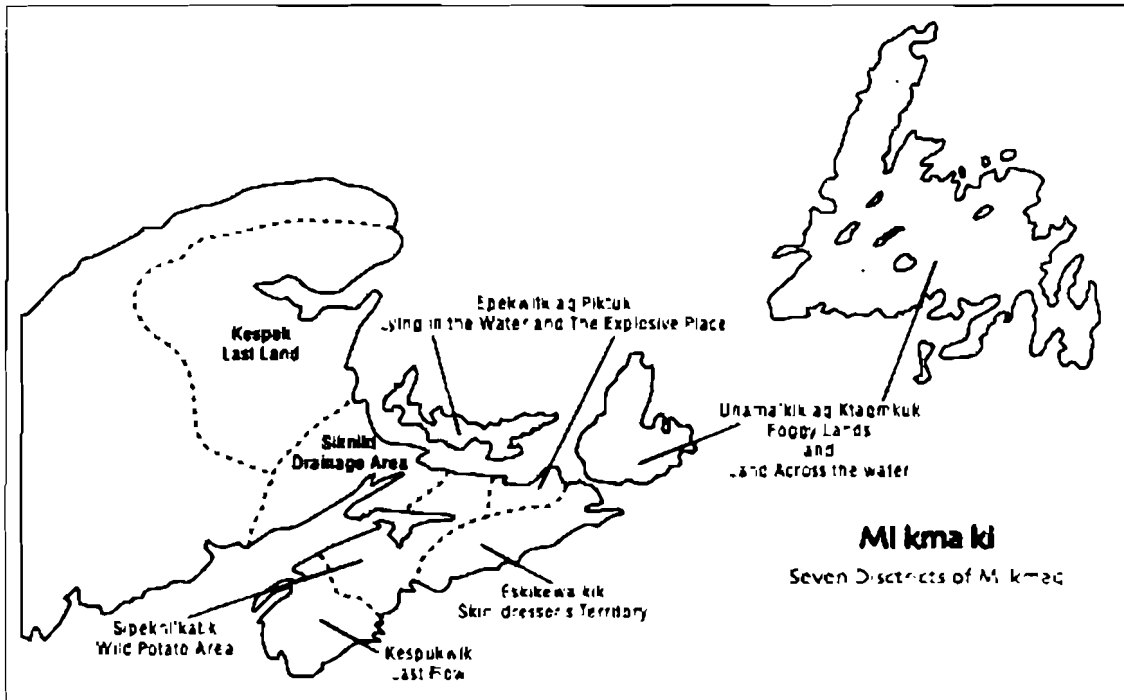


Figure 3.2-1: Map of the Mi'kmaq districts.²

The name Cobequid reportedly originated in the Mi'kmaq name *Way-Kob-begitk*, or "bound of the rushing water," referring to the mountain range forming a boundary to the north of the Bay of Fundy.³

3.2.2 European Settlement

Although European settlement along Nova Scotia's coasts and lowlands was well underway by the early eighteenth century, higher and more mountainous regions or "backlands" were not taken up until later decades. By June 1767, a trail cut to connect Truro to new settlers at Pictou crossed the Kemptown area or as it was then known, Salmon River Crossing.⁴ There is little record of settlement in this area at the time, but it is known that mills (presumably sawmills) were built before 1790 at Kemptown by David Archibald II, one of the first European settlers to the area. Grantees in proximity to the study area included Alexander S. Hingley, Henrietta McDonald, and Robert Munro (Figure 3.2-2).

² Confederacy of Mainland Mi'kmaq 2007:11,

³ Longworth 1866:14.

⁴ Yuill 1981:12.

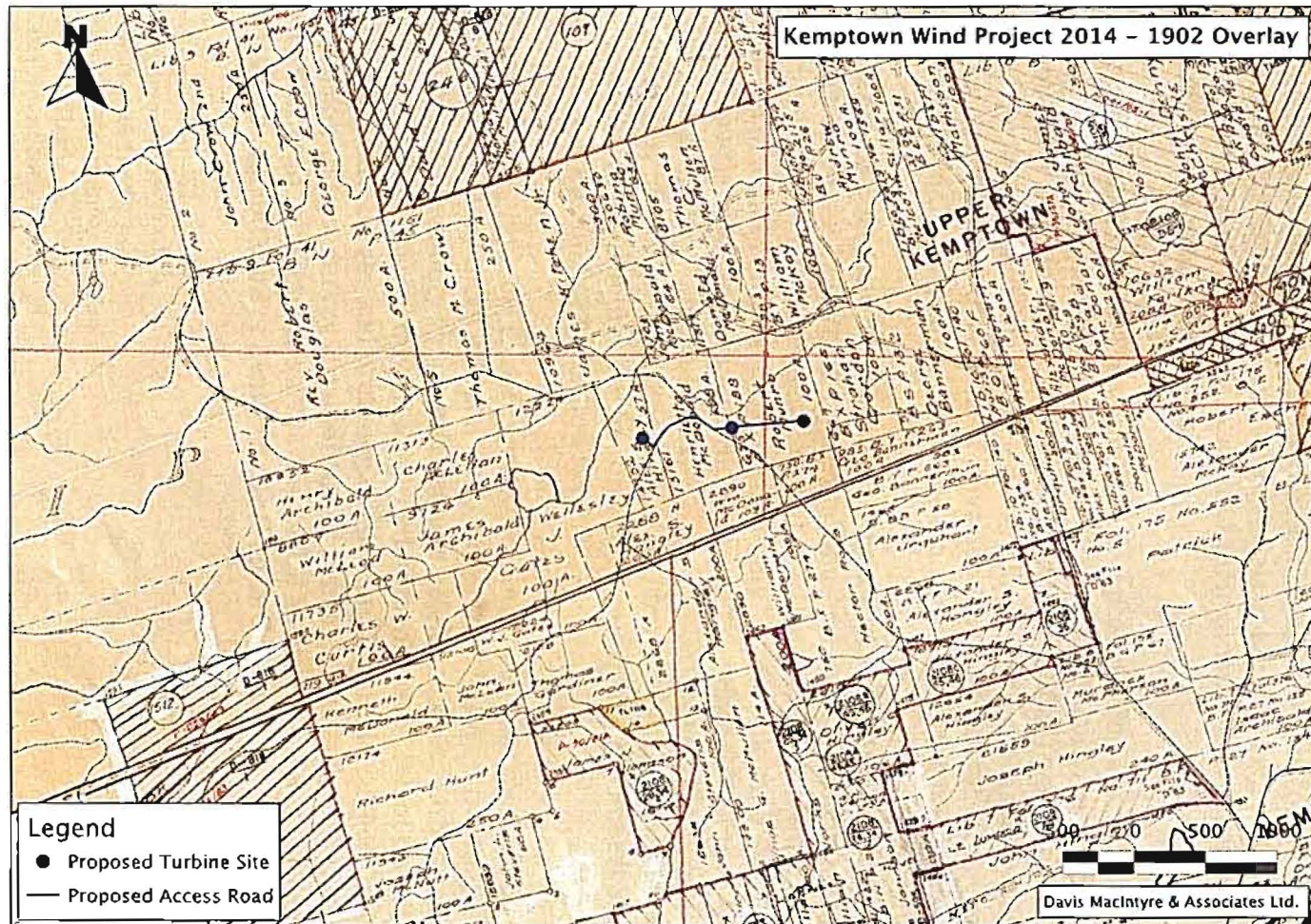


Figure 3.2-2: Detail of a georeferenced land grant map showing the three turbine sites along with modern roads.⁵

⁵ Department of Lands and Forests 1946.

Although in its early years the community retained its name as Salmon River Crossing, it was eventually given the name Kemptown by surveyor Alexander Miller, who named it for Sir James Kempt, Nova Scotia's Lieutenant-Governor beginning in 1820.⁶ Like many "backland" settlements, Kemptown's settlement appears to have been dominated by hardy Scottish settlers in the first half of the nineteenth century.

In 1825, the first gristmill in the area was established at nearby Earltown by John McKay. In the absence of maintained roadways, the stones for the mill had to be dragged for eleven miles over "roads barely worthy of the name."⁷ By 1837 no gristmills existed at Kemptown, the nearest being twelve to fourteen miles distant (presumably at Earltown). At this time, locals of Kemptown petitioned the Provincial Assembly for funds to support their construction of a new mill on the Salmon River to meet their needs.⁸

It appears that despite the road through Kemptown being a key route from Truro to Pictou, the journey could only be made with some difficulty. In 1842, the Truro to Salmon River Road (now most likely the Old Pictou Road) was in need of gravel before it could be "suitable for wheel travelling."⁹ Unlike coastal settlements and fortifications, the inland regions of Nova Scotia were often slow to develop, particularly in the backlands where the land was less fertile and accessible.

The Kemptown region also offered resources beyond lumber and limited farm production. In the 1830s or early 1840s John Archibald, a resident of the nearby community of Salmon River, sunk a shaft less than twenty feet from the Pictou Road in search of a coal seam. Archibald raised only "a few cauldrons" of coal before his operation was stopped by agents representing the General Mining Association. In 1858, the shaft was reopened and cleared of rubbish to reveal a promising coal seam of four to six feet in thickness.¹⁰ By October the Kemptown Mining Company offered coal at ten shillings per ton through their agents, Mr. Robert Smith of Truro and Mr. A. Scott Hingley of Salmon River.¹¹

In terms of geographical specifics, historical mapping indicates that by the late nineteenth century there was some settlement northeast of the study area. Church's 1874 map of the county shows homesteads belonging to G. Matheson and J. McKay (Figure 3.2-3). The smoothly curving road immediately north of the turbine sites lacks the sharp curves and precision of surrounding roads, suggesting that the mapmaker did not survey it personally or in detail. Similarly, the road is marked as a "winter road" on Fletcher's 1902 Geological Survey of Canada map and lacks signs of year-round habitation or heavy traffic (Figure 3.2-4).

⁶ Fergusson 1967:323-324.

⁷ Longworth 1866:138.

⁸ Nova Scotia Archives 1837.

⁹ Yuill 1981:14.

¹⁰ The Nova Scotian 1858.

¹¹ Nova Scotia Archives 1858.

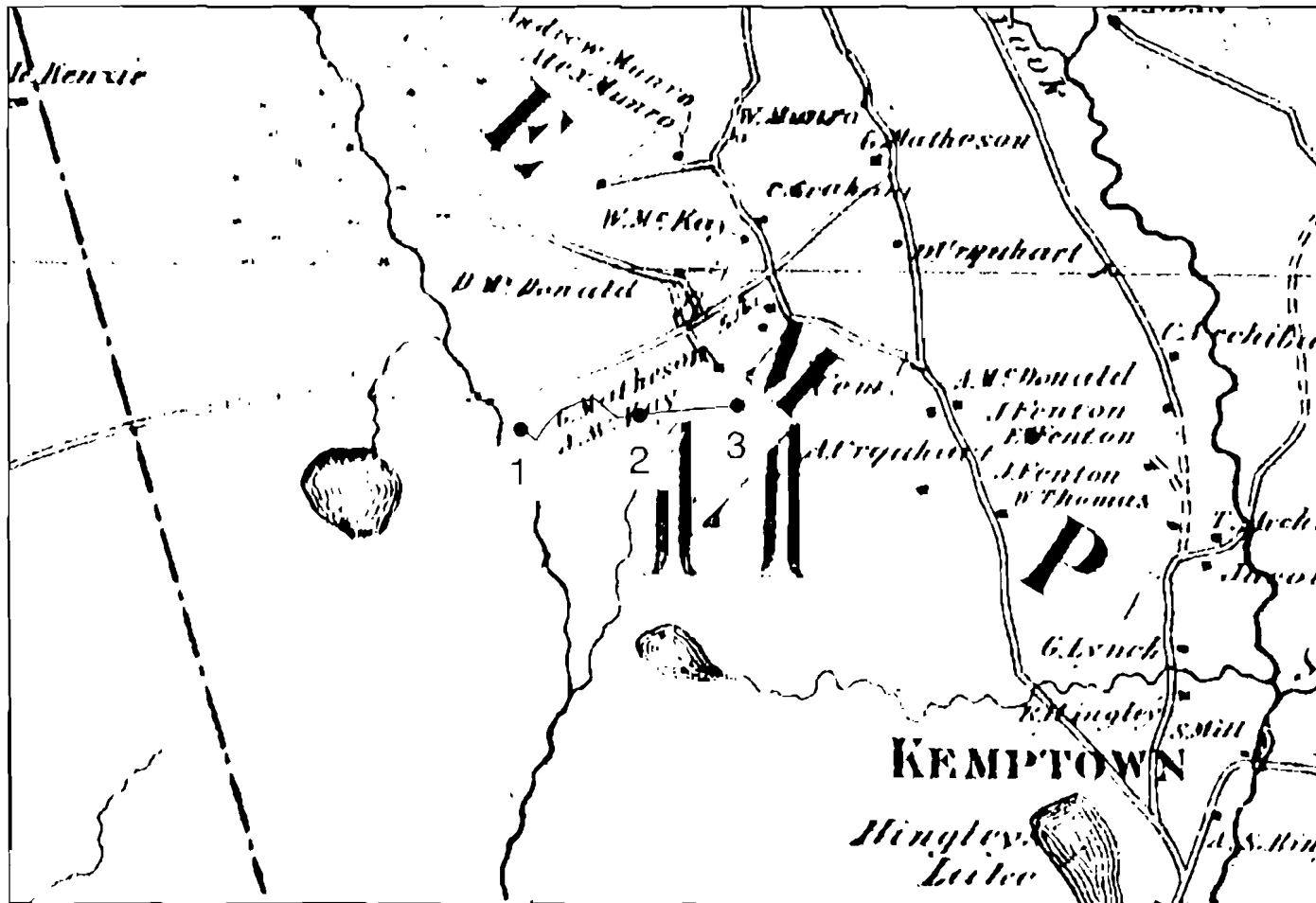


Figure 3.2-3: Detail of Ambrose Church's 1874 map of Colchester county, showing the approximate location of the proposed turbines and access roads in blue.¹²

¹² Note that Church's map is not accurate enough for georeferencing, and as such, this overlay is approximate.

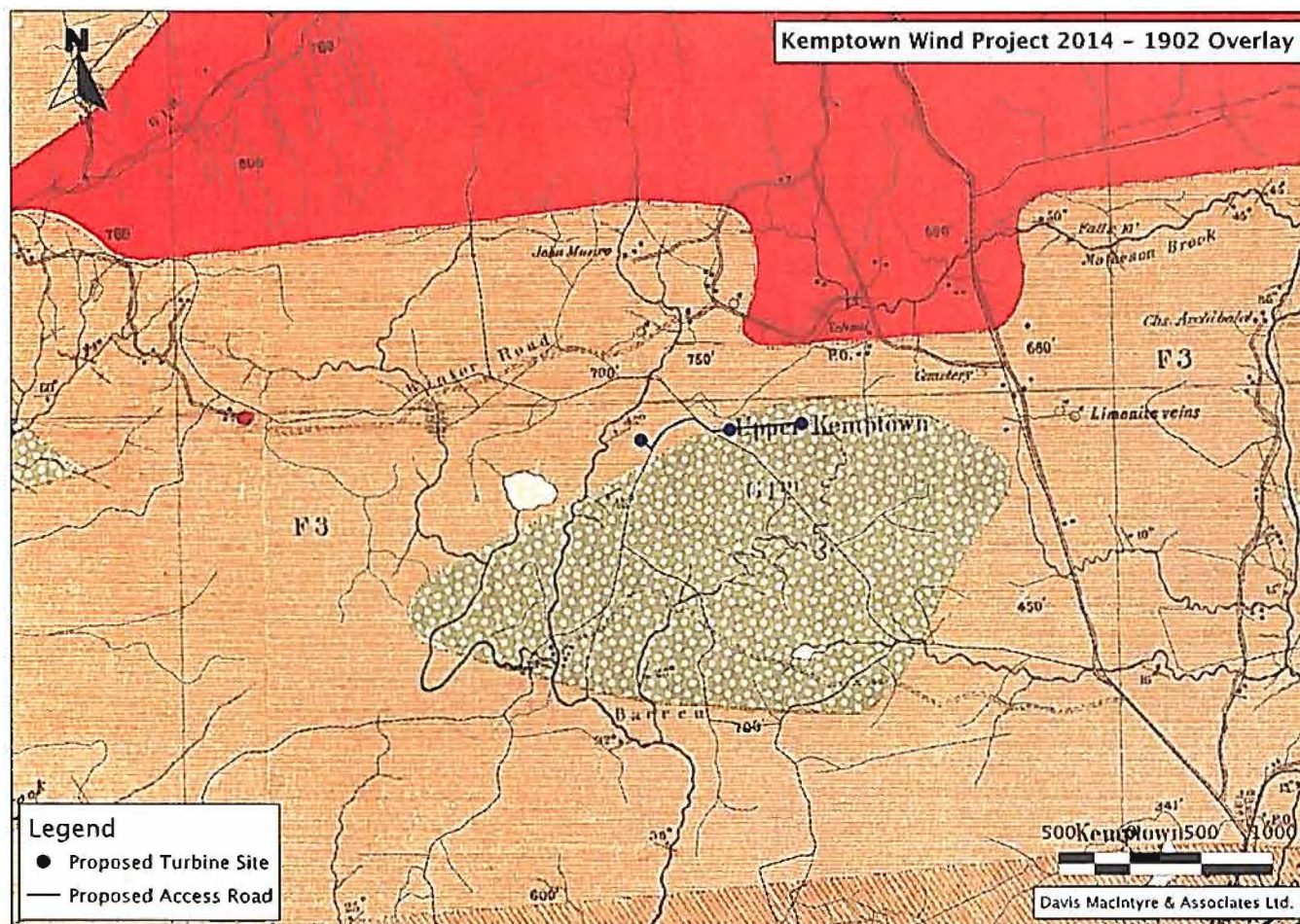


Figure 3.2-4: Detail of a 1902 geological survey map showing the study area overlaid on modern mapping. Modern roads and trails are shown as dotted lines.¹³

¹³ Fletcher 1902.

3.3 Field Reconnaissance

A field reconnaissance was conducted on 26 May 2014 by Stephen Davis and Laura de Boer, along with co-op students Travis Crowell and Irene Hart. The turbine sites were accessed on a dirt road used by heavy logging and quarrying equipment, which branches northwest off Kemptown Road several kilometers to the south of the study area.

The proposed site of Turbine 1 is located immediately north of a small abandoned gravel pit adjacent to the logging road. The area is covered in forest dominated by moderately mature spruce trees (Plate 1). The forest floor undulates heavily, and some ridges of exposed stone appear to suggest heavy equipment activity prior to forest regrowth, perhaps related to the nearby quarry. No cut or rotting stumps were observed but the forest is obviously comprised of secondary growth, suggesting that logging took place at least three decades ago.

Access between turbines sites 1 and 2 passes through a larger and more active gravel pit, with some ATV tracks and burned household garbage present. Some lumber had been dumped in the forest above the quarry pit and is rotted and overgrown. Signs for a local ATV club were also observed nearby and on the road to the study area.

From the gravel pit, the access road proceeds into a mixed forest of beech and maple with pockets of young, dense spruce. This mixed forest is also found at the location of Turbine 2, which is positioned on a south-facing slope (Plate 2).

Just under 50m north of the provided centre point of Turbine 2, the team encountered a low stone wall approximately 45m in length, half a metre high, and over a metre wide (Plate 3). The landscape to the northwest of the wall is clearly cultural, most likely overgrown field or pasture, as it is smooth and mossy with spruce predominating while the unmodified landscape to the south is undulating and dominated by hardwood. Oddly, the stone wall exists only as a single straight line rather than an enclosure, halting abruptly at either end.

When the team continued to explore this area, an additional five stone piles were found on the north side of an actively used ATV trail (Plate 4). One of the five included a piece of squared lumber along one edge of its base (Plate 5), suggesting it may have been a more carefully constructed feature than the other four mounds, which appear to be the result of field clearing. The coordinates of the identified stone features are presented in Table 1, and their relation to the study area is shown on Figure 3.3-1. The largest of the mounds was approximately 3 metres in diameter, while the smallest was less than two metres in diameter.

Table 2: Stone features in proximity to Turbine 2.

Feature	Location (UTM NAD83)	Significance
Stone Wall	20 T 490594 5037989 to 20 T 490636 5038006	Low
Stone Mound 1	20 T 490559 5038054	Low
Stone Mound 2	20 T 490538 5038061	Low
Stone Mound 3	20 T 490517 5038060	Low
Stone Mound 4 (Wood Sill?)	20 T 490517 5038072	Low
Stone Mound 5	20 T 490536 5038087	Low

East of the proposed site of Turbine 2, both the access road and the site of Turbine 3 were found to be in very open beech and maple forest (Plate 6). Visibility was very good, extending for at least 50m in all directions. The access road follows a ridge along a southward-facing slope, and the site of Turbine 3 similarly slopes southward. The forest floor is undulating, and ferns were sprouting throughout, suggesting that ground visibility will be drastically reduced by mid-June. Rotting cut stumps were occasionally observed, and the beech and maple trees were not fully mature, suggesting that the hillside has been logged within the past twenty to thirty years. The exposed soil below several tree-falls were examined, but no signs of cultural material was present (Plate 7).

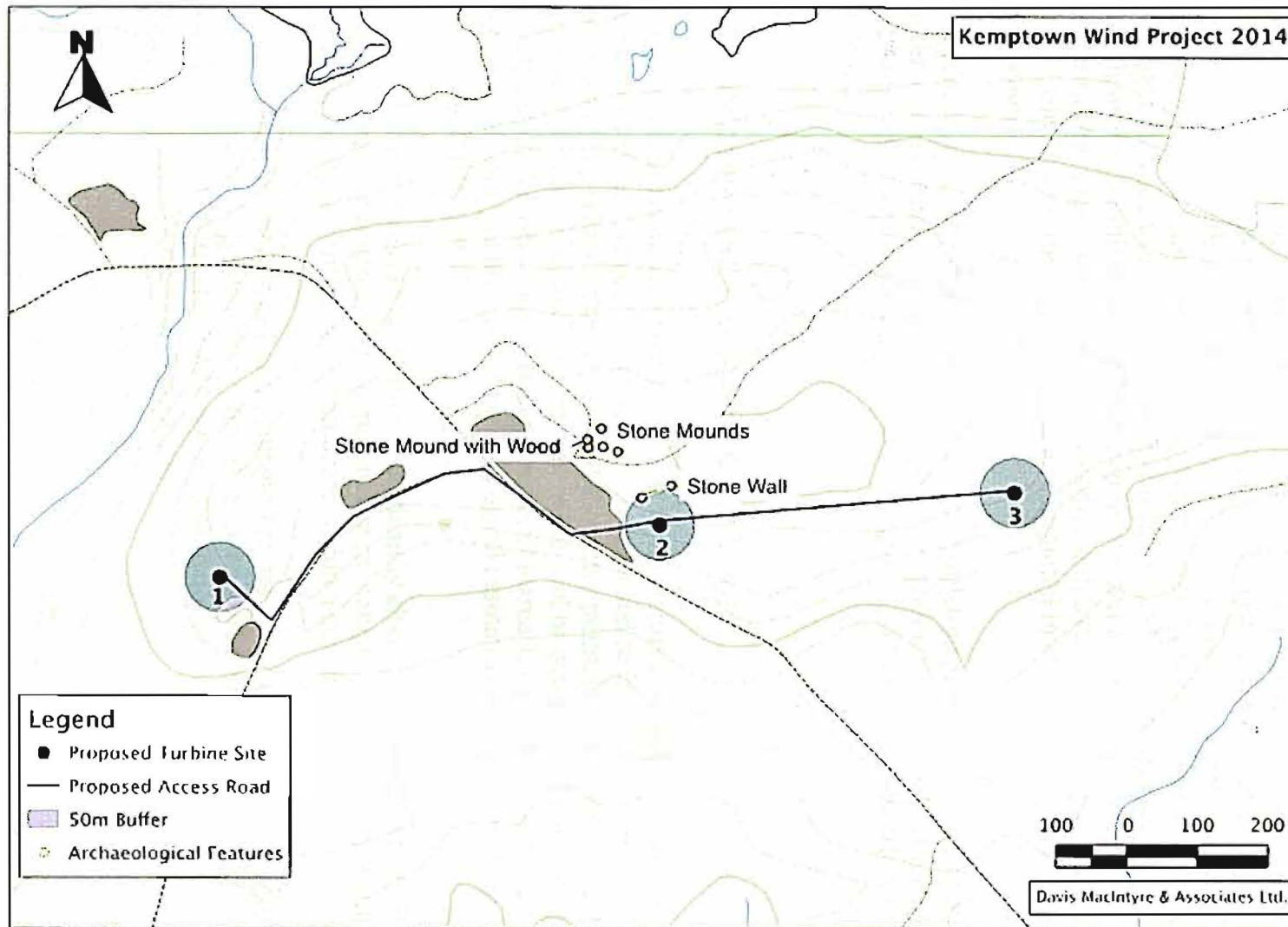


Figure 3.3-1: The study area showing identified archaeological features.

4.0 Results And Discussion

The only area of archaeological concern identified during this assessment is the region northwest of the stone wall near Turbine 2. The wall and piles of stone suggest agricultural activity in the form of field clearing and pasture construction. No house foundation or cellar feature could be located, and based upon nineteenth century mapping it is possible that the house associated with the field clearing is located farther north, where the Ambrose Church map and the 1902 Geological Survey of Canada map shows a curving "winter road" running east-west. While field clearing and stone wall construction is considered to be of low archaeological significance, it is indicative that more significant archaeological resources including house and barn foundations could be nearby, in this case most likely to the north. A MARI form for the stone features will be completed in accordance with provincial regulations.

The remainder of the study area is found on undulating ground, far from significant watercourses or other features that might attract human settlement. As such, it is not believed to be of elevated potential for either First Nations or historic European occupation.

5.0 Recommendations And Conclusions

This impact assessment has indicated that stone features including a short wall and at least five stone piles exist in proximity to proposed turbine site 2, with part of the stone wall lying within 50m of the turbine's centre point. It is recommended that the stone wall and the area to the northwest of the wall be avoided by heavy equipment during turbine construction if at all possible. The area surrounding the remaining two turbines showed no signs of archaeological resources or areas of elevated archaeological potential.

If the turbine or access road layout is significantly altered, it is recommended that the new layout be reassessed by a qualified archaeologist in order to determine the potential for significant heritage resources within a new impact area.

In the unlikely event that any archaeological material is encountered during ground disturbance activities, all activity should cease and the Coordinator of Special Places, Sean Weseloh-McKeane (902-424-6475) should be contacted immediately to determine a suitable method of mitigation.

6.0 References Cited

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PLATES



Plate 1: The site of turbine site 1, looking northwest.



Plate 2: A mixed hardwood and softwood forest at the site of turbine 2. Looking west.



Plate 3: The moss-covered stone wall near turbine 2, looking southwest.



Plate 4: The largest of the stone mounds, looking south.



Plate 5: The smallest of the stone mounds also includes a wooden beam or sill (near Irene Hart's feet) suggesting a feature with more structure than a regular stone mound.



Plate 6: The site of turbine 3, looking north.



Plate 7: Stephen Davis examines soil from a tree throw along the access road between turbine sites 2 and 3. Looking west.

APPENDIX A: HERITAGE RESEARCH PERMIT



Heritage Research Permit (Archaeology)

Office Use Only
Permit Number:

Special Places Protection Act 1989

(Original becomes Permit when approved by
Communities, Culture and Heritage)

A2014NS036

Greyed out fields will be made publically available. Please choose your project name accordingly

Surname de Boer

First Name Laura

Project Name Kempton Wind Farm

Name of Organization Davis MacIntyre & Associates Limited

Representing (if applicable)

Permit Start Date 15 May 2014

Permit End Date 31 August 2014

General Location: 4 kms northwest of Kempton, Colchester County

Specific Location: (cite Borden numbers and UTM designations where appropriate and as described separately in accordance with the attached Project Description. Please refer to the appropriate Archaeological Heritage Research Permit Guidelines for the appropriate Project Description format)

20 T 491169m E 5038025m N (turbine 1)

489994m E 5037875m N (turbine 2)

490619m E 5037950m N (turbine 3)

Permit Category:

Please choose one

Category A - Archaeological Reconnaissance

Category B - Archaeological Research

Category C - Archaeological Resource Impact Assessment

I certify that I am familiar with the provisions of the *Special Places Protection Act* of Nova Scotia and that I have read, understand and will abide by the terms and conditions listed in the Heritage Research Permit Guidelines for the above noted category.

Signature of applicant *Laura de Boer*
for Laura de Boer

Date 02 May 2014

Approved by
Executive Director

Date May 14-14

**Characterization of the magnitude of bat activity at the proposed
Kemptown Wind Energy Project, Colchester County, NS**

Final Report Prepared for:
RMS Energy
1383 Mt. Thom Rd.
Salt Springs, Nova Scotia

Attn: Lisa Fulton
Environmental Lead and Project Coordinator

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November 2013

Table of Contents

Context.....	4
<i>Project Background</i>	4
<i>Regulatory Context</i>	4
Study Objectives	5
Review of Key Issues	5
<i>Background</i>	5
<i>Direct Mortality</i>	5
<i>Habitat Availability</i>	6
<i>Movement Patterns</i>	7
Bats in Nova Scotia.....	8
<i>Nova Scotia Bat species</i>	8
<i>Ecology of Resident Species</i>	8
<i>White Nose Syndrome</i>	9
<i>Potential for Hibernacula</i>	9
Methods.....	11
<i>Study Area</i>	11
<i>Ultrasonic Surveys</i>	11
Results.....	12
Discussion.....	19
Recommendations	22
Literature Cited	24

Table of Figures

Figure 1. Number of bat call sequences recorded, by night, at the Smithfield abandoned mine opening, July 30 to September 20, 2013.	14
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Table of Tables

Table 1. Over-wintering strategy and conservation status of bat species recorded in Nova Scotia	10
Table 2. Locations of ultrasonic survey sites for the 2013 survey of bat activity at the proposed Kemptown Wind Energy Project area, Colchester county, Nova Scotia. Coordinates are NAD83 UTM Zone 20T.	12
Table 3. Site descriptions for ultrasonic survey sites for the 2013 survey of bat activity at the proposed Kemptown Wind Energy Project area, Colchester County, Nova Scotia.	12
Table 4. Number of echolocation bat call sequence files recorded per night for the 2013 survey of bat activity at the proposed Kemptown Wind Energy Project area, Colchester County, Nova Scotia. MYO = Myotis species, LACI = <i>Lasiurus cinereus</i>	15
Table 5. Number of echolocation bat call sequence files recorded per night for the 2013 survey of bat activity at abandoned mine openings (AMO) near the proposed Kemptown Wind Energy Project area, Colchester County, Nova Scotia. MYO = Myotis species, LACI = <i>Lasiurus cinereus</i> , UNKN = unknown species of bat.	17

Context

Project Background

Affinity Renewables (LLC), with oversight from RMS Energy, is proposing to install three GE 1.6 megawatt (MW) wind turbines near the community of Kemptown, Colchester County, Nova Scotia. The project is in an early phase with wind monitoring onsite at a meteorological tower.

Commercial scale wind energy production is one of the fastest growing sectors of the global energy industry as the demand for renewable energy sources for electricity generation continues to increase (Nelson 2009). This demand, combined with recent advances in wind turbine technology that have improved the cost-competitiveness of wind energy, has led to a global increase in the number of wind energy installations. In Canada, energy production and regulation falls under provincial jurisdiction and thus most renewable energy targets are set at the provincial level. In the province's Renewable Electricity Plan, the Provincial Government of Nova Scotia has set an aggressive target of 40% of the province's electricity needs to be met by renewable energy by the year 2020 (Nova Scotia Department of Energy 2010). Of this amount, 25% has been set as coming from made-in-Nova Scotia sources by 2015, and the wind energy sector is anticipated to be the largest contributor in meeting these goals. The Kemptown project is part of the Community Feed-In Tariff program (COMFIT) of the Renewable Electricity Plan which facilitates small-scale, local renewable projects that involve community groups.

Despite the many environmental benefits of electrical generation via wind energy, the rapid global growth of the wind energy sector has raised concerns regarding the impacts of these developments on both resident and migratory populations of wildlife (Arnett et al. 2008b). The documentation of large numbers of bat fatalities at wind energy facilities is a relatively recent development (Johnson 2005a), although is gaining considerable global attention. As a result, fatalities of bats have become a primary environmental concern associated with wind energy development.

Efforts to minimize conflicts between wildlife and wind energy have focused mainly on two areas: risk avoidance and impact mitigation (Weller and Baldwin 2012). Impact mitigation refers to those efforts focused on developing methods to reduce wildlife fatalities at operational wind facilities and does not apply to this project at this time. Risk avoidance involves conducting surveys prior to construction to avoid sites, or areas within sites, with high levels of usage by wildlife. The assumption of this approach is that low indices of activity prior to construction should result in low fatality rates post-construction since there should be fewer animals 'available' to be killed assuming that bats are not attracted to the infrastructure once built (Baerwald and Barclay 2009). As the planning phase proceeds for the development of the project, surveys of the wildlife at the proposed site are being undertaken to address any potential wildlife issues related to the development of the site. This document provides a summary of the echolocation survey undertaken for bats at the Kemptown Wind Energy Project in 2013.

Regulatory Context

The following legislation and policy were considered in relation to the proposed survey at the Kemptown Wind Energy Project:

- Federal Species at Risk Act (<http://laws-lois.justice.gc.ca/eng/acts/S-15.3/page-1.html>)
- Nova Scotia *Wildlife Act* (<http://nslegislature.ca/legc/statutes/wildlife.pdf>)
- Nova Scotia *Endangered Species Act* (<http://www.novascotia.ca/legislature/legc/statutes/endspec.htm>)

Additional resources that are relevant to the proposed surveys used include:

- Atlantic Canada Conservation Data Centre (<http://www.accdc.com/>)
- Wild Species The General Status of Species in Canada (<http://www.wildspecies.ca/home.cfm?lang=e>)
- Global Species Rankings (<http://www.natureserve.org/explorer/>)

Study Objectives

The objectives of this project were to:

- (1) Provide information on the occurrence and relative magnitude of bat activity in the proposed development area, based on analysis of acoustic survey results;
- (2) Provide relevant information on the resource requirements of local bat species that may be useful for the decision-making process on the proposed development; and
- (3) Make relevant recommendations based on the results of this project and recent developments in the field of bats and wind energy.

Review of Key Issues

Background

Currently in Nova Scotia there are >150 wind turbines in operation (CanWEA 2013) and, as of yet, we are not aware of any incidents of major mortality, though bats have been killed. For context and qualification, most of these turbines have been in operation for only a short period of time (months to 7 years or less) and it is not known how thoroughly all existing operational turbines have been surveyed for bat fatalities or how well documented and reported the findings are. In the following sections we discuss the various means by which bats may be impacted by wind energy developments, including direct mortality, changes to habitat availability, and disruption of movement patterns (e.g., foraging, mating, migrations, or abandonment of sites).

Direct Mortality

Proximate causes of bat fatalities at wind energy developments may be due to direct strike by rotating turbine blades, collision with turbine towers, barotrauma or any combination of the three. Barotrauma involves tissue damage to the lungs due to rapid or excessive air-pressure reduction near moving

turbines blades (Baerwald et al. 2008, Cryan and Barclay 2009) and the discussion of the relative role of barotrauma in the death of bats at wind energy developments remains on-going (Grotsky et al. 2011, Capparella et al. 2012, Rollins et al. 2012). In North America, significant bat fatality events at wind energy developments occur primarily in the late summer and early fall, peaking during the period that coincides with fall migration (Johnson 2005b, Cryan and Brown 2007, Arnett et al. 2008a). These trends have led researchers to believe that migration plays a key role in the susceptibility of certain bat species to wind turbine fatalities (Cryan and Barclay 2009). Although some fatality has also been documented during the spring (Brown and Hamilton 2006, Arnett et al. 2008a), numbers are much lower, thought to be a result of more scattered migratory behaviour, or possibly the use of different routes compared to fall migration.

The species that have the largest number of kills at wind farms are the long-distance migratory bats, including the hoary bat (*Lasiurus cinereus*), the eastern red bat (*L. borealis*), and the silver-haired bat (*Lasionycteris noctivagans*). In North America, these species make up about 75-80% of the documented fatalities at wind energy developments, with the hoary bat alone comprising almost half (Kunz et al. 2007, Arnett et al. 2008a). The cumulative impacts of current mortality rates as a result of wind turbines on these affected species could have long-term population effects (Kunz et al. 2007). Bat fatalities have also been reported for resident hibernating bat species, including the big brown bat (*Eptesicus fuscus*), the little brown bat (*Myotis lucifugus*), the northern long-eared bat (*M. septentrionalis*), and the tri-colored bat (*Perimyotis subflavus*) (Nicholson 2003, Johnson 2005b, Jain et al. 2007, Arnett et al. 2008a). At some sites in the eastern United States high numbers of fatalities of these resident, hibernating species have been reported (Kunz et al. 2007).

Various explanations for the high incidence of bat fatalities at wind energy developments have been proposed (Johnson 2005b, Kunz et al. 2007, Arnett et al. 2008a, Cryan and Barclay 2009). Estimates of the number of bat fatalities vary widely from less than 3 bats/turbine/year (Johnson et al. 2003, Johnson et al. 2004) to upwards of 50 bats/turbine/year (Nicholson 2003, Kerns et al. 2005, Jain et al. 2007). Given the considerable variability in species composition and rates of bat fatalities among wind energy facilities, it is likely that location-specific qualities of individual facilities are important (e.g., located along migration routes or other flight corridors). It has also been proposed that the use of turbines with increasing height has extended developments further into the flight space used by migrating bats (Barclay et al. 2007). However, behavioural observations of bats displaying flight patterns typical of foraging activity prior to collisions with turbines (Horn et al. 2008) may suggest that bats are actively foraging which may mean that foraging while migrating may take place for some individuals. Others have hypothesized that collisions may result from bats being attracted to turbines out of curiosity, misperception (failure to avoid a detected obstacle or interference with perception of an obstacle), or as potential feeding, roosting, and mating opportunities (reviewed in Cryan and Barclay 2009). To date, the cause(s) of bat fatalities at turbines remains unclear and is an active area of research.

As mortalities may be the result of site-specific and design-specific characteristics and conditions, it is important to conduct site-specific monitoring studies to make reliable inferences on the potential impacts of a wind energy development on local bat populations (American Society of Mammalogists 2008).

Habitat Availability

In forested landscapes, habitat availability for bats may be impacted by the alteration or removal of vegetation to accommodate roads and wind turbine installations. This may include the direct loss of

resources (e.g., roost trees), fragmentation of habitat components (e.g., foraging and roosting areas), or other disturbance that may cause bats to vacate certain areas, likely acting to degrade the local environment for bat colonies/populations that reside in the area during the summer. This negative impact of new wind energy developments is likely to occur, and will contribute to the cumulative effect of habitat loss that is occurring throughout the range of most bat species.

At the site level, small-scale clearings in forested landscapes have been shown to attract certain bat species, which use these areas for foraging (Grindal and Brigham 1998, Hayes and Loeb 2007). Removal of vegetation can create edges and small clearings which can act to concentrate prey for bats. The extent to which this loss of vegetation can be perceived to be beneficial to bats is not known and will vary from site to site, as there must be a balance between the availability of suitable roosting resources with the availability of suitable foraging areas within commuting distance to provide conditions that favour the occupancy of resident bat species (Henderson and Broders 2008).

Movement Patterns

From the perspective of bat movement, resident bats may be affected by wind energy developments through alterations to foraging areas and possible disruption of commuting movements between roosting and foraging areas. There is some genetic evidence to suggest that bat movements can be impeded by fragmentation of habitat, which can scale up to population or distributional level effects (Kerth and Petit 2005, Meyer et al. 2009). However, this is not well understood for most species.

Little is known about the dynamics of movement (e.g., altitude, travel routes, frequency of visitation) of resident, hibernating bats to and from hibernation sites. Anecdotal evidence suggests that bats likely use ridges and other linear landscape elements (e.g., riparian corridors) as travel routes, depending on the landscape (Arnett 2005, Lausen 2007, Furmankiewicz and Kucharska 2009). In the late summer and early autumn large numbers of bats congregate at the entrances to underground hibernacula in an activity referred to as 'swarming' (Davis and Hitchcock 1965, Fenton 1969, Thomas and Fenton 1979, Glover and Altringham 2008). During the swarming period bats do not roost in hibernacula; research being conducted in Nova Scotia indicates that resident bats are 'on the move', roosting transiently on the landscape (Lowe 2012), though we do not have a full understanding of the dynamics of these behaviours. Swarming may serve several functions, including courtship, copulation, and orienting young-of-the-year to over-wintering sites (Fenton 1969, Thomas and Fenton 1979).

Movement data from Ontario and Manitoba suggests that resident bats may move up to at least 120 km between hibernacula within a year, and up to at least 500 km between years (Fenton 1969, Norquay et al. 2013). In New England, there are records of bats moving 214 km between hibernacula within one year, with one female moving 128 km in only three nights during spring emergence from hibernation (Davis and Hitchcock 1965). Obviously these resident hibernating species are at least capable of large scale migratory movements on the order of hundreds of kilometers. It is not known whether flight behaviour (e.g., height, routes, etc.) during this time differs from when resident species are in their summering area; the paucity of information on this aspect of their biology would appear to be one of the largest impediments in accurately predicting the impact of wind energy developments on local bat populations (Weller et al. 2009).

Bats in Nova Scotia

Nova Scotia Bat species

In Nova Scotia there are occurrence records for seven species of bats (Table 1; van Zyll de Jong 1985, Broders et al. 2003, Segers et al. 2013), and each have been documented to have experienced fatalities at wind turbine sites (Arnett et al. 2008a). There are three species of long-distance migratory bats recorded in the province, the hoary bat, the eastern red bat, and the silver-haired bat. These three species have extensive distributional ranges throughout North America, with Nova Scotia at or near their northern range limit (van Zyll de Jong 1985). Low numbers of echolocation recordings of the long-distance migratory species in Nova Scotia by Broders (2003) and other unpublished work suggests that there are no significant populations or large scale migratory movements of these species in the province, but they do occur regularly and are often associated with coastal or off-shore occurrences (Cryan and Brown 2007, Czenze et al. 2011, Segers et al. 2013). Two species of bats in the genus *Myotis*, the little brown bat and the northern long-eared bat, are the only abundant and widely distributed bats in Nova Scotia (Broders et al. 2003, Henderson et al. 2009). These 5–8g insectivorous bats are sympatric over much of their range (Fenton and Barclay 1980, van Zyll de Jong 1985, Caceres and Barclay 2000). A third species, the tri-coloured bat, has a significant population in the province, however they are likely restricted to southwest Nova Scotia (Broders et al. 2003, Rockwell 2005, Farrow and Broders 2011). These three species are gregarious species that over-winter in caves and abandoned mines in the region (Moseley 2007, Randall 2011). There is only one unconfirmed observation of the big brown bat, also a gregarious species, hibernating at a cave in central mainland Nova Scotia (Taylor 1997).

Ecology of Resident Species

Northern long-eared and little brown bats are expected to be the most likely species to occupy the proposed development area. The life history of both of these species is typical for temperate, insectivorous bats. Their annual cycle consists of a period of activity (reproduction) in the summer, and a hibernation period in the winter. Females of the two species bear the full cost of reproduction in the summer, from pregnancy to providing sole parental care to juveniles (Barclay 1991, Hamilton and Barclay 1994, Broders 2003).

The northern long-eared bat is a forest interior species that primarily roosts and forages in the interior of forests (Broders 2003, Jung et al. 2004, Henderson and Broders 2008). Females form maternity colonies, roosting in coniferous or deciduous trees, depending on availability (Foster and Kurta 1999, Broders et al. 2006, Garroway and Broders 2008). Males typically roost solitarily in either deciduous or coniferous trees (Lacki and Schwierjohann 2001, Jung et al. 2004, Ford et al. 2006). The little brown bat is a generalist species that is associated with forests, as well as human-dominated environments (Barclay 1982, Jung et al. 1999). This species has been found to forage over water and in forests (Anthony and Kunz 1977, Fenton and Barclay 1980), and both males and females (i.e., maternity colonies) have been documented roosting in both buildings and trees (Crampton and Barclay 1998, Broders and Forbes 2004). During the summer, it appears that most of the commuting and foraging activity of northern long-eared and little brown bats occurs close to the ground (Broders 2003). Nonetheless, our ability to survey bat activity at high altitudes is extremely limited, and therefore our ability to make inference on the vertical distribution of bats is also limited.

A third species that occurs in significant numbers in Nova Scotia, the tri-colored bat, is not likely to occur in the proposed development area (Farrow and Broders 2011). In Nova Scotia, work that we have done in Kejimikujik National Park suggests that this species roost in *Usnea* lichen species and forages over waterways (Poissant et al. 2010).

White Nose Syndrome

In 2012, three species of bats found in Nova Scotia were listed by COSEWIC as Endangered, and in 2013 were listed as Endangered by the Province of Nova Scotia. This is primarily due to the spread of an emerging infectious disease known as White Nose Syndrome (WNS) that is responsible for unprecedented mortality in hibernating bats through much of eastern North America (Blehert et al. 2009, United States Fish & Wildlife Service 2012). The condition is caused by *Pseudogymnoascus destructans* (formerly *Geomyces destructans*), a cold-loving fungus that thrives in cave conditions and as such, impacts bat population directly during the winter hibernation period (Lorch et al. 2011, Blehert 2012, Minnis and Lindner 2013). It is thought to disrupt patterns of torpor which results in death by starvation or dehydration (Cryan et al. 2010, Reeder et al. 2012, Warnecke et al. 2013). First documented in New York State in 2006 (Blehert et al. 2009), WNS spread rapidly to 19 states and four Canadian provinces by 2011 and is thought to be responsible for the death of more than 5.5 million bats (United States Fish & Wildlife Service 2012). White Nose Syndrome has been confirmed among populations of seven species of bats; the little brown bat, the most abundant species in the region currently affected by WNS, has experienced the most dramatic population declines (Frick et al. 2010). Some hibernacula have seen mortality rates of 90 to 100 percent of resident hibernating bats as a result of infection with WNS (United States Fish & Wildlife Service 2012), leading researchers to believe that WNS could lead to local extinctions of the little brown bat, as well as other species (Frick et al. 2010).

White Nose Syndrome was first documented in Nova Scotia in April 2011 and declines of 80% to 99% have since been recorded in winter populations (Broders and Burns, unpublished data). Therefore it would be prudent to protect any surviving animals that may be genetically predisposed to surviving the infection. Even prior to WNS, bats were increasingly recognized as a conservation priority in North America. Now, in consideration of the sharp declines and rapid spread of WNS, serious concerns have been raised about the impact of WNS on the population viability of affected bat species, consequently impacting the conservation status of bat species at the local, national and global level (Table 1). Given that hibernacula represent one of the more critical resources for bats, as they allow successful over-wintering, they are important to protect.

Potential for Hibernacula

The Nova Scotia Proponent's Guide to Wind Power Projects (Nova Scotia Environment 2012) states that wind farm sites within 25 km of a known bat hibernacula have a 'very high' site sensitivity. There are no major hibernacula within 25 km of the Kemptown Wind Energy Project area (Moseley 2007). Abandoned mine adits at New Lairg, Pictou County, are within 25 km although no overwintering count data exists for these (Moseley 2007) and recent acoustic surveys in 2010 by Randall suggest they are not significant autumn swarming sites (Randall 2011). In other ultrasonic monitoring by Randall in 2010, at two other sites in the vicinity of the proposed development area, McLellan's Brook Cave, Pictou County and at Natural Bridge Cave, Colchester County she concluded that neither of these exhibited strong evidence of fall swarming activity by bats although there were captures of bats at Natural Bridge Cave

on one sampling night. The nearest known major bat hibernaculum to the Kemptown project is Hayes Cave, the largest known hibernaculum in NS, which is located in Maple Grove approximately 40 km from the proposed development area. At approximately 42 km away is Lear Shaft, located in Londonderry in an area with extensive underground mine workings and a number of mine openings. There are no underground records of hibernating bats from this site (owing to the structure of the site, a now-gated vertical shaft). In sampling on 7 nights in the autumns of 2009 and 2010, bat captures using harp traps resulted in an average of 8 bats captured per sampling hour indicating this is a fall swarming site (Burns unpublished data). Overwinter surveys for white-nose syndrome monitoring in 2012 yielded the collection of bat carcasses around the mine opening in winter demonstrating this site is a hibernaculum.

According to the Nova Scotia Abandoned Mine Openings Database (Fisher and Hennick 2009), there are 33 underground abandoned mine opening records in the vicinity of the Kemptown project (within 25km). Of these, the records suggest that 25 of the records have original depths of 30 m or less and/or were filled in or are flooded suggesting they would be unsuitable as hibernacula. Of the remaining 8 sites, 4 have been filled in (KPT-1-025, EMM-1-001, LCU-1-003, SPB-1-006) and 1 is one of the New Lairg sites investigated by Randall in 2010 (LCU-1-004; 2011) was not found to have high autumn bat activity levels. This leaves three openings to be potentially explored for bat activity.

Table 1. Over-wintering strategy and conservation status of bat species recorded in Nova Scotia

Species	Overwintering Strategy	Global Ranking ¹	COSEWIC Status	ACCDC status ³	NSESA ⁴
Little brown bat	Resident hibernator	G5	Endangered ²	S1	Endangered
Northern long-eared bat	Resident hibernator	G4	Endangered ²	S1	Endangered
Tri-coloured bat	Resident hibernator	G5	Endangered ²	S1	Endangered
Big brown bat	Resident hibernator	G5	Not assessed	N/A	Not listed
Hoary bat	Migratory	G5	Not assessed	S1	Not listed
Silver-haired bat	Migratory	G5	Not assessed	S1	Not listed
Eastern red bat	Migratory	G5	Not assessed	S1	Not listed

¹ Global Ranking based on the NatureServe Explorer: G1 = Critically Imperiled, G2 = Imperiled, G3 = Vulnerable, G4 = Apparently Secure, G5 = Secure. All the above species were reassessed in July 2012.

² Assessed by COSEWIC and designated in an emergency assessment on February 3, 2012.

³ Atlantic Canada Conservation Data Centre ranking, based on occurrence records from NB and NS: S1 = Extremely rare: May be especially vulnerable to extirpation (typically five or fewer occurrences or very few individuals).

⁴ Listing status under the Nova Scotia Endangered Species Act: Endangered = a species facing imminent extirpation or extinction; species were reassessed in July 2013.

Methods

Study Area

The project area is located near the community of Kempton, Colchester County which is situated approximately 16 km from the town of Truro which has a population of 12,500 people. This area is within the Rolling Upland District of the Carboniferous Lowlands Theme Region (Davis and Browne 1996) and the Nova Scotia Highlands Ecoregion and St. Mary's Block Ecodistrict (Webb and Marshall 1999). This area contains upland slopes ranging from 100 to 300 m in elevation. Softwood forests dominate the area with scattered sugar maple, beech and yellow birch occurring on low ridges and spruces, balsam fir, red maple and eastern hemlock common on well-drained mid-slopes. Forestry is the dominant land use activity in the area with some small mixed farming.

Ultrasonic Surveys

We used two automated bat detectors (model Song Meter SM2Bat+, Wildlife Acoustics, Concord, MA) to sample at two locations within the proposed development area (Table 2). One detector was deployed adjacent to a meteorological tower with two microphones: one microphone recorded at 2 m off the ground and another microphone recorded at approximately 40 m above ground (high microphone). The second detector was deployed along a trail in a regenerating forest and used one microphone that was placed at about 3 m above ground. Microphones were oriented parallel to the ground, or slightly down to shed rain. The seasonal timing of sampling likely corresponded to the end of the summer residency period, movement of resident species to local hibernacula, and to fall migration by migratory species.

Three other bat detectors (Anabat, Titley Electronics, Ballina, NSW, Australia) were placed in the vicinity of the identified abandoned mine openings (AMO) from the Nova Scotia Abandoned Mine Openings Database (Brookfield, BRF-1-002; Smithfield, SPB-1-003; Kempton, KPT-1-007; Table 2). These openings are approximately 22.1, 10.5 and 3.8 km away from the proposed wind energy development, respectively.

Identification of many bat species is possible because of the distinctive nature of their echolocation calls (Fenton and Bell 1981, O'Farrell et al. 1999). Species were qualitatively identified from recorded echolocation call sequences by comparison with known echolocation sequences recorded in this and other geographic regions. All recorded bat call sequences from SM2Bat units were converted to zero-crossing file formats using Kaleidoscope™ software (Wildlife Acoustics) and were imported into Analoow software (Titley Electronics, vs3.8v) for identification and analysis. Calls from Anabat units were directly used in Analoow. In the case of species in the genus *Myotis* (northern long-eared and little brown bat), we did not identify sequences to the species level as their calls are too similar to be reliably separated. Call sequences that were clearly bat generated ultrasound, but could not be confidently classified due to poor quality of the recordings were classified as 'unknown'. As the unit of bat activity, we used the number of recorded echolocation files, which approximate an echolocation call sequence, defined as a continuous series of greater than two calls (Johnson et al. 2004). Because an individual bat may be recorded making multiple passes, the data presented represent a measure of bat

activity, and cannot be used as a direct measure of the number of bats within or passing through an area.

Differences in bat call sequence detections, call quality and ultimately species identifications are known among different models of bat detectors. Recent comparisons have shown that Wildlife Acoustics SM2Bat units record more bat call sequence files than Anabat units (Allen et al. 2011, Adams et al. 2012) and these differences must be incorporated into the interpretations and inferences of data when using both detectors.

Table 2. Locations of ultrasonic survey sites for the 2013 survey of bat activity at the proposed Kemptown Wind Energy Project area, Colchester county, Nova Scotia. Coordinates are NAD83 UTM Zone 20T.

Site	Location	Site type	Coordinates		Deployed	Retrieved
1	Kemptown forest	Project Area	491314 E	5032843 N	30 Jul 2013	11 Oct 2013
2	Kemptown tower	Project Area	490786 E	5032690 N	30 Jul 2013	11 Oct 2013
3	Brookfield AMO	Mine opening	481526 E	5013245 N	30 Jul 2013	21 Sep 2013
4	Smithfield AMO	Mine opening	494061 E	5012824 N	30 Jul 2013	21 Sep 2013
5	Kemptown AMO	Mine opening	494234 E	5034854 N	28 Aug 2013	09 Nov 2013

Table 3. Site descriptions for ultrasonic survey sites for the 2013 survey of bat activity at the proposed Kemptown Wind Energy Project area, Colchester County, Nova Scotia.

Site	Description
1	The detector was placed along a trail through a regenerating coniferous forest.
2	The site was within a regenerating coniferous forest and the immediate vicinity of the tower had a gravel base with road access for the meteorological tower.
3	The exact location of the mine opening could not be located and was possibly filled in or collapsed. Regardless there was evidence of mine workings and a detector was deployed along a forest edge at the expected location of the opening and among the mine workings.
4	The exact location of the candidate mine opening could not be located but there were a number of locations where there was evidence of mine workings within 40 m of the GPS location which straddled a narrow patch of forest bounded by a road and a large field. The detector was deployed at the edge of the forest and the microphone was pointed into the field.
5	The exact location of the candidate mine opening could not be located and it is possible the opening was filled in. Detector was deployed in a small gap in a patch of forest approximately 20 m from the adjacent road.

Results

At site 1, the bat detector recorded from July 30 to October 3, 2013. Upon retrieval of this unit it was discovered that the unit had been vandalized with the power supply cut on October 4 such that no data was recorded for the remaining 7 nights before the unit was retrieved. Site 2 recorded data from July 30

to October 11, 2013 continuously. Detectors at the Smithfield and Brookfield abandoned mine openings were deployed and recorded continuously from July 30 to September 21 and the Kemptown abandoned mine opening recorded from August 28 to November 10, 2013.

Within the proposed wind energy development area there were 59 acoustic files recorded on the 3 microphones (2 detectors) with 14 classified as bat-generated ultrasound files and the remaining classified as extraneous noise (Table 4). Of these, 2 were recorded along the trail through the regenerating forest (site 1), 6 were recorded at the base of the meteorological tower (site 2) and 6 bat call sequence files were recorded on the high microphone on the meteorological tower. The majority of call sequences (10/14; 71.4 %) were classified as *Myotis* species (i.e., includes northern long-eared and little brown bats); as stated above no attempt was made to identify these call sequences to the species level given the difficulty in achieving such identifications. There were 4 call sequences attributed to hoary bats that were recorded on 3 nights during the fall migration period. Two hoary bat call sequences were recorded on August 17 where a single call was recorded on each of the low and high microphones at the same time and thus likely represent the same individual flying in the area. The other single hoary call sequences were recorded on each of August 27 and September 24th and are also suggestive that an individual bat was present each night and made the calls.

The bat detector at the Brookfield AMO recorded 46 acoustic files with 21 classified as bat-generated ultrasound files (Table 5). Sixty-six percent (n= 14) of the bat call sequences were classified as *Myotis* species, 28.6 % (n=6) were classified as hoary bat and there was one call sequence that was classified as unknown (4.7%). The hoary bat sequences were recorded on three nights with one sequence on the evening of Aug 21, two sequences on September 1st within 18 minutes of each other and three sequences on Sept 2nd within 28 minutes of each other. This suggests an individual bat on each night made the calls. The unknown sequence recorded was short in duration (5.14 milliseconds) consisting of 8 calls which lacked the distinctive frequency modulated sweep typical of bat calls and thus encompassed a maximum and minimum frequency of 39.54 and 38.54 kHz, respectively. These characteristics fall within known parameters for *Myotis* species or potentially a red bat however the missing shape parameters precluded a positive identification to a particular species group although do represent discrete bat call pulses. The bat detector at the Smithfield AMO recorded 210 acoustic files with 87 classified as bat-generated ultrasound files (Table 5). *Myotis* species again dominated the call sequences at 97.7% followed by 2.3% attributable to hoary bat call sequences. The hoary bat sequences at Smithfield were recorded on 2 separate nights with a single call sequence recorded on each of August 27 and September 8th. At the Kemptown AMO there was 1204 acoustic files recorded with 10 classified as bat-generated ultrasound files. *Myotis* species comprised 60% of the call sequences and the remaining 40% were attributable to hoary bat call sequences. The hoary bat sequences were recorded on three nights with one sequence on the evening of Aug 28, two sequences on September 2 and one sequence on September 3rd. This is suggestive of an individual bat on each night.

The average number of recorded bat call sequences per night in the proposed development area (average for the two sites) was 0.19 (SD =0.52) during the sampling period. To place the relative magnitude of activity recorded in the study area into context, in 129 nights of monitoring along five forested edges in the Greater Fundy National Park Ecosystem from June to August 1999, the average number of sequences per night was 27 (SD = 44; Broders unpublished data). In 650 nights of monitoring at river sites in forested landscapes in southwest Nova Scotia from June to August of 2005-2006, the average number of sequences per night was 128 (SD = 232; Farrow unpublished data), though note that rivers act to concentrate bat activity, as they are used as foraging and commuting corridors (Laval et al.

1977, Fenton and Barclay 1980, Fujita and Kunz 1984, Krusic et al. 1996, Zimmerman and Glanz 2000, Lacki et al. 2007). Both of these previous comparisons were conducted prior to the emergence of white nose syndrome and therefore may not be directly comparable. In a forested landscape in Colchester County, Nova Scotia, we detected an approximate 99% decrease in bat echolocation activity from 2012 to 2013 at forested and riparian sites that were monitored for bat activity following the confirmation of mortality from white nose syndrome in Nova Scotia (Segers and Broders, unpublished data).

The average number of recorded bat call sequences per night for the Brookfield, Smithfield and Kemptown abandoned mine openings were 0.40 (SD = 0.91), 1.64 (SD = 2.72), 0.14 (SD = 0.42), respectively. The Smithfield AMO had the highest level of bat activity of the four study areas and although bat activity was low, there was a trend of bat activity increasing towards the end of August and early September (Figure 1) as predicted for swarming sites.

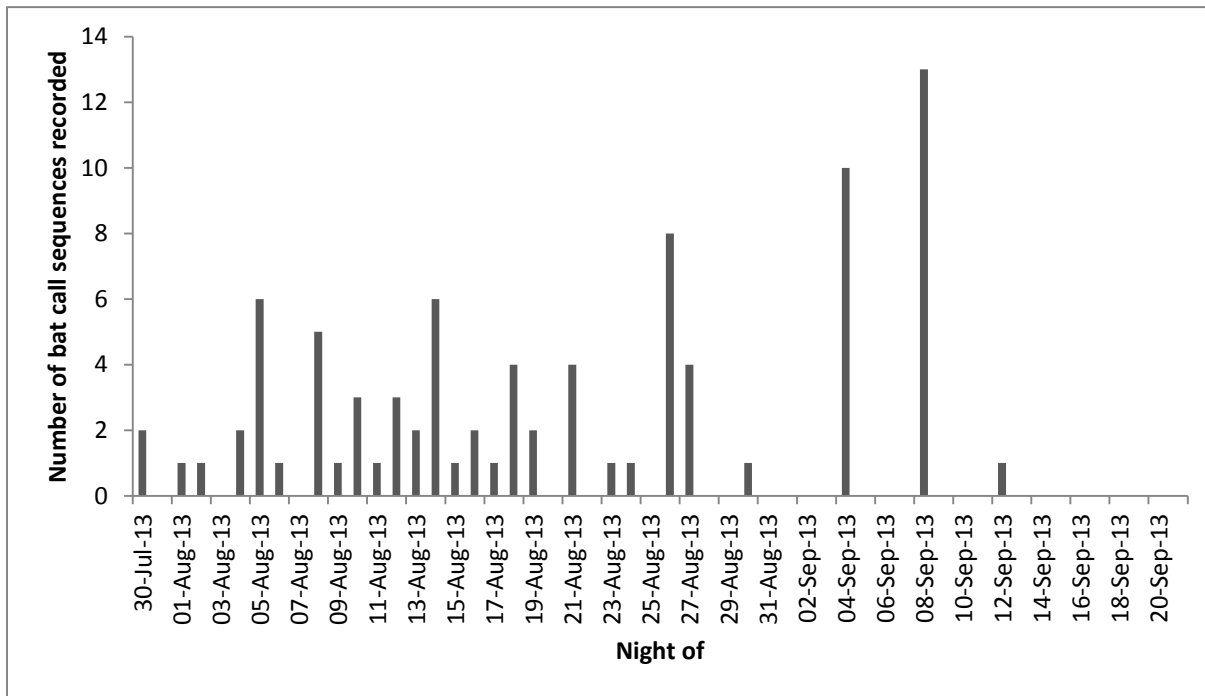


Figure 1. Number of bat call sequences recorded, by night, at the Smithfield abandoned mine opening, July 30 to September 20, 2013.

Table 4. Number of echolocation bat call sequence files recorded per night for the 2013 survey of bat activity at the proposed Kemptown Wind Energy Project area, Colchester County, Nova Scotia. MYO = *Myotis* species, LACI = *Lasiurus cinereus*.

Night of	Site 1	Site 2 (low mic)		Site 2 (high mic)		Nightly total all sites
	MYO	MYO	LACI	MYO	LACI	
30-Jul-13	0	0	0	0	0	0
31-Jul-13	2	1	0	0	0	3
01-Aug-13	0	0	0	0	0	0
02-Aug-13	0	0	0	0	0	0
03-Aug-13	0	0	0	0	0	0
04-Aug-13	0	0	0	0	0	0
05-Aug-13	0	0	0	0	0	0
06-Aug-13	0	0	0	1	0	1
07-Aug-13	0	0	0	0	0	0
08-Aug-13	0	0	0	0	0	0
09-Aug-13	0	0	0	0	0	0
10-Aug-13	0	0	0	0	0	0
11-Aug-13	0	0	0	1	0	1
12-Aug-13	0	0	0	0	0	0
13-Aug-13	0	0	0	0	0	0
14-Aug-13	0	0	0	0	0	0
15-Aug-13	0	1	0	0	0	1
16-Aug-13	0	0	0	0	0	0
17-Aug-13	0	0	1	0	1	2
18-Aug-13	0	0	0	0	0	0
19-Aug-13	0	0	0	1	0	1
20-Aug-13	0	0	0	0	0	0
21-Aug-13	0	0	0	0	0	0
22-Aug-13	0	0	0	1	0	1
23-Aug-13	0	0	0	0	0	0
24-Aug-13	0	0	0	0	0	0
25-Aug-13	0	0	0	0	0	0
26-Aug-13	0	0	0	0	0	0
27-Aug-13	0	0	1	0	0	1
28-Aug-13	0	0	0	0	0	0
29-Aug-13	0	0	0	0	0	0
30-Aug-13	0	0	0	0	0	0
31-Aug-13	0	0	0	0	0	0
01-Sep-13	0	0	0	0	0	0
02-Sep-13	0	0	0	1	0	1
03-Sep-13	0	0	0	0	0	0

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Night of	Site 1	Site 2 (low mic)		Site 2 (high mic)		Nightly total all sites
	MYO	MYO	LACI	MYO	LACI	
04-Sep-13	0	0	0	0	0	0
05-Sep-13	0	0	0	0	0	0
06-Sep-13	0	0	0	0	0	0
07-Sep-13	0	0	0	0	0	0
08-Sep-13	0	0	0	0	0	0
09-Sep-13	0	1	0	0	0	1
10-Sep-13	0	0	0	0	0	0
11-Sep-13	0	0	0	0	0	0
12-Sep-13	0	0	0	0	0	0
13-Sep-13	0	0	0	0	0	0
14-Sep-13	0	0	0	0	0	0
15-Sep-13	0	0	0	0	0	0
16-Sep-13	0	0	0	0	0	0
17-Sep-13	0	0	0	0	0	0
18-Sep-13	0	0	0	0	0	0
19-Sep-13	0	0	0	0	0	0
20-Sep-13	0	0	0	0	0	0
21-Sep-13	0	0	0	0	0	0
22-Sep-13	0	0	0	0	0	0
23-Sep-13	0	0	0	0	0	0
24-Sep-13	0	0	1	0	0	1
25-Sep-13	0	0	0	0	0	0
26-Sep-13	0	0	0	0	0	0
27-Sep-13	0	0	0	0	0	0
28-Sep-13	0	0	0	0	0	0
29-Sep-13	0	0	0	0	0	0
30-Sep-13	0	0	0	0	0	0
01-Oct-13	0	0	0	0	0	0
02-Oct-13	0	0	0	0	0	0
03-Oct-13	0	0	0	0	0	0
04-Oct-13	-	0	0	0	0	0
05-Oct-13	-	0	0	0	0	0
06-Oct-13	-	0	0	0	0	0
07-Oct-13	-	0	0	0	0	0
08-Oct-13	-	0	0	0	0	0
09-Oct-13	-	0	0	0	0	0
10-Oct-13	-	0	0	0	0	0
Totals	2	3	3	5	1	14
Site average						0.19
Num nights	66		73		73	

Table 5. Number of echolocation bat call sequence files recorded per night for the 2013 survey of bat activity at abandoned mine openings (AMO) near the proposed Kemptown Wind Energy Project area, Colchester County, Nova Scotia. MYO = *Myotis* species, LACI = *Lasiurus cinereus*, UNKN = unknown species of bat.

Night of	Brookfield AMO				Smithfield AMO			Kemptown AMO		
	MYO	LACI	UNKN	Nightly Total	MYO	LACI	Nightly Total	MYO	LACI	Nightly Total
30-Jul-13	1	0	0	1	2	0	2	-	-	-
31-Jul-13	0	0	0	0	0	0	0	-	-	-
01-Aug-13	1	0	0	1	1	0	1	-	-	-
02-Aug-13	0	0	0	0	1	0	1	-	-	-
03-Aug-13	0	0	0	0	0	0	0	-	-	-
04-Aug-13	2	0	0	2	2	0	2	-	-	-
05-Aug-13	0	0	0	0	6	0	6	-	-	-
06-Aug-13	0	0	0	0	1	0	1	-	-	-
07-Aug-13	0	0	1	1	0	0	0	-	-	-
08-Aug-13	3	0	0	3	5	0	5	-	-	-
09-Aug-13	0	0	0	0	1	0	1	-	-	-
10-Aug-13	0	0	0	0	3	0	3	-	-	-
11-Aug-13	0	0	0	0	1	0	1	-	-	-
12-Aug-13	0	0	0	0	3	0	3	-	-	-
13-Aug-13	0	0	0	0	2	0	2	-	-	-
14-Aug-13	0	0	0	0	6	0	6	-	-	-
15-Aug-13	0	0	0	0	1	0	1	-	-	-
16-Aug-13	0	0	0	0	2	0	2	-	-	-
17-Aug-13	0	0	0	0	1	0	1	-	-	-
18-Aug-13	0	0	0	0	4	0	4	-	-	-
19-Aug-13	0	0	0	0	2	0	2	-	-	-
20-Aug-13	0	0	0	0	0	0	0	-	-	-
21-Aug-13	0	1	0	1	4	0	4	-	-	-
22-Aug-13	0	0	0	0	0	0	0	-	-	-

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Night of	Brookfield AMO				Smithfield AMO			Kemptown AMO		
	MYO	LACI	UNKN	Nightly total	MYO	LACI	Nightly total	MYO	LACI	Nightly total
23-Aug-13	1	0	0	1	1	0	1	-	-	-
24-Aug-13	0	0	0	0	1	0	1	-	-	-
25-Aug-13	0	0	0	0	0	0	0	-	-	-
26-Aug-13	0	0	0	0	8	0	8	-	-	-
27-Aug-13	1	0	0	1	3	1	4	-	-	-
28-Aug-13	0	0	0	0	0	0	0	1	1	2
29-Aug-13	0	0	0	0	0	0	0	0	0	0
30-Aug-13	1	0	0	1	1	0	1	1	0	1
31-Aug-13	0	0	0	0	0	0	0	0	0	0
01-Sep-13	0	2	0	2	0	0	0	1	0	1
02-Sep-13	0	3	0	3	0	0	0	0	2	2
03-Sep-13	0	0	0	0	0	0	0	0	1	1
04-Sep-13	0	0	0	0	10	0	10	0	0	0
05-Sep-13	0	0	0	0	0	0	0	0	0	0
06-Sep-13	0	0	0	0	0	0	0	0	0	0
07-Sep-13	0	0	0	0	0	0	0	0	0	0
08-Sep-13	0	0	0	0	12	1	13	0	0	0
09-Sep-13	0	0	0	0	0	0	0	1	0	1
10-Sep-13	0	0	0	0	0	0	0	0	0	0
11-Sep-13	0	0	0	0	0	0	0	0	0	0
12-Sep-13	1	0	0	1	1	0	1	0	0	0
13-Sep-13	2	0	0	2	0	0	0	0	0	0
14-Sep-13	0	0	0	0	0	0	0	0	0	0
15-Sep-13	0	0	0	0	0	0	0	0	0	0
16-Sep-13	0	0	0	0	0	0	0	0	0	0
17-Sep-13	0	0	0	0	0	0	0	0	0	0
18-Sep-13	0	0	0	0	0	0	0	0	0	0

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Night of	Brookfield AMO				Smithfield AMO			Kemptown AMO		
	MYO	LACI	UNKN	Nightly total	MYO	LACI	Nightly total	MYO	LACI	Nightly total
19-Sep-13	1	0	0	1	0	0	0	0	0	0
20-Sep-13	0	0	0	0	-	-	-	0	0	0
21-Sep-13	-	-	-	-	-	-	-	0	0	0
22-Sep-13	-	-	-	-	-	-	-	1	0	1
23-Sep-13	-	-	-	-	-	-	-	0	0	0
24-Sep-13	-	-	-	-	-	-	-	0	0	0
25-Sep-13	-	-	-	-	-	-	-	1	0	1
*								Data not shown*		
Site total	14	6	1	21	85	2	87	6	4	10
Site average				0.40			1.64			0.14
Num nights				53			53			73

*Kemptown AMO was sampled further from 26-Sep-13 until 8-Nov-13 although no further bat call sequences were recorded

Discussion

Interpretation of these data are problematic for assessing relative risk to bats at the proposed development given our knowledge of the devastating impacts that white nose syndrome has had, and is having, on local bat populations. Elsewhere, white nose syndrome reduced the summer bat activity by >75% (Dzal et al. 2011). This past winter (2012-2013), there were hundreds of fatalities recorded at several known hibernacula in the province and annual monitoring counts of bats at such hibernacula down, on average, by 94% (Broders and Burns, unpublished data). The disease is now confirmed in seven counties in central Nova Scotia, including the proposed development area. These observations are suggestive of a major mortality event in the area, potentially decreasing the magnitude of bat activity in the area in the summer of 2013. This is supported by other work we are conducting in the region during summer suggesting a 99% reduction in the magnitude of echolocation activity in 2013, relative to 2012 (Segers and Broders, unpublished), and decimation of a number of maternity colonies in the region. For these reasons this dataset must be interpreted with caution.

Despite the above, there was no acoustic evidence of a significant movement or concentration of bats through the area investigated during this pre-construction survey of bat activity. The magnitude of activity was low compared to baseline levels (collected prior to 2007) expected in a forested ecosystem in the region. Although we cannot rule out the possibility that mortality events associated with this development will occur, we have found no evidence to suggest that the proposed project will directly cause a large number of bat mortalities. That being said, in light of white nose syndrome and the recent listing of the species as endangered, the significance of any mortality is greater than just a couple of years ago.

The majority of the identified echolocation sequences recorded for this project were attributable to the two species of *Myotis* bats known to occur in Nova Scotia, the little brown bat and the northern long-eared bat. This was expected as they are the only abundant and widely-distributed species in the province, and are two of only three species with significant populations in the province (Broders et al. 2003). Although we did not distinguish the calls of *Myotis* species, the majority of the recorded sequences likely represent the little brown bat, as this species is known to forage in open areas and over water. The northern long-eared bat is a recognized forest interior species (Jung et al. 1999, Henderson and Broders 2008), and is less likely to use open areas for foraging and commuting (Henderson and Broders 2008). Additionally, the northern long-eared bat has lower intensity echolocation calls and is thus not recorded as well as the little brown bat (Miller and Treat 1993, Broders et al. 2004). There were no echolocation sequences that were attributable to the tri-colored bat, which was expected as this species is only locally abundant in southwest Nova Scotia and the proposed development is outside of the known provincial distribution for this species (Farrow and Broders 2011).

Myotis bats are relatively new to the list of species among fatalities at wind turbines sites. This may be due to the fact that the first large scale wind developments were located primarily in western North America, typically in agricultural and open prairie landscapes (reviewed in Johnson 2005b). Fatalities of these resident, non-migratory species were largely absent from these sites, likely due to the association of these species with forested landscapes. More recently, evidence of *Myotis* fatalities resulting from collisions with wind turbines have been noted at sites in eastern North America (reviewed in Johnson 2005b, Jain et al. 2007, Arnett et al. 2008a). Although there are fewer documented fatalities of *Myotis* bats compared to long-distance migratory species, there is still a risk of direct mortality.

Other than direct bat mortality as a result of collisions with turbines, there is also the potential that disruption of the forest structure (e.g., removal of trees and fragmentation of forest stands for roads and clearings) will degrade the local environment for colonies/populations of *Myotis* bats that reside in the area during the summer. This can occur by the elimination of existing roost trees, the isolation of trees left standing, as well as the elimination or degradation of foraging areas for bats. These negative impacts will almost certainly occur and will add to the cumulative impact of habitat loss that is occurring throughout the ranges of these species. Additionally, these resident bat species make what are generally considered to be short distance migrations, in comparison to long-distance migratory behaviour by other bats species, from their summering areas to underground sites where they hibernate. Little is known about the flight behaviour and dynamics of these movements (i.e., height of travel, and routes); therefore, it is difficult to predict the specific effects that wind developments will have on the movements of local populations of bats.

The low number of call sequences attributed to the hoary bat, a long-distance migratory bat species, suggests that there are no large populations or migratory movements of these species at the study area. This fits with our current knowledge of their status in the province, but they do occur regularly but in low frequency although are especially vulnerable to wind facilities. This species is a solitary, tree-roosting species with an extensive distributional range throughout North America (van Zyll de Jong 1985). This species, in addition to red and silver-haired bats, have received the greatest attention with regards to wind energy developments because they make up the large majority of documented fatalities at existing wind energy developments in North America. Any mortality of this species would be significant to Nova Scotia given their low numbers in the region. Significant bat fatality events at wind energy developments occur primarily in the late summer and early fall, peaking during the period that coincides with the long-distance fall migration of these species (Johnson 2005b, Cryan and Brown 2007, Arnett et al. 2008a), leading researchers to believe that migration plays a key role in the susceptibility of certain bat species to wind turbine fatalities (Cryan and Barclay 2009). It has been proposed that this may be because these species travel at a height that puts them at increased risk of collisions with rotating turbine blades (Barclay et al. 2007, Arnett et al. 2008a).

The low number of bat call sequences recorded at the abandoned mine openings suggest they are not major hibernacula. However, given the impacts of WNS such low levels of activity are not unsurprising, even if the sites were important hibernacula. Although this activity is generally low and would not qualify for the criteria set out by Randall (2011) for designating swarming sites, this current work was carried out post-white nose syndrome which almost certainly reduced the overall magnitude of bat activity recorded. Further, Randall's work was carried out directly at the entrances of underground sites where activity is highest as the animals interact, whereas the detector at Smithfield was placed on a forest edge near presumed entrances and therefore activity may be lower since it is not directly at the swarming site entrance. Despite this, the activity at the Brookfield and Kemptown AMO's suggest that they are not currently major autumn swarming sites for bats. The Smithfield AMO had the highest level of bat activity recorded of all three study areas sampled in this study and the seasonal trend of increasing activity fits the pattern of increased activity at swarming sites in the period of the end of August and early September that begins to decrease around the middle of September (Burns unpublished data; Tutty 2006). These data are more suggestive of the site being a swarming site and may also potentially be a hibernaculum. Alternatively, this site may not represent a swarming site but may be situated along a migration corridor for bats to other travel among swarming sites which may explain the trend in bat activity following the patterns known for the autumn swarming season. Further work would be required to assess the importance of this site as an autumn swarming site, migration corridor or over-wintering site (hibernaculum).

Recommendations

1. *Post-construction monitoring* – A rigorous post-construction monitoring program, appropriately designed to account for searcher efficiency and scavenger rates, needs to be established to quantify bat fatality rates. These surveys should be conducted over an entire season (April to October), but especially during the fall migration period (mid-August to late-September) for at least two years. Should fatalities occur, they should be investigated with respect to their spatial distribution relative to wind turbines, turbine lighting, weather conditions, and other site specific factors, and should trends be identified, operations should be adjusted in an adaptive management framework. In this manner, mitigation can be focused on any identified high risk areas/infrastructure to minimize future fatalities. These data are essential for assessing potential risks at future developments in the region; therefore it is critical that the results of these surveys be appropriately reported.
2. *Retain key bat habitat* – Key bat habitat should be identified and retained in the project area to continue to support existing summer colonies/populations of bats. Retention of these bat habitat resources should be in a spatial manner that provides connectivity in the project area and with the larger landscape to ensure foraging and roosting areas remain well connected. Consideration of the potential for fragmentation of bat habitat resources should also be taken with regards to the development of road networks and transmission lines in the project area.
3. *Minimize project footprint* – To the extent possible, minimize the direct loss of bat habitat resources (e.g., wetlands, riparian areas, mature deciduous-dominated forest stands), and minimize the extent of bat habitat impacted by the development.
4. *Return to pre-project state upon decommissioning* – The project area should be returned to the state that existed prior to the development of the site once the project is decommissioned. This should include planning to ensure the continuity of forest stand succession to provide and maintain appropriate roosting areas well into the future as existing roost trees die off. Retention of forest stands of a range of ages will provide mature trees for bat roosting resources in the future.
5. *Develop an operations fatality mitigation plan* – Recent experimental case studies in Alberta and the United States have demonstrated dramatic reductions in bat fatalities at operational wind energy facilities can be made by changing operational parameters during the peak fatality period (Baerwald et al. 2009, Arnett et al. 2010). These include changes to when turbine rotors begin turning in low winds via alterations to wind-speed triggers and blade angles to lower rotor speed. These studies have found decreases in bat mortalities ranging from 44% to as high as 93% reductions on a nightly basis at relatively low cost to annual power production loss, at approximately $\leq 1\%$. This plan should be adaptive as operations continue through time and be in place prior to operations commencing such that if any bat mortalities be observed at the site once operational, the plan can be implemented immediately.

6. *Remain up to date with current research* –There is presently an abundance of on-going research aimed at determining the impacts of wind energy developments on populations of bats. Other studies are focusing on investigating the efficacy of potential mitigation measures, including the effects of weather on bat activity patterns and collisions with wind turbines, and possible bat deterrents (including acoustic and radar emissions). As these are active areas of research, it is essential that the most current studies and guidelines are used to guide management decisions and development plans for wind energy projects.

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Kempton Spring Pellet Group Inventory

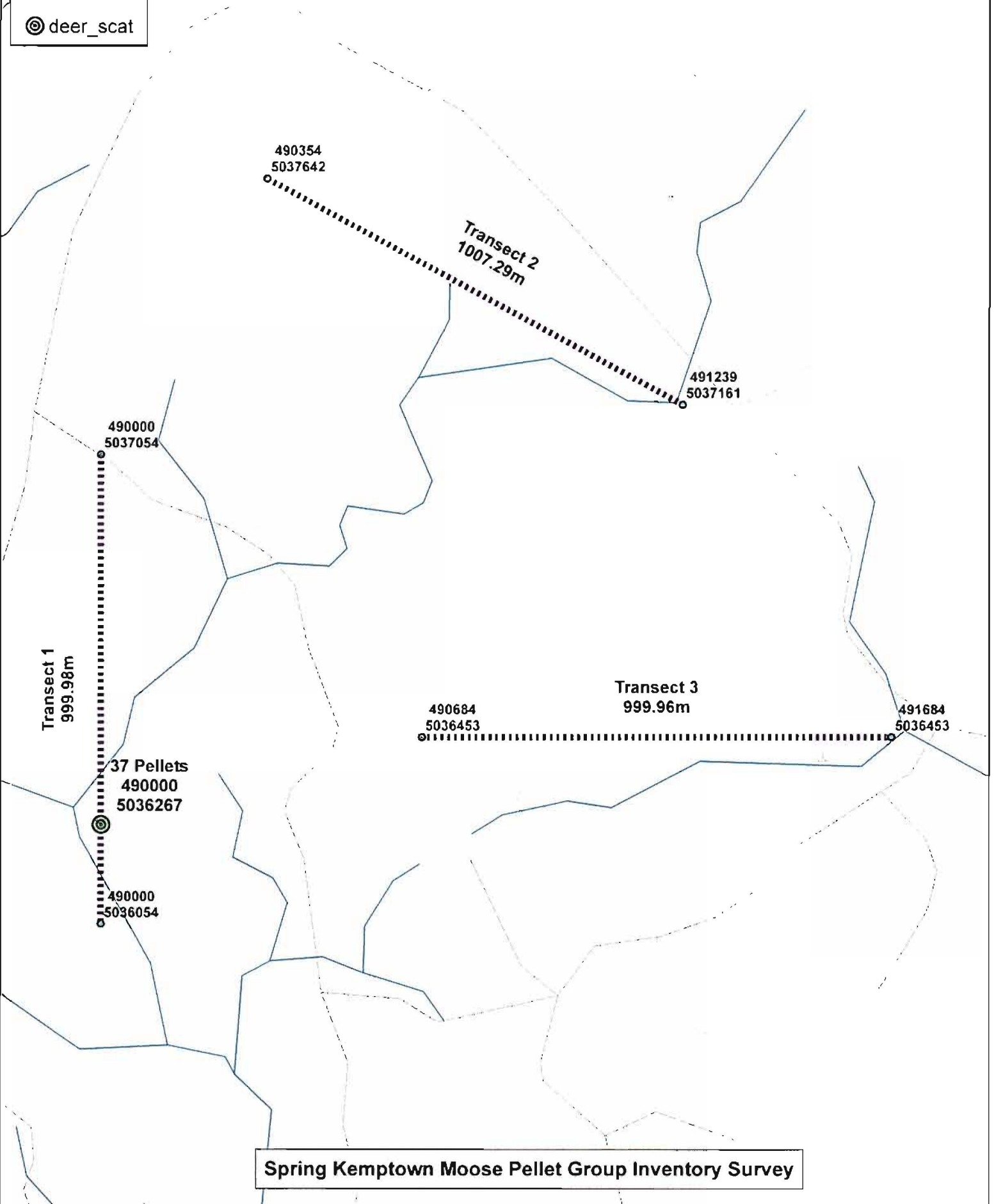
Three new transects were set up by Ross Hall. The field work was done by Jody Hamper. Each transect was 1 kilometer long and one meter on each side was observed for moose and whitetail deer sign. There was one pile of deer pellets found on transect one, there was also some light browsing observed. The actual start and end coordinates of each transect are on the attached map.

The survey was conducted on April 12, 2014. It was an overcast day.

Legend

⊙ deer scat

1:10,303



Spring Kemptown Moose Pellet Group Inventory Survey



NOVA SCOTIA

Energy

Office of the Minister

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March 12, 2013

Reuben Burge
796 Dan Fraser Rd
Pictou, NS
B0K 2A0

Dear Affinity Renewables:

Re: Community Feed-In Tariff Approval

On June 12 2012 Nova Scotia Department of Energy, presented you with your Community Feed-In Tariff (COMFIT) approval for three 1.6 MW wind turbines (for a total of 4.8 MW) in Kempton, Nova Scotia. Since that time more capacity has become available on the substation, and therefore the approval has been increased to 5.4 MW (Project Number 182). Attached to this letter is a certificate indicating your approval.

In order to maintain your COMFIT approval, you must comply with:

- (1) The specifications of the proposed project as outlined in your COMFIT application and any supplemental information provided; any alterations to your proposal (e.g., technology type, ownership structure, specifications, etc.) requires prior approval by the Department. Alterations must be submitted in writing for approval.
- (2) The Electricity Act and the Renewable Electricity Regulations. Amongst other things, section 34 of the Renewable Energy Regulations requires you to submit a report to the Department of Energy within 30 days of your project's connection to the distribution grid, failure to do so may result in revocation of your COMFIT approval.

As a condition of your approval, you must comply with any conditions set by Nova Scotia Power Incorporated.

As a further condition of approval, you must complete:

- **Community Consultation:** A minimum of two public information sessions must be held prior to commencing construction of the project. Results of the information sessions must be submitted to the Department of Energy, outlining any community concerns with the proposed project.

- **Project Time Line and Milestones:** As per S. 30 of the *Renewable Electricity Act and Regulations*, a detailed project schedule including timelines and key milestones must be submitted to the Department of Energy within 60 days of approval. You will be required to report on the progress of the project, in accordance with your submission.
- **Detailed Business Plan and Financial Estimates:** As per Section 6 of the COMFIT application, applicants must provide detailed information regarding the site's resource assessment and the project's financial viability, including the cost of unexpected sources of capital.
- **Environmental Assessment.**
- **Wind Energy Mapping:** The Department of Energy and Department of Natural Resources are endeavoring to map wind development within the province. All approved projects are required to submit the appropriate geographic information system data, and work collaboratively to address any recommendations emerging from an assessment of the cumulative impact of wind energy in the province. More information is provided in the guidance note.

These conditions are not an exhaustive list of the permits and approvals needed for your project. COMFIT approval does not supersede any additional regulations, permits or approval required by other government authorities as your project unfolds. Projects must still comply with all other conditions and milestones as set by government entities and Nova Scotia Power Inc. Failure to meet additional requirements may result in revocation of your COMFIT approval, even though they may not be an explicit condition at this time.

A COMFIT guidance note is attached with information pertaining to the implementation of your project. The guidance note is not a condition of approval, but information that may be useful to you as you implement your project. As per Directive 004: Annual Progress reports, the Department looks forward to receiving your annual reports on how COMFIT proceeds have assisted in meeting community sustainability goals.

Please note that you are also required to submit a report to the Department of Energy within 30 days of your project's connection to the distribution grid as identified in Section 34 of the *Renewable Electricity Regulations*. Failure to do so may result in revocation of your COMFIT approval.

If you have any questions about your approval, or if we can be of further assistance to you, please call COMFIT Clerk at (902) 424-5293 and a representative will be happy to assist you.

Yours sincerely,



Charlie Parker
Minister

Enclosure

No. Project 182 REISSUED

Community Feed-In Tariff Approval

This certifies that *Affinity Renewables* has received Community Feed-In Tariff Approval by the Nova Scotia Department of Energy for a 5.4 MW large wind project in Kempton, Nova Scotia. Approval may be revoked should a project not meet the requirements of the Community Feed-In Tariff program or deviate from details specified in its Community Feed-In Tariff application.



A handwritten signature in cursive script, reading 'Charlie Parker', written over a horizontal line.

Charlie Parker
Minister

No. Project 182

Community Feed-In Tariff Approval

This certifies that *Affinity Renewables* has received Community Feed-In Tariff Approval by the Nova Scotia Department of Energy for a 5.4 MW large wind project in Kempton, Nova Scotia. Approval may be revoked should a project not meet the requirements of the Community Feed-In Tariff program or deviate from details specified in its Community Feed-In Tariff application.



A handwritten signature in cursive script, reading 'Charlie Parker', written over a horizontal line.

Charlie Parker
Minister