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FINAL REPORT

Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities

UNION OF NOVA SCOTIA MUNICIPALITIES

PROJECT NO. 1031581

FINAL REPORT NO. 1031581

FINAL REPORT TO

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ON

Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities

January 28, 2008

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Table of Contents

List of Tables

List of Figures

List of Appendices

EXECUTIVE SUMMARY

Over the past decade, wind energy has emerged worldwide as one of the most promising sources of renewable energy, of particular interest in light of global and local concerns regarding climate change and the need to dramatically reduce greenhouse gas emissions. Despite this rapid growth, or perhaps because of it, wind energy has been greeted with mixed reactions from communities. There are various real and perceived impacts associated with wind energy generation, and governments worldwide have been attempting to regulate wind energy development to ensure community safety and acceptability while taking advantage of its' economic and environmental benefits. This report summarizes the current state of knowledge on the impacts of wind energy generation, common and unique approaches, and "best practices". It also presents a set of model policy approaches and by-laws to be considered by Nova Scotia municipalities wanting to include provisions for wind energy generation in their land-use planning strategies and by-laws.

This study was undertaken on behalf of the Union of Nova Scotia Municipalities acting in partnership with Nova Scotia Department of Energy, Service Nova Scotia and Municipal Relations, and Halifax Regional Municipality. The purpose of the study, as expressed in the Request for Proposals (RFP), was to "undertake research and create a written report targeting municipalities that provide them with science-based information on best practices guidelines and model wind turbine by-laws that will aid them in decision-making". Recognizing that each municipality has unique circumstances related to wind power generation, the model by-laws resulting from this study serve as starting points for municipalities in Nova Scotia interested in better policies and practices that will advance wind energy development in their jurisdictions while balancing and protecting a range of other community interests.

The following results are presented in this report:

1. A short review of the status/issues with respect to wind energy development and municipalities in Nova Scotia.
2. A review of wind turbine zoning by-laws, guidelines and best practices in Nova Scotia.
3. A review of wind turbine zoning by-laws, guidelines and best practices, primarily in Canada.
4. Specific discussion and recommendations for model wind turbine zoning by-laws and practices for Nova Scotia municipalities, designed to conform with the Municipal Government Act, and available in a format which can be easily adopted and adapted by municipalities.
5. A compendium of science-based literature that supports the recommended by-laws and best practices.

The review of literature includes information on the impacts of wind energy generation and approaches to its regulation at the local, regional, national and international levels from published or peer reviewed journal articles, unpublished documents and websites, and case studies of by-laws. Interviews with technical experts are also included. The report examines the impacts of wind turbines, both large and small, that relate to noise; property values; visual impact; birds and bats; vegetation and habitat; aviation safety; blade throw; ice throw; fire; shadow flicker; structural failure; telecommunications and electromagnetic interference; oil spills; erosion; and traffic and roads.

It is, however, important to point out that much of the research and many of the consequent viewpoints surrounding wind energy issues are not conclusive. There is as yet a shortage of substantive peer reviewed studies on some of the most controversial topics even though there is a steady release of new information and slower completion of significant studies. The report, therefore, notes that there is no scientific or societal consensus on some aspects of wind energy development, and that there is controversy related to some impacts of wind energy; for example, the question of a safe distance from receptors to avoid or mitigate significant adverse effects from noise. These uncertainties will likely continue into the future, at least until a more significant body of research and literature has been produced around the topic of wind energy and its impacts. Municipalities, however, cannot wait for scientific consensus on all issues before they move forward on by-laws.

Wind energy development has been generally accepted as an important social, environmental and economic opportunity, an important technology to deploy in the carbon constrained era associated with global climate change. There is currently a call for more clarity of legislation in this area both from communities and developers. Municipalities need to balance the need to protect citizens and communities, the desire for flexibility from the industry and the commitment to increased renewable energy alternatives. A review of municipal plans and by-laws provides context to how municipalities have approached these issues in the following categories: application process; decommissioning; health and safety; height; management plan; noise; electromagnetic, radio, telecommunications, radar and seismoacoustic systems; roads; setbacks; testing or meteorological towers; and visual. It is pointed out that by-law decisions will in many respects need to be contextual, in consideration of the unique characteristics of each municipality – its communities, land use patterns, geography and topography, wind potential, commitment to renewable energy alternatives, and resident's readiness or attitudes. There is also logic to consider intra-provincial, regionally consistent or integrated by-laws and policies in recognition of the trans-boundary nature of wind resources and economic potential.

The recommended approach in this report is to recognize that a balance of factors need to be considered in regulation of wind turbines, appreciating that over time adjustment may be required as knowledge, practice and experience grows. It is also recommended that community consultation among citizens, municipal staff and council be facilitated in order to establish effective and locally appropriate approaches to the regulation of wind turbines and that this consultative and participatory approach be extended to specific developments, sites and opportunities for community engagement. The impacts associated with wind development also need to be considered not in isolation, but in relationship to local and global impacts associated with conventional Nova Scotia energy sources. It is recognized that since wind development represents an important opportunity, some would say necessity, for both economic and environmental improvement, the implementation of regulations is needed as rapidly as feasible.

The report reviews four planning mechanisms that are available to Nova Scotian municipalities that range from fairly prescriptive to highly discretionary: Development Permits (As-of-Right Development); Land Use By-law Amendments; Site Plan Approval and Development Agreements. The strengths and challenges of each of these mechanisms are outlined. Possible policy options are then presented that take into account the strengths and challenges of the mechanisms.

The Model By-law presented in Appendix B is intended as a guideline for municipalities to draft a Land Use By-law (LUB) or amend an existing LUB to incorporate wind energy. Provisions are set out to illustrate the variety of options available within the framework of the Municipal Government Act of Nova Scotia. The Model By-law provides examples and options to assist municipal planners in developing provisions that suit the needs of the specific municipality.

1.0 INTRODUCTION

Over that past decade, wind energy has emerged worldwide as one of the most promising sources of renewable energy. Between 1997 and 2007, the wind energy industry has seen a ten-fold increase, and in 2006 alone, Canada added 768 megawatts (MW) of wind-generated energy capacity to its mix, representing a 112% growth. Despite this rapid growth, or perhaps because of it, wind energy has been greeted with mixed reactions from communities. There are various real and perceived impacts associated with wind energy generation, and governments worldwide have been attempting to regulate wind energy development to ensure community safety and acceptability. This report summarizes the current state of knowledge on the impacts of wind energy generation, common and unique approaches, and "best practices". It also presents a set of model policy approaches and by-laws to be considered by Nova Scotia municipalities wanting to include provisions for wind energy generation in their land-use planning strategies and by-laws.

1.1 Wind Energy in Canada and Nova Scotia

There are multiple overlapping regulatory jurisdictions in Canada, each with their own role and responsibility in enabling the development of wind energy generation while protecting the interests of the public they serve. A short summary of current state and type of involvement by various levels of government is presented below.

At the Federal Level

In response to an increasingly strong public interest in addressing environmental concerns (most significantly climate change) the Government of Canada has supported innovative technological solutions such as renewable energy generation technologies. This has included financial support for the research and development (R&D) phases of renewable energy technologies, as well as direct incentives (capital investments, tax rebates, etc) to put renewable energy technologies on an equal footing with conventional fossil fuels.

The government of Canada currently supports various stages of wind energy development through the following mechanisms:

- ecoENERGY for Renewable Power Program - Financial payment upon production (one cent per kilowatt-hour for up to 10 years to eligible low-impact, renewable electricity projects constructed between April 1, 2007 and March 31, 2011).
- Technology Early Action Measures (TEAM) - Supports projects that are designed to develop technologies that mitigate greenhouse gas (GHG) emissions.
- Atlantic Canada Opportunities Agency (ACOA) Business Development Program- offers access to capital in the form of interest-free, unsecured repayable contributions, focusing on small and medium sized enterprises.
- The Renewable Energy Technologies Program (RETP) - Funds R&D pre-commercialization, including testing and demonstration projects.

- Canadian Renewable and Conservation Expenses (CRCE) - fully deductible expenditures associated with the start-up of renewable energy and energy conservation projects for which at least 50 percent of the capital costs of the property would be described in Class 43.1
- Class 43.1 – (Canada Revenue Agency and Natural Resources Canada) - Capital cost allowance (CCA) rate of 30 per cent for certain types of renewable energy and energy efficiency equipment.

In addition, through new regulations such as those associated with the new national carbon cap and trade market, the Government of Canada is prompting industries and communities to move towards less carbon intensive modes of production, including increased reliance on clean and renewable energy sources such as wind. In due time, the carbon market might introduce further incentives for the wind energy industry in Canada by allowing industries to buy renewable energy credits towards meeting their required greenhouse gas emission reduction targets.

At the Provincial Level

Nova Scotia is at an interesting junction with respect to renewable energy and wind energy in particular. It faces a combination of challenges and opportunities in that it is one of the world's largest emitters of greenhouse gasses per capita due to the heavy reliance on fossil fuels for electricity generation, and yet it is also the beneficiary of a world class abundance of renewable energy resources. There is a unique opportunity for governments and communities to integrate the responsible use of Nova Scotia's natural energy resources into an overall energy plan in order to overcome the challenges.

Canada's *Constitution Act* provides provincial governments with the power to regulate the development, conservation and management of sites and facilities in the province for the generation and production of electrical energy. The *Environmental Goals and Sustainable Prosperity Act* (EG&SP Act) legally binds the provincial government to a number of emissions reduction targets including reducing green house gas emissions by at least ten percent below 1990 levels by the year 2020. The EG&SP Act also provides the provincial government with the authority to establish programs and measures to develop alternative energy and renewable energy sources.

The Nova Scotia government, in its *Opportunities for Sustainable Prosperity 2006*, highlights the concept of 'sustainable competitiveness' as a keystone of its approach to economic growth. This approach aims to "develop an economy that enhances the social and natural systems that support its growth through the adoption of new and emerging technologies, good stewardship and good design." This document recognizes that in order to remain competitive in the global market, there is need for investing in innovative businesses that enhance economic growth in the arena of sustainability. Renewable energy technologies are quoted as an example of such innovation.

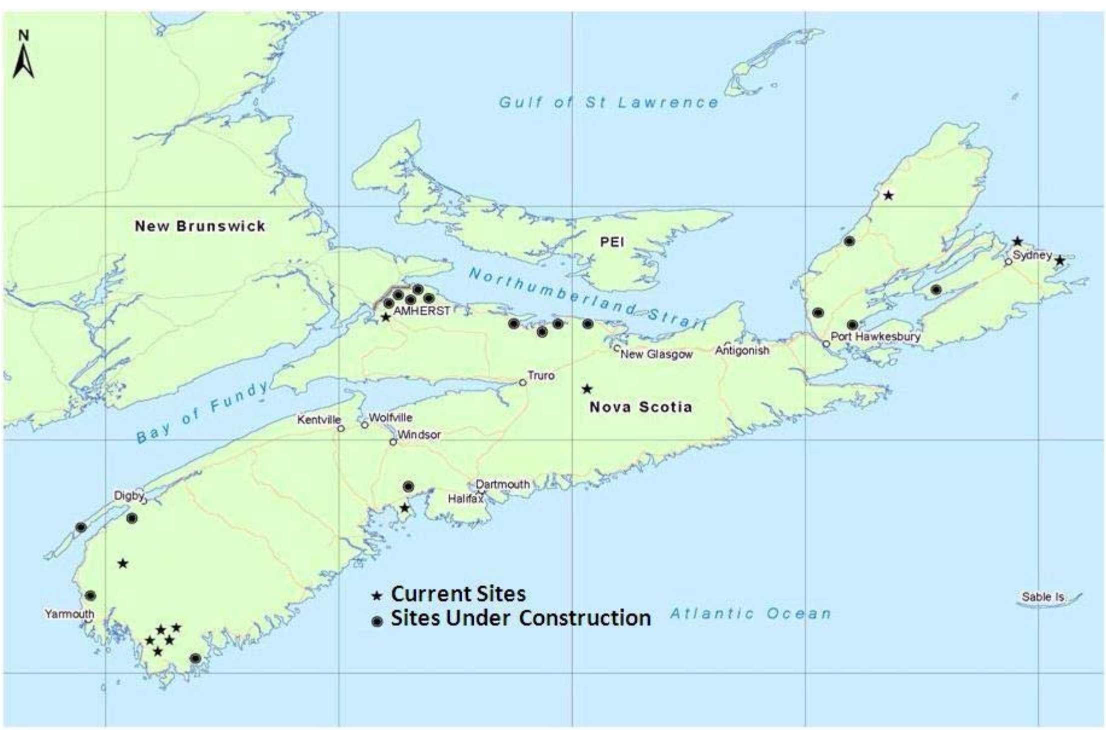
While the *Opportunities for Sustainable Prosperity* document commits the Government of Nova Scotia to supporting renewable energy in principle, the details of this commitment are articulated in the Province's new Consultation Paper on Energy Strategy. The EG&SP Act and the Renewable Energy Standard set out a goal of 20 percent renewable energy in the total electricity mix by 2013, which is equivalent to about 500MW of new renewable energy capacity. Wind energy is expected to fulfill the majority of the 2013 standard and the number of wind turbines in the province is estimated to grow from over 35 to around 250 within the next six years. Along with this goal, the Province has commissioned a study to examine ways to integrate wind into the energy system in Nova Scotia, including practical limits to this integration. As well, the former Minister of Energy committed to do more to support Nova Scotia's renewable energy industry and continue to look at electricity market reform, a commitment that has not been modified since.

Another recent development with regards to wind energy generation in Nova Scotia is the completion of a Nova Scotia Wind Atlas in 2007 (www.nswindatlas.ca). The Wind Atlas is a project of the Nova Scotia Department of Energy in partnership with the K.C. Irving Chair in Sustainable Development at the Université de Moncton and the Applied Geomatics Research Group at the Nova Scotia Community College. The new Wind Atlas provides the most accurate map of wind resources in the province to date at a resolution of 200m and at various heights above ground (30m, 50m and 80m). It confirms the suggestion that the province is endowed with ample wind energy resources, especially along the coast and offshore, and throughout most of Cape Breton Island.

While the Province has an important leadership role to play in setting targets and providing information to enable the wind energy industry, the speed at which wind energy generation can grow in Nova Scotia is ultimately dependent on the province's largest power provider and distributor, Nova Scotia Power Inc. (NSPI). Currently, large-scale electricity generators (including commercial wind farms) must feed their electricity into the NSPI grid in most parts of the province. Due to technological and transmission limitation, NSPI is able to accept a finite amount of wind power on the grid and interested power producers must put forward a proposal in response to a Request for Proposals (RFP), which, would then put them in NSPI's Interconnection Request Queue. Currently, being listed in this queue is the only way a commercial-scale wind energy development can provide electricity to the NSPI grid. It is possible for proponents to build projects and feed power to customers in other provinces. In this process, projects do not have to go through an RFP and can apply directly to NSPI, paying a transmission charge to the utility.

In November 2007, NSPI announced that it is signing power purchase agreements to move forward on eight wind energy projects corresponding to about 240MW of wind-generated energy. Figure 1 below illustrates the general location of current and under-development wind turbines throughout the province.

FIGURE 1 Current and Under Construction Wind Turbines (Adapted from NSPI)



At the Municipal Level

In Nova Scotia, all wind energy generation facilities are located within a municipal jurisdiction. As such, local governments or municipalities are another set of important stakeholders making decisions concerning wind energy development. Municipal governments play the role of balancing the public interest with protecting the interests of local communities. The latter half of the scale is particularly important in connection with wind power development when the extent of public concern around wind generation in Nova Scotia is taken into account.

Various levels of government, including municipalities are also being pressured to respond to environmental and climate change concerns by the public: there is growing interest in renewable energy initiatives that are not solely driven by economics but by community concern for local and global sustainability.

There has been no shortage of media stories in the past couple of years documenting community resistance to wind power projects throughout Nova Scotia. This resistance, involving many stakeholders, has taken many forms including the collection of petitions against a development in the cottage-country of Pugwash and a family abandoning their home in Pubnico, claiming health impacts from a nearby wind farm. These stories, as well as records from recent public consultations on wind power in Nova Scotia suggest the following: while citizens generally support the idea of renewable energy, they have many concerns about the implementation of these projects in their communities specifically. Citizens are concerned about the effects these projects may have on the community and its residents; specifically, noise, shadow flicker, 'viewscape' alterations, as well as concern for community identity and resulting property values. Concern has also been expressed that communities are expected to accept all of the potential downsides while the profits often flow out of the community to developers.

Given the local controversies over wind energy generation, municipalities clearly have an important role in enabling this type of development with minimal risk to the social and natural environment while creating a forum for citizens' concerns to be heard and addressed. In addition, municipalities have much to gain from development of wind energy. According to the Nova Scotia Department of Energy (2007) these benefits include:

- Every MW of wind power generation requires an investment in the order of $1.5 to $2 million (local components of this include land, buildings, interconnections, tower footings, cranes, etc.);
- Municipal tax benefits - approx. $5,500 per MW installed (land and buildings taxed at regular rate);
- GHG reduction benefits;
- Enhanced energy infrastructure;
- Potential benefits of added revenue source for property owners, farmers, etc;
- Local content (manufacturing, site prep, materials, etc.); and
- Every MW of installed wind power generation provides enough clean energy for approximately 350-400 homes.

Currently, municipalities in Nova Scotia are addressing wind development through a number of different mechanisms, and using different standards in their by-laws as further described in Section 3.2 and 3.3 of this report. There is an interest in learning from the experience of municipalities in Nova Scotia and other jurisdictions to provide guidance for those Nova Scotia municipalities that do not currently have any provisions on wind turbine development, or those that may be interested in validating or refining their existing provisions. This gives rise to the current study, as described in Section 1.2.

1.2 Study Context and Methodology

This study was been conducted in response to a Request for Proposals from the Union of Nova Scotia Municipalities in partnership with Nova Scotia Department of Energy, Service Nova Scotia and Municipal Relations, and Halifax Regional Municipality (HRM). The purpose of the study, as expressed in the RFP was to "undertake research and create a written report targeting municipalities that provides them with science-based information on best practices guidelines and model wind turbine by-laws that will aid them in decision-making". Recognizing that each municipality has unique circumstances related to wind power generation, the model by-laws resulting from this study simply aim to serve as starting points for municipalities interested in better policies and practices that will advance wind energy development in their jurisdictions.

The study consisted of three distinct and, at times overlapping tasks described below:

Task 1 - Review of Literature

A thorough review of literature pertinent to the impacts of wind energy generation and approaches to its regulation at the local, regional, national and international level formed the basis of this project. The study built on a similar project conducted for HRM in 2005/06 (leading to the creation of HRM's Draft Wind Energy Master Plan) and focused more specifically, but not exclusively, on studies that have been conducted or published over the last 2 years in the area of wind power generation. The literature examined consisted of:

- Published and/or peer reviewed journal articles – A total of 33 were identified and the most relevant documents reviewed in detail.
- Unpublished documents and websites – This included information from the organizations such as Canadian Wind Energy Association (CanWEA), wind energy developers, community groups, and academics. Research also included interviews with technical experts to complement information available online.
- By-law examples, completed or under development in Nova Scotia – planning departments in about a dozen municipalities that have had experience with wind developments, were contacted and interviewed on the "lay of the land" and lessons learned on this topic in their municipality.
- By-laws examples from other jurisdictions – Several sets of municipal and provincial/state regulations from across Canada (e.g. PEI, Ontario, Alberta and BC) and internationally (e.g. California, Australia, UK, Denmark, Germany, New Zealand, Britain) were examined. Phone interviews were conducted with Canadian planners in municipalities (Ontario and Alberta primarily) that have experience with relevant by-laws.

To keep track of all this information, a standard research and reporting template was used. This template contains key information on each document reviewed or each interview conducted, and includes the title of the source, the date, the author/organization and bibliographic reference, main findings or initiatives (categorized by areas of interest such as noise, set back, visual impact, bird and bats etc.) and other comments such as the researchers' sense of whether the information may be biased (and if so, how it is biased) or what the un-written/un-published implications or results of a finding or initiative might be.

The Annotated Bibliography (Appendix A), presents the relevant sections of this research template, providing detailed information on scientific and technical documents reviewed, online material consulted, and technical interviews conducted. Appendix A also includes a list of provincial and municipal governmental bodies that were consulted as part of this task, either through interviews, email correspondence, or web searches.

Task 2 - Information Synthesis

The information gathered during the research phase of this project was synthesized by the project team. This analysis considered the information in 2 different ways:

- Examination of the potential impacts of wind energy generation – The project team produced a series of short briefs on each of the commonly cited, real or perceived impacts of wind energy generation. The categories of impact in this substantive analysis include: aviation safety, birds and bats, blade throw, erosion, fire, ice throw, noise and infrasound, oil spills, property values, shadow flicker, structural failure, telecommunications and electromagnetic interference, traffic and roads, vegetation and habitat, and visual impact. Each brief clearly lays out the current state of knowledge on the topic. It summarizes the findings from published peer reviewed and academic sources, as well as studies commissioned by government, industry, environmental groups, and community groups. The briefs identify areas of controversy or uncertainty where different sources disagree on the types and severity of impacts. They also point out areas of consensus among various stakeholders.
- Understanding of regulatory approaches used by various municipalities – The project team produced a series of "case studies", summarizing both the direction and the specific decisions around municipal regulations governing wind energy generation. This level of analysis integrates the experience of Nova Scotia municipalities (12), Ontario municipalities (6), Alberta municipalities (2), one PEI municipality and provincial bodies (Nova Scotia, PEI, Ontario, Alberta and BC). The analysis is organized around the following themes: application process, decommissioning, electromagnetic, radio, telecommunications, radar and seismoacoustic systems, health and safety, height, management plan, noise, setbacks, roads, testing or meteorological towers, and visual. Under each theme the specific by-laws used by different municipalities are described and compared. Once again, this analysis aims to show similarities and differences among municipalities approaching the subject of wind energy generation regulation.

Task 3 - Creation of Model Policy, By-laws and Guidelines

Based on the analysis described above, the project team formed a consolidated view of the patterns and range of opinions and approaches on both impacts and regulations around wind energy. Through a series of meetings, the project team discussed the information and drafted a set of options for model municipal policy and by-laws based on the best available information. Along with each option, the project team put forward a short explanation of the logic for putting forward a specific approach or by-law, its potential strengths and weaknesses, and its relative degree of prescription or rigor compared to what is currently in place locally and nationally. The explanation aims to equip individual municipalities with information to help them decide among a number of options or to modify the model policy or by-laws for their own use based on local concerns, agendas and intents.

The methodology described above led to the creation of the five deliverables specified in the RFP, which are presented in this report. Table 1 presents a cross reference between the project deliverables and sections of this report.

TABLE 1 Presentation of Study Deliverables in this Report

Deliverable	Corresponding Report Sections
1. A short review of the status/issues with respect to wind energy development and municipalities in Nova Scotia.	Section 1 and 2
2. A review of wind turbine zoning by-laws, guidelines and best practices in Nova Scotia.	Section 1.1 and 3.2 and 3.3
3. A review of wind turbine zoning by-laws, guidelines and best practices, primarily in Canada.	Section 3
4. Specific discussion and recommendations for model wind turbine zoning by-laws and practices for Nova Scotia municipalities, designed to conform with the MGA, and available in a format which can be easily adopted and adapted by municipalities.	Section 4 and Appendix B
5. A compendium of science-based literature that supports the recommended by-laws and best practices.	Appendix A

1.3 Definitions and Acronyms

The language of the wind energy generation industry and its regulation can be fairly technical and unfamiliar to a municipal audience. This section defines some commonly used terms and acronyms in the field and also in this report. A version of these definitions can be used by municipalities in their LUBs.

Wind Turbines - Wind turbines are structures that produce power by capturing the kinetic energy in surface winds created by the sun and converting it into energy in the form of electricity. Wind turbines use the mechanical power generated by the turning of the blades to turn a generator located in the nacelle unit of the turbine. The generator produces electricity that is carried by cables to transmission lines that connect to the larger electrical grid, in the case of large turbines, or to homes and site-based business operations, in the case of small turbines.

Key factors that affect the power produced by wind turbines are the strength of the wind, the area swept by the rotor and the height of the turbine. Generally, the stronger the wind resource, the larger radius of the area swept, and the greater the height of the tower, result in increasing the wind turbine's capacity to produce power. It is important to note that even small increases in wind velocity will significantly affect the turbine's generating power so siting and design decisions that are conducive to increasing the capture of greater wind velocity have an important effect on the amount of energy produced and the economic viability of the development. Advances in technology continue to result in more efficient turbines that can adapt to a broader range of siting environments.

Large vs. Small Turbines - Turbines are often described in two broad categories – small and large. There is a vast difference between large scale turbines that can be grouped into wind farms and operated as an energy generation enterprise, and small scale wind turbines that might sit on a farm or residential property and cover the electricity needs of the owner.

Generally, municipalities have more experience with regulating large scale wind turbines. Policies and by-laws relating to small wind turbines are in more of a developmental stage since the technology is not widespread in Canada; therefore practical experience with impacts and mitigation strategies is developing as well.

There are a variety of approaches to regulating wind turbines according to scale in Nova Scotia: some municipalities have one set of by-laws that are applicable to both large and small turbines, others have different sets of by-laws for large and small, and others still have by-laws for only large or only small. Ideally, by-laws for both sets of scales are best in order to adequately address safety and siting issues, and to encourage the development of wind energy in different contexts.

There are also vast differences in how municipalities (and the wind energy industry itself) define small and large scale wind turbines. Examples of these differing definitions are:

- Based on nameplate rated capacity (small scale is described as below either 100kW, 200kW or 300kw);
- Base on the total turbine tower height (for example, below 60m is small scale);
- Based on the rotor diameter and total swept area (rotor diameter of no more than 15.0m and a total swept area of no more than 180m^2 for small turbines);
- Based on the intended end use of the power produced (small scale is primarily for on-site consumption and large scale is generally intended to feed electricity into the provincial grid); and
- A combination of the above.

CanWEA describes large scale wind turbines as having a rated capacity of greater than 300kW and connecting and providing power to the local utility grid. Small scale wind turbines are described as having a rated capacity of not greater than 300kW and being use primarily for power generation for on-site use (either behind the meter or off-grid).

NSPI describes small scale wind turbines in the province as being typically owner-operated units that connect directly to the consumer's service and are in the range of 1kW to 50kW, with the vast majority being in the 1kW and 10kW range. NSPI's net metering program aligns with the small scale category and is applicable to power generators rated less than 100kW. Large scale wind turbines connect with NSPI's distribution and transmission systems and typically are designed with capacities in the range of 0.6MW to 2.0MW. These installations would have a formal Interconnection Agreement with the host utility and would have a Power Purchase Agreement with the end user/purchaser of the energy generated (Ellis, NSPI, 2007).

Many other sources also differentiate between different sizes of small scale turbines, referring for example, to mini, micro, small and medium as various categories. There is no consensus on the thresholds for defining these various categories. The literature cited throughout this report on small scale turbines covers the entire range of turbines under 300kW.

For the purposes of this report, the definitions of large and small wind turbines are based on the intended use of the power produced, following roughly the size guidelines suggested by NSPI. Large scale turbines will be considered those that are commercially operated and at least 100kW (usually closer to 300kW) capacity or higher. Small scale turbines will be considered those owned and operated for the owner's use and typically having a capacity of less than 100kW and a total height of less than 60m. A third term, mini turbines, will be used in the model by-laws to refer to turbines under 10kW in capacity and less than 20m in total height to reflect the smaller size of these small scale turbines

Other Related Definitions:

Blade - Part of the wind turbine that rotates in the wind and extracts kinetic energy from the wind.

dB(A) - 'dB' stands for decibel and is a measurement for the sound pressure. 'A' refers to a weighting that is the adjustment of measured sound so that it matches perception by the human ear.

Decommissioning - The final closing down of a development or project or the point at which it has reached the end of its operational life and the process by which the site is restored to an agreed use or condition.

Electromagnetic Interference - Interference with telecommunications and radar systems.

Habitable Structures - All structures designed to accommodate people including residential, commercial, institutional, industrial and recreational buildings, but not including accessory structures such as sheds and storage areas.

Hectare – 10,000 sq metres, 2.47 acres.

Ice Throw - Ice fragments that are thrown from the blade of an operational turbine.

Nacelle - The frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather.

Nameplate Capacity- Manufacturer's maximum rated output of the electrical generator found in the nacelle of each turbine.

Net Metering - An agreement with local utility that allows wind turbine owner to send excess electricity to the utility and then withdraw electricity when wind system does not produce power, essentially a way of 'banking' energy for the wind turbine owner.

Off Grid - A stand alone generating system that is not connected to the utility grid.

Proponent - Developers, operators and owners or investors of wind turbine development.

Remediation - Planned process to return site as close to its original natural state as possible.

Separation Distance - The distance between the wind turbine and any specified building, structure, road, or natural feature.

Setback - Distance between a property line and a wind turbine tower.

Wind Turbine Facility (Wind Farm) - Generally, two or more large scale wind turbine generators which are connected to the transmission or a local distribution grid. Wind turbine facilities require a central computerized monitoring system that monitors the operation of the turbines. Usually a small building on site houses this system and there is a link to a headquarters off site. Regulators may define a minimum number of wind turbines as constituting a farm (for example, collections of more than five turbines) but there is no consistency in the literature as to what the threshold should be.

The following is a list of commonly used acronyms in the wind energy industry in Canada and throughout this report.

ACOA	Atlantic Canada Opportunities Agency
AD	Air Defense
AusWEA	Australian Wind Energy Association (former acronym)
Auswind	Australian Wind Energy Association (current acronym)
CADS	Canadian Air Defense System
BC	British Columbia
BOREAS	Boreal Ecosystem-Atmosphere Study
BWEA	British Wind Energy Association
CanWEA	Canadian Wind Energy Association
CBRM	Cape Breton Regional Municipality
CCA	Capital Cost Allowance
CRA	Canadian Revenue Agency
CRCE	Canadian Renewable and Conservation Expenses
CWIF	Caithness Wind Farms Information Forum
DND	Department of National Defense (Canada)
EG&SP Act	Environmental Goals and Sustainable Prosperity Act
EUB	Energy and Utilities Board (Alberta)
GHG	Greenhouse Gas
HRM	Halifax Regional Municipality
ISO	Not an acronym, but represents the International Organization for Standardization
Km	Kilometers
Leq	Equivalent continuous noise level
LPA	Local Planning Authority
LUB	Land Use By-laws
M	Meters
MOE	Ontario Ministry of the Environment
MGA	Municipal Government Act (Nova Scotia)
MPS	Municipal Planning Strategy
MW	Megawatts
NREL	National Renewable Energy Laboratory
NRCan	Natural Resources Canada
NS	Nova Scotia
NSPI	Nova Scotia Power Incorporated
NSURB	Nova Scotia Utility and Review Board
NWCC	National Wind Coordinating Committee (USA)
PEI	Prince Edward Island
R&D	Research & Development
RABC	Radio Advisory Board of Canada
RCMP	Royal Canadian Mounted Police
RCS	Radar Cross Section
REPP	Renewable Energy Policy Project (USA)
RETP	Renewable Energy Technologies Program
RFP	Request for Proposal
RICS	Royal Institute of Chartered Surveyors
TEAM	Technology Early Action Measures
WECO	Wind Energy in Cold Climates
WTGs	Wind Turbine Generators

2.0 WIND TURBINE IMPACTS

Generally speaking, the lack of accurate information on the impacts of wind energy developments has been the most significant barrier to wind energy development. In the absence of empirical knowledge on the negative and positive effects of such developments, communities are often swayed by anecdotal information which may or may not be biased. There is also significant fear about the types or severity of impacts which has, in some instances, led to a back-lash against wind energy. It is difficult for municipalities to rule for or against a given wind energy development, or even engage in a productive conversation and information sharing exercise with citizens in absence of scientific information on the impacts. Fortunately, as the number of wind energy developments increases around the world, so do the studies and information available about this renewable energy source. Although the availability of peer-reviewed articles is still limited, there is more available on the topic now than there was even a year ago. Similarly, there will be more available a year from now as the industry continues to grow at a tremendous rate. This summary of the primary potential impacts was developed through a substantive literature review, drawing as much as possible on peer-reviewed technical reports on the subject.

Noise/infrasound and visual impact are more heavily debated than other discussed impacts within the literature on wind energy's particular impacts. Without the presence of standard guidelines, the industry has been left to develop relatively freely. In some cases, negative impacts have only been recognized in light of operational experience. These collective lessons are contributing to the progressive development of future guidelines, regulations, and legislation pertaining to wind power. These impacts are also considered in determining the valued environmental components within the effects assessment methodology underlying the environmental and socio-economic impact assessment.

It was noted throughout the literature review that the views expressed with regard to wind power impacts were also often related to the process and mechanisms employed in the development, assessment and approval of projects. In some cases it was seen that earlier, broader and deeper stakeholder education and consultation resulted in reduced degrees of concern regarding impacts. Further, particularly when neighbouring communities and landowners were engaged in processes leading to compensation for potential effects, direct local or landowner benefits related to the development or in some cases innovative community participation models (including revenue, tax or other financial incentives, and participatory planning), the degree of opposition or concerns were reduced.

The short briefs that follow describe the current state of knowledge on each of the commonly sited real or perceived impacts of wind energy development. Unless otherwise stated, there was no indication in the literature that the impacts would be different for small and large turbines.

2.1 Aviation safety

Generally speaking, there should be very little opportunity for physical interaction between aircraft and wind power installations, assuming that standard setbacks surrounding airport facilities are in place. The deployment of such setbacks is already a well established practice, particularly regarding any structures with specific height characteristics (see Transport Canada and Nav Canada requirements). To date there has been one reported accident, which related to aviation safety and wind turbines. In

2005, a crop dusting pilot died after hitting a guy wire caused a wing to be sheared off and the plane to crash into an anemometer at a recently installed wind farm in the United States (Craig, 2006).

Aviation safety is directly related to two of the other impact topics, and thus relevant information can be found in the subsections Visual Impact and Telecommunications/Electromagnetic Interference.

2.2 Birds and bats

There is a common public perception that bird and bat populations will be negatively impacted as a result of wind energy developments. Some researchers believe bird populations are being decreased significantly as a result of wind development, while others believe wind development has no significant impact on bird and bat species.

The US National Wind Coordinating Committee (NWCC) issued a second edition fact sheet in 2004 titled "Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions". This summary indicated that impacts on birds and bats vary depending on location, and that generally two types of impacts have been observed: 1) direct mortality from collision, and 2) indirect impacts due to avoidance, habitat disruption, and displacement. Although both migrating and resident birds can collide with wind turbines, raptors are at a higher risk and have a higher frequency of collisions (some researchers suggest raptor carcasses are more recoverable as they are not as readily movable by scavengers in comparison to smaller birds whose carcasses may disintegrate into smaller pieces when they strike a turbine blade, making them more difficult to find on the ground). They also conclude that most nocturnal migrating birds migrate at elevations above today's typical turbine heights and that most topographical relief has little influence on migratory behaviour. Collisions appear more likely during inclement weather.

During a six month study at the Maple Ridge Wind Farm located in New York State, the remains of 326 bats were found and 125 bird incidents were recorded (Curry & Kerlinger, LLC).

A study undertaken in Southern Spain entitled "The effects of a wind farm on birds in a migration point: the Strait of Gibraltar" observed wind turbine effects on bird populations (Lucas, et al. 2004). The authors concluded that, although bird impact is an important factor to consider when developing wind farms, they are no more detrimental to birds than other man-made structures. Flight behavioral patterns were studied, and associated observation of soaring birds changing their flight direction when they fly near turbines led to the conclusion that soaring birds can detect the presence of wind turbines and alter their paths.

The US National Academy of Sciences suggests it takes at least 30 wind turbines to reach a kill rate of one bird per year (Committee on Environmental Impacts of Wind Energy Projects, National Research Council, 2007). It was also noted that site selection and weather patterns have a substantial effect on this number. No more than 40,000 birds have died a year in the U.S. as a result of wind turbines.

Researchers stress the importance of comparison data, acknowledging that while in absolute numbers, wind turbines kill a seemingly large number of birds and bats, in comparison to other factors, the number dying from wind energy development are relatively insignificant. For example, it is estimated in Toronto alone 10,000 birds collide with the city's tallest buildings every year. Information in Table 2 below (Curry & Kerlinger, LLC) provides further comparison:

TABLE 2 Summary of Bird Death Statistics According to Various Studies

Cause	Bird Deaths/Year in the U.S.	Source
Glass Windows	100 to 900+ million	Dr. Daniel Klem of Muhlenberg College
House Cats	100 million	The National Audubuon Society
Automobiles/Trucks	50 to 100 million	National Institute for Ubran Wildlife and U.S. Fish and Wildlife Service
Electric Transmission Line Collisions	Up to 174 million	U.S. Fish and Wildlife Service
Agriculture	67 million	Smithsonian Institution
Communication Towers	4 to 10 million	U.S. Fish and Wildlife Service
Oil and Gas Extraction	1 to 2 million	U.S. Fish and Wildlife Service
Hunting	More than 100 million	U.S. Fish and Wildlife Service
Wind Turbines	<40,000	National Research Council

A discussion with a local scientist at the Nova Scotia Department of Natural Resources suggests that location choice is the driving factor in determining level of impact on birds and bats. Avoiding staging areas for migratory song birds, extreme fog areas, and specifically the lower Digby Neck (Brier Island) and Cape Sable Island could result in significantly less net impact on birds. Locating wind turbines on coastal areas is less of a concern for bats as most bat species tend to be found in centrally located areas in Nova Scotia (Elderkin, personal communication, 2007).

The literature around impacts on bats is relatively thin; however, a few studies have focused specifically on bats. The number of bat deaths recorded yearly at the Summerview Wind Farm in Pincher Creek, Alberta has resulted in a monitoring study being conducted by the University of Calgary, headed by Professor Robert Barclay (CBC News, 2006). More than 500 dead bats were found in 2005 at this wind farm. Dr. Barclay has offered the hypotheses that bats may be attracted by the sound of the turbines, or they may not use their sonar while migrating, making it difficult for them to avoid structures in their path. Dougan & Associates reported Dr. Barclay's study of the 38 1.8 MW turbines as having found 620 bats and only 30 birds killed in one season (Dougan & Associates, 2007). This is an example of a location which seems to be extremely sensitive to bats, and not for birds. This demonstrates again that proper siting and environmental assessments are essential in the planning of a wind farm.

One of the few post-construction surveys done on a Canadian wind farm was conducted by Ross James (former curator of the Royal Ontario Museum) for AIM PowerGen Corporation on the Erie Shores Wind Farm in Ontario. This wind farm has 66 turbines and stretches 24km. The following are the findings of that study (Dougan & Associates, 2007):

- Tundra Swans were seen to fly through the wind farm daily (when present) and foraged in fields with no fatalities documented.
- Geese flew through the wind farm to forage in surrounding fields and often the same fields as the turbines; no waterfowl collisions were recorded or carcasses found, despite the fact that many geese were seen flying past operating turbines within 100m.
- Bald Eagles nested just north of the wind farm in 2006 and 2007; immature and adult eagles would fly within 200m of the turbines with no collisions observed. However, the nest was abandoned in 2007, likely due to heavy equipment being used to dismantle a crane at night. It was recommended that no wind turbines be placed between a nest and the lakeshore, or within 1km of either side of the nest.
- Breeding bird surveys revealed no decrease in numbers adjacent to the turbines, and smaller birds often nested quite close to the turbines.
- Diurnal (active daily) raptors were not hindered by the turbines; three dead birds were found in two years, as compared to thousands that were observed flying past or over active turbines.

- The number of diurnal raptors observed at Hawk Cliff (approximately 32 kilometers west) was higher in 2006 than in previous years, suggesting no change in migration numbers along the Lake Erie shoreline.
- Hundreds of gulls fly daily along the lakeshore bluffs past the nearest wind turbines, plus hundred were seen daily in the same fields as the turbines; in two years of searching there has been one recorded death.
- Smaller diurnal migrants flew through the wind farm in thousands each fall and were undeterred by the presences of the turbines; despite the thousands seen on migration, no dead diurnal migrants were found.
- Nocturnal migrants represent the majority of fatalities at the wind farm; mortality has not been unusual and is estimated to be near the levels that have been found at other carefully studied North American installations.
- The author estimates that a 500 metre setback from the Lake Erie shoreline is sufficient.

This farm is an example of a well-sited wind development from the perspective of a lack of negative impacts on bats and birds. The following is an example of two proposed developments which are not likely to have such favourable results, as reported by the Coastal Habitat Alliance (CHA, 2007).

Over 60,000 acres of land in the Laguna Madre region of the South Texas Coast in Kenedy County, more than 500 wind turbines are being proposed by two separate developers. Construction has already started, but there is significant opposition from many parties, notably led by the CHA. The CHA claims there has been no regulatory oversight and the only studies done have been done internally by the developers; one being fatally flawed and the other not being released. The proposed area is one of the most significant migratory bird corridors which connects Canada and the United States to Mexico and South America; therefore, it is one of the most utilized and highly populated throughout the year. EDM International Inc., commissioned by CHA, concluded that, “the operation of these proposed projects could result in the largest and most significant avian mortality event in the history of wind energy.” The CHA claims that both proposed projects violate the U.S. Fish and Wildlife Service’s Interim Guidance for siting wind energy facilities by siting these turbines in an area that is clearly stated to be avoided.

Developments such as these may not only result in more significant avian impacts but may also contribute to an increase in opposition to wind development in other locations, and ultimately even more restrictive regulation. As CHA states, “A failed or flawed project of this scope will spur additional legal opposition and new state regulations could have a chilling effect on other important wind development projects in more responsible locations across Texas.” It is therefore important to take a proactive approach to the development of siting guidance and regulation.

Research into the interactions of birds and bats with wind turbines continues to add to the body of knowledge of these impacts and our ability to draw conclusions on the significance of these impacts; however, thus far there is no reason to believe that wind turbines are a particularly significant concern to birds and bats mortality if projects are planned carefully and mitigation strategies are implemented as directed by the Environmental Assessment process. It is important to understand that specific local studies in the context of prospective development can avoid or mitigate adverse effects on bird and bat populations. An initial site evaluation, when combined with an assessment of local knowledge, can provide the basis to predict, with reasonable certainty, the effects a wind energy development might have on the resident and migratory bird and bat species in the area. The intent is to document prevalent species, levels of bird and bat use, as well as behaviour. Noting the presence of endangered species in the area is also important, as sites within their habitat and local range are particularly important to avoid. As results are typically very site-specific, this is the recommended general procedure to follow regardless of location.

2.3 Blade throw

Blade throw describes the situation when the full blade or part of the blade becomes detached from the wind turbine system and falls or is thrown through the air. There are a number of factors that can contribute to such an occurrence: unforeseen environmental events outside the design envelope; failure of turbine control/safety system; human error; incorrect design for ultimate and/or fatigue loads; and poor manufacturing quality (Larwood 2006).

CanWEA commissioned the report "Recommendations for Risk Assessments of Ice Throw and Blade Failure in Ontario" (Garrad and Hassan 2007) which provides a literature review of wind turbine rotor blade failures. The report states that the reduction of blade failures coincides with the widespread introduction of turbine design certification and type approval. They note that the main causes of failure are currently from human interference with control systems leading to over-speeding of the rotors, lightning strikes or manufacturing defects in the blade and assembly. Mitigation mechanisms and improved design and quality control are addressing these issues.

Research undertaken for the California Wind Energy Collaborative (Larwood 2006), indicated that municipalities were using setbacks based on the height distance to provide protection against blade throw; these setbacks varied between 1.25 and 3 times the height of the total turbine (base to tip of rotor blade). The study did not reach a conclusion on what could be considered an appropriate setback and recommended that further study be undertaken. A professor at Rutgers University in New Jersey recommends a minimum separation distance 518m to adequately mitigate against blade throw from a wind turbine based on calculations for a radius of blade over 30.5m (Matilsky).

Caithness Windfarm Information Forum (CWIF), a British voluntary group concerned about industrial wind farm development, states that blade throws account for the largest number of accidents associated with wind turbines with 114 recorded incidents since the 1990s. CWIF notes that in northern France, following four instances of blade parts being lost from turbines over a period of several months, a 500m exclusion zone was proposed around all operational wind turbines (zone excludes all members of the public, including car parking, offices, use of walkways, etc.). CWIF believes that there should be a minimum distance of at least 1km between turbines and occupied housing to effectively mitigate against risks associated with blade failure.

Despite an extensive search, no studies were found that speak specifically to cases of blade throw associated with small turbines, or ways to mitigate such impacts. The suggestion for setbacks as cited in Larwood, 2006) in the order of 1.25 to 3 times the total height of turbine is the best guidance that can be found currently as applied to small scale turbines.

2.4 Erosion

Large scale wind turbines are occasionally sited on slopes of hills to maximize the local potential of harnessing wind power. Since on many sites the actual area available for construction of wind turbines is limited, facilities are often sited on slopes where there is the potential of erosion. Construction can also result in increased exposure of the land area to the weather. Erosion can also occur on access roads if they are not properly maintained. These impacts can be adequately managed through controls identified in the environmental assessment or planning stages, and should be part of an overall environmental management plan.

2.5 Fire

It is not common for fires to start at a wind turbine without a catalyst action, typically triggered by another impact. For example, fires are generally started by structural failure, lightning or other storm action.

A few incidents of wind turbines catching on fire have been reported (Craig, 2006). A turbine located in Wales in 1997 caught fire as a result of overheating. In Denmark in 1999, the brakes on a turbine failed as a result of a storm, causing over-rotation and subsequently a fire. In 2000, a turbine was struck by lightning in Germany, burst into flames, and then the tower split 10m above the base. In 2004, a fire started following a refit of turbines in the United States.

Due to the height of turbines, there is little action fire crews can take to reduce the damage once a turbine has caught fire. Typically the turbine will be completely destroyed. The major concern is to protect the surrounding area and public from the debris that may fall within a several hundred meter range as the turbine burns.

2.6 Ice throw

Ice fragments can either fall from a stationary wind turbine or can be thrown from the blades of an operational turbine. Icing occurs due to a confluence of conditions of temperature and humidity. There is little risk of injury to the public from ice falling from a stationary wind turbine since the ice will fall within an area close to the base of the tower. The primary concern for ice fall is for operational staff working on site during icing conditions. The potential risk of injury to the public is from ice thrown from an operating turbine. The build up of ice can be greater on an operational blade and the flexing of the blade and forces of motion can result in ice throw.

Risks from ice throw are minimized through a series of actions including setbacks; monitoring of weather conditions that are conducive to icing so that operational time is curtailed or reduced during these time periods; design features to reduce the build up of ice on blades and to ensure that the operating parts of a structure can withstand increases in load; use of warning signs to alert public to risk; and automatic shut down systems in the wind turbine system that respond to changes in weather, changes in vibration that may result from icing and other sensory mechanisms (Morgan, 1998; Garrad Hassan, 2007). Specific design features that minimize risks include the use of ice sensors to detect when ice is building up to trigger a shut down of the operation, blade heating systems and, in areas where icing is slight, painting blades black to maximize solar radiation (Baring-Gould, 2005). Some European countries require that there be manual start-up following an icing shutdown to reduce ice throw.

Currently, there is a great deal of research underway to improve design and safety measures for wind turbines that operate in cold climates as a result of the increasing number of wind turbines being installed in northern climates. In Europe, several governmental agencies are supporting a project entitled Wind Energy in Cold Climates (WECO) (Morgan, 1998). CanWEA is also involved in research in this area.

Considerations for planning to minimize these risks include an assessment of the probability of icing. The climatic conditions in Nova Scotia are conducive to heavier icing conditions, and require meeting Class III and IV of the Canadian Standards Association Communications Structures Climatological Design Criteria (CanWEA, Position on Setbacks, 2007). Therefore wind energy developers need to consider these conditions in their analysis of risk and system design for ice throw. Height of tower, micro-climate (especially in various coastal settings) and the altitude of the potential site are also factors to consider in determining potential icing issues (Baring-Gould, 2005).

A Public Health and Safety Guide (Global Energy Concepts 2005) prepared in the United States outlined a best practice approach to minimizing the risks of ice throw:

- Turbine controls that automatically stop turbine operation when the sensors become iced up;
- Operator intervention to prevent ice throws and equipment damage; and
- Safety zones that create setback distances - for moderate icing conditions (5 icing days per year) setback distances of approximately 230m to 350m were suggested for turbines with a 50m rotor. This corresponds to a potential strike risk of 1-in-10,000 to 1-in-1,000,000 per year.

The Garrad Hassan study (Garrad Hassan, 2007) states that beyond 220m from a turbine the risk of injury from ice throw is negligible. Another researcher recommends a minimum separation distance 518m to adequately mitigate against ice throw from a wind turbine based on calculations for a radius of blade over 30.5m (Matilsky, date unknown). CanWEA suggests a recommended distance of blade length plus 10m from public roads, non-participatory property lines and other developments and a distance from receptor dwellings that is generally greater than 250m (as defined by noise criteria based on Ontario regulations). Other mitigation measures that have been suggested include limiting site access, public awareness and signage, and signal warnings when starting up a turbine after an icing event.

Despite an extensive search, there were no studies found that speak specifically to the case of ice throw associated with small turbines, or ways to mitigate such impacts. A CanWEA survey of municipal minimum setbacks for small wind turbines indicates a wide range from 15m to all property lines to 3 times total turbine height from habitable buildings, although there was no indication in the survey as to why municipalities have introduced specific setback distances (i.e. public safety, visual, noise, etc.) (CanWEA, Small Wind Siting and Zoning Study, 2006). Some small wind proponents maintain that icing with small turbines is not a realistic problem since the blades become so heavy with the ice that they stop turning. Ice therefore will ultimately break off or melt and fall straight down to the base of the turbine, although it is recognized that there are no specific studies on smaller wind turbines and ice throw (Sagrillo, 2003). The question of what happens to the ice during a start up phase is unclear as well as how this may apply to the various sizes of small wind turbines. Given that recommended setbacks for ice throw and blade throw are similar in the case of large turbines (Larwood, 2006), it may be reasonable to assume that similar guidelines for blade throw (1.25 to 3 times turbine height) are appropriate to also shield against ice throw in the case of small wind turbines.

2.7 Noise

There is a vigorous and controversial public debate regarding sound emitted from wind turbines. Issues include sound emission, infrasound, and appropriate separation distance to protect residents and properties that are adjacent to wind developments. Varying perspectives regarding concerns around noise, infrasound, and amplitude modulation have translated into to a variety of inconsistent regulations and guidelines. The lack of commonly accepted standards has impacted the industry worldwide. Inconsistency in regulations challenges developers and equipment manufacturers who benefit from consistent expectations and playing field. This state of flux and dispute also makes it difficult for municipalities and other regulators to easily select best practices to adapt to their regulatory frameworks.

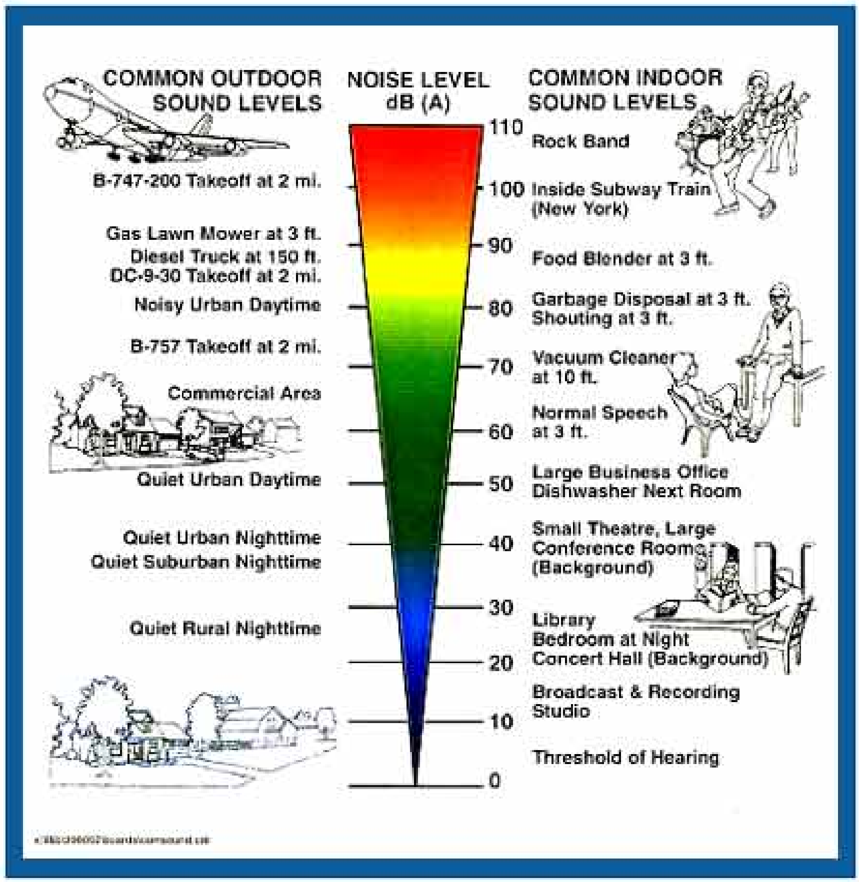
For clarity, it is useful to note that the literature on sound focuses on three categories:

- Noise – which consists of those frequencies audible to the human ear at various tones and comfort levels;
- Infrasound – which has frequency too low to be detectable by the human ear and instead may be experienced through “vibrations”; and
- Amplitude Modulation (AM) – which is a low frequency modulation of a wide set of frequencies.

In all cases, the debate centers on the levels, duration and time frequency at which the sound can negatively impact human health or quality of life. The debate about noise impacts is further complicated by the difficulty in measuring or verifying health or quality of life impacts in this early era of extensive wind development. The extent to which complaints or concerns regarding noise voiced by neighbors or opponents of wind energy projects arising from indisputable evidence or as an opposition tactic is also disputed and unknown.

Figure 2 highlights comparable indoor and outdoor sound levels.

FIGURE 2 Comparable Indoor and Outdoor Sound Levels



(From San Antonio International Airport)

2.7.1 Large Scale Turbines

Specifically relating to infrasound and amplitude modulation, the report “Wind Turbines and Infrasound” submitted by HGC Engineering to the Canadian Wind Energy Association (CanWEA, 2006) concludes that, “based on Canadian and international studies, infrasound generated by wind turbines should not be considered a concern to the health of nearby residents.” The report states that older turbine models with downwind rotors created infrasound, but this is no longer a concern with modern turbines given that the low frequencies generated by new turbines have not been found to be a health concern. The report also explains that what is often confused as infrasound from wind turbines is actually the modulated (pulsing) amplitude modulation.

With regard to amplitude modulation, Dr. G.P. van den Berg has conducted studies and published peer-reviewed articles. In his opinion, amplitude modulation is a concern regarding wind development. He has researched and published multiple documents on the ‘pulsing’ sound wind turbines can make when the atmospheric conditions are stable. This often happens late in the day, early evening and nighttime, and causes the turbines to generate a sound that has been described by nearby residents as “a clapping noise", and is incidentally at a frequency close to a beating human heart. The impulsive noise is created each time a blade passes the tower. The following excerpt references data taken from Dr. van den Berg's study of a 30MW, 17 turbine farm in Northwestern Germany:

> On quiet nights the wind park can be heard at distances of up to several kilometers when the turbines rotate at high speed. On these nights, certainly at distances between 500 and 1000m from the wind park, one can hear a low pitched thumping sound with a repetition rate of about once a second (coinciding with the frequency of blades passing a turbine mast)… In daytime these pulses are not clearly audible and the sound is less intrusive or even inaudible (especially in strong winds because of the then high ambient sound level). (van den Berg, 2003)

Complaints had come from residents (in the Netherlands) living 500m and more from the farm, and annoyance was expressed by residents up to 1900m away. Sound measurements were taken 400m and 1500m away over 400 night hours in four months. Wind speeds at hub height at night were up to 2.6 times higher than expected, leading to up to 15dB higher sound levels than during the day. Dr. van den Berg concluded in part, "The number and severity of noise complaints near the wind park are at least in part explained by the two main findings of this study; actual sound levels are considerably higher than predicted, and wind turbines can produce sound with an impulsive character" (van den Berg, 2003). As is the case with developments in general, complaints are not universal and the means to assess actual impacts not easily measurable and quantifiable.

It is also impossible to generalize about the distances at which specific noise levels will be evident since audible noise from any wind development is always contextual. Audible noise measurements from a turbine or wind farm will vary widely depending on the manufacturer and nature of the turbine, landscape, wind speeds, time of measurement, weather and other climatic conditions. It can be further difficult to compare measurements cited from noise monitoring due to varying methodologies, equipment types and scope of area (i.e. whether regulation or monitoring protocol is based upon distance, property line or nearest dwelling, and if so whether at exterior or interior).

2.7.2 Small Scale Turbines

Most studies on noise from wind energy generation have concentrated on large, commercial scale wind turbines. Noise concerns related to small wind turbines have not been well documented, affected by the lack of adequate data for noise emissions. Since the late 1990s, anecdotal reports and audio recordings have pointed to concerns with noise impacts but there has been a lack of quantifiable data that gives accurate measures for noise emissions. Specific noise measurement and reporting techniques for small turbines were identified as being necessary since the wind speeds when noise may become most objectionable may differ between medium and small turbines (Gipe).

In a research paper by the National Renewable Energy Laboratory (NREL) on acoustic tests for small wind turbines in the U.S., the authors recognized the unfavourable reputation of small wind turbine noise associated with "high tip speeds, furling or blade flutter". The researchers recognized that because small wind turbines will most likely be placed closer to residences than large wind turbines the issues related to noise may be of greater importance than when siting large turbines. The importance of having reliable data on noise emissions was noted, for both the wind turbine installer and local authorities, so that noise emissions were understood and effective mitigation measures could be put in place. The research project tested eight small wind turbines between 400W and 100kW and noted that several models tested showed significant progress towards quieter turbines (Migliore, 2003).

Although there has not been rigorous comparative research on the topic, it is thought that small turbines are somewhat paradoxically, more noisy than larger turbines. However, this statement cannot be substantiated at this point, given the lack of scientific measurements and comprehensive studies on small scale turbines. There is only limited information available on typical noise levels from small wind turbines. Some samples are presented in Table 3 below. These numbers are not particularly reliable for forecasting given the speed at which the technology around small wind turbines is changing. It is possible that modern small wind turbines display a very different level of noise.

TABLE 3 Typical Noise Levels for Small Scale Turbines (after Gipe 2001, as cited in HRM 2006)

Type of Turbine	Hub Height (m)	Noise Level (dBA) at Select Distances (m) and Wind Speeds (m/s)
Ampair 100	13.4	50 @ 13.9m and 8m/s 75 @ 13.9m and 10m/s
Air 403	13.4	50 @ 14m and 8m/s 75 @ 14m and 10m/s
BWC 850	19.2	80 @ 20.4m and 8m/s 150 @ 20.4m and 10m/s

2.7.3 Noise Mitigation

The amount of noise disturbance associated with a wind turbine depends on several factors including the type of turbine, distance from residences, number of turbines, and the ambient noise levels. This may be the reason why it is difficult to reliably forecast and avoid or mitigate noise disturbance by conventional land-use planning techniques. There are also a variety of perspectives, but little in the way of substantive research or human health risk assessment, to reach definitive conclusions as to the significance of adverse effects regarding human health, with respect to the types and levels of noise associated with wind development. Different experts and stakeholders have therefore come to different conclusions on what an appropriate set-back or allowable noise level may be as shown in Table 4.

The following is a list of sample regulations from around the world, inclusive of both decibel regulations and setback requirements (modified from "Wind Turbines: Noise and Setback Regulations: a Brief Summary" by Kaija Metuzals, 2006). Note that there may be multiple regulations for each location and this list is not all-inclusive.

TABLE 4 Summary of Decibel Regulations and Setback Distances

Country	dB	Separation Distance	Name or Date of Regulation	Source
New Zealand		200-400m recommendation		Leventhall 2004
United States: New York		92m	N/A	Mollica 2004 *in* Wind energy dev: a guide for local authorities in NY 2002.
United States: California	Max 60dBA	Height of tower = 100m	N/A	s.4290 – Handbook of Permitting 2003
United States: Washington		305m		KITE report 2006, p.34
Denmark	40-45dBA		1991	Pedersen 2003 and www.windpower.dk

TABLE 4 Summary of Decibel Regulations and Setback Distances

Country	dB	Separation Distance	Name or Date of Regulation	Source
Denmark		4x height = 600m	N/A	Sondergaard 2005 in NWCC, Washington DC
Germany	35-70dBA at night, 45-70dBA during the day		Clean Air Act and TA Technische Anleitung laerm, 1974, 1998	Pederson 2003
The Netherlands	40dBA at night at 1m/sec, 50dBA during the day at 12m/s		Besluit v.18 oktober , 2001	Pedersen 2003
France	No more than 3dBA at night or 5dBA during the day over background levels		Loi 92-1444 du 31 dec. 1992	Pedersen 2003
Sweden	40dBA at the exterior of dwellings		2001	Pedersen 2003 Noise annoyance from wind turbines – a review
United Kingdom	5dBA above background noise both day and night		ETSU DTI 1996 and ETSU-R-97, 1996	Pedersen 2003 www.britishwindenergy.co.uk/ref/noise.html
World Health Organization	30dB indoors		1999, 2005	Berglund et al. 1999 Pierpont 2005

2.7.3.1 Separation Distance Approach

The application of simple setback requirements as the basis to mitigate health or quality of life impacts associated with noise are inherently problematic for reasons identified above – lack of definitive understanding or consensus regarding the degree and characteristics of noise (volume, amplitude modulation, frequency, timing etc.) that cause adverse effects; the degree of effect that is significant (health or nuisance); and the variety of other non-distance related moderating influences. Nonetheless, regulators do need to address setback criteria and consider noise effects among the range of factors in doing so.

With respect to setbacks, most jurisdictions that have implemented setbacks in the past few decades have relied on a 200 to 500m separation distance from areas they want to protect. For example, in 2005, the British Wind Energy Association's recommended setback of 350m was considered conservative. Among the jurisdictions surveyed within Nova Scotia, the separation distances between wind turbines and habitable dwellings on an adjacent property ranged from 150m to 600m or 2 times to 4 times the total turbine height. Some property owners, neighbours, researchers and opponents of wind developments have argued that this range is not always adequate, especially to protect against amplitude modulation noise as described above. Some of these stakeholders have called for larger separation distances (up to 1.6 to 2.2 km) to reduce the impact of noise for those living in close proximity (Harry, 2007, Pierpont, 2005, Palmer 2006) but there is a lack of peer-reviewed research that can defensibly support the larger end of these separation distances as being necessary to meet acceptable health or quality of life standards. On the other side of the equation, the same lack of broadly accepted research does not ensure that shorter setback distances will invariably avoid real or perceived negative impacts on neighbours and will certainly not eliminate controversy. There was one case identified wherein a municipality, based largely on noise considerations, has opted for a larger separation distance – the municipality of Trempealeau County in Wisconsin, for example, uses a 1 mile (1.6 km) separation distance from the nearest inhabited structure unless all property owners located closer agree to mitigation methods put in place by the developer (Trempealeau County, 2007). The UK Noise Association and the Academy of Medicine in Paris also recommend that turbines should not be sited within a mile (1.6km) of where people live (Stewart, 2006), but this has not become practice in the UK.

A well publicized case in Nova Scotia concerns a family residence in Pubnico. Residents claimed that they have been greatly affected by sound from the close wind turbines (the closest is approximately 330m away). Although still unresolved and controversial in Nova Scotia, a report commissioned by the Government of Canada and carried out by HGC Engineering on the location concludes that the noise is within the Ontario Guidelines (currently the most stringent noise guidelines available in the country) except when the wind is light, from the south, and when there is high humidity. During these instances, the noise exceeds these Guidelines by a considerable amount (13dBz) (Howe & McCabe, 2006). In the interim, the family has vacated their home as they believe the effects of the wind turbine noise are making them ill.

Despite these uncertainties, the overview of jurisdictions across Canada, the United States, in Europe and beyond indicates that with a few exceptions, the preponderance of jurisdictions that have established setback distances have decided that distances 1000m or less, with most at 700m or less, or 3 to 4 times overall turbine height, are satisfactory.

2.7.3.2 Decibel Approach

Within the wind energy industry, and in fact in a number of jurisdictions, the idea that a setback alone is a satisfactory means to mitigate noise has come under criticism. Alternately, many local and provincial or state jurisdictions have put in place regulatory mechanisms based upon sound characteristics at a point of reception (nearest property line, residence or likely receptor etc.) CanWEA, as well as many wind energy manufacturers and developers in Canada (including Vestas and Wind Prospect Inc.) have also argued against establishing absolute separation distances maintaining that they do not take into account many factors, including surrounding topography and number of turbines. In addition, continued improvements in wind turbine technology can lead to reductions in noise emissions. The suggestion and established practice from these groups is to instead institute an allowable decibel level at the property line or closest receptor, and require wind energy developers to use a combination of setback and technology to meet the allowable limits. Note that noise levels for a certain turbine given a specific wind energy development sited in a certain environmental setting can be predicted through a combination of manufacturer's product testing and third party modelling by experts.

The World Health Organization (WHO) recommends that a 30dBA standard inside be set for wind turbines and other low-pitched sound emitters, as well as stating that a sound level of 45dBA creates sleep disturbance (WHO, 1999). The WHO explains that continuous noise indoors above 30dBA will create negative sleep effects, and non continuous noise at 45dBA will disrupt sleep (WHO, 1999). A wind and site engineer (Mills, personal communication, 2007) at Vestas Americas proposes a 35-40dB limit at any residence, similar to those of the New Zealand and Denmark regulations (40dB) and the UK regulations (35-40dB). The Australian Environmental Noise Guidelines, as they relate to wind farms, have a limit of 35dB or within 5dB of the current background noise, with a 40dBA level exception for "intensive rural or primary production/rural industry zone" (EPA, 2007). Gordon Whitehead, local sound consultant, audiology service provider, and university professor, suggests that sound at 35dB begins to create sleep disturbance (Whitehead, 2007).

Of course, sound levels decrease over distance, nominally by 6dB every time the measurement distance is doubled due to geographical spreading. Normalized data, taken from the Danish Wind Energy website by Adam Sacora, portrays this:

Sound Level by Distance from Source

Distance m	Sound Level Change dB(A)	Distance m	Sound Level Change dB(A)	Distance m	Sound Level Change dB(A)
9	-30	100	-52	317	-62
16	-35	112	-53	355	-63
28	-40	126	-54	398	-64
40	-43	141	-55	447	-65
50	-45	159	-56	502	-66
56	-46	178	-57	563	-67
63	-47	200	-58	632	-68
71	-49	224	-59	709	-69
80	-50	251	-60	795	-70
89	-51	282	-61	892	-71

(Sacora, 2004)

Close examination of this data shows that at some distances the degree of noise attenuation is greater than 6dB which results from absorption in the atmosphere and the effects of obstructions, including terrain. Therefore, if a single turbine emits a 90-100dBA noise level, a 50-60dBA may be reached at 40m and a 35dBA level may be reached at a distance of 500m (BWEA, 2000). Referring to the range of research conducted, it can be reasonably concluded that factors such as atmospheric pressure, obstacles, terrain, wind direction, masking noise, and number of turbines may impact this calculation by up to 15dB either way.

Given that the BC Land Use Policy (Wind Power Projects, 2005) suggests a 10dBA change in sound level between the exterior and interior of a habitable dwelling, most of these regulations are in the same range of acceptable sound levels. Assuming this is true, and taking into account Gordon Whitehead's suggestion concerning sleep disturbance, it could be argued that regulations should not allow facilities to exceed 45dBA at the exterior of a habitable dwelling. The Ontario Guidelines currently have a 40dBA limit at the exterior, but there have been public complaints made in several areas despite this limit. Mr. Tom Mills, at Vestas (personal communication, 2007), supports the Australian guidelines (a limit of 35dBA or 5dBA above the background level) implementation in order to prevent the negative publicity wind energy receives when news reports are continuingly be published of more families negatively affected by the noise. Dr. John Walker of Jacques Whitford (personal communication, 2007), a noise and acoustics specialist, agrees with Mr. Mills in his support for the Australian guideline to avoid personal discomfort.

British Columbia, Alberta, and Ontario have opted for a sound level regulation of 40dBA. Jacques Whitford project experience includes numerous sites in Canada where complaints have been noted when the sound level is as low as 40dBA. William K. G. Palmer, presenter at various conferences on the topic of wind turbines and professional engineer, suggests that Ontario's 40dBA limitations are not enough to protect neighbouring citizens (Palmer, 2006). Palmer's paper focuses on the Enbridge Ontario Wind Project. According to the MOE guidelines (mentioned previously), noise impact assessments must be performed under a worst case scenario. Palmer references the work of Dr. van den Berg who states the worst case scenario for wind turbine noise occurs at night when there is limited masking noise due to slower wind speeds close to the earth and faster wind speeds at the height of the turbines; therefore, making the turbines seem louder than during the day. Palmer notes:

> Applying the method shown in the noise assessment of the Enbridge Screening Report will result in over 87% of homes at distances of up to 900 metres above the Ontario standard for noise at times when masking is not available. 169 homes – some at distances of up to 928 metres from the nearest turbine, will be subject to noise above Ontario standards.

Palmer's final recommendations are to have a public safety setback from lot lines of two times the total turbine height, and a noise separation distance of 1000m to homes.

At the same time in the US, a jury in Abilene, Texas set a precedent for future noise claims against wind power in December 2006, by ruling that the plaintiffs' (neighbouring citizens) claims that the wind turbines in question were a sound nuisance were unjustifiable. The jury sided with expert testimony that the noise level was not intrusive given the distance, size, and noise emissions. This particular wind farm consisted of 400 wind turbines and the sound level measured at 800m was 30dB when the turbines were in full operation during daylight hours. During nighttime hours, the sound from the turbines was actually masked by the natural nighttime sounds from crickets, etc. at a reading of 35dB. A sound reading taken inside of the courtroom for comparison was 32dB (Tillotson & Pinker).

2.7.3.3 Reducing Noise Impacts

As indicated previously, there appears to be no scientific consensus on the significance of effects of noise from wind turbines. While many jurisdictions have set a standard based upon a 40dBA limit there are some emerging concerns that the 40dBA measured at the exterior of a receptor is not sufficient to avoid unacceptable effects. The Australian guideline of 35dBA or 5dBA above the background noise is an example of a more conservative basis to establish a decibel-based limit regarding impacts to human health and quality of life. Here again the decision regarding noise limits cannot be evaluated in isolation. The full spectrum of adverse and positive factors and effects associated with wind energy development are all part of the equation. Municipalities that decide to use a decibel approach to address noise impacts will need to investigate the implications of the dBA level they choose and find an acceptable balance between how this will protect neighbouring landowners, facilitate wind turbine development in their communities and contribute to reducing the local and global effects associated with current conventional energy sources.

In light of all these considerations and conflicting information a prudent policy and regulatory approach may be to consider a combination approach that prescribes minimum setback distance unless proponents can satisfactorily demonstrate (through defensible modeling) that dBA limits will not be exceeded. As described, the range of recent dBA limits most often encountered in this research range from 35dBA to 40 dBA or 5dBA above background (at dwellings). Limits based purely on separation distance will not easily account for unique site characteristics or changes in technology resulting in lower noise emissions.

If municipalities choose to apply simpler siting criteria purely related to separation distance they will have to consider the broad range of options in current practice recognizing the current prevalence of shorter distances and some recent trends towards greater separation distance.

It is necessary to conclude that the ultimate decision regarding noise-related regulation involves a number of considerations, balancing issues and uncertainty related to health and quality of life impacts with broader environmental, social and economic considerations. These regulations are also connected to other policy topics such as compensation, community benefits and provincial policies regarding alternative energy requirements.

2.8 Oil spills

There is a small amount of oil contained in the gearbox of the nacelle unit of a wind turbine. An oil leak would usually either be contained in the nacelle unit or would leak down the side of the tower. This impact is very small and would generally be noticed and repaired before the oil reaches the ground.

Several incidents have occurred involving the leaking of lubrication oil, mostly in Germany. In 2005, oil from a nacelle in Rheinland-Pfalz leaked from the machinery and down the tower. Some oil also found its way onto the blades, causing it to be thrown over a large area during operation. The amounts and concentrations were modest and the environmental effects, while adverse, were not deemed significant.

Sometimes these events are precipitated by other damage to the nacelle, such as in Saxony, Germany in 2003 where a turbine was destroyed by a storm, causing oil to contaminate the immediate area. Here too, the significant effects were localized and amenable to remediation.

2.9 Property values

There is a commonly expressed public concern that neighbouring property values will decrease as a result of wind energy development. However, there is little evidence to either verify or refute this concern, especially in Canada. The lack of independent, rigorous, peer-reviewed research, and the academic literature offers very little to clarify the issue. Two sample studies were found from Britain and the United States.

The British Wind Energy Association (BWEA) recently posted a news article in March 2007 that concludes that the effect of wind development on property values is neutral or positive. This conclusion is based on an independent study conducted by the Royal Institute of Chartered Surveyors (RICS) and Oxford Brookes University which found that there was no clear relationship between the location of wind farms and property prices in the nearby vicinity. The study also states that the belief that wind developments affect housing prices is nothing but an “urban myth”. The RICS published a report in 2004 which concluded that any negative impacts wind development had on property value was reversed after a period of two years. However, the more recent aforementioned study by the same group goes as far as asserting that there is no credible empirical evidence that demonstrates a direct link between wind energy projects and housing values.

Two opinion polls were conducted by Robertson Bell Associates (an independent British market research agency, commissioned by National Wind Power in 1997 and 1998) with similar results. At the Taff Ely Wind Farm in South Wales. Of the respondents, 78% said the wind farm had no effect on their housing prices with a further 15% admitting to not knowing. The number of respondents who said that housing prices have increased a little or a lot (3% and 1%, respectively) was exactly equal to the number of respondents who believed the prices have decreased a little or a lot (3% and 1%, respectively). This study was based upon 336 face-to-face interviews, carried out in homes within a two-mile radius of Taff Ely wind farm. The second poll was conducted in the vicinity of the Novar Wind Farm in Scotland. In this study, based upon 203 face-to-face interviews, carried out in homes near the Novar Estate wind farm, 72% of those surveyed said the wind farm had no effect on property values, with a further 26% admitting to not knowing the effects. None were of the opinion that the values decreased and 1% believed the prices had increased a little as a result. These kinds of surveys have not been conducted in Canada, to the best of knowledge.

The Renewable Energy Policy Project (REPP – United States Government-funded agency) conducted a study in 2003 throughout the US which found similar conclusions. It examined ten different wind farms and their impact on property values in comparison to neighbouring test communities (typical growth rates, prices previous to development). With ten different wind farms being studied on these three different variables, 30 cases were deemed to have been studied. The study focused on wind farms installed between 1998 and 2001 with greater than 10 MW capacities. Over 25,000 property sales records were examined over a span of six years (pre and post development). The study, entitled The Effect of Wind Development on Local Property Values (2003), found that in twenty-six of the cases studied land and home values were higher than any of the control cases (before wind development, a comparable community, etc). There was no evidence of a decrease in property value. It should be noted that in the cases of increase, the increase could not be directly attributed to the presence of a wind farm due to a lack of relevant information.

Although there is continuing public concern regarding the effects of wind development on property value, research to date indicates that there is no clear relationship between property value increases or decreases with the presence of wind developments.

2.10 Shadow flicker

Shadow flicker is the visual impact that results when the sun passes behind the blades of a wind turbine and casts a shadow which then flickers as the blades rotate. Shadow flicker is dependent on the weather conditions (sun is shining or not), geographical position, topography and time of day. The duration and severity of shadow flicker effects varies depending on the time of year. The wind direction can also affect the potential impact because the rotor orientation will change according to its direction. Finally, the distance of the rotor from a receptor will influence the impact, since light perception diminishes with distance. The primary impact of shadow flicker is annoyance. There have also been suggestions that shadow flicker could induce epileptic episodes in susceptible individuals. According to epilepsy research, the level where people affected by photosensitivity (sensitivity to flashing lights) is between the frequency of 5 to 30 flashes per second (Hertz) (Epilepsy Foundation, 2005). Scientists have also found that the frequencies that cause disturbance to people generally are above 2.5 Hz (Department for Business

Enterprise and Regulatory Reform, UK). Shadow flicker from wind turbines usually has a frequency range of between 0.5 Hz to 1.25 Hz which is well below the level of concern for this health issue (Nobel Environmental Power, Department for Business Enterprise and Regulatory Reform, UK).

There is limited history of specific regulatory guidance or requirements in Canada on shadow flicker, although when noted, 20-30hrs/year of flicker is typically considered to be the threshold for concern. A British government ministry states that at a distance of 10 rotor diameters (usually equivalent to 400 to 800m) a person should not experience shadow flicker (Department for Business Enterprise and Regulatory Reform, UK). Shadow flicker can be calculated by modeling tools considering the machine geometry and latitude of the site (Allen, 2005).

A report prepared for the County of Essex, Ontario by the Jones Consulting Group, outlines several standards that are used globally to mitigate against the impacts of shadow flicker. These include limiting the amount of time a receptor is affected by shadow flicker to a maximum of 30 hours per calendar year and a maximum of 30 minutes per day (based on a world case calculation – maximum shadow during a day between sunrise and sunset on a cloudless day); maximum of 30 hours per year based on actual/real predicted values as opposed to worst case calculation (based on a German court decision to tolerate 30 hours of actual shadow flicker per year and then applying the probability of sunshine for the area); and separation of the turbine and receptor of a minimum distance of 10 rotor diameters. Variations of the maximum 30 hours per year of shadow flicker have become the prominent standard in use globally. The distance that should be calculated is for receptors within 1300m of a turbine with a total height of 140m (Jones Consulting Group, 2007).

Instead of using an extensive buffer zone (setback) shadow flicker has been mitigated by measures including shutting down of turbines during the times of the day when the shadow flicker will interact with a dwelling (usually in the early morning and evening), controlling the direction of the turbine blades so that the blades are not directly parallel to the sun, and introducing vegetative barriers, such as trees, between turbines and points of potential shadow flicker impact. There may be some financial impact on wind turbine proponents when required to shut down turbines to mitigate against shadow flicker.

With regard to small wind turbines, it is suggested that there are no problems associated with shadow flicker due to the lower height of the turbine towers, the smaller length of the blade, the thinner width of the blade, and the faster rate that small wind turbine blades rotate as compared to large scale blades (for example, 28 rpm for smaller scale and 16 rpm for larger turbines). There may be some shadow casting but generally there has been no demonstrated impact from shadow flicker (Sagrillo, 2003).

2.11 Structural failure

Structural failure of wind turbines is not a common occurrence in relation to the number of operational turbines around the globe, but when it does happen it can be quite dangerous due to the size and weight of the components. Geotechnical investigations are required prior to foundation installation to ensure stability of the location and placement of the turbine; however, it is the structural integrity of the turbine itself that is questioned.

The CWIF compiled data of all reported accidents up until August 31, 2007. “From the data obtained, this (structural failure) is the third most common accident cause, with 47 instances found. ’Structural failure’ is assumed to be major component failure under conditions which components should be designed to withstand. This mainly concerns storm damage to turbines and tower collapse. However, poor quality control and component failure can also be responsible - the collapse in May 2005 of a brand-new 300 foot turbine in Oklahoma during light winds are a good example of this" (Caithness Windfarm Information Forum, 2007).

A variety of structural failures over the past few decades are worth highlighting. In Westpahlia, Germany, lightning struck a turbine, causing a fire and the mast to split. In Denmark, a storm caused brake failure in three turbines, resulting in all three being destroyed. At another location in Germany the same year, a single turbine suddenly collapsed. Concrete damage was quoted as the cause. Two towers collapsed in Holland during a storm at separate locations. In Cornwall, UK, an entire wind power station consisting of 22 turbines was shut down as a result of metal fatigue. The same thing happened at two farms in Wales. In Norway, the nacelle and rotor of a turbine broke away from the tower as a result of overloading the brakes and safety systems. Again in Germany, a turbine completely collapsed after just two weeks; the cause was faulty welding. There are many more incidents which could be cited, some of which caused human fatalities, but this list gives a basic overview of the potential damages.

Hydraulic valves, gearbox, and transformer failures are all also possible structural failure events. Failed pins between the gearbox and turbine are a potential occurrence as well. As with any mechanical structure, there is risk of failure. Specific to turbines, there is potential for structural, mechanical, blade, and/or transmission failure. There are a number of ways of reducing risk and possibly preventing structural failure, including ensuring workers are properly credentialed, experienced and adequately trained. Seeking out equipment that is technologically advanced and appropriate to the conditions, as well as establishing safety fallback systems will help to mitigate overall risk.

2.12 Telecommunications and electromagnetic interference

There is an expressed public concern that wind energy development will generate electromagnetic interference that affects the operation of microwaves, televisions, radar or radio transmissions. Sources show that this interference can be avoided and mitigated if properly planned.

'Electromagnetic Interference', Appendix 3 of the Best Practice Guidelines for Implementation of Wind Energy Projects in Australia published by AusWEA (Australian Wind Energy Association, 2002), states that interference can be easily avoided by proper site selection for each turbine. Regardless of whether there is any visible telecommunications equipment, it is advised to check with the area officials for the closest location of such equipment. It is important to ensure that the turbines are not directly in the line of sight between any transmitters or receivers, or that they are located in the first Fresnel zone (complete volume enclosed by the shape of an ellipsoid between the transmitter and receiver). Potential issues are the tower or rotating blades obstructing, reflecting, or refracting electromagnetic waves, or the turbine's electrical generator producing the interference. Careful planning, site selection, shielding design and maintenance can eliminate and mitigate any interference issues. One highlighted example is Thursday Island in far north Queensland, Australia where wind turbines are in close proximity to a microwave tower, radio masts and an airways corporation satellite with zero reported interference. Another example is Trust Power's Tararua Wind Farm in New Zealand where all turbines were strategically placed to avoid the microwave beams which crisscross the site.

In "Wind energy conversion: Recent progress and future prospects" (Musgrove 1987), P.J. Musgrove suggests that wind energy development may accelerate telecommunication progress in reaching rural areas by providing cost-effective access to electricity. Years later, this has become true with Bell Aliant using a combination of solar and wind energy to power their remote radio sites in Labrador.

Suggestions for avoiding radar impacts when planning a wind farm include reducing the radar cross section (RCS) of a turbine and slightly altering the positional design. Developers should be responsible for such avoidance methods, as well as for obtaining permits from federal/provincial authorities demonstrating that the wind turbine will not interfere with electromagnetic signals. Further, should interference be observed during monitoring, it will be corrected by the developer.

Another specific concern in Canada is the potential interference with the Canadian Air Defense System (CADS). The Radio Advisory Board of Canada and CanWEA included this explanation in their "Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radio Communication, Radar, and Seismoacoustic Systems report" (CanWEA 2007):

> Air defense (AD) radars must be capable of tracking friendly and hostile targets within Canada's aerospace. Detailed studies have shown that Wind Turbine Generators (WTGs) cause a number of serious problems with respect to AD radars. These problems include blanking, reducing the radar's ability to detect real targets, clutter, false targets, and reporting inaccurate positional information on real targets.
>
> Any organization considering establishing a WTG site, within a 100km radius of an AD radar, should contact the Department of National Defense (DND). DND can determine if the proposed WTG is within line of sight of the radar beam and/or if interference problems are likely. In order to avoid potential interference with air defense radars used in support of national sovereignty, it is important to consult with the appropriate authority prior to establishing a WTG site.

In relation to small turbines, CanWEA has stated that there is no electromagnetic interference from small turbines due to their size and also the materials from which they are built. A CanWEA study quotes a representative from the National Renewable Energy Laboratory saying that there has been no indication of a problem with electromagnetic emissions and no study has been undertaken in this area since it is not perceived to be an area of concern. Small turbines are in fact used in to power remote telecommunication systems and military facilities (Small Wind Siting and Zoning Study, CanWEA, 2006).

Proper planning, communication with all invested parties, and responsible site selection will avoid and mitigate any potential telecommunications interference issues in relation to wind energy development.

2.13 Traffic and roads

Impacts on traffic and roads relate mainly to large scale wind turbines that are usually located in rural environments. Building large scale turbines in rural environments can present access challenges. The practice has been to utilize existing roads to facilitate a more rapid development schedule and to keep costs down. In some cases, due to the size of the turbine equipment, existing roads may have to be altered. There are generally two types of traffic generated from a wind turbine project – construction traffic and operational traffic. The impacts on existing infrastructure are small and can be of limited duration; however, these impacts do need to be properly managed.

Construction traffic usually takes place over a short period of time. The delivery of the turbines can require alterations to the flow of local traffic due to the size of the equipment (large cranes and heavy vehicles with articulated loads). A traffic management plan should be prepared and approved by the appropriate regulatory authority. Remediation requirements will need to be identified for any damage that occurs during this period. The coordination of the traffic management plan should include utility operators such as power, telephone and cable in the event that the size of the structure being transported physically interferes with utility lines.

Operational traffic which includes traffic related to the general maintenance of the wind turbines requires small groups of people and small vehicles resulting in minimal impact on nearby road networks. The roads constructed for servicing the turbines do need to be well maintained, though, to prevent potential impacts due to erosion and/or creating a negative visual impact on the local landscape. During the decommissioning phase, similar requirements will be needed for transportation equipment.

2.14 Vegetation and habitat

Impacts to vegetation have not become a high profile issue in relation to wind energy development. There are minimal effects on vegetation as a result of wind turbines which are situated responsibly; but there is a risk of habitat avoidance by certain sensitive species. Wind farm sites are typically on agricultural land in rural areas, and land around the base of the turbines is still typically arable.

Construction of the turbines poses the greatest risk of damage to vegetation in the area, but the effects of this may be mitigated through restoration and enhancement. Staging areas will be needed during the construction phase for cranes and the assembly of the turbines. If staging areas are temporary, remediation of the land around the turbine base should be planned. Environmental management plans are an important component of any wind farm development for this reason. If situated and planned properly, nearly all vegetation damage, external of the turbine footprint, can be avoided.

Fragmentation of current habitat by access roads, transmission lines or the turbines themselves, can significantly affect breeding of certain species, and the loss of area-specific resources for sensitive species. Additionally this fragmentation, as well as other environmental effects such as noise, can lead to habitat avoidance by native species, causing displacement of populations and potentially reduced energy consumption due to limited feeding. However, offshore installations may increase local fish and other marine populations, creating additional habitat, and increased feeding opportunities for seabirds and other marine predators.

Increased human activities are often accompanied by increased potential for contamination from transportation, industrial chemicals, and runoff from increased impermeable surfaces. These factors can seriously impact the health and sustainability of native habitats if left unchecked, but these effects can be reduced and mitigated through appropriate monitoring and remediation of problem areas. If implemented properly, these steps can help protect sensitive areas around turbine infrastructure from damage.

If wind energy development is not situated responsibly, there is potential for substantial habitat and vegetation loss, as well as forest fragmentation. Proper planning and environmental assessment are essential in avoiding substantive, and in some cases, irrevocable damage to the vegetation and habitat at any site.

There is very little research on the impact of wind turbines on land mammals. One study done in southwestern Oklahoma suggests that Rocky Mountain elk, despite loss of some habitat, were not adversely affected by wind development as determined by location preference and lack of dietary changes (Walter et al, 2006). A local expert expressed concern over limiting connectivity corridors for large mammals (marten, moose, bobcat, etc.) if highland areas become occupied by wind development, without provisions for functional connectivity (Elderkin, personal communication, 2007).

2.15 Visual impact

The visual impact of wind turbines is one of the most controversial aspects surrounding wind energy development, mainly due to its subjectivity. Deciding whether something is visually intrusive is less quantifiable than most other impacts where quantitative measurements can be compared to specific guidelines or requirements.

In December 2006, a judge in Abilene, Texas set the foundation for future nuisance claims against wind power in his jurisdiction by throwing out the plaintiffs' (neighbouring citizens) claims that the wind turbines in question (FPL Energy's Horse Hollow Wind Energy Center) constituted a visual nuisance. Texas law can be interpreted broadly but this judge declared that a wind farm's visual appeal is entirely subjective; therefore, not relevant in court (Tillotson & Pinker).

The Jones Consulting Group Ltd. considered the subjectivity of the visual impacts of wind turbines within their constraints analysis for the Town of the Blue Mountains in Ontario (Jones Consulting Group Ltd., constraints analysis, 2007). Their analysis endeavoured to address this, through utilization of a consistent methodology. They outlined visual sensitivity of an area – the natural, uninterrupted landscape that exists – as well as the visual absorption capacity – the ability for that natural, uninterrupted landscape to absorb change. In the same region, the Niagara Escarpment Commission, an Ontario provincially mandated commission that maintains the Niagara Escarpment area to ensure compatible development with the natural environment, has taken a position prohibiting any large scale wind development facilities anywhere within the Niagara Escarpment Plan partially due to their assessment of negative visual impacts.

The Town of Truro, Nova Scotia, believes a workable visual impact assessment could be addressed through the development agreement process where all parties have the opportunity for input and appeal. This process takes into account diverse perspectives and makes a decision considering the views of all who participate. The Municipal District of Taber, Alberta has a similar process; holding an open meeting for questions and concerns considering visual impacts and other concerns, to be heard by a council who will then deem whether or not a proposed wind development project is suitable for the area and citizens.

The assessment of visual impacts is necessarily largely qualitative and subjective. Determining existing landscape values is inherently subjective. Subsequently, attempting to determine the visual impact and relative value of wind energy development further increases the subjectivity of any assessment. The degree of impact that the development will have on the landscape is subject to some methodological assessment and can therefore provide some basis for comparison and judgments.

A particularly substantive analysis regarding the visual impacts of wind farms is included in the Irish Department of the Environment, Heritage and Local Government's "Wind Energy Development Guidelines" (2004). This report considered the following factors as important aspects in controlling the visual impact of wind turbines: siting and location, spatial extent and scale, cumulative effects, spacing of turbines, height of turbines, colour and lighting. More than one tower requires a qualitative assessment to minimize the visual impact in certain areas. The development of incremental wind turbine proposals is monitored to gauge the cumulative visual impact on the environment.

Colour - As presently written, Canadian federal aviation laws recommend turbines to be painted in orange and white stripes, which may result in the turbines being more visually present within their environment than what might otherwise be expected. To date we are not aware of any existing wind turbines that actually employ this colour scheme. Recent communication with Transport Canada officials indicates that this recommendation is being discouraged since the orange markings cause reduced visibility of the blade when rotating (Mason 2007). The common practice is to colour the turbines with a matte finish so as to reduce reflection.

Scale - The spatial design of a wind farm should be developed in context with the existing landscape. While wind farms certainly affect the perception of a landscape, an installed wind farm should ideally not dominate or take over a landscape, but instead should be in balance with what previously exists, such as numbers of other human-made structures.

Spacing - The spacing of turbines largely depends on the surrounding environment. Where the wind farm is surrounded by vegetation or a complex and/or irregular landscape pattern, irregular spacing may be more appropriate. Where turbines are located on a regular landscape, turbines may have less visual impact if they are in turn spaced in a regular (e.g., linear) or uniform manner.

Numbers - A single tower at a certain height may not be as imposing on the landscape as having more than one and therefore may be permitted in some environments. Height plays an important role regarding the visual dominance of the structure(s), but the challenge with placing restrictions on height is that it can lead to a requirement for more turbines to generate the same amount of power. Typically, the higher the turbine the more energy it can generate, thus requiring fewer turbines to generate a fixed amount of electricity. The height is also an important factor regarding the visual components indicated above. A key challenge regarding the height of the turbines is the dominating effect it can have on the landscape and/or surrounding properties.

Lights and signs - Placement of lights and signs on turbines can also affect their visual impact. From investigations undertaken in Canada, the only lighting that are usually installed on wind towers are flashing red beacons at the top of the nacelle unit as required by aviation regulations. Industry representatives are working with Transport Canada and Environment Canada to establish clear and practical guidelines for turbine lighting to minimize nighttime lighting effects overall.

Wires and cables - Some minor visual impacts are also associated with placement of wires and cables. Typically, if the connection to the grid is made above ground there will be an additional visual impact on the landscape, compared to if the cables are trenched. With respect to small turbines it is important to clearly mark guy wires for small wind structures that use guyed towers to ensure that they are visible and do not become a safety hazard on the property.

Overall, the visual impacts of wind energy development must be considered largely a subjective matter. Some jurisdictions are deciding not to allow construction of wind turbines on that basis, while others are proceeding either regardless of concerns, or after deeming them insignificant. In some measure, local perspectives on visual impacts actually reflect the culture of an area and the attitudes of its citizens generally towards matters such as economic development, alternative energy and the importance of longstanding community patterns.

3.0 APPROACHES TO WIND TURBINE REGULATIONS

Various aspects of wind development can be regulated by different levels of government in Canada. This section provides an overview of the regulations and legislative or policy approaches used by all three levels of government, but focuses most specifically on Canadian municipalities. The survey of applicable legislations spans municipalities in Nova Scotia, PEI, Ontario, and Alberta. In addition, provincial policies and guidelines were examined in Nova Scotia, PEI, Ontario, Alberta and BC to provide further understanding of the regulatory framework for wind turbines. The regulatory role of the Federal government was also briefly examined. Finally, international examples from various levels of government complement this overview.

3.1 Federal and Provincial Legislation

The role of the federal and provincial governments in promotion and support of wind energy developments has been described in Section 1.1 of this report. In addition, federal and provincial governments play a role in regulating wind energy development, primarily through the environmental assessment process. Tables 5 and 6 summarize the applicable statutes and regulations administered by the Federal and Provincial governments that may relate to wind energy development throughout Nova Scotia.

TABLE 5 Potentially Applicable Federal Acts and Regulations

Approval Requirement or Guideline	Departments or Agencies Typically Involved	Trigger for Review
Environmental Assessment (EA) – most likely a screening level assessment in accordance with the requirements of the Canadian Environmental Assessment Act	Canadian Environmental Assessment Agency – coordinates Federal EA Involvement of other departments depends on the trigger for the review, The following may be involved as Responsible Authorities or to provide expert advice: ▪ Natural Resources Canada ▪ Fisheries and Oceans ▪ Environment Canada ▪ Transport Canada Other agencies to be involved based on Law List and other triggers may be: Atlantic Canada Opportunities Agency (ACOA)	Construction on federal land Application for federal ecoEnergy Incentive (or other federal funds) Possible effect on Navigable waterways Possible effect on fish habitat Possible damage to migratory birds
Fisheries Act – subsection 35(2) authorization	Fisheries and Oceans Canada	Possible affect on fish habitat
Navigable Waters Protection Act	Transport Canada	Potential effects on navigable waters
Blasting permit near fisheries	Environment Canada	Possible effect on fished waters
Species at Risk Act	Environment Canada	Possible effect on species at risk
Migratory Birds Convention Act	Environment Canada	Possible effect on migratory birds
Siting, marking and lighting scheme	Transport Canada	Any structure taller than 20 m
Aeronautical Safety	Nav Canada	Any structure taller than 30.5m or within a 10km radius of an airport
Seismoacoustic Monitoring Equipment	Natural Resources Canada	Possible effect on monitoring array (considered for radius of at least 10–50km)

TABLE 5 Potentially Applicable Federal Acts and Regulations

Approval Requirement or Guideline	Departments or Agencies Typically Involved	Trigger for Review
Air Defence Radar	Department of National Defence (DND)	Possible effect on radar (considered for radius of at least 100km)
Air Traffic Control Search Radar	DND and Nav Canada	Possible effect on radar (considered for radius of at least 60km)
Canadian Coast Guard Vessel Traffic Radar System	Canadian Coast Guard	Possible effect on radar (considered for radius of at least 60km)
Military Airfield	DND	Considered for a radius of at least 10km
Weather Radars	Environment Canada	Possible effect on radar (considered for radius of at least 80km)
Radio Communication	Industry Canada, DND and RCMP	Possible effect on radio (considered for radius of at least 1km)

TABLE 6 Potentially Applicable Provincial Acts and Regulations

Approval Requirement or Guideline	Departments or Agencies Typically Involved	Trigger for Review
Environmental Assessment (EA) (see Proponent's Guide to Wind Power Projects 2007)	Department of Environment and Labour	Class 1 EA for generation facility of production rating of 2MW or more
Wind Energy Generation on Crown Land Policy	Department of Natural Resources	Requests for wind energy projects on Crown land

*Further explanation/information on a Class 1 EA can be found in the Regulatory Time Frames for Environmental Assessment information bulletin by the NS Department of Environment and Labour (2001).

Approvals under the Environment Act may be required depending on development needs of project (e.g. installation of a bridge, maintenance of a culvert, etc.). As well, other provincial government departments such as Department of Agriculture and Fisheries, Department of Transportation and Public Works, Service Nova Scotia and Municipal Relations, and Department of Health and Department of Energy may have to be consulted.

Note that in comparison with other provinces Nova Scotia has relatively little provincial legislation impacting the placement of wind turbines. Ontario, for example, has a provincial noise regulation that requires wind turbines to have a Certificate of Approval (Noise) under Section 9 of the Environmental Protection Act for turbines located within 1 km of a receptor (PIBS 4709e), while the B.C. policy requires every wind farm to undergo computer model analysis for potential sound impacts (1205-01/WIND). The province of PEI's Planning Act (Section E 54.1 (1)) requires a setback as three times total height of the turbine from any existing habitable building. It also includes a series of setback requirements for wind turbines from dwellings, roads, and lot lines and also requirements for signage.

3.2 Municipal Policy Directions

The erection of wind turbines and the use of land for development of wind energy are considered to be a 'development' under the Municipal Government Act and are therefore subject to municipal land use policy and regulations. The Municipal Planning Strategy (MPS) is a key document that defines the vision, goals, objectives and overall policies that direct growth and development in the municipality. The strategy includes a set of policies that guide the Land Use By-laws (LUB). Section 3.2 provides an overview of policy directions (overarching planning mechanisms) used by various municipalities, while

Section 3.3 focuses on examples of by-laws and detailed guidelines on targeting various potential impacts of wind development.

Some Nova Scotian municipalities have included statements in their MPS or Official Plans that define their approach to wind turbine development. In almost all instances, the MPS includes a statement on the desirability of wind power, often making reference to Provincial goals around renewable energy. This is in all cases balanced by a commitment to enabling wind energy development while protecting the community against its impacts. Some examples of such MPS statements are:

- The County of Cumberland’s Official Plan recognizes the benefits of renewable energy and the County’s renewable energy resource and opportunities, specifically mentioning wind power. The County‘s intention is to support the development of wind turbines and to address concerns related to their development while recognizing the need for flexibility to accommodate advancements in technology.
- The MPSs in both the Counties of Argyle and Barrington recognize the desirability of emission free energy and accommodate wind turbine development in a manner that is flexible and yet responds to impacts on residential developments.
- Town of Truro indicates intent to facilitate wind energy development while ensuring minimal or no adverse affects through zoning, setback requirements and developing regulations and facilitating public review of important view planes.
- Cape Breton Regional Municipality (CBRM) MPS refers to facilitating the development of wind turbine projects and ensuring that existing developments are protected from adverse effects (height, noise and view planes).
- The Region of Queens Municipality MPS recognizes the economic and environmental benefits of the developments while also recognizing the need to limit potential impact to adjacent properties.
- The County of Pictou states their support for wind energy and intends to provide for the future development of wind turbines while regulating them so that there are no adverse affects particularly on residential development.

While the MPS statements are relatively similar across the board, there is significant variation among Nova Scotia municipalities in their policy response to wind energy in terms of the planning mechanisms used. This is best summarized in Table 7 for a selection of Nova Scotia municipalities.

TABLE 7 Current Regulatory Approaches to Wind Development Among Nova Scotia Municipalities (2007)

Municipality	Applicable Wind Turbine Regulatory Approach
District of Argyle	Wind turbines are permitted as-of-right in multiple zones except Coastal Wetland zone by development permit and subject to by-law requirements.
District of Barrington	Wind turbine generators are permitted to locate as-of-right by development permit in specified zones subject to by-law requirements.
Town of Truro	Development of wind turbines (total height not exceeding 80 m) will be by development agreement only in identified zones.
County of Cumberland	Small scale turbines (no greater than 100kW and power generated primarily for on site consumption) are permitted as accessory use in any zone where accessory uses are permitted. Large scale turbines are permitted by development permit subject to by-law requirements.

TABLE 7 Current Regulatory Approaches to Wind Development Among Nova Scotia Municipalities (2007)

Municipality	Applicable Wind Turbine Regulatory Approach
Region of Queens Municipality (Planned areas only)	Wind turbine generators were considered as-of-right in some zones but with proposed revisions to LUB, utility scale wind turbines are now being considered by development agreement.
Cape Breton Regional Municipality	Utility scale wind turbines are permitted as a General Provision throughout the municipality subject to by-law requirements.
County of Pictou	Utility and domestic scale wind turbines are permitted by development permit anywhere in planning area subject to by-law requirements.
County of Kings	Small scale turbines (no greater than 100kW and less than 52m) are permitted by development permit in specific zones subject to by-law regulations and turbines under 6.1m are permitted as accessory structures in any zone.
Municipality of East Hants	Mini and small scale wind turbines are permitted as of right subject to by-law requirements and large scale turbines are subjected to site plan approval and associated requirements.
District of Guysborough	Wind turbines and wind farms are permitted by development permit in certain zones subject to by-law requirements.
District of Lunenburg	Small wind turbines (less than 12,000 kWh per year) are permitted in designated zones and large scale wind turbine or multiple wind turbines capable of producing in excess of 12,000 kWh per year are permitted through a development agreement process in District 3.
HRM	Wind turbines permitted by development permit in certain zones subject to by-law requirements.

This variation is not unique to Nova Scotia. A similar range of policy approaches are in place throughout Canada and internationally as well. All Ontario municipalities surveyed use site plan control mechanisms for large scale wind turbine development. In Alberta, municipalities surveyed use a combination of development agreements and site plan control mechanisms. The City of Charlottetown only requires a building permit process. While in some cases small wind turbines are permitted as accessory uses, they can also be subject to site plan control mechanisms as has been done, for example, in Grey Highlands, Ontario.

3.3 Municipal By-law Case Studies

This section describes the approaches used by municipalities to address the various impacts described earlier in Section 2. Some municipalities have provisions to address each major impact directly (e.g. noise by-laws), while others have a framework that address several impacts simultaneously (e.g. setback distances accounting for noise, blade throw, ice throw etc), or a combination of both. Depending on what type of planning policy mechanism is used (e.g. as-of-right vs. development agreements) the approaches described below may be more prescriptive (e.g. by-laws) or discretionary (e.g. directions or requirements for inclusion in development application).

The following sections draw primarily, but not exclusively, on the experience of municipalities listed below:

Nova Scotia

County of Pictou

Town of Truro

County of Kings

District of Guysborough

Cape Breton Regional Municipality

Region of Queens Municipality

County of Cumberland

District of Barrington

District of Argyle

Halifax Regional Municipality

Municipality of East Hants

District of Lunenburg

Prince Edward Island

City of Charlottetown

Ontario

Municipality of Grey Highlands

County of Bruce

Township of Huron-Kinloss

Township of Frontenac Islands

County of Prince Edward

City of Windsor

Alberta

Municipal District of Pincher Creek

Municipal District of Taber

In the case of all municipalities, the by-laws examined were existing by-laws with the exception of HRM which is currently undertaking a major consultation and policy development process for wind turbines. Some of the by-laws were very recently passed as in the case of Grey Highlands, East Hants and Pictou. Some municipalities are in the process of reviewing their regulations as in Pincher Creek and Bruce County. In the case of Bruce County, there are references in some places in this report to proposed amendments being considered and debated to indicate the scope of emerging issues and regulations under consideration.

It is important to note that with new municipal regulations, the issues related to the experiences of practical applications, enforceability of regulations and challenges to regulations (on the part of both proponents and citizens) will continue to emerge. Just as wind technology is changing and requiring adaptation, municipal regulations will continue to change and adapt in response to technological change and the practical experience of wind turbine development in local contexts.

In response to this reality, a few Canadian municipalities with a history of dealing with wind energy have put in place review processes to revise and refine their municipal policy approaches. For example, the Municipal District of Pincher Creek planned for a review of wind turbine development in its Municipal Development Plan. Council was required to undertake a study which would examine the impact of wind energy development when 300 wind energy systems were constructed or 450 systems had been approved. Pincher Creek is currently in the process of this assessment having gone through the first stage of public consultation and proposed by-law amendments. Similarly, Grey Highlands requires that after one year of the wind energy system being approved and commencing operation, Council will undertake a review of the approval process including any public comments related to the facility and consider if amendments are required to any future planning process. The municipality is currently entering the process of establishing a Dispute Resolution Protocol that will create a complaint procedure for the public and identify solutions for remediation. Kings County policy for small wind turbines requires that council reassess the wind turbine policies within 5 years of adoption to review how many turbines are sited, the impact on tourism and landscape, the incidents of bird and bat kills, and any other identified issues.

There are also some examples of international regulations provided in this section.

3.3.1 Application Process

Where a discretionary planning tool such as a Site Plan Approval or Development Agreement is used to regulate wind turbines, an application process is involved. The following information represents a sampling of the type of information requested by municipalities in the application processes for wind turbine developments.

Large Scale Turbines

The most comprehensive example of an application process in Nova Scotia is Cumberland County. The application process requires a tentative site plan showing all buildings, boundaries and natural features and alterations of site and environs for 1km in addition to meeting the requirements for the zone where the turbine is located. Prior to construction the municipality requires a final site plan, decommissioning plan, copies of documentation of approvals from Transport Canada and Nav Canada, copies of all environmental assessment documentation required under the Canadian Environmental Assessment Act and any approvals or certificates required under the Nova Scotia Environment Act and regulations. The municipality also requires emergency response plans for site safety and adequate emergency service personnel training, and a professional engineer's design and approval of turbine base. In BC, development of wind turbines on crown land requires a report submitted by the proponent in the project development stage that includes two distinct sections: project definition and impact assessment. The development plan must include location, timing, construction particulars, public access and safety, installed turbine capacity, targeted long term production levels, environmental management strategies, site security, reclamation and decommissioning and other matters reasonably requested by the Ministry of Agriculture and Lands.

The Municipal District of Taber requires an accurate site plan including the location of overhead utilities on or abutting the subject lot or parcel; analysis of visual impact including the cumulative impact of other wind turbines and impact of overhead transmission lines; scale elevations or photos of turbines – total height, tower height, rotor diameter and colour; manufacturer's specifications; analysis of noise impact; specifications of foundations or anchor design; results of public consultation; status of government approvals including Nav Canada, Transport Canada, provincial government requirements; information regarding public safety; impacts to the local road system including required approaches from public roads; and a plan outlining decommissioning and reclamation of site. Pincher Creek has requirements similar to Taber but in addition includes a referral process by which the council shall consider the input from the adjacent jurisdiction if its boundaries are located within 2km of the wind turbine system and municipal district landowners within a 2km radius.

The Township of Frontenac Islands may require all or any of the following: noise impact study; visual impact study to determine impact and mitigation measures for shadow or reflection of light onto adjacent sensitive land uses; visual impact study on landscape as viewed from lake, road or other public lands; a study to prevent negative effect on airstrips or telecommunications; and a study to determine impact and mitigation for identified natural heritage features.

Huron-Kinloss Council requires a site plan for the area within 500m of subject property; approval of professional engineer for design; agreement to be subject to site plan control; compliance with noise mitigation requirements; Transport Canada approval if sited within 10km of airport; fulfill any requirements of the environmental screening process of province; and when placed on agricultural land ensure the continued use of prime agricultural land for farm use and minimize loss of production farm land.

The County of Bruce currently suggests the following considerations in their approval process: a professional drawing or site plan including all existing structures within 500m of subject property; professional engineer's approval; agreement to site plan control; compliance with provincial noise guidelines; setbacks and height that are established in zoning by-laws; written approval of Transport Canada if built within 10km of airport; identification of impacts and mitigation measures on urban areas and emphasis on using lands of lesser agriculture capability; and a holding provision.

The County of Bruce is also considering changes to its policies concerning wind generation systems. A proposed approval process being discussed would include the following elements: a noise assessment according to provincial standards including a map indicating all lands and sensitive receptors impacted by the >40dB emission level; report on how shadow casting has been calculated and the results for modelling for all receptors within 500m of a turbine; information about possible electromagnetic interference; a table indicating the setbacks for all sensitive receptors within 500m; an archaeological study if required by provincial government; and other information deemed critical by jurisdictional bodies.

<u>Large and Small Scale Turbines</u>

The Town of Truro requires a scaled plan with height and design configuration, including colour and lighting; location of proposed site and setbacks, topography, location and proximity to roadways and proposed access to site, distance to residential areas and other structures, existing and proposed vegetation, fencing and other security measures; written confirmation that turbine(s) will not affect telecommunications and radar; written confirmation that turbine(s) have been reviewed or will not require approvals from Transport Canada; graphic representation indicating visual impact of wind turbine on surrounding properties and from various vantage points throughout town; non-refundable processing fee plus advertising deposit; and any other information requested.

In Grey Highlands the process includes the following sections: preliminary consultation, public notification, information requirements and peer review. The preliminary consultation includes staff, proponent and Council to review the proposal and scope the requirements. Public notification outlines the process of notification. Information requirements are necessary information that must be provided for large systems and may be required for micro, small or medium systems: environmental impact assessment; visual impact assessment; planning justification report; site plan information; copy of documentation as part of environmental assessment acts; provide evidence that there will be no electromagnetic interference; provide report assessing shadow flicker impacts and mitigation measures; noise impact report; ice throw report; and management plan. A peer-reviewed report, at the proponents cost, may be required at council's discretion.

Developers in the UK are required to apply for a permit from the local planning authority (LPA) for any wind projects less than 50MW. Local officials check to ensure the plans are in accord with national, regional, and local regulations. The developer's environmental statement and the public's response to consultation are considered in the final decision made by the planning committee. If the project is rejected at this stage, the developer can appeal the decision. It is reported that there has been a one in three success rate of appeals.

Small Scale Turbines

The County of Kings requests that proponent provides manufacturer's information and Canadian Safety Association certification; a site plan for location of turbines in relation to lot lines, dwelling and adjacent dwellings; authorization documents from Transport Canada and Nav Canada; and an environmental impact assessment where required. The Municipal District of Taber requires an accurate site plan including the location of overhead utilities on or abutting the subject lot or parcel; scale elevations or photos of turbines – total height, tower height, rotor diameter and colour; manufacturer's specifications; analysis of noise impact; specifications of foundations or anchor design; and information regarding public safety. Pincher Creek requires manufacturer's information, letter of approval from Nav Canada, noise data indicating noise levels below 30dBA at property line in districts where use is discretionary and provide an analysis for noise to any residence located on adjacent properties within 200m radius, evidence that strobe and shadow effect will not affect the enjoyment of the adjoining residences, and any other evidence requested. The City of Charlottetown requires a site plan; location and proximity to other structures, residences, power lines or other utility lines within a radius equal to three times the tower height; certification by engineer or manufacturer; certified sound level values, approval from Transport Canada that the turbine development complies with the Aeronautics Act and the Charlottetown Airport Zoning regulations.

3.3.2 Decommissioning

While it is important to make provisions and plans for decommissioning of turbines before they are erected, the municipality faces a significant challenge in enforcing requirements for decommissioning. If a Development Agreement is used as the permitting mechanism, a bond can be required to ensure compliance with the proponent's decommissioning plan. However, where turbines are permitted as of right, the municipality has no way of imposing consequences on the developer or operator if the developer does not follow decommissioning requirements. This is important to keep in mind as municipalities decide on the policy and planning mechanism guiding the permitting of wind turbines.

Regardless of the challenges with enforcement, municipalities that have provisions for wind energy development often include requirements regarding decommissioning. Municipalities vary in the detail they require from wind turbine developers for decommissioning of turbine(s); some only require a date by which inactive turbines will be decommissioned. For example, Kings County requires the removal of small scale turbines within one year of inactivity. Several municipalities require that turbines be decommissioned within 2 years (Truro, Barrington, and Argyle).

Other municipalities specify in more detail the steps that need to be undertaken in a decommissioning process and the municipality's expected outcome of this process. Cumberland County specifies that all structures and accessory infrastructure for large turbines (including wind testing facilities and above ground accessory infrastructure such as overhead transmission lines and substations) be removed and the applicable surface site be restored to a reasonable natural state within 18 months (except for roads) of the time a turbine has ceased to produce power for 6 months or when the development of the project ceases. Pincher Creek requests that preliminary plans for decommissioning is included in the application and indicates that once a turbine has not produced power for a minimum of 2 years a status report is required. Council then reviews the report and can request the turbine be decommissioned.

Grey Highlands includes in its decommissioning plan method of removal, reinstatement of the lands to its prior use, and estimation of the costs of decommissioning and how this would be funded entirely by the developer including the determination of securities. Proponent will submit a status report to council within 3 months of a turbine not producing power which will identify the reason for the shut down and estimated timeframe to return to operational status. If the turbine is not operational within 1 year or longer, at the discretion of council, decommissioning of the turbine will commence according to management plan.

Nova Scotia Power Inc. (NSPI) would require a bond for decommissioning if the development is on crown land or offshore; however, if the land is privately owned, it is a matter up to the landowner and developer to negotiate. Once the developer and landowner have reached an agreement, the developer acquires a Power Purchase Agreement from NSPI (if not exporting the energy elsewhere).

3.3.3 Health and Safety

There are several issues related to health and safety of wind turbines. Municipalities have developed policies and regulations to effectively mitigate against these potential impacts. Most commonly, setbacks are the mechanism used to protect the community against most of these impacts. Other possible approaches are explored in this section.

<u>Ice Throw</u>

There is little mention of specific measures to deal with ice throw and ice shedding impacts of wind turbines in the municipalities surveyed. An exception is Municipality of Grey Highlands which requires an ice throw report that includes an assessment of the likelihood of ice throw and the mitigation measures which should include the use of an ice detection system and operational protocols to eliminate or minimize ice throw risks. The municipality also requires a map outlining the extent of risk of ice throw around each turbine overlaid on a site plan illustrating features on and off the site. Design standards (certification and type approval) are required in the management plan to reduce risks associated with ice throw.

CanWEA recommends for large scale turbines a minimum distance of the blade length plus 10m from public roads, non-participating property lines and other developments as a setback distance to address ice throw. Based on current wind turbine systems being installed that have blades ranging from 38 to 42m the setback would range between 48 to 52m from roads or property lines. For proposed wind turbine systems within 50 to 200m of a public road, a risk assessment must be done and mitigation measures put in place to minimize individual risk. CanWEA states that beyond 200m the risk of ice throw is essentially removed; however, as indicated in Section 2, there is considerable difference of opinions on what this "safe distance" may be.

Planners in Bruce County have recommended in a review process of the Official Plan that in the county's planned overview of wind turbine policies that further research be undertaken with Environment Canada and other weather experts on cold weather operation of wind turbines and potential safety issues in light of changing weather patterns.

Turbine Tower Design

The issues related to safety and tower design include the height of turbine blade from grade and generally the minimum requirement of rotor blade clearance from grade is 7.5m. CanWEA suggests that a minimum of distance between the lowest reach of rotor blades and the ground be 8 to 10m. Municipalities require fencing, lockable gates and/or lockable doors to address tower access and safety depending on the design of the wind turbine system. For monopole designs generally a lockable door is a sufficient requirement. For other turbine designs, security fences (of at least 1.8m in height) with lockable doors are required. There are often specifications in by-laws that a ladder or other access device not be located closer to the ground than 3 to 3.7m.

For small wind turbines that are supported by guy wires, CanWEA recommends that the innermost and outermost guy wires be clearly visible to a height of 2m above the guy wire anchor lines. In a survey conducted on behalf of CanWEA of by-laws for small wind turbines, either blade clearance was not mentioned specifically or a separation distance between the blade tip and grade ranged from 4.5m to 6.1m (Small Wind Siting and Zoning Study, 2006).

There is varying opinion about the safety of small wind turbines mounted on roofs and attached to sides of buildings. In Europe, there is growing interest in urban wind turbine applications that would include these types of applications but research into their viability and safety is at an early stage. In North America there is not a lot of practical experience with these applications (WINEUR, 2005). The County of Kings allows the mounting or attaching of a turbine to another structure only if the turbine is less than 6.1m.

Blade Throw

Some municipalities address issues of blade throw through ensuring that wind power systems meet the approved standards of organizations such as the International Electrotechnical Commission and Canadian Safety Association and having a professional engineer's approval of the project. Grey County, for example, requires design standards (certification and type approval) in the management plan to reduce risks associated with blade throw. Research in California (Larwood 2006) indicated that municipalities were using setbacks between 1.25 and 3 times the total height of the turbine to provide protection from blade throw. There was no conclusive appropriate setback distance proposed by the study and further research is continuing in the area.

In their suggested proposals for setbacks for large wind turbines in Ontario, CanWEA recommends setbacks for residential and town/village boundaries be calculated according to the separation distances required to prevent impacts from noise in Ontario rural areas. CanWEA suggest that the setbacks would be sufficient to prevent negative impacts from blade throw since they were generally greater than 250m. CanWEA recommends for large scale turbines a minimum distance of the blade length plus 10m from public roads, non-participating property lines and other developments as a setback distance to address blade throw. Based on current wind turbine systems being installed that have blades ranging from 38 to 42m the setback would range between 48 to 52m from roads or property lines. For proposed wind turbine systems within 50 to 200m of a public road, a risk assessment must be done and mitigation measures put in place to minimize individual risk.

Turbine Structural Failure

Some municipalities address issues of turbine structural failure, as they do ice and blade throw, through ensuring that wind power systems meet the approved standards of organizations such as the International Electrotechnical Commission and Canadian Safety Association and having a professional engineer's approval of the project. Grey County, for example, requires design standards (certification and type approval) in the management plan to reduce risks associated with turbine structural failure. CanWEA recommends that small wind turbines have an engineering analysis of the towers.

Oil Spills

There were no specific references to prevention of oil spills in the municipal by-laws surveyed. A local authority in Massachusetts (County of Barnstable Massachusetts, cited in HRM Draft Wind Energy Master Plan, 2006) has recommended that tower structures be designed to contain any spills or leakages.

Fire Damage and Risk

There were no specific by-laws relating to fire damage and risk in the municipalities surveyed. A couple of municipalities requested proponents to provide an emergency management plan (Grey Highlands and Cumberland County), which would encompass emergencies related to fire. In Australia, local fire departments are specifically contacted by wind farm developers so that an emergency plan is coordinated and access to locked gates and facilities is planned for.

Aviation Safety

Many municipalities require that a wind turbine proponent provide documentation that the system is in compliance with applicable air safety regulations concerning lighting, colour and markings, height and location. Any structure taller than 20m above ground level, within 6km of an airport, or 2km of a Transport Canada radar, radio navigation or radio communication tower needs to be reviewed by Transport Canada. Nav Canada and DND also require notification of turbine developments within 10 km of airports. Nav Canada requests notification of any proposed structure taller than 30.5m. Some municipalities specifically require written approval from Transport Canada when a large turbine is sited within a 10km distance of an airport (County of Bruce). The Town of Charlottetown requires approval from Transport Canada and compliance with any Federal or Provincial regulations pursuant to the Aeronautics Act and the zoning regulations of the local airport.

3.3.4 Shadow Flicker

Municipalities have addressed the issues of shade flicker and shadow casting through several measures.

Pincher Creek requires the proponent to provide evidence that strobe/shadow effect will not affect the enjoyment of the adjoining residences for small wind turbines. Town of Truro requires that wind turbines do not cause existing residences to experience shadow or flicker. The Township of Frontenac Islands can require a visual impact study to determine impact and mitigation measures required for shadow or reflection of light coming from any part of the wind turbine onto adjacent sensitive land uses.

In Grey Highlands, a report assessing impact of shadow flicker on any point of reception and proposed mitigation measures is required. The methodology used for a report for large scale facilities is based on all turbines within 1300m of a point of reception, a maximum of 30 hours of shadow flicker per year at any point of reception modeled on the astronomically worst case scenario, and graphic modeling of shadow flicker for the site.

The County of Bruce is proposing an amendment that would include a regulation that states that shadow flicker, experienced by a sensitive non-participatory receptor within 1500m of a the turbine, shall not exceed a maximum of 30 hours per year of maximum of 30 minutes per day as a result of the wind turbine. Shadow flicker calculations would be based on “worst case scenario” in that prevailing weather or cloud cover conditions will not be taken into consideration. Mitigation of shadow flicker will not be considered. Shadow casting for all sensitive non-participatory receptors located within 500m need to be calculated and the results of modelling provided. The use of the worst case scenario calculation is anticipated by the planning department to be a contentious issue.

3.3.5 Height

In many municipalities there is a general provision in the by-laws that exempts several forms of towers and spires, including those of wind generation systems, from height restrictions. These types of provisions allow for the erection of a wind turbine.

Some municipalities have an additional provision restricting the total height of wind turbines in order to manage the scale and visual impacts of such structures. The total height is measured from the finished grade to the uppermost extension of the rotor blade. The tallest wind turbine in the world currently is just over 200m tall (located in Lassow, Germany). Example restrictions can be found in Table 8 below.

TABLE 8 Example of Height Restrictions

Town	Height Restriction (m)
Town of Truro	80
Township of Huron-Kinloss	120
Township of Frontenac Islands	130

In the case of small wind turbines, the County of Kings and East Hants both restrict the height allowance to no more than 52m in height. The Municipal District of Pincher Creek is considering changes to its Land Use By-laws to define small scale wind energy conversion systems as 25m or shorter in height. The maximum height for small turbines in the City of Windsor is 30m while the City of Charlottetown restricts the total turbine height to 23m. The County of Kings also restricts the height of a turbine that can be attached or mounted to another structure to under 6.1m. CanWEA's publication (Small Wind Siting and Zoning Study, 2006), notes that small to medium wind turbines generally require tower heights of 24-50m to reach reasonable wind currents that are adequate for generating energy. The document ties in lot size requirements to height restrictions (for example, for property sizes between 0.1ha and 0.2ha the wind turbine tower height would be limited to 25m and the property sizes of 0.2ha or more there would be no wind turbine tower height limitation).

The height of the turbine can affect the setback distance since many municipal by-laws are based on a formula that multiplies the total height of the turbine by a set numeric value to generate a value for the setback distance.

3.3.6 Management Plan

Management plans are sometimes required by municipalities to clearly outline a developer's responsibilities for the wind turbine development over its total lifecycle. As with decommissioning plans, there are challenges with enforcement if development takes place as of right. If a development agreement is used as the permitting process, the municipality has more power in ensuring that the management plan is carried out, for example by requiring a bond or regular monitoring and reporting. It should be noted that provincial and federal Environmental Assessment processes often require an Environmental Management Plan that larger wind power projects will likely be subject to. Where a in the same direction and be kept operating at once. East Hants requires that a visual representation including scale, elevation, colours, proportion of wind turbines, photographs and digital representations showing placement and landscap however there is often a requirement for annual reporting (for example, results of bird monitoring) which is one way that the regulators can stay in contact with proponents during operational stages of the project.

Some municipalities require management plans as part of the development agreement application. The management plan for Grey Highlands includes the following categories: procedures for rehabilitation/reinstatement of temporary disturbance areas; construction details; traffic management with details on volumes, frequencies and haul routes of construction vehicles; decommissioning details; emergency management plan which includes details concerning on-site safety and measures to train emergency services personnel; preventative maintenance; and design standards and safety protocols to reduce the risks associated with ice throw and blade/turbine failure.

The County of Bruce is considering the requirement of an Environmental Management Plan that outlines the construction details; operational and maintenance requirements of the wind turbine systems; establishes the process for complaints, any required mitigation measures and required monitoring; and a description of how decommissioning and rehabilitation of the turbines and ancillary infrastructure will be handled.

3.3.7 Noise

Policies and regulations to mitigate the impacts of noise from wind turbines vary greatly across jurisdictions in Canada and internationally. The most common approach to date has been to introduce a prescribed setback distance as described further in the section on setbacks, given that noise levels decrease with increasing distance. A second approach, used by a growing number of municipalities and recommended by CanWEA and by the wind industry generally, is to use a decibel approach, setting a standard for the acceptable sound level at a receptor such as the outside of a neighbouring residence. There is considerable variation in the acceptable decibel levels between jurisdictions. The acceptable level is also influenced by the setting (if it is in an urban or rural area, with rural areas having lower levels of background sound) or the time of day (higher levels are more common during the day). Noise strength is affected by siting and environmental conditions at the site – the distance sound travels, air absorption (affected by weather conditions), reflection, screening (terrain), vegetation and ground (Søndergaard, DELTA). The World Health Organization has defined 30dB as an acceptable level inside a residence bedroom (WHO, 1999) which would equal a sound level of 40dB outside of the residence once sound has passed through an open window. For wind turbines, CanWEA recommends a sliding scale for acceptable sound level starting at 40dBA at wind speed of 4m/s, rising to 53dBA at 11m/s. Table 4 in Section 2 provides a summary of the various setbacks and noise level limits that have been used across the world.

Municipal by-laws on noise in Nova Scotia, where they exist, are generally defined as restricting "activities that unreasonably disturb the peace and tranquility of a specific area". Quantitative standards in terms of acceptable decibels of sound for wind turbines have not been established at the provincial level in Nova Scotia. The Town of Truro, parts of Lunenburg County and East Hants County have developed a decibel standard at the municipal level. Truro requires all turbines be constructed so that the noise produced does not exceed 40dBA or 5dBA above background noise, whichever is greater, when measured at a non-participant dwelling or structure or in a residential zone. East Hants requires that noise levels "do not exceed 40dbs or above the existing background noise" at adjoining property lines. District 3 in Lunenburg sets a 45dBA from adjacent property lines for wind turbines.

Among the jurisdictions surveyed within Nova Scotia, the separation distances between wind turbines and habitable dwellings on an adjacent property ranged from 150m to 600m or 2 times to 4 times the total turbine height. These separation distances would take into consideration concerns about noise impacts and other safety issues. For municipalities that do not use a decibel approach, a specific separation distance (either a specific metre distance or a multiple of the total tower height) is used to provide protection against noise impacts.

In Ontario, the provincial government requires wind turbines to have a Certificate of Approval (Air) under Section 9 of the Environmental Protection Act for turbines located within 1km of a receptor. Specific guidance for wind turbines is given in urban and rural areas and supplemented in the document "Interpretation for applying MOE Technical Publications to Wind Turbine Generators" (note that Ontario's Ministry of the Environment has recently initiated a review of the noise policy for wind turbines). In urban areas, the lowest sound level limit at the point of reception (dwelling where sound or vibration is received) under conditions of average wind speed (up to 8m/s) is 45dBA, while in rural areas, it is 40dBA. Noise impact assessments calculate sound pressure levels at each critical point of reception for each wind turbine or wind farm and are to use the ISO 9613 standard.

In Alberta, Directive 038: Noise Control of the Energy and Utilities Board (EUB), states the requirements for noise control that apply to all operations and facilities under the jurisdiction of the EUB including wind turbines (those approved under the Hydro and Electrical Energy Act). The directive sets permissible sound levels for outdoor noise at the point of receptor. The basic sound level at night time is determined to be 40dBA Leq and 50dBA Leq during daytime. A Noise Impact Assessment is required to ensure that possible noise impacts are considered prior to construction and operation and new wind turbine development must use computer modelling that includes the cumulative effects of adjacent wind farms or wind turbines. The directive also states that a new development must not exceed a sound level of 40dBA Leq (night time) at 1.5km from the facility fence line if there are no closer dwellings.

In British Columbia, the provincial government developed the Wind Power Projects on Crown Land Policy (2005) that states wind turbine sound level will be reduced to a maximum of 40dBA on the outside of an existing permanently-occupied residence not owned by the proponent or the closest boundary of existing, undeveloped parcels zoned residential and not owned by the proponent. The BC policy states that the locations of the turbines will be determined through modelling, using a methodology that satisfies the ISO 9613-2 standard. The sound level requirement will be applied to residences and undeveloped parcels zones residential in existence at the time of application. Unlike Ontario which does not require a sound assessment when the distance of turbine and receptor is greater than 1km, the B.C. policy requires every wind farm to undergo computer model analysis for potential sound impacts.

Municipalities are also initiating the inclusion of specific requirements from wind energy proponents in reports on noise impacts. The Municipality of Grey Highlands Official Plan requires a Noise Impact Report for large scale wind energy systems (and possibly for smaller systems) that includes characteristics of noise emanating from individual wind turbines and the cumulative levels of multiple wind turbines; air absorption based on frequency; ground effects such as vegetation, buildings and structures and topography; weather effects including prevailing wind direction, wind speed and variations in wind speed at different heights and potential for lower background noise levels; tonal noise at discrete frequencies and/or an identifiable pattern that may be heard through background noise; broadband noise created by interaction of blades and atmospheric turbulence; and low frequency or impulsive noise. The Municipal District of Pincher Creek requires that development applications include an analysis of potential noise at the site of installation, the boundary of the parcel containing the development and any habitable residence within a 2km distance for large wind energy conversion systems and for small wind energy conversion systems an analysis for noise to any residences that are located on adjacent properties within a 200m radius.

The County of Bruce is considering including some provisions in their Official Plan that would ensure that large wind turbine generating systems be planned in a way that no more than 25% of a neighbouring non-participatory landowner’s lot would be impacted by a potential noise exposure from a turbine that would be greater than that allowed by the provincial guidelines for a sensitive receptor. This same county is considering requiring proponents to provide a map that shows all lands and sensitive receptors potentially impacted by the >40dBA emission levels so as to give context of how noise from turbines will affect neighbouring landowners. As well, consideration will be given to regulation that requires new land uses in zones that permit wind energy conversion systems to be developed in accordance to provincial noise regulations.

With regard to small wind turbines, CanWEA in their publication “Small Wind Siting and Zoning Study,”, proposes that the mean value of the sound pressure level from small wind energy systems not exceed more than 6dBA above background sound, as measured at the exterior of the closest neighbouring inhabited dwelling for wind speeds below 10m/s. In Alberta, the Municipal District of Pincher Creek requires that noise levels for small scale wind energy conversion systems in land use districts where use is discretionary should not exceed 30dBA at the property line. There is some discussion on the accuracy and appropriateness of using a decibel measure for small turbines given that background noise can make the wind turbine noise indistinguishable (Kings County, Dalhousie Report, 2006).

3.3.8 Electromagnetic, Radio, Telecommunications, Radar and Seismoacoustic Systems

Wind turbines, either individually or grouped in wind farms, can negatively affect radio, telecommunications, radar and seismoacoustic system. Several municipalities require some form of documentation from Nav Canada that would address some of the potential electromagnetic interference issues. The only specific reference to electromagnetic interference in the policies and by-laws surveyed in Canada was in the Municipality of Grey Highlands which requires evidence that electromagnetic interference will not occur as a result of the proposed development and refers to potential impacts on the integrity of the Government of Ontario's Public Safety Network.

The Radio Advisory Board of Canada (RABC) and CanWEA developed the Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radio Communication, Radar and Seismoacoustic Systems in 2007 to provide guidance for proponents to determine if there is a possibility that a proposed wind farm may impact these systems. The document is not intended to be used for the basis of any regulatory decision; however, it is important for municipalities to be aware of the potential constraints for wind turbine proponents based on these systems being present in the municipality. Determining whether there would be unacceptable interference would have to take place through site specific analysis. The document outlines general guidelines for determining the consultation zone – a zone where a proponent would require consultation with the appropriate agency responsible for the system:

- For point-to-point system, over-the-air reception (FM transmitter), cellular type network, satellite system, and land mobile networks the radius of consultation should be at least 1km.
- For Natural Resources Canada monitoring array, the radius of consultation should be at least 50km and least 10km from a single monitoring station.
- For seismoacoustic monitoring array, the radius of consultation zone should be 10km.
- For DND Air Defence Radar the radius of the consultation zone should be at least 100km and the radius for DND or Nav Canada Air Traffic Control Search Radar should be at least 60km.
- For a major military or civilian airfield the radius of the consultation zone should be at least 10km.
- For Environment Canada Weather Radar the radius of consultation zone should be at least 80km.

The RABC and CanWEA document also provides contact information for the appropriate agencies and more detailed information about zones of consultation and how they are determined.

Several Nova Scotian municipalities have recently been contacted by DND facilities in their areas concerning developments of wind turbines, indicating that this topic is an emerging concern for both DND and municipalities. One municipality has been requested to contact the local DND facility to ensure strategic placement of future wind turbines in relation to Defence Radar Infrastructure within a 60 km radius of DND radar facilities.

In relation to small turbines, there currently seem to be no concerns related to electromagnetic interference (CanWEA, Small Wind Siting and Zoning, 2006), although how small turbines are defined may not be consistently understood among various parties concerned with this issue.

3.3.9 Roads

The impacts on existing roads and the development of new roads for wind turbine development are addressed in some municipalities. Grey Highlands requires a traffic management plan that includes details on volumes, frequencies and haul routes of construction vehicles. In Pincher Creek, the application process requires a report on impacts to local roads that includes approaches from public roads and follows municipal road standards. For developments on crown land in BC, roads are permitted up to maximum of 20m in width. In the Town of Frontenac Islands wind farms will have access to a public road either deeded by right of way or licence.

3.3.10 Separation Distances and Setbacks

Separation distances for wind turbines address a number of objectives including noise, visual impact, safety, environmental protection and other on and off-site impacts. Separation distances can be defined at the federal, provincial and municipal level. For example, some distances will be defined by federal agencies concerned with aeronautical safety, protection of fish habitat, navigable waters, species at risk, and migratory birds. Some provinces such as Ontario, Alberta and British Columbia have province-wide noise guidelines for industry and utilities with specific reference to wind turbines.

The use of the terms separation and setback are used interchangeably in this text. Technically, a setback describes the distance between a property line and a building. Separation distance would be used to describe the distance required to separate structures in other circumstances (separation based on noise levels, other structures, safety concerns, etc.). Due to the fact that the majority of the literature reviewed and the municipal regulations surveyed used the term setback to describe both the technical definition and all other separation considerations, this report predominately uses the term setback to describe both mechanisms.

Municipalities, within Nova Scotia and across Canada, vary in the complexity of separation and setback requirements for wind turbine developments. These distances vary according to a number of factors including whether the setting is either urban or rural, the population density, the size or nameplate capacity of the turbine, and the number of turbines considered for development. Separation distances are also developed that regulate the relationship of turbines to one another on a site and to dwellings or other buildings associated with the turbine or property. There are different approaches to the goal of what setbacks or separations distances address. For example, the Municipality of Grey Highlands, in recent amendments to wind turbine by-laws, has approached the issue of setback or separation distances through a process of defining a study area with a number of criteria that needs to be assessed and evaluated as opposed to defining specific setback distances.

Some municipalities only have setbacks for regulating the placement of turbines in relationship to closest receptors or dwellings while other municipalities have a series of setbacks for dwellings on and off site, roads, property lines, other turbine developments, and special zones. An established setback from a neighbouring dwelling will protect residents within the dwelling from the unwanted impacts of wind turbines (e.g. noise) while an established setback from the property line will protect neighbouring properties in their entirety – thus for example, allowing neighbouring properties full liberty in building new structures anywhere on their site without having to worry about impacts of the wind turbines on any such new structures. The Regional Municipality of Cartier in Manitoba originally considered a separation distance of 2km to adequately allow for aerial spraying of crops, but as a result of recent research, now believe 500m will be sufficient for this purpose (personal communication, 2008)

In some cases, the development of setbacks from either dwellings or property lines will greatly affect the ability of proponents to build wind turbines. The County of Pictou changed its draft setback criteria from originally having setbacks for property lines to setbacks for dwellings since the lot sizes in the county were of the size which would severely restrict wind turbine development if based solely on property lines. The change to setbacks for dwellings allowed for greater opportunity for development of wind turbines. Similarly, Cumberland County measures setbacks from “an existing building intended for human occupation on a neighbouring property,” not from property lines. This is to avoid problems associated with narrow properties; putting the separation where it is needed and not inadvertently restricting development on neighbouring properties through a reverse application of setbacks.

Table 9 below illustrates examples of application of various types of setbacks used in Canadian municipalities.

TABLE 9 Setback Approaches and Examples

Type of Setback	Description and Examples
Setbacks for dwellings on neighbouring property	These setbacks are calculated in many different ways. Municipalities have used setbacks based on a multiple of the total height of the tower. Some municipalities determine the setback according to the size of the radius of the blade or a multiple thereof. Land use by-laws may also be used to specify requirements for notification of neighbours within a specified radius of a wind turbine development, in this case a small wind turbine. Examples include: ▪ Twice the total height of a horizontal or vertical axis rotor for utility scale(Argyle) ▪ The greater of 500m or 3 times or 300% of the height of the wind turbine (grade to highest point of rotor arc) (Cumberland) ▪ For a utility wind turbine height (height of tower plus the radius of the rotor) up to 76.2m the setback is 175.3m; for a wind turbine height greater than 76.2m the setback increases .304m for each 0.304m increase in height (CBRM) ▪ Minimum setback is 600m for utility scale. When a residence is constructed within the setback distance of utility scale turbines erected after the effective date of the by-law, the wind turbine development may expand as long as it is not located closer to the residence than the initial wind turbine development. (Pictou) ▪ No wind turbine closer than 400m to adjacent residential or commercial property (Guysborough – Districts 4,5,6 & portions of 1&2) ▪ No wind turbine closer than 15m of twice the distance of the blade radius from the boundary whichever is greater to an adjacent residential property (Guysborough – Northeastern Guysborough Planning Area) ▪ Minimum setback to rural residential is 600m for turbine above 40kW (Huron-Kinloss) ▪ Minimum setback from dwelling outside wind turbine zone is 350m (Township of Frontenac) ▪ Minimum setback from nearest neighbour’s dwelling 150m to 600m depending on zoning and size of lot and size of kilowatts permitted (Prince County) ▪ Not less than twice the height of the turbine (ground to top of rotor’s arc) from dwelling (Taber) ▪ Not less than four times height (arc) from dwelling unit (not belonging to the owner of the land on which the turbine is to be situated). (Pincher Creek) ▪ Twice the height of turbine (arc) from buildings on adjacent lot for small turbine (Charlottetown) ▪ Minimum setback is three times total height from any existing habitable building (PEI) ▪ Minimum setback of 110% of total height of the turbine from nearest dwelling. When tower of small system is attached to a building the min. setback from the nearest dwelling on a different lot will be equal to 110% of the total height of the tower. (City of Windsor)

TABLE 9 Setback Approaches and Examples

Type of Setback	Description and Examples
Setbacks with dwellings on site	Some municipalities explicitly state that there are no setback requirements for turbines from dwellings on the site as the turbine while other municipalities require setbacks that include distances based on a multiple of tower height from all habitable units regardless of which property they are on. Setbacks are also sometimes set for accessory buildings related to wind turbines. Examples include: ▪ Twice the total height of a horizontal or vertical axis rotor from a large turbine in any zone (Argyle) ▪ Minimum setback from an existing building for human occupation on site is 1.25 times or 125% of height of large scale turbine (Cumberland) ▪ Setbacks are waived for dwelling of owner of the property of utility scale turbine (CBRM) ▪ No setback requirement for residences on same lot for utility scale turbines (Pictou) ▪ Minimum setback 1.10 times the total wind turbine height for residential buildings and 10m from all lot lines (or provisions for setbacks from roads whichever is greater) for accessory wind generation facilities - >40kW (Huron- Kinloss) ▪ Minimum setback from dwelling in wind power zone is 5m plus the blade length (Township of Frontenac) ▪ One and a half times the height of turbine (arc) from building on property for small (Charlottetown) ▪ Minimum setback is 3 times total height from any existing habitable building but can build closer on the lot if it meets the above criteria and if permit holder is owner of lot and if turbine is not closer to dwelling on lot than the distance equal to total height of turbine, (PEI)
Setbacks from property lines	Setbacks from property lines are calculated using a variety of measures including set distance, calculation based on a multiple of the total height of turbine and length of blade plus a defined number of metres. Some municipalities include setbacks for turbine accessory facilities from property lines as well. Municipalities will waive setbacks from property lines if neighbouring owner grants permission or if the properties are held in same ownership. Examples include: ▪ Minimum setback from external property line is the length of the rotor arc plus 7.5m for large scale (Cumberland) ▪ Minimum setback from all property lines is one times the height of turbine (ground level to height of rotor blade in vertical position) for utility scale (Pictou) ▪ No closer than 400m from property boundary line for wind farms (Guysborough) ▪ No closer than 4 times the total height of turbine from adjoining property lines and in case of wind farms greater or lesser setbacks can be considered through an impact study (East Hants) ▪ Minimum setback from property line for village residential zone is 350m and minimum setback for property line for other zones is length of turbine blade plus 5m (Township of Frontenac Islands) ▪ 1.2 times the height of turbine (arc) from buildings on adjacent lot for small (Charlottetown) ▪ Minimum setback from adjacent lot lines shall be a measurement equal to the length of 7 rotor blades (Lunenburg, District 3) ▪ Not locate closer than total height of turbine from lot line that is not owned by permit holder – unless permit holder gets permission from owner of land (PEI) ▪ No turbine will be positioned any closer than 1.5 times the total height of the turbine to any tenure boundary in any direction for safety reasons (BC Crown land)

TABLE 9 Setback Approaches and Examples

Type of Setback	Description and Examples
Setbacks from roads	Setbacks from nearby roads may be calculated using the variety of measures including set distance, calculation based on a multiple of the total height of turbine and length of blade plus a defined number of metres. Examples include: ▪ Minimum setback from public highway is 1 times or 100 percent of the height of turbine (Cumberland) ▪ Minimum setback from boundary of public road is 300m for utility scale (Pictou) ▪ Minimum setback 1.25 total height of turbine from right-of-way line for >40kW (Huron- Kinloss) ▪ Minimum setback is length of turbine blade plus 5m (Township of Frontenac) ▪ Not less than twice the height of the turbine (ground to top of rotor's arc) from dwelling and meet other setbacks that cover principal use and if this is not sufficient for public roads the setback can be increased(Taber) ▪ Setbacks must meet principal use in district and can be increased to reduce impact for utility scale (Pincher Creek) ▪ Not to be closer than total height of turbine to nearest road/right of way except for access road (PEI) ▪ Public road footage requirement may be waived if lot for wind turbine abuts and fronts upon a private road or on a 'K' road or if existing lot or newly created lot is served by an existing right-of-way (or if a new right of way is created it shall have a minimum width of 6m) for utility scale (Argyle and Barrington)
Setbacks for multiple turbines on a site	Municipalities sometime regulate the separation distance between turbines on a site and increase minimum setbacks when there are multiple turbines on one site. Some municipalities do this on a case by case basis taking into consideration proximity to other immediate land uses, density of turbine development, underlying utilities and information gathered from development hearing. Examples include: ▪ Minimum separation between small scale turbines shall be equal to or exceed the height of the tallest turbine (Kings County) ▪ Setback can be increased from minimum when there are multiple turbines (Taber)
Setbacks for multiple wind turbines on multiple properties	Municipalities have developed setbacks for turbines on multiple properties in several different configurations including: setbacks for wind turbines on adjacent properties but different projects, setbacks for wind turbines on adjacent properties but same project, setbacks for wind turbines on adjacent properties of same ownership. Examples include: ▪ Setbacks for wind turbines on adjacent properties but different projects- Minimum setback is four times the diameter of the rotor for large scale turbines (Cumberland) ▪ Setbacks for wind turbines on adjacent properties of same ownership and which contain wind turbines- Minimum yard requirement may apply to the abutting yard – measured from tower base to the lot line for utility scale (Barrington)
Setbacks for special zones	Municipalities have instituted setbacks for special zones such as coastal shorelines and lakeshores. Examples include: ▪ Where wind turbines abut coastal shoreline (actual high-water level) or the Coastal Wetlands zone boundary line, the minimum yard requirement for the abutting yard is ½ the diameter of the rotor blade's full arc plus applicable minimum yard requirement for utility scale (Argyle) ▪ Where wind turbines abut coastal shoreline (actual high-water level) the minimum yard requirement of the abutting yard is not less than ½ the diameter of the rotor's arc plus applicable minimum yard requirement. Where abutting yard is within Coastal Wetland zone and the distance as measured from the CW zone boundary to the coastal shoreline is greater than the minimum yard requirement of not less than ½ the diameter of the rotor's arc plus applicable minimum yard requirement, then the minimum yard requirement will be the greater distance for utility scale(Barrington) ▪ No wind turbines within 100m of a lake edge (Guysborough)

TABLE 9 Setback Approaches and Examples

Type of Setback	Description and Examples
Setbacks for small wind turbines	Setbacks for siting small turbines include the following mechanisms: distance from line determined by total height of turbine, distance from line determined by total height of turbine multiplied by a numeric value, and distance from line determined by not exceeding a maximum rotor diameter on a lot according to differing lot sizes. Municipalities have also defined minimum lot size for turbines, particularly small turbines, which limits the development of turbines on certain lots. Examples include: ▪ Setback of 183m from neighbouring residential dwellings for small scale turbines (Kings) ▪ At minimum, setback for small scale should be equal to turbines total height (base to tip of rotor blade) from lot lines, dwellings, public parking lots and public right of ways (Kings County) ▪ Mini turbines (under 1000W) shall have a setback of the total height of the tower from adjoining property lines and small scale wind turbines (under 10kW and under 52m) shall have a setback of 1.5 times the total height of tower from adjoining property lines (East Hants). ▪ Setback from lot line is not less than the proposed height of the small turbine (Proposed Bruce County) ▪ On lot area of less than 1.0ha the rotor diameter will not exceed a max of 7m (total swept area of no more than 40m^2); on property of more than 1.0ha the rotor diameter shall not exceed a max of 15.0m (total swept area of 180m^2) (Proposed Bruce County) ▪ Horizontal distance measured at grade from tower to the property boundary is at least the total height of the turbine (Taber) ▪ Base of system shall be located 4 times the height of the tower from property line; only one system allowed per titled area (Pincher) ▪ Roof mounted turbines are not permitted; only on lots of minimum width and length of 3 times the height (arc) of the turbine, not in front or side yard area, guy wires and anchors should not be located closer than ¼ of the height of the turbine (arc) to the property boundary (Charlottetown) ▪ Twice the height of turbine (arc) from buildings on adjacent lot for small turbine (Charlottetown) ▪ One and a half times the height of turbine (arc) from building on property for small (Charlottetown) ▪ Minimum setback of 110% of total height of the turbine from nearest dwelling. When tower of small system is attached to a building the min. setback from the nearest dwelling on a different lot will be equal to 110% of the total height of the tower. (City of Windsor)

CanWEA has undertaken a substantive study on this topic and developed a set of recommendations for large scale turbines in rural Ontario concerning setbacks. These recommendations identify two key considerations when establishing setback distances: ensuring acceptable sound levels for surrounding dwellings and ensuring public safety for ice shedding and turbine failure. CanWEA's recommended setbacks for large turbines in rural areas are as follows:

- Neighbouring Dwelling Setbacks: calculated with the Ontario Ministry of the Environments regulations for appropriate sound level limits for rural areas (estimated at 250m or greater given current wind turbine technology)
- Public Road Setbacks: a minimum distance equal to one blade length plus 10m from the nearest public road (proponent to demonstrate through risk assessment and mitigation measures that individual risk is minimized for turbines proposed within 50m to 200m of the public road).
- Property Line Setbacks: a distance equal to one turbine blade length plus 10m from all property lines unless appropriate agreements or easements are put in place with adjacent property owners.
- Radio, Telecommunication, Radar and Seismoacoustic System Setbacks: determined according to a review of the guidelines developed by the Radio Advisory Board of Canada and CanWEA
- Environmentally Sensitive Areas and Natural Feature Setbacks: determined through site-specific study as part of either provincial or federal environmental assessment processes.

CanWEA's proposed recommendations for setbacks for small scale wind turbines (rated capacity of 300kW or less) in the following categories:

- Neighbouring Dwelling Setbacks: calculated so that the mean values of sound pressure level for small turbines do not exceed more than 6dBA above background noise for wind speeds below 10m/s
- Property Line Setback: turbine based no closer to the property line than the height of the wind turbine tower (excludes the height of the rotor) and no part of the wind system structure, including guy wire anchors, extend closer than 3m to the property boundaries of the installation site. Setbacks can be waived from adjacent properties if the adjacent owner agrees to an easement binding on current and future owners.

This property setback is further defined in the proposed height restrictions for small wind turbines. CanWEA recommends that for property sizes between 0.1ha and 0.2ha, the wind tower height (excludes the height of the rotor) be limited to 25m. For property sizes of 0.2ha or greater there will be no limitation on wind turbine tower height subject to the setback requirements outlined above and the proposed height does not exceed height recommended by manufacturer or distributor of the system.

3.3.11 Testing or Meteorological Towers

There are few references to testing or meteorological towers in the jurisdictions surveyed. There are policies that enable these towers to be established for certain periods of time, for example in BC on crown land a licence is given for a 2 year period for occupation of monitoring towers. Wind testing and meteorological towers require temporary use by-law and site plan control approval in Grey Highlands. Temporary test towers to assess wind energy resources may be erected for the life the project, otherwise removed within one year of inactivity in the County of Cumberland.

3.3.12 Visual

In some Nova Scotia municipalities, there are statements in the MPS and by-laws concerning the visual impacts of wind turbines. Visual impacts can be a result of the physical characteristics of the wind turbine and the physical siting of the turbines. Concerning the specific wind turbine structure itself, there are by-laws to address issues such as signs, advertisements, colour and finish, and lighting. Generally, where included, signage is restricted to the nacelle and relates to the owner/manufacturer; colour and finish are restricted to non-reflective materials and colours that are unobtrusive; and lighting is restricted to the regulations for lighting required by Transport Canada or other regulatory agencies. Similar by-laws are in place concerning signage and colour and finish in municipalities surveyed in Alberta. In some Ontario municipalities, advertising or manufacturing logos are prohibited on the wind generation system. Signage on the ground is also specifically regulated.

Several Nova Scotia municipalities have provisions relating to the visual impacts of wind turbines. Cape Breton Regional Municipality specifies in the MPS that utility scale wind turbines be regulated by setbacks so that viewplanes are not blocked. The County of Cumberland has restrictions in the Secondary Planning Strategy for the Joggins Planning Area that restrict several uses, including large scale wind turbines, from areas within 20m landward of cliffs and shoreline so as to prevent interference with the aesthetic qualities of the views and natural vistas. The Town of Truro requires the proponent to provide a graphic representation of the proposed wind turbine or wind farm indicating the potential visual impact of the wind turbine on surrounding properties and from various vantage points throughout the town. The town also requires that wind farms have a minimum separation distance between turbines of 5 times the rotor diameter or arc, that the wind generators be uniform in size and design and that all wind farm generators in a farm rotate in the same direction and be kept operating at once. East Hants requires that a visual representation including scale, elevation, colours, proportion of wind turbines, photographs and digital representations showing placement and landscaping be included in the site plan approval process for large wind turbines.

In Ontario, the Township of Frontenac may require wind farm development proposals to provide a visual impact study on the landscape as viewed from the several points on land and water. An impact study may be part of the environmental screening report when wind turbines potentially impact natural heritage features or functions as identified in the official plan.

One of the most comprehensive set of requirements for a Visual Impact Assessment has been developed by the Municipality of Grey Highlands which was recently approved in October 2007. According to the Official Plan the Visual Impact Assessment includes the following items: landscape assessment of potentially affected areas; visibility analysis including effects of night lighting; analysis of key viewpoints and visibility during day and night; generation of computer of photo-montage visualizations of project from key locations; public consultation; identifying guidelines and designs for mitigation of identified impacts; and reduce visual impacts by requiring all turbines in same facility to be similar, placed at rear of traditional farm parcels where feasible, generally be of monopole construction and have appropriate matte finish (not to preclude newer and more efficient technologies as long as their impacts are mitigated), prohibit artificial lighting except for minimum air safety, prohibit any form of signage on turbine, locate outdoor storage areas appropriately and consistent development of buildings in character with predominant buildings in the area. Electrical transmission and distribution facilities are subject to the policy of being located below grade and/or co-located with existing infrastructure where feasible and approved by regulations. The Municipality of Grey Highlands will evaluate the visual impact assessment according to the findings in the “Landscape and Visual Assessment Guidance for Wind Energy Farm Development” report. Municipal planning staff indicated that there has been some discussion by a proponent about appealing the regulations but there has also been a general willingness to work with the regulations and the municipality.

The County of Bruce is considering a provision in amendments for large scale wind turbines to request a description of the visual effect for the proposed turbines that includes at a minimum, photo montages that simulate the appearance of turbines and transmission lines from key locations and an assessment of how the turbines will affect view, These representations would be undertaken by individuals or firms with experience in visual assessment. A detailed landscape analysis indicating ‘Zones of Visual Influence’ could be requested by the County in locations of high landscape quality.

Similar practices are in effect in Alberta. In the Municipal District of Taber development applications for wind turbines may be required to provide an analysis of the visual impact of the project especially with respect to the scenic qualities of the landscape. The analysis would include the cumulative impact of other systems in the area and the impact of overhead transmission lines. The Municipal District of Pincher Creek requires all transmission lines from the wind system to the substation or grid to be underground and is currently considering a review of wind energy policies that includes the visual impact on landscape.

Internationally, there is growing literature on the visual impacts of wind turbines and guidelines for how to assess visual impacts. An Australian government funded report by the Australian Wind Energy Association and the Australian Council of National Trusts developed the "Wind Farms and Landscape Values National Assessment Framework" (2007). The framework gives a clear sequence of steps for dealing with the subjective aspect of wind farm development and is a resource to help develop a consistent approach to landscape assessment – what the identified landscape values are, how the wind farm development will impact them and what mitigation processes can be implemented. The Scottish National Heritage has a policy statement on siting wind turbines and natural heritage for turbines over 50kW. The government of the United Kingdom, in their "Planning for Renewable Energy, A Companion Guide to PPS22", outlines a process on how local authorities can develop landscape and visual impact assessments identifying zones of visual influence including cumulative and sequential effects. New York State Energy Research and Development Authority's Wind Energy Tool Kit lists the visual and aesthetic impacts that need to be considered and that may require mitigation. The list includes siting, professional design, screening, downsizing, relocation, camouflage/disguise, low profile, alternate technologies, non-specular materials, lighting, maintenance, decommissioning and offsets.

While many jurisdictions require visual assessment as part of the application process, it is not clear how this information is interpreted and evaluated by municipalities once received. In some cases, the information becomes a basis for presentations to the public or council, who then apply their own judgement as to whether or not the visual impacts are acceptable.

3.4 The Role of Consultation, Education and Communication

As described in Section 2 of this report, there is a level of uncertainty and lack of information and, in select cases, a lack of scientific consensus on some aspects of wind energy generation. This, coupled with a few controversial stories on wind energy in the media, has generated hype around wind energy development that is based on very little factual information and is often confusing to the uninformed public. For this reason, consultation, education and communication on the positive contribution of wind energy as a renewable energy resource and the potential impacts of wind energy are key in the success of wind energy developments.

The Nova Scotia *Municipal Government Act* (1998) has certain provisions that require municipalities to engage in public consultation. Before adoption of all planning documents (including municipal planning strategies, land-use by-laws and amendments to them), the *Act* requires municipal council to put in place a public participation program. The format and content of a public participation program is left to the discretion of the municipality, as long as it "identifies opportunities and establishes ways and means of seeking opinions of the public concerning the proposed planning documents". Before a planning document or a development agreement (or amendments to them) is approved, the municipality has to hold a public hearing. The public hearing must be advertised and held in accordance with specifications in the *Act.*

Wind turbine developments that undergo an Environmental Assessment process (see Tables 5 and 6 in Section 3.1 that outline when assessments are required), may have a public input requirement as part of the assessment process. In the provincial Environmental Assessment process, a Class 1 EA involves a 25 day review period, with mandatory public comment period. Potential environmental effects assessed include, but are not limited to, wildlife, noise and visual impacts. Decision options include approval, rejection, more information, environmental assessment report or focus report. Public hearings on the proposed development can be called at the Minister's discretion.

Given the potential for public sentiments to run high on matters connected with renewable energy and wind power in particular, it is wise to engage the public in a meaningful conversation and consultation on these topics in advance of any specific project proposals. Ideally, communities work towards energy plans or some form of comprehensive energy strategy. This would be a good place to initiate community conversations around renewable energy development. The policy stage, at which municipalities establish their by-laws and procedures around wind power development, is also an important stage to engage in more specific communications around wind energy. A public hearing prior to issuing a development permit for a wind energy development is often not the most fruitful point for an open and multi-faceted community discussion on this topic to begin. By this stage, opinions, priorities and points of view may have already solidified based on informal and incomplete information. Public engagement should be sought early in the decision making process on wind energy issues if at all possible.

Examples of successful public consultation and communication activities have been demonstrated at different stages in the planning process for renewable energy.

In Great Britain, the government identifies local planning authorities as both policy makers and direct agents for change in implementing appropriate renewable energy developments. The government actively encourages local councils and planning authorities to engage with local communities on renewable energy, its benefits and possible negative impacts, prior to dealing with actual project proposals. This strategic planning system is also encouraged to ensure that there is early involvement of communities in key decisions. Local authorities are expected to play a pivotal role in interpreting and acting upon national and regional renewable energy targets at the local level.

Specific renewable energy proposals also present an opportunity for consultation, education and effective communication. Auswind has included a Stakeholder Communication and Consultation Plan in their Best Practices document. The proponent maintains records of all consultations undertaken, including who was consulted, by what method, what issues were raised and how they were addressed. These records form the basis of a consultation report for the planning application which will be updated as the project evolves. The District of Taber in Alberta places great importance on 'development hearings' for each proposed development. These hearings provide an open forum for questions, concerns, opinions and education in the community and have contributed to the successful development of two wind farms. Proponents are often required to provide information on the public consultation process as part of the application process for the project and also for input from the public on specific topics such as visual impacts.

The Municipality of Grey Highlands has recently amended its by-laws on wind turbines and included a process to establish a Dispute Resolution Protocol which will establish a complaint procedure for the public and identify solutions for remediation concerning wind turbine impacts. Both the public and wind energy proponents will be involved in determining what form this protocol should take. The amendment specifically mentions the issues of noise and shadow flicker as being addressed in this protocol. The County of Bruce is considering asking proponents for large scale wind turbines to provide a 'Complaint Protocol' that outlines how the public and agencies can lodge complaints and how such complaints will be addressed by the proponent. Within Nova Scotia, HRM has an Effective Public Participation

Program policy (9.3.2) which will be used by municipal staff in the process of deciding appropriate location and siting of wind turbines. HRM is currently engaged in a major consultation and policy development process for wind turbines. The public participation policy outlines the steps to be considered to ensure transparency, inclusiveness, collaboration and openness to the constructive exchange of information. These steps include processes to encourage the naming of constraints, sharing of information, exchange of ideas, fostering group problem solving and using tools that encourage creative and multi-dimensional thinking. There is also reference to outreach to groups that may feel under-represented in decision- making (HRM Regional MPS Amendment, 2006).

Some jurisdictions are recently introducing innovative community-based models for wind development that are moving from consultation to participation to encourage, develop and finance wind projects. For example, ‘revenue participation’ and ‘flip’ (ownership percentage flips to greater local ownership at a certain stage in a project) financial structures are being used in Minnesota so local landowners can participate in the development of utility-scale wind power (Yarano, 2008). The goal of these projects is to return financial benefits to landowner beyond the typical land lease payments provided in projects developed by utilities or independent power producers. In exchange for these increased financial benefits, local landowners take a greater role in early development of the projects, occasionally including start-up cash contributions, securing land rights and applying for local permits. By participating in the risk and rewards of development, local communities increase local financial benefits by keeping energy dollars at ‘home’. According to the Minnesota Department of Commerce., there are currently more than 850MW of community-based wind projects completed, under contract or being negotiated with Minnesota utilities.

It is also worthwhile to recognize that inclusion of landowner compensation and effects monitoring protocols and mechanisms during the consultation phase of a project can have a moderating effect on community and landowner resistance.

4.0 OPTIONS FOR POLICY APPROACHES AND BY-LAWS

The following sections outline some of the options available for municipalities wishing to regulate wind energy development. In light of the literature review presented in this report (Sections 2 and 3) it should be clear that there is no scientific or societal consensus on many aspects of wind energy development. There is significant controversy around some impacts of wind energy (for example the question of a safe distance from receptor for protection against noise impacts, or even the more simple question of how many birds and bats are killed by wind turbines). These controversies will likely continue into the future, at least until a more significant body of literature has been produced around the topic of wind energy and its impacts. Municipalities, however, cannot wait for scientific consensus on all issues before they move forward on by-laws, given that lack of action may have even more negative impacts on a municipality (for example, in terms of missed opportunities for economic development or citizen dissatisfaction) than introducing less-than-perfect legislation.

It should also be recognized that the assertive development of wind energy potential is in accord with broader Nova Scotia, national and global concern and commitments regarding environmental protection and particularly global climate change. Wind energy has been generally accepted as one of the most promising and important renewable energy technologies, the rapid timely growth of which is deemed critical in addressing this significant global and regional challenge. The uncertainties regarding impacts to local residents and local environmental or socio-economic components must be considered in light of these larger issues. The ongoing environmental and human health effects of conventional non-renewable energy sources are also well known and in many aspects significant. In so far as these effects can be reduced or in essence exchanged by an increase in renewable alternatives is generally believed to be of social benefit. This is particularly the case, if care is taken to simultaneously implement measures to reduce energy demand, so that an increase in alternative energy accelerates a reduction in conventional energy sources.

Therefore, despite the uncertainties in the science, municipalities should feel justified in their attempts to introduce policy around wind energy. There is currently a call for more clarity of legislation in this area both from communities and developers. Communities want to ensure that their interests and their properties are protected. Developers want clarity in what they can and cannot do and they too have an interest in ensuring that communities are protected and satisfied so as to prevent a back-lash to this fairly young industry. The trick for most municipalities is going to be balancing the need to protect the character, health and safety within communities with the desire for flexibility, respecting the strong desire to support alternative, renewable energy options, the advantages associated with economic opportunities and from the industry, the benefits arising from regulatory certainty and attractive business prospects. Each municipality therefore needs to consider its interests, values and its own unique socio-political circumstances in moving forward on wind energy legislation.

To establish effective and locally appropriate approaches to the regulation of wind turbines, there is a need for a community conversation in different municipalities in Nova Scotia, among citizens, municipal staff and council. This report and especially the policy and by-law options presented in this section are meant to frame and inform (with the best of available information) these community conversations. They are not meant to tell a municipality how to modify their MPS and LUBs. Those decisions are ultimately vested in political and administrative leadership and must be made by that leadership at each municipality. It is also pointed out that in many respects wind energy issues transcend municipal boundaries and therefore there are worthwhile reasons to consider regional and in so far as jurisdictional issues can be resolved, provincial or even inter-provincial policies and regulations.

4.1 Policy Option Review

As illustrated in Section 3.2 of this report, there is a variety of planning mechanism and policy tools used by municipalities for regulating wind energy developments. Broadly speaking, these range from fairly prescriptive (e.g. development permits) to highly discretionary (e.g. development agreements). On the prescriptive side of the spectrum, applications are simply judged against a standard checklist of regulations. The application process is fairly simple and quick, but there is little flexibility in the evaluation system and the standards may be too restrictive. At the discretionary end of the spectrum, development applications are considered on a case by case basis and their suitability determined through a consultation process that involves municipal council and may involve the community as well. This is a longer and more expensive process but allows for more flexibility in the evaluation process. The pros and cons of various mechanisms at the disposal of municipal planners are further described below.

Development Permits (As-of-Right Development)

The LUB identifies uses of land that are permitted within certain zones subject to compliance with a set of prescribed standards. A Municipal Development Permit is issued when a proposed development meets the requirements of the LUB. A wind turbine development can be identified as a permitted use in a zone and therefore can be permitted "as-of-right" when it complies with prescribed standards.

Strengths:

- Permitting wind turbines to develop as-of-right in particular zones provides certainty to developers and enables development of wind industry.
- Approvals can be obtained within a relatively short period of time.

Challenges:

- This is a generic approach that can exclude areas from wind turbine development which on a case-by-case basis may be suitable for turbines or farms. It can also allow wind turbine development in areas that for social or environmental reasons may be unsuitable.
- Allowing wind turbines to develop as-of-right makes it difficult to articulate quantitative regulations that will adequately cover all impacts of wind energy development projects. For example, visual impacts would be very difficult to manage through by-laws.
- Wind turbine technology is changing at a rapid pace. Requirements established on the basis of current technology could quickly become redundant or potentially burdensome for wind development in the future.
- Knowledge about the positive and negative effects of wind turbines, as well as societal thresholds of acceptance of these effects is evolving. Standards and requirements that are currently set may become out-of-date before necessary amendments can be made.
- There is no formal opportunity to draw on local knowledge or provide for public input into the development proposal.
- There is no ability to enforce decommissioning and environmental management plan requirements.

Land Use By-law Amendment

Another option related to the as-of-right development option is the use of the process of land use by-law amendment. In this case a wind turbine zone would be set-up in policy through the municipal planning strategy but not applied on the zoning map. When a proposal is made to establish a wind turbine or a wind turbine farm, the land use by-law would have to be amended to apply the proper zone. This involves a public hearing and is open to appeal to the Utility and Review Board. Once the proper zone is applied the development goes ahead in the same way as in the as-of-right development.

Strengths:

- Allows for a public process through the public hearing but the outcome is limited to compliance with the existing policy in the municipal planning strategy.
- Avoids the lengthy and costly development agreement process while still having public involvement.
- Allows the municipality to establish locational criteria for wind turbines without having to predetermine the locations on the ground.

Challenges:

- Open to appeal to the Utility and Review Board. This adds time and uncertainty to the process.
- Even without an appeal it will add time to the process.

Site Plan Approval

Site Plan Approval enables municipalities to assess components of a development and impose site specific conditions for approval. The Site Planning Approval recognizes the development as a permitted use but one that is required to meet specific criteria outlined in the LUB. Developments that are subject to this planning tool are managed on a case-by-case basis. Site Plan Approval criteria for wind turbines or farms could include location of structures; type, location and height of walls, fences, tree, shrubs and ground cover or other landscaping elements used to protect and minimize the development's impact on adjoining lands or retention of existing vegetation; location of easements; grading or alteration in elevation or contour of the land and provision of the management of storm and drainage; location, number and size of signs or sign structures, and provisions for the maintenance of any of the above items.

Strengths:

- The assessment criteria identify the type of conditions that can be imposed and the scope of assessment, which provides clarity for the developer.
- Planning staff have greater input and influence on development proposal.
- The process is site specific, and thus, can take into account site specific factors such as environmental impacts and development obstacles.
- There is some assurance of approval for a proposal if the identified conditions are met.
- The onus is more clearly on the developer to identify and assess impacts and propose mitigation procedures.
- The decision to grant site plan approval can be appealed by the public within the surrounding area, to council.

Challenges:

- There is a need for clear and concise criteria for assessment so that developers and municipalities have a mutual understanding of the extent of the assessment and potential conditions that could be imposed.
- Development planning staff must have the appropriate skill set to make an informed decision on the assessment criteria and site plan approval.
- The process is site specific, and thus, requires an increased amount of resources.

Development Agreements

Development agreements allow specific development standards to be negotiated within the context of the supporting policy found in the municipal planning strategy. The process results in an agreement of the range of conditions that the developer is required to meet. The Development Agreement process requires a full public notification and assessment of the proposal in relation to MPS policy and can only be approved after a duly advertised public hearing is held. The agreement is registered against the property and runs with the land until it is discharged. Development agreements are appealable to the Utility and Review Board.

Strengths:

- Full public process and extensive assessment of the application allows for contentious issues such a noise, visual and safety impacts to be publicly addressed.
- The onus is more clearly on the developer to identify and assess impacts and propose mitigation procedures.
- More direct control by Council over the development.
- Can require a performance bond.
- Can require a management plan, or visual impact assessment criteria.
- The process is site specific.
- There is a high level of community consultation.
- Development agreements can be appealed to the Utility and Review Board.

Challenges:

- Less certainty for the developer over what the final outcome might be which could affect the viability of the project due to financial and timing considerations.
- Could be perceived as a challenge to the development of wind turbines in the municipality on the part of some developers.
- Council's decision on the development is appealable on the part of any aggrieved person to the Nova Scotia Utility and Review Board.
- The development agreement process is the most time consuming and expensive process for both the municipality and the developer.

4.1.1 Possible Policy Options

Given the above mentioned advantages and disadvantages of each planning mechanism, some possible policy direction options are presented below.

Option 1 – Choose one planning instrument as the mechanism for developing mini, small and large scale turbines throughout the municipality, and include a provision in the MPS or wind energy by-law section in the LUB specifying the mechanism. The municipality may choose to vary the requirements of the application process for mini, small and large scale turbines (for example to make the application for individually-owned small auxiliary units less cumbersome).

Choose an as-of-right development/development permit, land use by-law amendment or site plan approval if:

- The main objective of the wind energy by-laws is to facilitate and accelerate the development of wind energy in the municipality.
- There is a high level of interest from the municipal council and community in wind energy development.
- There is a high level of comfort among council and staff with a set of standard by-laws (options presented in the next section).
- The municipality is relatively uniform (e.g. primarily rural) and looking for overarching, umbrella regulations.

Choose a development agreement if:

- The main objective of the wind energy by-laws is to address public sensitivity around wind energy or there is great discomfort in the community and a need for consultations on proposed projects.
- The municipality is relatively heterogeneous (e.g. mix of rural, suburban and urban areas) and there is a need for flexible regulations.
- There is discomfort around the uncertainties in the science and resistance to “tying” the municipality to a set of standards that may be out of date before too long.

The text for this provision would read something like this (example given for a case where development agreement was chosen as planning mechanism):

> “Development Agreements are required for large-scale and small-scale wind power projects given the situation/goals/objectives. In addition to satisfying the requirements of the Wind Energy Land Use By-law [relevant LUB section], a development agreement application must be submitted. Development Agreements are valid for 4 years from the date issued. A Development Agreement may be renewed once for an additional 2 years. A new Development Agreement application, with updated plans, is required for renewals.”

Option 2 – Choose two (or more) different planning mechanisms depending on the scale of development. In most cases a less cumbersome mechanism would be more appropriate for smaller wind turbines; therefore, a municipality may choose to allow large scale turbines through development agreements, but use an as-of-right approach for smaller turbines. A variation on this option would be to allow single turbines (or a collection of turbines up to certain threshold) as-of-right or by land use by-law amendment but require a development agreement for developments involving larger groups of turbines (above a threshold limit) which tend to have a more major impacts on the surroundings.

The choice of planning mechanism used would follow the same logic as presented for Option1.

Option 3 – Choose two (or more) different planning mechanisms depending on the location of development. This option would involve the municipality zoning its land with consideration of wind energy development suitability through constraints and opportunities mapping exercise (see, for example, Halifax Regional Municipality's Wind Energy Master Plan). The constraints and opportunities to be considered include proximity to residential areas and institutional uses, wind strength, proximity to airport and military bases, parklands, habitat and environmentally sensitive areas, archeological sites, birds and bats nesting habitats, construction hazards, geology, and proximity to existing roads and power lines. This list should be vetted by municipal council and/or through community consultations and the relative importance of different factors established prior to the constraints and opportunities mapping exercise.

The result of the exercise may be a simple map designating various zones representing various levels of overall suitability for wind energy development. The most suitable areas will be those with relatively few constraints and concerns, where the municipality will want to encourage wind energy development. Therefore, developments in the high suitability zones can be permitted as-of-right. On the other hand, the areas with low suitability will be those where there are sensitivities or reasons for concern. Development in these zones may be prohibited all together or require a development agreement process to carefully address any issues arising.

Option 4 – Combine the approaches in Option 2 and 3 described above and put in place a policy mechanism that takes into account both scale and location. One example of such an approach is presented in Table 10 below. This option presents the most complex approach; however, it also potentially represents the best way to facilitate the least controversial wind development projects, and protect the public against the most controversial proposals.

TABLE 10 Example of a Potential Policy Approach

	Most Suitable Zone	Medium Suitability Zone	Low Suitability Zone
Mini Turbines	As-of-Right (no permit)	As-of-Right (no permit)	Development Permit
Small Turbines	As-of-Right (no permit)	Development Permit	Development Permit
Single Large Turbine	Development Permit	Site Plan Approval	Development Agreement
Array of Large Turbines (two or more)	Development Agreement	Development Agreement	Not Allowed

Defining the approval mechanism for the number of turbines on a site is at the discretion of municipalities which will have to take into account the impact of multiple wind turbines in the different zones; for example, an array of 2-5 large wind turbines could be considered by site plan approval in the most suitable zone. Municipalities may also want to consider if there is a need to consider the impact of a potential array of small wind turbines in their planning approach.

Note that regardless of what policy approach is taken, the development of wind turbines will likely involve some form of an application process (more comprehensive for development agreements, more brief for development permits, etc.) Also regardless of the policy approach chosen, a set of standards will be needed to allow municipal staff and council to determine the acceptability of proposed projects (by-laws to abide by in as-of-right developments, guidelines and direction to be used for discretionary evaluation of applications). The next section proposes some recommended options for the application process and specific by-laws and/or guidelines around various aspects of wind energy impacts.

4.2 By-laws and Guidelines

The recommended options are provided in the same categories presented in Section 3.

4.2.1 Application Process

The application process, whether for a development permit, a land use by-law amendment, and a site plan approval, or a development agreement will require proponents to describe certain aspects of the proposed development. The following are lists of elements that a municipality may wish to include in the requirements in its application process. These lists were generated by compiling the requirements in other application process from a selection of municipalities throughout Canada. There is no need for all Nova Scotia municipalities to require all of the items on these lists in their own application process, nor would all requirements be appropriate for all types of applications (development permit applications will likely be much less onerous than development agreement applications). The requirements of the application should also be in line with any by-laws put in place (e.g. if there is a by-law limiting height, then the application for a development permit should specifically require an indication of proposed heights).

<u>Large Scale Turbines - Potential Content of Application</u>

- Project definition including installed turbine(s) capacity, targeted long term production levels, scale elevations or photos of turbines showing total height, tower height, rotor diameter and colour;
- Site plan showing all buildings, boundaries and natural features and alterations of site;
- Turbine manufacturer's specifications and professional engineer's design and approval of turbine base;
- Analysis of visual impact including the cumulative impact of other wind turbines and impact of overhead transmission lines, mitigation measures for shadow or reflection of light onto adjacent sensitive land uses;
- Analysis of noise impact including a map indicating all lands and sensitive receptors impacted by the >35dB (or 5dBA above background) emission level (or other noise level specified in by-laws) and estimated noise levels at property lines and receptors;
- Impacts to the local road system including required approaches from public roads;
- Study to determine impact and mitigation for identified natural heritage features;
- Copies of documentation of approvals from Transport Canada and Nav Canada for turbines taller than 20m and 30.5m respectively;
- Copies of all documentation required for Canadian Environmental Assessment Act and Nova Scotia Environment Act and regulations if applicable;
- Evidence of notification to DND, Nav Canada, Natural Resources Canada or other applicable agencies regarding potential radio, telecommunications, radar and seismoacoustic interference if applicable;

- Evidence and results of public consultation if conducted;
- When placed on agricultural land, evidence of the continued use of prime agricultural land for farm use;
- Emergency response plans for site safety; and
- Decommissioning and reclamation plan.

Small Scale Turbines – Potential Content of Application

- Description of proposed project including scale elevations or photos of turbines – total height, tower height, rotor diameter and colour;
- Manufacturer's information and Canadian Safety Association certification;
- A site plan for location of turbines in relation to lot lines, dwelling and adjacent dwellings;
- Analysis of noise impact including a map indicating all lands and sensitive receptors impacted by the >35dB (or 5dBA above background) emission level (or other noise level specified in by-laws) and estimated noise levels at property lines and receptors;
- Copies of documentation of approvals from Transport Canada for turbine heights of 20m or higher and copies of notification of Nav Canada for turbine heights of 30.5m or higher;
- Evidence of notification to DND and Nav Canada if within a 10km radius of airfield;
- Evidence that strobe and shadow effect will not affect the enjoyment of the adjoining residences; and
- Evidence of preliminary consultation and public notification.

Mini Scale Turbines – Potential Content of Application

- Description of proposed project including scale elevations or photos of turbines – total height, tower height, rotor diameter and colour;
- Manufacturer's information and Canadian Safety Association certification;
- A site plan for location of turbines in relation to lot lines, dwelling and adjacent dwellings;
- Analysis of noise impact including a map indicating all lands and sensitive receptors impacted by the >35dB (or 5dBA above background) emission level (or other noise level specified in by-laws) and estimated noise levels at property lines and receptors;
- Copies of documentation of approvals from Transport Canada for turbine heights of 20m of higher and copies of notification of Nav Canada for turbine heights of 30.5m or higher;
- Evidence of notification to DND and Nav Canada if within a 10km radius of airfield;
- Evidence that strobe and shadow effect will not affect the enjoyment of the adjoining residences; and
- Evidence of preliminary consultation and public notification.

4.2.2 Decommissioning

As discussed in Section 3.3.2, municipalities face challenges in requiring decommissioning activities due to a lack of ability to enforce, especially when development takes place as of right. None the less, provisions for decommissioning should be included in municipal legislation to state that the responsibility and cost of taking down a wind turbine after its use lies with the owner/developer.

Particularly in situations where a developer depends on the municipality and community's good will for continued investment and activity in an area, this statement might be enough to provide clarity on what the municipality expects and encourage the developer to ensure decommissioning activities take place accordingly. Where a Development Agreement is used as a planning mechanism for permitting turbines, municipalities should require a decommissioning plan included in the application process and may wish to require a bond posted to ensure compliance. Guidance on decommissioning from the municipality may include the timeframe within which the structure(s) should be removed. One to two years after the structure has ceased to produce power is a reasonable timeframe for beginning the decommissioning process or at the very least giving notice of project shut-down to municipal council, which may then specify the time period within which structures will have to be removed. Provisions may also include the degree to which the site needs to be reclaimed by specifying that all structures, including ancillary structures need to be removed, and that the proponent is responsible for returning the land to its natural state.

4.2.3 Health and Safety

There are a number of issues related to health and safety of wind energy generation facilities that municipalities should include in their by-laws. Either the proponent can be asked to comment on each of the items listed below in their development application, or provisions to the effect described below can be included in the LUB that the proponents would need to abide by.

Ice Throw:

Option 1: Require a minimum separation distance of 2 to 3 times the total turbine height for large scale turbines from receptors, roads and property lines and 1.5 to 3 times the total turbine height for small and mini scale turbines from property lines and roads.

Option 2: Require an ice throw report that includes an assessment and map of the likelihood of ice throw through the site and on neighbouring properties, as well as mitigation measures such as ice detection systems and operational protocols to eliminate or minimize ice throw risks.

Note that setbacks of approximately 500m have been suggested to completely eliminate the risk from ice throw. Higher setbacks do, however, restrict development further. A separation distance of 2 to 3 times the total turbine height from property lines is recommended if municipalities are concerned about protecting future land use on adjoining properties. Due to lot sizes this may restrict the development of wind turbines so municipalities will need to balance the rights to protect future land uses of adjoining properties with facilitating development of wind energy in their municipality based on their local context. Provisions are also provided in some municipal bylaws that these setbacks can be waived if adjacent landowners are in agreement.

Ultimately, the decision on what the appropriate setback should be lies with elected council.

Turbine Tower Design

Require a minimum distance of 8m between the lowest reach of rotor blades and the ground; and minimum distance of 3.5m between the lowest reach of ladder (or other access device) and the ground for both large, small and mini scale turbines. Also require fencing (of at least 1.8m in height), lockable gates and/or lockable doors to address tower access and safety for towers that are not of a monopole design

For smaller wind turbines supported by guy wires, require that the innermost and outermost guy wires be clearly visible to a height of 2m above the guy wire anchor lines.

Blade Throw

Option 1: Require a minimum separation distance of 2 to 3 times the total turbine height for large scale turbines from receptors, roads and property lines and 1.5 to 3 times the total turbine height of small and mini scale turbines from property lines and roads.

Option 2: Require design standards, and/or a professional engineer's approval that the wind turbine meets approved standards of responsible safety associations.

Note that setbacks of approximately 500m have been suggested to completely eliminate the risk from blade throw. Higher setbacks do, however, restrict development further. A separation distance of 2 to 3 times the total turbine height from property lines is recommended if municipalities are concerned about protecting future land use on adjoining properties. Due to lot sizes this may restrict the development of wind turbines so municipalities will need to balance the rights to protect future land uses of adjoining properties with facilitating development of wind energy in their municipality based on their local context. Provisions are also provided in some municipal bylaws that these setbacks can be waived if adjacent landowners are in agreement.

Ultimately, the decision on what the appropriate setback should be lies with elected council.

Turbine Structural Failure

Require design standards, and/or a professional engineer's approval that the wind turbine meets approved standards of responsible safety associations.

Fire, Oil Spill, etc

Require an emergency management plan as part of the application process.

Aviation Safety

Require written approval from Transport Canada when a turbine is above 20m. Require notification to Nav Canada when a town is above 30.5m. Require written approval from Nan Canada or DND when a large or small turbine is sited within a 10km distance of a military airport.

4.2.4 Shadow Flicker

Option 1: Require a visual impact study that includes an analysis of shadow flicker and its impacts and proposed mitigation measures on adjacent properties within 1.3km for large scale turbines and a visual impact study that includes an analysis of shadow flicker and its impacts and proposed mitigation measures on adjacent properties for small and mini turbines.

Option 2: In addition to the visual impact study, include a by-law quantifying the level of shadow flicker acceptable. One option is a worse case maximum of 30 hours of shadow flicker per year of maximum

30 minutes per day experienced by a receptor as a result of the wind turbine. Another option is maximum of 30 hours per year of maximum 30 minutes per day based on actual/real predicted values.

4.2.5 Height

The municipality needs a provision excepting wind turbines from height restrictions for structures within most zones.

In addition, some municipalities have attempted to restrict the height of wind turbines to limit visual impacts. It is debatable that communities are sensitive to the difference in visual impacts associated with height (i.e. a 120m turbine is not less publicly acceptable than a 100m turbine). Taller turbines are able to catch higher speed winds and generate more power and are thus more desirable. With a rapidly growing industry, the typical total height of large turbines is growing rapidly, so a height restriction that appears non-restrictive today might appear restrictive in a few years. For the above mentioned reasons, municipalities may choose to not regulate the height of turbines. A restriction on the height of turbines is necessary if the setback provisions depend on it (i.e. if the setbacks are set to a multiple of the total turbine height for example), this is especially true for smaller turbines. Height restrictions can be developed for municipalities that are concerned about height and its visual impact.

Option 1: Include a provision excepting wind turbines from typical height restrictions in a zone. Do not regulate maximum total turbine heights.

Option 2: Include a provision excepting wind turbines from typical height restrictions in a zone. Set a maximum total turbine height for large, small and mini scale turbines; for example 120m for large, 60m for small, and 20m for mini scale turbines.

Issues that relate to height include aviation safety that is mentioned in 4.2.3.

4.2.6 Management Plan

A management plan may be required as part of the application process to clarify the responsibilities of the owner/developer in various stages of project lifetime. It may include: construction details; operational and maintenance requirements; traffic management with details on volumes, frequencies and haul routes of construction vehicles; the process for complaints; any required mitigation measures and required monitoring; emergency management plan; design standards and safety protocols to reduce the risks associated with ice throw and blade/turbine failure, decommissioning details. The management plan overlaps with several of the other provisions included in this section (e.g. decommissioning plan, emergency plan etc). Also note that management plans are only enforceable under a discretionary process (e.g. development agreement).

4.2.7 Noise

As a main public concern, the issue of noise certainly merits addressing through municipal legislation. There are three approaches to regulating noise. The first is to require a certain maximum allowable noise level (either at the property boundary or at nearest receptor) in dBA. A second approach is to require a separation distance (either from property boundary or nearest receptor) large enough to ensure noise (including infrasound and amplitude modulation) do not negatively impact those beyond the site. A third approach would be to combine criteria for maximum allowable noise with minimum separation requirements, allowing the minimum separation distance to be reduced pending meeting demonstrated minimum dBA levels.

The use of decibel criteria is a recent approach to regulating noise in Nova Scotia; other provinces have a longer history of using this approach. In Ontario, for example, the provincial government has a provincial noise standard which wind turbines must meet. Municipalities require in their by-laws that wind turbines meet this standard. If there are problems with non-compliance to the decibel regulation then the onus is on the province to investigate and ensure that the noise complaint is resolved. A provincial noise standard protocol means that the standard is developed and reviewed by the province.

Nova Scotian municipalities need to consider the implications and possible challenges of implementing a decibel approach without a provincial standard in place. The municipality needs to define the noise standard and the protocol for baseline noise assessment. The onus would be on the municipality to interpret and assess possible non-compliance with the decibel regulations once a turbine has been commissioned. Possible ways to reduce the level of responsibility for this, both financially and technically, is to require compliance testing by the proponent as part of the permitting process. Compliance testing would mean that the proponent agrees to a follow-up testing protocol as defined by the municipality (for example, testing of all sensitive receptors in a defined period of time once the turbine development has been commissioned). Alternatively, municipalities could require as part of the permitting process that proponents will test decibel readings based upon complaints received after the wind turbine has been commissioned. These two mechanisms would place the financial and technical responsibility for responding to complaints and non-compliance with the decibel regulation on the proponent.

In both the case of decibel standard and separation distance, there is a decision as to whether the property line or the nearest receptor (usually defined as nearest habitable dwelling) is the appropriate reference point. Using the property boundary as reference point ensures that no part of a road or neighbouring property is negatively impacted by noise from the wind turbine. But this can be restrictive and, in some cases, may lead to a complete prohibition of wind turbines in a municipality if the lot shapes and sizes are challenging. One recommended alternative is to use the property boundary as a reference point but include a statement in the by-law specifying that the reference point can be changed to nearest dwelling, if the proponent can provide written consent from adjacent property owners.

Option 1: Require a sound limit including a specific dBA limit and/or dBA above background noise levels at the exterior of the nearest habitable dwelling.

The decibel approach is promoted by CanWEA and other champions of the wind energy industry as it allows for relaxation of actual setbacks if developers can actually show that the turbine(s) are not so noisy as to change the overall sound levels in the neighbouring properties. This approach is more cumbersome as measurements need to be made at the property line and/or receptors, however it can be less restrictive than a setback. It can also be used for both large scale and small scale applications. While there are no universally accepted dBA standards, the range proposed most often by other municipalities in recent standards, or by credible researchers, is 35dBA (more conservative) or 40dBA (less conservative but more common) or 5dBA above background noise levels at the exterior of the nearest habitable dwelling.

Option 2: Require an absolute separation distance from the exterior of the nearest habitable dwelling.

As mentioned in Section 2 and 3, there has been much controversy over the appropriate setback for masking the impacts of noise from a wind turbine. The distance at which all or most effects are either eliminated or deemed to be is insignificant is far from agreed. The typical setbacks of 200 to 350m which were commonly put in place just a few years ago have now been seen to be more generally extended to 400 to 750m in a number of more recent regulations. Even these distances have been challenged by some emerging research, experts, commentators and advocates who are calling for more conservative setbacks of 1 to 2km for large scale turbines. A 1600m or greater separation distance is very conservative but advocates of this approach argue that these distances are necessary to negate and eliminate any possible negative effects relating to noise and other wind turbine impacts. Others believe that a less stringent but still conservative 1000m separation distance is adequate to accomplish the same objective. 1000m or greater separation requirements are not common and are greater than the preponderance of current regulations both in Canada and internationally. No examples of 1000m setbacks were identified in Europe where wind development is to this date considerably more prevalent and population densities typically higher than North America. Many advocates contend that the noise associated with wind development, while noticeable, is not significant and that the more typical shorter setback distances accompanied by assessment of site specific circumstances in the context of broader consideration of community and societal benefits are entirely satisfactory. They argue that over time, as wind development becomes more commonplace, it will, like many features of modern life in the developed world, be accommodated without substantial negative effect or perception. This well established view asserts that larger setbacks are too restrictive and may in effect eliminate the possibility of wind energy generation in some municipalities and in many specific locations where the optimal wind conditions are found in areas(such as coastal regions) where long established pre-existing uses are prevalent. Councils will therefore need to balance the opportunity for development, broader environmental and social considerations with protection against noise impacts on residents.

Option 3: Require a general provision for noise limits in the LUB (not specific to wind turbines) limiting sound levels to a dBA limit and/or dBA above background noise levels at the exterior of the nearest habitable dwelling.

As previously described, there are few quantitative limits to noise levels for any projects in most Nova Scotia municipalities (Truro, East Hants and parts of Lunenburg being the exceptions). This means that a noise by-law of this sort, specific to wind turbines, could be argued to discriminate against wind turbines, while other “noisy” structures (roads, factories, other operations) are not subjected to noise limits. Municipalities could introduce a general noise by-law to this effect, or this may be done at the provincial levels similar to Ontario and Alberta. Some commentators encountered during this study proposed that the establishment of noise standards at the provincial level in Nova Scotia would be an important and beneficial step, assisting municipalities and developers alike to address this issue consistently.

Option 4: Require a separation in metres from the property line OR a sound limit in dBA and/or dBA above background noise levels at the exterior of the nearest habitable dwelling.

This option combines options 1 and 2 and is recommended as a way of putting a protective separation distance in place while giving the developers the option of forgoing that distance if they can prove that noise levels at the property boundary are within prescribed limits. This option encourages the developer and the industry to develop innovative solutions that address problems regarding noise levels, while also providing assurance that at a given setback the development will not be challenged.

4.2.8 Electromagnetic, Radio, Telecommunications, Radar and Seismoacoustic Systems

Impacts or radio waves and electromagnetic interference are typically addressed by other regulatory bodies and do not need to be regulated by the municipality per se. However, municipalities should include a provision in the requirements for the application process on wind turbines, asking for evidence of communication with appropriate bodies (DND, Nav Canada, Transport Canada, or other appropriate bodies.) Note that most such concerns can be addressed through design (e.g. keeping the turbines away from line of sight of transmission towers) or mitigated with technological fixes (e.g. devices amplifying radio signals, put in place by wind energy developers). The municipality should require a description of mitigation methods in the application.

4.2.9 Roads

If roads and local traffic is a concern, the municipality can require a traffic study to be included as part of the application process. Note that this can be part of a more comprehensive management plan for the site.

4.2.10 Separation Distances and Setbacks

Through Section 4, appropriate separation distances have been described to protect against health and safety and noise complaints. There are no additional reasons for introducing setbacks of any kind. In accord with the options described above, it appears that a minimum setback of 2 to 3 times the total turbine height for large scale turbines from receptors, roads and property lines is appropriate if noise concerns are dealt with separately, for example through a decibel noise limit approach. If setbacks are being used to account for noise, then municipalities would need to decide on an appropriate separation distance (see discussion in Section 4.2.7) in light of information and considerations outlined. Setbacks for small and mini turbines are not as well researched; the suggested setbacks are 1.5 to 3 times total turbine height of small and mini scale turbines from property lines and roads.

Please note that municipalities can get quite sophisticated with setback requirements, defining various reference points (receptor, property lines, nearest road, structures on own site etc.) as described in Section 3. The most common and straight forward practice is to require setbacks from either property line or habitable dwellings on adjacent properties. This means that municipal regulations attempt to protect the neighbours against a development, leaving the responsibilities for self-protection to the owners of the wind development (therefore, for example, not requiring a setback from structures on the same lot as the wind turbines). Another common practice is to waive setback requirements if adjacent properties are owned by the same owner or are of the same nature (i.e. used for wind energy generation).

4.2.11 Visual

As mentioned earlier in this chapter, municipalities can require a visual impact assessment as part of the application process. Ultimately, visual impacts are going to be the most difficult to control, given they are very subjective. Some by-laws the municipalities can put into place to further reduce the visual impacts of turbines include:

- All wind turbines should be a coloured in a solid light colour and include a non-reflective matte finish (unless otherwise required to conform with Transport Canada regulations for aviation safety)
- Signage should only be permitted on the nacelle unit and relate to the owner, operator or manufacturer of the wind turbine.
- No lighting should be placed on the exterior of the wind turbine unit above a height greater than 5m, except as required by Transport Canada for aviation safety purposes. Any other lighting used shall be directional lighting towards the ground.
- All cables used for the transfer of power from the property to the main grid or buildings consuming the energy generated should be placed underground.

5.0 CONCLUSION

5.1 The Use of Model By-laws

The main objective of this project has been to review the literature available on wind energy and its regulation at the municipal level, and to generate a model set of by-laws that can be used by Nova Scotia municipalities. Given the range of options put forward in Section 4 of this report, it is clear that municipal councils will need to make several decisions about how they regulate wind energy and what specific by-laws they put in place. There are no internationally accepted standards for addressing some of the most controversial issues surrounding wind energy (including noise). Instead there are a broad range of possibilities, each with their own advantages and disadvantages. Elected officials will have to decide how restrictive they will want to be in their approach to regulation and in the specifics of their by-laws based on larger societal goals and objectives, and balancing of various risks (e.g. health risks to nearby residents versus risks from climate change if a transition to alternative energy sources is delayed).

For the reasons mentioned above, it is not possible to put forward one set of model by-laws that municipalities can take off the shelf and use right away without debate. However, Appendix B of this report includes one set of model by-laws, with the primary goal of providing municipalities with some appropriate legal language to use around the topic of wind energy development. The model by-laws have been written to suit the needs of those Nova Scotia municipalities that do not have land use by-laws in place already, because these municipalities were seen to be most in need of assistance in the form of model language. It is assumed that other municipalities will modify and integrate ideas and text from this model by-law into their own existing LUBs. Such municipalities may wish to add a Wind By-law section to their LUB, or they may wish to add a section on wind by-laws under each of their zoning categories (if applicable) described in the LUB. Some municipalities may be exploring options with overlay zones particular to wind development (for example, based on a suitability analysis that defines "most suitable" and "least suitable" areas), in which case applicable wind by-laws will appear under the description for each overlay zone.

5.2 Other Considerations

While the inclusion of provisions in planning documents and LUBs is an important step for municipalities serious about addressing the questions around wind energy development, they are likely to be most effective in the context of broader efforts at the municipal, provincial, regional and national scale. Some additional areas of special consideration include the following:

- There is a need for the creation of community energy plans or other strategic planning exercise in communities to address larger issues around energy diversification and competing uses. Such a document might address questions such as how energy will be used, who will benefit from new energy projects, who will control the infrastructure, whether compensation or direct benefits will be allocated to effected populations etc. These questions should ultimately be answered through community dialogues as they directly impact the future of municipalities and citizens.

- There is a need for further research into many aspects of wind energy generation. As discussed in Section 2 of this report, there are many uncertainties concerning the impacts of both large scale and small scale turbines. Particularly, there is a lack of independent technical studies in Atlantic Canada given its climatic context. Furthermore, there is very little information about the changes that can be expected in terms of performance of wind turbines given the exceedingly present impacts of climate change such as increased extreme weather events. Municipalities and municipal organizations are well-advised to raise these concerns with senior levels of government and encourage further research in this field, specifically in the local context.
- Some options for regulations put forward in this document may be better suited to the Provincial Government, especially given the overlap between provincial and municipal roles in serving the interest of communities. A prime example is the regulation of noise. This is handled at the provincial level elsewhere in Canada, where an acceptable noise limit is written into legislation regardless of source. This means that wind turbines are subjected to the same noise level restrictions as other applications. This prospect that the Province could establish a consistent noise standard applied to a range of developments and activities is worthy of close consideration in Nova Scotia. Municipalities and municipal associations are advised to engage in discussions over these issues with the appropriate provincial bodies. In addition to enacting specific regulations around issues such as noise, the Province has the power to ensure that municipalities make a geniuine effort to address wind energy in the course of their land use planning. One way to do this is to include a provision for wind energy in the Statement of Provincial Interest. Statements of Provincial Interest in place in Nova Scotia recognize the importance of land and water resources. They currently cover the topics of drinking water, flood risk, agricultural land, infrastructure and housing. They serve as guiding principles for directing land use decisions by requiring that development undertaken by the Province and municipalities should be reasonably consistent with the statements. Adding a statement on wind energy to the Statement of Provincial Interest can be an effective way of influencing the municipalities' decision to take appropriate action and provide provisions for wind power development in their municipal planning strategies, land use by-laws and other planning documents.
- In planning for wind energy and facilitating its uptake, a regional approach may be most appropriate. This would expand the marketplace for new technologies, promote uniformity of regulations, and share the costs of research, development and planning. An eventual shift toward better infrastructure connectivity with the rest of Atlantic Canada may serve the wind industry in Nova Scotia well, as an expanded market could increase rubostness of renewable energy options on the grid and improve the econonmic payback of such projects.
- Consideration should be given to mechanisms for enhancing community and landowner benefits and proactive compensation regimes. Evidence suggests that some of the objections to wind development focused on specific potential effects are in essence employed as a means of stalling or preventing developments that cause local residents to accommodate disruptions, new activities and changes without sharing in potential benefits. These changes to communities associated with wind development impact a range of long held community values including aesthetic and quality of life factors. It is useful to recognize that these concerns can, at least in part, be mitigated with financial, participatory and consultative mechansims.
- As described earlier, the growth and promotion of wind energy development is in accord with provincial, national and international commitments regarding an overall shift to renewable energy sources. This is generally deemed imperative against the spectre of climate change concerns and the need to rapidly reduce greenhouse gas emissions by shifting from greenhouse gas intensive non-renewable energy sources while simultaneously reducing overall energy demand. Therefore the uncertainty regarding issues and impacts associated with wind energy development needs to be evaluated in balance and context with the known effects and impacts arising from current patterns of energy production and use.

APPENDIX A

Bibliography

Part 1 - Summary of Published Literature Reviewed

Title	Author	Reference	Summary
Microgeneration: A Discussion Paper for Stakeholder Review and Comment Version 1.0 (Discussion Purposes Only - DOES NOT Represent Government Policy)	Alberta Energy	Alberta Energy, August 2007	Specifically discusses very small scale wind energy generation - at the individual level - in an attempt to make it possible for individuals to produce wind energy for self reliance, but also to regulate this market so individuals are not producing more energy than they need and creating a profit venture.
Wind Farm Revitalizes Brownfield Site	American Ceramic Society Bulletin	American Ceramic Society Bulletin, 86(8), 16, 2006	Case study from California. Steel Winds Wind Farm is located on a former industrial site along the shores of Lake Erie. It is the first commercial deployment of state-of-the-art 2.5-MW Liberty series wind turbines manufactured by Clipper Wind power, Carpinteria, California. Located just south of Buffalo, NY, the 20-MW project is situated on a 30-acre portion of a former Bethlehem Steel facility, which is being returned to productive use under the NY Department of Environmental Conservation Brownfield Cleanup Program. Steel Winds will generate enough electricity to serve the needs of about 6000 homes. For the first five years the project will be operated by UPC Wind, with turbine operation and maintenance services provided by Clipper Wind power.
A Skyscraper for New Age	Ashrae Journal	Ashrae Journal, p.7-8, July 2007	Case study from China. Can a skyscraper produce more energy than it consumes? The question will be answered in 2009 when the Pearl River Tower opens in Guangzhou, China. The 71-story, 2.2 million-ft2 (204,000m2) skyscraper is designed by Skidmore, Owinga and Merrill (SOM) to conserve and generate enough power to meet its energy demands. One of the more innovative element will be the sculpted facade that directs wind to wind turbines on the building's mechanical floors.
Best Practice Guidelines for Implementation of Wind Energy Projects in Australia	Australian Greenhouse Office	AusWEA (Australian Wind Energy Association), March 2002	The guidelines aim to establish the process and approach for identifying, developing and implementing appropriate wind energy projects while acknowledging that each wind energy development will require assessment on its individual merits. Similarly the exact timing of the various activities outlined in these guidelines will vary depending on the individual developer's preferred approach. As a result no attempt has been made to define a checklist of project specifications or provide a schedule that can be universally applied to all developments equally. The developer will always need to investigate specific issues that may relate to a particular site and address these accordingly during the development process.
Environmental Noise Assessment Pubnico Point Wind Farm	Brian Howe and Nick McCabe	Howe, Brian and McCabe, Nick. Environmental Noise Assessment Pubnico Point Wind Farm, Nova Scotia, August 2006	The sound level from the wind turbine generators can exceed the background sound level in the area by up to 13 dB under certain wind and atmospheric wind conditions, most notably light wind from the south.
When lightning strikes wind turbines	Carsten Wagener, Edward Doherty	Wagener, C., Doherty, E. in *Machine Design* , 82-84, October, 2007	Discussion on technologies for avoiding damage when wind turbines are hit by lightning. In a typical lightning strike of a wind turbine, Franklin-type lightning rods in each blade conduct lightning energy to the rotor and then to the skin of the wind turbine nacelle. It then travels down the external skin of the tower to the base. Surge arresters connect between the 400/690-V power supply and a ground rod to keep lightning current out of the power circuitry.
Sail-Shaped Office Towers Support Wind Turbines	Catherine A. Cardno	Cardno, C.A. in Civil Engineering (08857024), 77(10), 14-15, 2007	Case study from Bahrain. The article reports on the construction of two 50-story sail-shaped towers in Bahrain connected by three bridges that support a *wind* turbine that will generate electricity for the towers. The architectural form of the towers was created from using the nautical expression of a sail to harness the consistent onshore breeze and to create towers that would transcend time. The *wind turbines* are centered on one of the three bridges linking the towers. The shape of the towers creates negative air pressure as it funnels offshore breezes toward the wind turbines.
Environmental Impacts of Wind Energy Projects	Committee on Environmental Impacts of Wind Energy Projects, National Research Council	National Research Council. (2007) Environmental Impacts of Wind Energy Projects.	The US National Academy of Sciences suggests it takes at least 30 wind turbines to reach a kill rate of one bird per year. It was also noted that site selection and weather patterns have a substantial effect on this number.
The Influence of Large-Scale Wind Power on Global Climate	David W. Keith, Joseph F. DeCarolis, David C. Denkenberger, Donald H. Lenschow, Sergey L. Malyshev, Stephen Pacala, Philip J. Rasch	Keith, D.W., et al. Proceedings of the National Academy of Science of the United States of America, 10.1073/pnas.0406930101, 2004, electronic version available at http://www.pnas.org.proxy.hil.unb.ca/cgi/content/full/101/46/16115	Assessment of climatic impacts of wind turbines. Large-scale use of wind power can alter local and global climate by extracting kinetic energy and altering turbulent transport in the atmospheric boundary layer. This paper reports on climate-model simulations that address the possible climatic impacts of wind power at regional to global scales by using two general circulation models and several parameterizations of the interaction of wind turbines with the boundary layer. It is found that very large amounts of wind power can produce non-negligible climatic change at continental scales. Although large-scale effects are observed, wind power has a negligible effect on global-mean surface temperature, and it would deliver enormous global benefits by reducing emissions of CO2 and air pollutants.
Energy Harvesting Gets Big - And Small	Don Tuite	Tuite, D. in *Electronic Design/Energy Independence* . 64-68. June, 2007	Discusses the scaling of energy harvesting: Megascal Harvesting, Microscale Harvesting, and Practical Designs.
Wind Turbines' Magnetic Appeal	Drew Robb	Robb, D. in *Power Engineering* . 6-8. 2007	The use of permanent magnets (PM) in wind power, paired with direct-drive, multiple generator and compared to synchronous/induction generators.
Comparative study of the behaviour of wind-turbines in a wind farm	Emilio Migoya, Antonio Crespo, Javier Garcia, Fermin Moreno, Fernando Manuel, Angel Jimenez, Alexandre Costa	Migoya, E.,et al. in *Energy* , 32(10), 1871-1885, 2007	The Sotavento wind farm is an experimental wind farm which has different types of wind turbines. It is located in an area whose topography is moderately complex, and where wake effects can be significant. One of the objectives of Sotavento wind farm is to compare the performances of the different machines; particularly regarding power production, maintenance and failures.
Wind farms Environmental noise guidelines (interim)	Environment Protection Authority (EPA), South Australia	EPA, December 2007. ISBN 1-876562-43-9	35dBA regulation, or 40dBA in an internsive rural or primary production/rural industry zone, or the background noise (LA90, 10) + 5dBA
Do wind turbines produce significant low frequency sound levels?	G.P. van den Berg	van de Berg, G.P. presentation at the 11th International Meeting on Low Frequency Noise and Vibration and its Control: Maastricht, The Netherlands 30 August - 1 September 2004	Low frequency sounds occur when the blade encounters a sudden variation in air flow when it passes the tower; this has not been considered important because it resonates at 1 Hertz. However, this paper argues that this sound modulates a higher frequency sound that is well audible and impulsive in nature. This is stronger at night when the atmosphere is stable, and can become worse if frequencies from multiple turbines coincide.
Effects of the wind profile at night on wind turbine sound	G.P. van den Berg	van den Berg, G.P. in Journal of Sound and Vibration, 277(4-5), 955-970. 2007	As a result of atmospheric changes at night, sounds from wind turbines can be up to 2.6 times higher than predicted at night. Turbines can also produce a thumping, impulsive sound when wind speed increases. Traditional predictions of noise levels are inaccurate because they do not account for this increase at night, or the thumping sound made at high wind speeds by the blades passing the tower. Coinciding pulse trains can cause the sound to increase directly in relation to how many turbines coincide. If two coincide, the pulse is 3db higher, if three coincide the pulse raises 5db.

Part 1 - Summary of Published Literature Reviewed

Title	Author	Reference	Summary
The Impact of R&D on Innovation for Wind Energy in Denmark, Germany, and the United Kingdom	Ger Klaassen, Asami Miketa, Katarina Larsen, Thomas Sundqvist	Klaasen, G., et al. in *Ecological Economics* , 54(2-3), 227-240, 2005	This paper examines the impact of public research and development support on cost reducing innovation for wind turbine farms in Denmark, Germany, and the United Kingdom (UK). The authors first survey the literature in this field. The literature indicates that Denmark R&D policy has been more successful than in Germany or the UK in promoting innovation of wind turbines. Furthermore, such studies point out that (subsidy-induced) capacity expansions were more effective in the UK and Denmark in promoting cost-reducing innovation than in Germany. The second part of the paper describes the quantitative analysis of the impact of R&D and capacity expansion on innovation. Authors arrive at robust estimations of a learning-by-doing rate of 5.4% and a learning-by-searching rate of 12.6%.
Public Health & Safety	Global Energy Concepts	New York State Energy Resource and Development Authority; Public Health and Safety. 2005	This report is part of a series in the NewYork State and Energy Resource and Development Authority's Wind Energy Tool Kit that examines a series of possible health and safety impacts of wind turbines and suggests that jurisdictions can address these potential impacts through establishing reasonable setbacks.
Wind Farms: Environmental Noise Guidelines	Government of South Australia	Government of South Australia. ISBN: 1 876562 43 9. February 2003	Case study from Australia. The core objective of these guidelines is to balance the advantage of developing wind energy projects in this State with protecting the amenity of the surrounding community from adverse noise impacts. Wind farms need specific guidelines because wind turbines have unique noise generating characteristics and the environments surrounding wind farm sites usually have low ambient noise.
The spectrum of power from wind turbines	Jay Apt	Apt, J. in *Journal of Power Sources* . 169(2), 369-374. 2007	The power spectrum density of the output of wind turbines provides information on the character of fluctuations in the turbine output. Here both 1-second and 1-hour samples are used to estimate the power spectrum of several wind farms. The measured output is found to follow a Kolmogorov spectrum over more than four orders of magnitude, from 30s to 2.6 days. Given the magnitude of these fluctuations, a wind system that incorporates batteries, fuel cells, super-capacitors, or other fast-ramp-rate energy storage systems would match fluctuations much better, and can provide an economic route for deployment of energy storage systems when renewable portfolio standards require large amounts of intermittent renewable generating sources.
Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk	Jesper K. Larsen, and Magella Guillemette	Larsen, J.K., Guillemette, M. in *Journal of Applied Ecology* , 44(3), 516-522, 2007	Wind energy is a fast growing renewable energy source and many offshore wind parks will be erected in shallow waters (<40m deep) where various coastal bird species are found. The two main issues regarding offshore wind farms and birds are disturbance and collision risk. The movement and noise of rotors affected neither the number of common eiders flying within corridors nor the number of birds reacting to decoys. This suggests that the avoidance behaviour observed was caused by the presence of the structures themselves and that eiders use vision when avoiding human-made structures. The observed avoidance behaviour may result in a reduction of habitat availability within and around wind parks, and raises concerns about the possible impact of the extensive development of large-scale wind parks in shallow offshore waters, which are the main feeding areas for sea ducks and other marine birds.
Wind Turbines: Noise and Setback Regulations: a Brief Summary	Kaija Metuzals	Metuzals, K. 2006. Wind Turbines: Noise and Setback Regulations: a Brief Summary	Summary of decibel regulations and setback distances table
Flexible gears bolster wind-turbine reliability	Kenneth J. Korane	Korane, K.J. in *Machine Design* . P.24-28, August 2007	Focuses on a gearbox product designed by Tinken out of Canton, Ohio which can handle 50% more torque than conventional gearboxes, thus increasing the lifespan by up to 6 times.
In Defense of the Wind	Lynn Tillotson & Pinker, L.L.P.	Printed document/booklet for advertisement/education purposes	Discusses development plans, appropriate sound thresholds, dealing with opposition, etc. Highlights December 2006 jury case in Abilene, Texas where a group of residents charged FPL Energy's Horse Hollow Wind Energy Center (the largest wind farm development in the world with more than 400 turbines) with the accusation that the turbines created a visual and auditory nuisance. Jurors deliberated for two days, and by a vote of 11-1 decided that the wind farm had not created a nuisance for the plaintiffs. This was the first case of its kind and monoumentous in the development of wind energy.
The Effects of a wind farm on birds in a migration point: the Strait of Gibraltar	Manuela de Lucas, Guyonne F.E. Janss, Miguel Ferrer	Lucas, M.d., et al. in *Biodiversity and Conservation* , 13(2), 395-407. 2004. electronic copy available at http://www.kluweronline.com.proxy.hil.unb.ca/issn/0960-3115/contents	The interaction between birds and wind turbines is an important factor to consider when a wind farm is constructed. A wind farm and two control areas were studied in Tarifa (Southern Spain). Variables were studied along linear transects in each area and observations of flight were also recorded from fixed points in the wind farm. The main purpose of the research was to determine the impact and degree of flight behavioural change in birds resulting from a wind farm. Study suggests that soaring birds can detect the presence of the turbines because they change their flight direction when they fly near the turbines and their abundance did not seem to be affected. This is also supported by the low amount of dead birds found in the whole study period in the wind farm area. More studies will be necessary after and before the construction of wind farms to assess changes in passerine populations. Wind farms do not appear to be more detrimental to birds than other man-made structures.
Small-Scale Wind Turbines, Policy Perspecties and Recommendations for the Municipality of the County of Kings	Marta Downarowicz, Rachel Harrison, Robert Kostiuk, Jeff Wilson	Dalhousie University School of Planning. 2006	Report written by Dalhousie School of Planning for the Municipality of Kings County that explores the implementation of small scale wind turbines and makes recommendations for permanent policy amendments. The report gives an overview of policy in other jurisdictions, the County's MPS and LUB, and stakeholder input.
Landscape and Visual Assessment Guidance for Wind Energy Farm Development	Municipality of Grey Highlands	University of Guelph. 2006	Report by School of Environmental Design and Rural Planning, University of Guelph, that developed a methodology for landscape assessment and development of criteria for required visual impact assessments.
Permitting of Wind Energy Facilities; A Handbook	National Wind Coordinating Committee	National Wind Coordinating Committee (US), Revised 2002.	A handbook for the process of permitting wind energy in the United States with a clear bias in favour of the wind energy industry. Reviews the typical steps in permitting, known impacts of noise, land use impact, bird mortality, etc. Very specifically and clearly recommends upwind placement/turbines as it helps to decrease the noise.
Life Cycle Assessment for Emerging Technologies: Case Studies for Photovoltaic and Wind Power	Niels Jungbluth, Christian Bauer, Roberto Dones, Olf Frischknecht	Jungbluth, N. et al. in The International Journal of Life Cycle Assessment, 10(1), 24-34. 2005. electronic copy available at http://www.springerlink.com.proxy.hil.unb.ca/content/r7347txq7567357m/	This assessment includes four different wind turbines with power rates between 30kW and 800kW operating in Switzerland and two turbines assumed representative for European conditions - 800kW onshore and 2MW offshore. The complex installation of offshore turbines, with high requirements of concrete for the foundation and the assumption of a shorter lifetime compared to onshore foundations, compensate the advantage of increased offshore wind speeds. The differences for environmental burdens of wind power basically depend upon the capacity factor of the plants, the lifetime of the infrastructure, and the rated power. The higher these factors, the smaller the environmental burdens are. The wind power system is quite dependent on meteorological conditions and the materials used for the infrastructure.
Exergy and reliability analysis of wind turbine systems: A case study	Onder Ozgener, Leyla Ozgener	Ozgener, O., Ozgener, L. in *Renewable and Sustainable Energy Reviews.* 11(8), 1811-1826. 2006	The study undertakes an exergy and reliability analysis of wind turbine systems. In order to extract the maximum possible power, it is important that the blades of small wind turbines start rotating at the lowest possible wind speed. The starting performance of a three-bladed, 3 m diameter horizontal axis wind turbine was measured in field tests.
Giant fans of wind energy	Patrick Mahoney	Mahoney, P. in *Machine Design* . P.47-51. August , 2007	This article focuses on how the wind turbine works technically and the obstacles that come with an industry and product that are literally becoming super-sized. One portion discusses 'How high is too high?' and concludes that 100-m towers are better for inland while 80-m towers work better on the coast. According to the Global Wind Energy Council, global wind power capacity has been rising 20% annually (at least) since 2000. Modern wind turbines produce 200x more power than equivalent turbines of two decades ago.
Irish coast tidal turbine gets go-ahead after successful trials	Professional Engineering	Professional Engineering, p.9, 13 June 2007	The 'SeaGen' unit will have a 12 MW capacity, making it the world's largest tidal current device by a significant margin. Turbine is like submerged windmill running off of tidal energy. To be installed and connected to the grid by early September 2007.
Wind Turbines Pose Lubrication Challenges	Saurabh Lawate, Michelle Graf (The lubrizol Corp.)	Lawate, S., Graf, M. in *Power Engineering* . P.62-66. August 2007	Focuses on maintenance of wind turbines; particularly on the use of lubricant and oil analysis.

Part 1 - Summary of Published Literature Reviewed

Title	Author	Reference	Summary
Is wind power ready for prime time?	Stephen Mraz	Mraz, S. in *Machine Design.* P.44-45. August 2007	Upscale residents of Martha's Vineyard and Cape Cod oppose a wind farm there. The Cape Cod Wind Farm project would consist of 130 spinning wind turbines covering 25 square miles. The site would be 6 miles from shore, but residents fear it would spoil the scenery and kill the fish. Greenpeace (environmental activist group) insists that offshore windmills pose no threat to marine or avian life.
Public policy modelling of distributed energy technologies: strategies, attributes, and challenges	Thomas Bruckner, Robbie Morrison, and Tobias Wittmann	Bruckner, T., *Ecological Economics* , 54(2-3), 328-345. 2006	The systems which provide active and passive energy-services are undergoing rapid institutional, commercial, and technical change. As part of this transformation, distributed energy technologies are expected to play a greater role. In addition, governments and local authorities are seeking to encourage selected distributed technologies, including wind power and cogeneration, for reasons of public interest. Even so, most energy sector policy support models have difficulty realizing distributed technologies, particularly where complex component/system interactions arise. High-resolution modelling addresses these shortcomings through increased topological resolution, greater temporal disaggregation, extended model scope, and support for context-dependent component performance. New modelling technique supports decentralized decision-making, automatically captures interacting commercial and technical dynamics, and may be used to investigate structural evolution. A summary of national energy policy modeling strategies and a roadmap are provided.
A changing perspective blows in	Tim Lloyd Wright	Wright, T. in *Hydrocarbon Processing.* P.13. August 2007	Investment in new wind projects reached $15 billion last year. The market for turbines grew by 30%. The world currently has around 75 GW of installed wind power capacity. About 20% of that was installed in 2006 alone.
Generating energy can be a breeze, Kruse says	USA Today	USA Today, 07347456. July, 2007	Entrepreneurs Andy Kruse and David Calley present their product: Skystream - a residential wind turbine, 170 pounds, as short as 34 feet, 1.8 kilowatt
Response of Rocky Mountain Elk (Cervus elaphus) to Wind power Development	W. David Walter, David M. Leslie Jr., and Jonathan A. Jenks	Walter, W.D. et al. in *American Midland Naturalist* , 156(2), 363-375, 2006	Wind-power development is occurring throughout North America, but its effects on mammals are largely unexplored. Our objective was to determine response of Rocky Mountain Elk to wind-power development in south-western Oklahoma. Ten elk were radio-collared in an area of wind-power development on 31 March 2003 and were relocated bi-weekly through March 2005. Wind-power construction was initiated on 1 June 2003 and was completed by December 2003 with 45 active turbines. The largest composite home range sizes (>80 km2) occurred April-June and September, regardless of the status of wind-power facility development. The smallest home range sizes (<50km2) typically occurred in October-February when elk aggregated to forage on winter wheat. No elk left the study site during the study and elf freely crossed the gravel roads used to access the wind-power facility. Carbon and nitrogen isotopes and percent nitrogen in feces suggested that wind-power development did not affect nutrition of elk during construction. Although disturbance and loss of some grassland habitat was apparent, elk were not adversely affected by wind-power development as determined by home range and dietary quality.
Wind Jammers	Wall Street Journal	Wall Street Journal - Eastern Edition, 250(49), A12. August 2007	The article comments on the opposition by residents in Cape Cod, Martha's Vineyard and Nantucket in Massachusetts to a proposed wind farm in the area. Environmental group Greenpeace considers wind power a key source of renewable energy while some of the local residents consider it an offense against the scenery. The Cape Wind project will establish 130 wind turbines on Horseshoe Shoal. It asserts that advocates often promote renewable energy not for its economics but because it is virtuous.
Minnesota Model Encourages Community Wind	Dan Yarano	Yarano, D. in North American Windpower. 4(12), 18-22, 2008	Some jurisdictions are recently introducing innovative community-based models for wind development that are moving from consultation to participation to encourage, develop and finance wind projects. For example, ‘revenue participation’ and ‘flip’ (ownership percentage flips to greater local ownership at a certain stage in a project) financial structures are being used in Minnesota so local landowners can participate in the development of utility-scale wind power. The goal of these projects is to return financial benefits to landowner beyond the typical land lease payments provided in projects developed by utilities or independent power producers. In exchange for these increased financial benefits, local landowners take a greater role in early development of the projects, occasionally including start-up cash contributions, securing land rights and applying for local permits. By participating in the risk and rewards of development, local communities increase local financial benefits by keeping energy dollars at ‘home’. According to the Minnesota Department of Commerce., there are currently more than 850MW of community-based wind projects completed, under contract or being negotiated with Minnesota utilities.

Part 2 - Summary of Online Research Findings

Website Link	Organization	Publications	Date	General Information
http://www.eub.ca/docs/documents/directives/Directive038.pdf	Alberta Energy and Utilities Board	Directive 038, Noise Control	Revised February 2007	Revised provincial requirements for noise control with specific wind turbine references in 1.3, 3.5.3, and 4.1.2.
www.nationalwind.org/events/siting/proceedings.pdf	Allen, Matthew	Tools for Evaluating Wind Turbine Visibility	2005	Summary of paper presented at conference on topic of wind turbine visibility including line of sight profiles, viewshed mapping, shadow flicker and photgraphic simulations.
http://www.awea.org/smallwind/documents/AWEASmallWindMarketStudy2007.pdf	American Wind Energy Association (AWEA)	AWEA Small Wind Turbine Global Market Study	2007	Reviews market for small wind and identifies state and federal policy as the pivotal factor for sustaining and growing small wind market.
www.awea.org/smallwind/documents/permitting.pdf	American Wind Energy Association (AWEA)	Permitting Small Wind Turbines: A Handbook	Sep-03	Handbook that outlines considerations for permitting small wind turbines based on the California experience.
http://www.awea.org/smallwind/toolbox2/zoning.html	American Wind Energy Association (AWEA)	Small Wind Toolbox: Zoning		Brief overview of zoning do's and don'ts from the US experience.
http://www.auswind.org/downloads/bestpractice/AUSWINDBestPracticeGuidelines.pdf http://www.auswind.org/downloads/bestpractice/AllAppendicesBPG181206.pdf	Australian Wind Energy Association (AusWEA)	Best Practice Guidelines for Implementation of Wind Energy Projects in Australia and Appendices	2006	Guidelines document best practice processes: site selection, preparation for development application, construction, operation and decommissioning at the end of the development's life. For all electromagnetic effects, means of mitigation, avoidance, and remedy can be found. Organizations involved in producing wind standards are highlighted.
http://www.auswind.org/downloads/landscape/Wind%20Farms%20&%20Lscape%20Iss%20Web.pdf	Australian Wind Energy Association (AusWEA)	Wind Farm and Landscape Values: Draft Issues Paper	May-04	A large amount of information on characteristics, landscape values, design solutions, and landscape assessment information.
http://www.auswind.org/downloads/landscape/NAF07-06-27FINAL.pdf	Australian Wind Energy Association and Australian Council of National Trusts	Wind Farms and Landscape Values, National Assessment Framework, Final Version	Jun-07	Framework is to provide a method for assessing, evaluating and managing the impact of wind turbine farms on landscape values.
http://www.state.vt.us/psb/document/7250Deerfield/Petition+SupportDocs/Zimmerman/DFLD-JZ-18_Shadow_Flicker_Analysis.pdf	AWS Truewind, LLC	Shadow Flicker Analysis	Jun-06	Shadow flicker analysis report of the proposed Deerfield Wind Project in Vermont, done on behalf of Vermont Environmental Research Associates
www.nationalwind.org/events/siting/proceedings.pdf	Baring-Gould, Ian	Turbine Operation in Icing Climates	2005	Summary of paper presented at conference on topic of icing.
www.nationalwind.org/events/siting/proceedings.pdf	Bo Sondergaard, Danish Electronics, Light and Acoustics (DELTA)	Propagation of Noise from Wind Turbines on-shore and offshore	2005	Precis of paper presented at National Wind Coordinating Conference on wind turbine impacts.
http://www.bwea.com/media/news/070328.html	British Wind Energy Association (BWEA)	New research blows away myths on wind farms	28-Mar-07	The research found no clear relationship between proximity of wind farms and property prices. Paper cites another study in the US found that property prices within a five mile radius of a wind farm appeared to rise above the regional average, suggesting that wind turbines actually had a positive effect on value.
http://www.bwea.com/ref/noise.html	British Wind Energy Association (BWEA)	Noise from Wind Turbines - the facts	Jun-00	Therefore, if a single turbine emits a 90-100dBA noise level, a 50-60dBA may be reached at 40m and a 35dBA level may be reached at a distance of 500m.
http://www.bwea.com/you/siting.html	British Wind Energy Association (BWEA)	Siting a small wind turbine	Jun-05	The turbulence at top and bottom of cliffs or sharp edges makes them unsuitable for wind turbines. It is essential that turbines be sited away from obstructions, with clear exposure or fetch for the prevailing wind. The ideal position for a wind turbine generator is a smooth hill top, with a flat clear fetch, at least in the prevailing wind direction. Study recommends turbines be placed away from local obstructions such as large trees and houses, or use a taller tower to ensure that the turbine is well above the obstructions.
http://www.bwea.com/small/cases.html	British Wind Energy Association (BWEA)	Small Wind Case Studies	2007	Several case studies on performance of small wind turbines. Corrour Station - 2.5 kW battery charging wind turbine used for lighting the unmanned remote train station for one hour over each time the train stops when it is dark. Berwickshire Housing Association - three 1.5 kW rooftop turbines aiming to lower tenants fuel costs and reduce reliance on fossil fuel based energy. Ladygrove Primary School - 2.5 kW turbine, generates electricity directly for use in the school with extra being supplied to the local grid, received ~$25 000 funding, annual savings of ~$800 and a reduction of 3.5 tonnes/year of CO_2 emissions.
http://www.caithnesswindfarms.co.uk/	Caithness Wind Farm Information Forum	Summary of Wind Turbine Accident data to August 31st 2007	2007	Accident statistics relating to wind turbines up until August 31st, 2007.
http://www.canwea.ca/images/uploads/File/FINAL-CanWEAPositionOnSetbacks-2007-09-28.pdf	Canadian Wind Energy Association (CanWEA)	CanWEA Position on Setbacks for Large-Scale Wind Turbines in Rural Areas (MOE Class 3) in Ontario	2007	Guidance for Municipalities in Ontario on Setbacks for Large-Scale Wind Turbines in Rural Areas.
http://www.canwea.ca/images/uploads/File/Wind_Energy_Policy/Municipal_Policy/Rural_Municipalities_Review_an d_Approval_Processes_-_Final.pdf	Canadian Wind Energy Association (CanWEA)	Overview for Municipalities of the Review and Approvals Required for Wind Farms in Ontario	2005	Comprehensive list of non-municipal bodies that may require review and approval of wind farms and the aspects of development that require municipal approval in rural Ontario.

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http://www.canwea.ca/images/uploads/File/Wind_Energy_Policy/Municipal_Policy/Rural_Municipalities_Zoning_Template_-_CanWEA_-_Final.pdf	Canadian Wind Energy Association (CanWEA)	Proposed Official Plan Amendment for Rural Municipalities in Ontario Related to Wind Energy Resources	2005	Proposed amendment for Official Plan, Zoning by-law, setback matrix and definitions.
http://www.canwea.ca/images/uploads/File/EN/Small_Wind_Siting_Guidelines.pdf	Canadian Wind Energy Association (CanWEA)	Small Wind Siting and Zoning Study: Development of Siting Guidelines and a Model Zoning By-law for Small Wind Turbines (under 300 kW).	2006	eFormative Options and Entegrity Wind Systems report that addresses small wind definition, overview of municipal approaches to small wind, best practice guidelines for consumers and installers, and model zoning bylaw.
http://www.canwea.ca/images/uploads/File/CanWEA_Infrasound_Study_Final.pdf	Canadian Wind Energy Association (CanWEA)	Wind Turbines and Infrasound	2006	HGC Engineering report addresses the issues of infrasound and wind turbines and potential impact on residences.
http://www.canwea.ca/images/uploads/File/CanWEA_Wind_Turbine_Sound_Study_-_Final.pdf	Canadian Wind Energy Association (CanWEA)	Wind Turbines and Sound: Review of Best Practices and Guidelines	2007	HGC Engineering report reviews best practices related to wind turbines and noise.
http://www.canwea.ca/images/uploads/File/Wind_Energy_Policy/RABC-CanWEA-TechnicalInformationGuidelinesrePotentialImpactofWindTurbines_2.pdf	Canadian Wind Energy Association (CanWEA) and Radio Advisory Board of Canada (RABC)	Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radio communication, Radar and Seismoacoustic Systems	2007	Guidelines provide a series of analytical methodologies to help identify potential impact and interference and act as a voluntary trigger for proponent to notify applicable authority.
http://www.canwea.ca/images/uploads/File/GH-RiskAssessment-38079or01a(1).pdf	Canadian Wind Energy Association (CanWEA), by Garrad Hassan Canada Inc.	Recommendations for Risk Assessments of Ice Throw and Blade Failure in Ontario	31-May-07	Recommendations for assessing the risk of ice fragments shed from wind turbines striking members of the public in the vicinity of wind farm projects in Ontario and a literature review of wind turbine rotor blade failures based on publicly available information.
http://www.cbc.ca/technology/story/2006/09/08/bats-turbines.html	CBC News	Why are wind turbines killing Alberta's bats?	8-Sep-06	University of Calgary research project under Dr. Robert Barclay to determine impacts on bats from win turbine development (specifically at the Summerview Wind Farm in Pincher Creek, Alberta)
www.cwee.unbc.ca/publications/Mackenzie%20et%20al%202007%20EA%20Scoping%20Documents%20for%20BC.pdf	Centre for Wind Energy and the Environment	Wind Energy Development and Environmental Impact Assessment Scoping Process for British Columbia	2006	Report on workshop discussions held at the University of Northern British Columbia on the effect of wind energy development on aerial wildlife.
http://coastalhabitatalliance.org/reports/Collision-Report-Executive-Summary-12-18-07.pdf	Coastal Habitat Alliance	Collision Report	Dec-07	Case study of two proposed developments in South Texas which have already begun construction despite the opposition due to the location: one of the most significant migratory bird corridors connecting Canada and the US to Mexico and South America. A failed project results in bad publicity for wind development, and in this case, it could result in major negative environmental effects (bird fatalities).
http://www.countyofessex.on.ca/general/documents/FinalBackgroundStudy5.9.07_000.pdf	County of Essex, by Jones Consulting Group Ltd.	Background Research Paper Windpower & Renewable Energy Planning Study	4-Sep-07	Outlines several standards that are used globally to mitigate against the impacts of shadow flicker. These include limiting the amount of time a receptor is affected by shadow flicker to a maximum of 30 hours per calendar year and a maximum of 30 minutes per day (based on a world case calculation – maximum shadow during a day between sunrise and sunset on a cloudless day); maximum of 30 hours per year based on actual/real predicted values as opposed to worst case calculation (based on a German court decision to tolerate 30 hours of actual shadow flicker per year and then applying the probability of sunshine for the area); and separation of the turbine and receptor of a minimum distance of 10 rotor diameters. Variations of the maximum 30 hours per year of shadow flicker have become the prominent standard in use globally. The distance that should be calculated: within 1300m of a turbine with a total height of 140m.
http://www.stopillwind.org/downloads/WindTurbineAccidentComp.pdf	Craig, David	Wind Turbine Accident Compilation	2006	Accident statistics relating to wind turbines, last updated January 1, 2006.
http://www.currykerlinger.com/birds.htm	Curry & Kerlinger, LLC	What Kills Birds?	date unknown	Various causes of bird mortalities and statistics to match
http://www.berr.gov.uk/energy/sources/renewables/planning/onshore-wind/shadow-flicker/page18736.html	Department for Business Enterprise and Regulatory Reform, UK	On Shore Wind: Shadow Flicker		Brief information sheet on shadow flicker for on shore wind turbines.
www.airforce.forces.gc.ca/8wing/squadron/atess_turbines_e.asp	Department of National Defence	Wind Turbines and Potenital Impact on Air Traffic Control and Air Defense Radar Systems	2007	Process that outlines when to consult with DND concerning the potential development of a wind turbine farm.
http://www.countyofessex.on.ca/general/documents/DA2007WindTurbinesandWildlifeLiteratureReviewFinal.pdf	Dougan & Associates Ecological Consulting & Design	County of Essex Windpower & Renewable Energy Planning Study: Wind Turbines & Wildlife: A Literature Review	Dec-07	Summerview Wind Farm (Pincher Creek, Alberta) study found 620 bats killed in one season (and 30 birds). A case study is done on the Erie Shore Wind Farm, as it is one of the few Canadian examples of a location which has done a significant post-construction study in Canada. Results are very positive; showing that proper siting can reduce bird and bat mortality at wind farms.
www.cws-scf.ec.gc.ca/publications/eval/prot/protocols_e.pdf	Environment Canada, Canadian Wildlife Service	Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds	Apr-07	Companion to Wind Turbines and Birds, A Guidance Document for Environmental Assessment that provides information on types of protocols that may be useful for baseline studies and follow-up monitoring at proposed wind energy sites.

Part 2 - Summary of Online Research Findings

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www.cws-scf.ec.gc.ca/publications/eval/turb/turbines_e.pdf	Environment Canada, Canadian Wildlife Service	Wind Turbines and Birds, A Guidance Document for Environmental Assessment	Apr-07	Guide refers to environmental assessment of wind energy installations with respect to birds. Pre-assessment tool to identify site and design features that should be considered to minimize impacts on birds. The guide uses a matrix approach based on site sensitivity and facility size to rank the proposed project into one of four project categories that indicates the relative level of effort anticipated in determining and mitigating potential adverse effects to birds. Baseline information, follow-up requirements, and information on assessing cumulative effects are included.
http://www.epilepsyfoundation.org/about/types/triggers/photosensitivity.cfm	Epilepsy Foundation	Triggers: Photosensitivity and Seizures	2002, revised 2005	Information page by the Epilesy Foundation, US concerning exposure to flashing lights that can trigger seizures.
www.wind-works.org/articles/noisewt.html	Gipe, Paul	Noise from Small Wind Turbines: An Unaddressed Issue		Article by researcher and author of wind turbine publications about lack of research into understanding and analysing impacts of noise from small wind turbines.
www.powernaturally.org/Programs/Wind/toolkit/18_publichealthandsafety.pdf	Global Energy Concepts	Public Health and Safety	2005	Part of a series of reports in the New York State Energy Research and Development Authroity's Wind Energy Tool Kit focussing on public health and safety
http://www.energy.gov.ab.ca/Electricity/pdfs/FactSheet_Wind_Power.pdf	Government of Alberta	Talk About Wind Power: Facts on Wind Power	Sep-07	Fact Sheet: wind has the potential to power 20% of Canada's electricity demand (17 million homes), Alberta currently produces 497 MW of wind energy connected to the grid and has 5500 MW proposed, describes the 'cap' in wind energy in place Alberta before September 2007.
www.em.gov.bc.ca/AlternativeEnergy/windpower/windpolicy_07.pdf	Government of British Columbia	Wind Power Projects on Crown Land	2005	The Wind Power Operational Policy outlines the type, term and pricing of tenures for wind energy projects on Crown lands.
www.communities.gov.uk/documents/planningandbuilding/pdf/147447	Government of Great Britain	Planning for Renewable Energy, A Companion Guide to PPS22	2004	Document outlines how different levels of government will be involved in renewable energy planning and describes how criteria based policy will be developed.
www.gov.mb.ca/conservation/wind-farms	Government of Manitoba	Questions and Answers Regarding Manitoba's Crown Land Policies for Wind Farms	2006	Through the Energy Development Initiative the province is developing a wind power strategy and has outlined in a general format its approach to wind farm development on Crown lands.
http://www.windturbinenoisehealthhumanrights.com/wtnoise_health_2007_a_barry.pdf	Harry, Dr. Amanda	Wind Turbines, Noise, and Health	Feb-07	Negative health effects occur in people living as far as 1 mile from wind turbines; therefore, until further medical research can be conducted, she recommends a setback of 1.5 miles.
http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,1633,en.pdf	Irish Department of the Environment, Heritage & Local Government	Wind Energy Development Guidelines	2004	This report considered the following factors as important aspects in controlling the visual impact of wind turbines: siting and location, spatial extent and scale, cumulative effects, spacing of turbines, height of turbines, colour and lighting. More than one tower requires a qualitative assessment to minimize the visual impact in certain areas. The development of incremental wind turbine proposals is monitored to gauge the cumulative visual impact on the environment.
www.irac.pe.ca/document.aspx?content=legislation/PlanningAct-SubdivisionAndDevelopmentRegulations.asp	Island Regulatory and Appeals Commission, PEI	Planning Act, Subdivision and Development Regulations	Updated June 27, 2007	Section E 54.1 outlines PEI Provincial regulations for Wind Energy Conversion System Developments
www.energy.ca.gov/2005publications/CEC-500-2005-184/CEC-500-2005-184.pdf	Larwood, Scott and vanDam, C.P, California Wind Energy Collective	Permitting Setback Requirements for Wind Turbines in California	2006	Study that looks at barriers to new wind energy development with newer turbine designs and reviews existing setbacks and resommendaitons for development of setbacks.
www.physics.rutgers.edu/~matilsky/windmills/throw.html	Matilsky, Terry	More on Rotor Throw and Ice Projectiles		Professor of Physics and Astronomy at Rutgers University in New Jersey who advocates for a more conservative setback distance to protect from ice and blade throw of 518m.
http://www.nrel.gov/docs/fy04osti/34662.pdf	Migliore, P. et al	Acoustic Tests of Small Wind Turbines	2003	Preprint of a conference paper of the National Renewable Energy Laboratory of the National Wind Technology Centre in the US where 8 small wind turbines ranging from 400W to 100kW were tested for acoustic emissions. Improvement has been made in newer small wind turbines to reduce noise.
www.ene.gov.on.ca/envision/gp/4709e.pdf	Ministry of the Environment, Ontario	Interpretation for Applying MOE NPD Technical Publications to Wind Turbine Generators	Revised July 6, 2004	Guidance document to assist wind turbine development proponents in determining what information should be submitted when applying for a Certificate of Approval (Air).
http://www.mdpinchercreek.ab.ca/WECS%20Review.pdf	Municipal District of Pincher Creek No. 9 Report prepared by Oldman River Regional Services Commission	Wind Energy Conversion Systems Review - Draft	2007	Mandated review commisisoned by muncipality after a specified number of turbines were developed in the municipality. Review contains current bylaws, information from public consultations and proposed future direction for bylaws and further study.
http://www.nationalwind.org/publications/wildlife/Mitigation_Toolbox.pdf	National Wind Coordinating Committee (NWCC)	Mitigation Toolbox 2007	2007	Mitigation toolbox is a compilation of mitigation policies, guidelines and research that are either directly or indirectly applicable to the wind industry. Although there is considerable research on mitigation, and there are many tools that might be applied in the context of wind power, few scientifically proven mitigation strategies are currently available to the wind industry.
www.nationalwind.org/publications/siting/Siting_Factsheets.pdf	National Wind Coordinating Committee (NWCC)	State Siting and Permitting of Wind Energy Facilities	Apr-06	Offers examples of range of approaches for siting wind energy projects in several US states.
www.nationalwind.org/events/siting/proceedings.pdf	National Wind Coordinating Committee (NWCC)	Technical Considerations in Siting Wind Developments: NWCC Research Meeting, Dec. 1-2, 2005	2006	Summaries of papers presented at conference on topics of visual, lighting, sound, electromagnetic and safety impacts.
www.nationalwind.org/publications/siting/Wind_power_Facility_Siting_Case_Studies.pdf	National Wind Coordinating Committee (NWCC)	Wind Power Facility Siting Case Studies: Community Response	Jun-05	Study examined communities' reactions to local wind development projects with the intent of identifying circumstances that distinguish welcomed projects from projects that were not accepted.

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http://www.nationalwind.org/publications/wildlife/wildlife_factsheet.pdf	National Wind Coordinating Committee (NWCC)	Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions	Nov-04	Fact Sheet: Second Edition, average American Home uses approximately 10,000 kWh per year (~6,000-12,000), 1 MW turbine may generate enough power for 200-600 households; impacts on birds/bats vary from wind farm to wind farm, generally two local impacts are observed: 1) direct mortality from collision, 2) indirect impacts due to avoidance, habitat disruption, and displacement; both migrating and resident birds can collide; raptors are at a higher risk, higher frequency of collisions, reasons unknown; belief that most nocturnal migrating birds migrate at elevations above today's typical turbine heights and that most topographical relief has little influence on migratory behaviour. Pertains to wind turbines of 40 kW or larger.
http://www.nationalwind.org/publications/siting/permitting2002.pdf	National Wind Coordinating Committee, National Conference of State Legislatures, USA	State Siting and Permitting of Wind Energy Facilities	2002	Compilation of examples that represent the range of siting approaches for wind turbines across the United States.
http://www.wind-watch.org/press-070402.php	National Wind Watch	Noise Complaints on Rise with New Industrial Wind Power Projects	2-Apr-07	The French National Academy of Medicine has called for a halt of all large-scale wind development within 1.5 kilometers of any residence, because the sounds emitted by the blades constitute a permanent risk for people exposed to them. The U.K. Noise Association studied the issue and agreed with the recommendation of a 1-mile setback. National Wind Watch calls on the commercial wind industry to respect the people who reside in targeted development regions, to honor their right to healthy lives and peaceful enjoyment of their homes, by adopting meaningful setbacks -- measured in miles, not in feet.
www.navcanada.ca/ContentDefinitionFiles/Services/ANSPrograms/forms/NC10-0441_en.dot	Nav Canada	Land Use Proposal Submission Form	current	General land use procedure outline and form to submit to Nav Canada for potential wind turbine development
www.noblepower.com/issues-and-answers/documents/06-08-23NEP-ShadowFlicker-FS4-G.pdf	Noble Environmental Power	Wind Fact Sheet #4: Shadow Flicker		Brief information sheet explaining shadow flicker and possible health impacts related to photosensitivity of certain individuals.
http://www.gov.ns.ca/enla/ea/docs/EAGuideWindPower.pdf	Nova Scotia Department of Environment and Labour	Proponent's Guide to Wind Power Projects: Guide for preparing an Environmental Assessment Registration Document	2007	Guide ensures that proponents will consider issues associated with wind turbines as part of the Nova Scotia Environmental Assessment process.
http://www.gov.ns.ca/natr/land/policywindenergy.htm	Nova Scotia Department of Natural Resources	Wind Energy Generation on Crown Land	2007	Policies and procedures for developing wind energy generation systems on Crown Land in NS.
http://www.ontario-sea.org/pdf/LandownersGuideToWindEnergy.pdf	Ontario Sustainable Energy Association	Ontario Landowner's Guide to Wind Energy	2005	A tool for landowners considering wind power development on their land covering models, impacts, land options, lease agreements and financial analysis.
http://www.powerauthority.on.ca/Storage/52/4743_C-8-2_Att_17.pdf	Palmer, William K.G. P.Eng.	Setbacks to Wind Turbines in Ontario: An Engineering Justification Based on Public Safety Risk and Ontario Noise Regulations	Aug-06	Claims the statements and conclusions reached in the Enbridge Ontario Wind Project Environmental Screening Report were inadequate and without justification. He recommends a setback from property lines of 2 times (turbine tower height + blade radius) and a noise setback from homes of 1000m. "...Applying the method shown in the noise assessment of the Enbridge Screening Report will result in over 87% of homes at distances of up to 900 metres above the Ontario standard for noise at times when masking is not available..."
http://www.ninapierpont.com/pdf/Health,_hazard,_and_quality_of_life_3-2-05.pdf	Pierpont, Nina MD PhD - published as an editorial article in the Malone (NY) Telegram	Health, hazard, and quality of life near wind power installations: How close is too close?	Mar-05	Strong belief that wind turbines should not be sited any less than 1.5 miles (2.2km) from any receptor. Also noted negative effects of noise generated from wind development on the older generation (loss of inner ear functionality, dizziness, etc).
www.gov.ns.ca/just/regulations/REGS/envassmt.htm	Province of Nova Scotia	Environmental Assessment Regulations, Section 49 Environment Act - Schedule A Class 1	current	Pertains to Environmental Assessment required for an electric generating facility which has a production rating of 2 megawatts or more derived from wind energy.
http://www.awea.org/smallwind/documents/permitting.pdf	Renewable Energy Program, California Energy Commission and American Wind Energy Association	Permitting Small Wind Turbines: A Handbook, Learning from the California Experience	2003	Information on installing and permitting small wind turbines. Includes model zoning ordinance and best practices for municipalities in California
www.ceere.org/rerl/publications/whitepapers/Wind_Turbine_Acoustic_Noise_Rev2006.pdf	Renewable Energy Research Laboratory, University of Massachusetts	Wind Turbine Acoustic Noise	June 2002, amended Jan. 2006	Includes information on sources of wind turbine sounds, infrasound, sound reduction methods, sound from small turbines, factors that affect sound, noise standards and regulations. Recommendation include the following: For large scale turbines- Consider turbines only when accompanied by manufacturer's noise data based on IEC standards or where turbine will be sited in area where there will clearly be no problem; must comply with community noise standards but not held to additional levels of regulation; siting of wind turbines must take into consideration sound levels; if turbine is proposed within a distance equivalent to 3 times the blade-tip height of residences or other noise-sensitive receptors, a noise study should be performed and publicized. For small turbines (under 30Kw)- Sound levels should be measured at higher and lower wind speeds in addition to those measured under the IEC standard. Operation-mode, time-dependent and frequency-dependent component need to be described - need to provide sound measures that proved accurate representation of issues. Wide variety of sound levels from small turbines make blanket setback limits difficult; should be examined carefully based on technology.

Part 2 - Summary of Online Research Findings

Website Link	Organization	Publications	Date	General Information
http://www.bwea.com/ref/novar.html	Robertson Bell Associates, commissioned by National Wind Power Limited	Novar Residents Survey	Jul-98	Between 13th June-1st July 1998, 203 interviews were carried out among people living near Novar Estate (34 turbines): 69% of those questioned were in favour of the development of wind power in the UK and 68% supported their 'local' wind farm. More people thought the turbines graceful than ugly.
http://www.bwea.com/ref/taffely.html	Robertson Bell Associates, commissioned by National Wind Power Limited	Taff Ely Residents Survey	Dec-97	Between 6-11 December 1997, 336 face-to-face interviews were carried out among people living within a two mile radius of the Taff Ely Wind Farm (20 turbines): more than three in five (63%) say they support the Taff Ely wind farm, including 28% who say they strongly support it. Seven in ten residents (71%) identify no drawbacks with the wind farm.
http://www.wind.appstate.edu/reports/Fall2004AdamSacora'sNoiseEmittedbySmallWindTurbinesResearchPaper.pdf	Sacora, Adam	Assessing the Noise Emitted by Small Wind Turbines	Fall, 2004	Graph taken from the Danish Wind Industry Association showing the 6dBA decrease given doubling of distance.
www.renewwisconsin.org/wind/Toolbox-Fact%20Sheets/Shadow%20flicker%20and%20strobing.pdf	Sagrillo, Mick	Home-sized Wind Turbines and "Strobing"	2003	Article published in Windletter, monthly newsletter of the American Wind Energy Association, by a small wind energy advocate that states that small wind trubines do not create shadow flicker problems because of size.
www.awea.org/faq/sagrillo/ms_ice_0306.html	Sagrillo, Mick	Home-Sized Wind Turbines and Flying Ice	Jun-03	Sagrillo reviews the literature available and identifies several papers and reports that address ice throws at large wind farms, but none about home-sized turbines. He examines these reports to understand their relevance to home-sized wind systems, and attempts to draw any applicable conclusions. He states that risks are very limted and through ancedotal references refers to ice throw as not occuring beyond the radius of the total turbine height during heavy winds.
http://www.sanantonio.gov/aviation/info_noise_regulations2.asp	San Antonio International Airport	Figure: Indoor and Outdoor Noise Level Measurements	date unknown	Common indoor and outdoor sound level measurements.
www.scotland.gov.uk/library/pan/pan45-00.asp	Scottish Executive Development Department	Renewable Energy Technologies, PAN 45, Revised 2002	2002	Information on impacts and suggested mitigation strategies of wind turbines
http://www.snh.org.uk/pdfs/polsum/StrategicLocationalGuidanceforOnshoreWindframsSummary.pdf	Scottish Natural Heritage	Policy Summary: Strategic Locational Guidance for Onshore Wind Farms in Respect of the Natural Heritage	July 2002, Updated April 2005	This document describe an effort to "zone" Scotland to protect national historic sites, etc form impact of wind turbines.
www.web1.msve.msv.edu/cdnr/icethrowseifertb.pdf	Seifert, Henry	Risk Analysis of Ice Throw from Wind	2003	Research paper presented at BOREAS, Finland analysing risks of ice throw.
http://www.shetland.gov.uk/developmentplans/documents/ADOPTEDVERSION.pdf	Shetland Islands Council	Interim Planning Policy Guidance: Domestic & Community Aerogenerators and Solar Energy	Nov-04	Planning and guidance policy from Shetlands Island Council, including brief sections on noise, shadow flicker, electromagnetic inference, visual impact, and safety.
http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CMF.PDF	State (California)	California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (California Energy Commission)	Oct-07	Voluntary guidelines which provide information to help reduce impacts to birds and bats from new development or repowering of wind energy projects in California. They include recommendations on preliminary screening of proposed wind energy project sites; pre-permitting study design and methods; assessing direct, indirect, and cumulative impacts to birds and bats in accordance with state and federal laws; developing avoidance and minimization measures; establishing appropriate compensatory mitigation; and post-construction operations monitoring, analysis, and reporting methods.
http://www.moorsydeactiongroup.org.uk/dnload/noiseassoc_report.pdf	Stewart, John (The UK Noise Association)	Location, Location, Location: an investigation into wind farms and noise by The Noise Association	Jul-06	As a general rule, turbines should not be sited within a mile of where people live. Academy of Medicine in Paris agrees. The official government guidelines for the siting of wind farms should be revised to take account of the more intrusive nature of the noise in areas where the overall background noise is low.
http://www.sd-commission.org.uk/publications/downloads/Wind%20Power%20-%20your%20questions%20answered%20FINAL.pdf	Sustainable Development Commission	Wind Power: Your Questions Answered	date unknown	Explains UK application process for wind development approval, as well as answers questions relating to the idea of 'Why Wind Power?'
http://www.thebluemountains.ca/intranet/files/documents/Constraint%20Summary%20Report%2024%204%2007.pdf	Town of Blue Mountains, by Jones Consulting Group Ltd.	constraints analysis: Rewneable Energy Review	24-Apr-07	The analysis outlined visual sensitivity of an area – the natural, uninterrupted landscape that exists – as well as the visual absorption capacity – the ability for that natural, uninterrupted landscape to absorb change. In the same region, the Niagara Escarpment Commission has taken a position prohibiting any large scale wind development facilities anywhere within the Niagara Escarpment Plan partially due to their assessment of negative visual impacts.
http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/Part6/includes/printable.asp?lang=en	Transport Canada	Canadian Aviation Regulations (CARs),Part VI - General Operating and Flight Rules, Standard 621.19 - Standards Obstruction Markings	2000	Standards to ensure aviation safety based of height and location of a structure.
www.tc.gc.ca/pdf/26-0427.pdf	Transport Canada	Standards Obstruction Markings - Aeronautical Obstruction Clearance Form	current	Form to submit to Transport Canada for structures within 6 km of aerodrome, 2 km of a TC radar, radio navigation or radio communication antenna, over 20 m in height, or a new structure within 15 m of a dominant structure and exceeds it in height.

Part 2 - Summary of Online Research Findings

Website Link	Organization	Publications	Date	General Information
http://windfarms.files.wordpress.com/2007/12/wind_ordinance_11-28-071-final-draft-_1_.pdf	Trempealeau County	Wind Generator and Wind Generating Facility Ordinance for Trempealeau County; Chapter 21	Nov-07	Setback requirement of 1 mile (1.6km) from any inhabited structure unless mitigation methods agree to (and recorded) by any habitant within this boundary.
http://www.defenselink.mil/pubs/pdfs/WindFarmReport.pdf	U.S. Department of Defense	The Effect of Windmill Farms on Military Readiness	2006	Report to the Congressional Defense Committees that discusses mitigation approaches to reduce impact of wind turbines on air defense radar.
http://joomla.wildlife.org/documents/positionstatements/Draft_Wind_Energy.pdf	Wildlife Society (US): The Impacts Wind Energy Facilities on Wildlife and Wildlife Habitat (Technical Review)	(Draft position statement)		The document makes the point that the use of standardized protocols to address specific questions would greatly improve comparability of studies and credibility of efforts. Consistency across data collection efforts, post-construction evaluations, and access to resulting data will be critical for conducting meta-analyses so that consistent effects could be detected. Policy of The Wildlife Society in regard to wind energy development is outlined.
www.bwea.com/pdf/small/wineur.pdf	WINEUR	Wind Energy Integration in the Urban Environment	Jul-05	Study to identify conditions necessary for integration of small wind turbines in the urban environment
www.awea.org/pubs/documents/01_AWEA_Audubon_Proceedings_2_24.pdf	Workshop Proceedings, American Wind Energy Association, Audubon California, Centre for Energy Efficiency and Renewable Technologies	AWEA / Audubon Workshop: Understanding and Resolving Bird and Bat Impacts	Feb-06	Meeting summary from the "Understanding and Resolving Bird and Bat Impacts" forum held in January of 2006. Wind developers, government officials, researchers, conservation organizations and other experts gathered to share the best current data on wind power's impacts on birds and bats in California and to consider state-wide guidelines for the study, siting and operation of wind power facilities to prevent and minimize such impacts. Abstracts of panel presentations and individual speeches are included, along with summaries of the discussions following each presentation.
http://www.who.int/docstore/peh/noise/guidelines2.html	World Health Organization (WHO)	Guidelines for Community Noise	1999	World Health Organization's Noise Guidelines: continuous sound greater than 30dBA disrupts sleep, and sound at 45dBA creates sleep disturbance.

Part 3 - Summary Discussions with Technical Experts

Correspondence with	Location	Organization	Date	Discussion
Gordon Whitehead, Retired Audiologist	Nova Scotia	N/A	2-Apr-07	Personal letter of communication to Ms. Aftab Erfan (Jacques Whitford) as a response to the public input meeting held at St. Margaret's Bay Centre to discuss wind development within the HRM. "The purpose of this letter is to provide a brief comparison between my report of 23 May 2006, which contained the sound level measurements and analysis that I generated, and the report of HCG Engineering entitled Environmental Noise Assessment – Pubnico Point Wind Farm, Nova Scotia, of 23 August 2006 (Natural Resources Canada Contract NRCAN-06-00046), in addition to a couple of other points."
Dr. John Walker, Noise & Air Quality Specialist	Nova Scotia	Jacques Whitford	5,6-Nov-07 & 11-Jan-08	Infrasound occurs naturally. When people are exposed to frequencies of less than 20 hertz, you begin to get complaints of infrasound. Modulation from the wind turbine blades is about 1 hertz, but 'masking' noise (i.e. highway or other wind) often makes it acceptable during day time. Stratification of the atmosphere at night causes background noise to decrease and the turbines to seem louder. The wind turbine sound/velocity is often oddly close to a resting human heart. Recommended a conversation with Tom Mills @ Vestas. In agreement that more accurate regulations are needed in the industry. Acknowledges that best distance from the turbine depends on the turbine height and power but sees 1.5km as a viable option. Explains that upwind turbines are the only viable option now and reduce noise considerably from where wind power originated - although do not eliminate modulation issues.
Tom Mills, Wind & Site Engineer	Oregon	Vestas	6-Nov-07	More accurate regulations are needed as the current ones are based on the old German models. Developers will tend push the current (inadequate) regulations and subsequently 'dirty' the name/concept of wind energy. Regulations are not advanced enough to protect against impacts of wind turbines currently as inferior regulations are being stretched. It's important to note the sound level of individual turbines in comparison to background noise at any location. Suggest setting a 35/40 db sound level/limit at the nearest residence, then if developer has the resources and wants to push that, they have to do a site background noise check and must prove that they are less than 5 db higher than the current background noise. Also suggests referring to South Australian Sound Guidelines, which were based on the New Zealand guidelines relating to ISO 9613-2.
Bill Ellis, Manager Technical Services	Nova Scotia	Nova Scotia Power Inc.	9-Nov-07	Nova Scotia Power's Net Metering Program aligns with the Small-scale category and is applicable to generators (any renewable type) rated less than 100 kW. These are typically owner-operated units that are normally directly connected to the consumer's service. These wind turbines are typically in the 1 kW to 50 kW range with the vast majority in the 1kW to 10kW range and are usually mounted on steel truss tower which are guyed. There is a standard NSPI power rate for this type of connection and information can be found in NSPI's Rates & Regulations (Regulation 3.6). The Large-scale wind generation aligns with the various wind turbines (currently 60 MW) connected to NSPI's Distribution (12 kV and 25 kV) and Transmission systems (69 kV, 138 kV, 230 kV, 345 kV). These large-scale utility grade wind generators are typically designed with capacities in the range of 0.6MW to 2.0MW and as high as 5MW under development, with the majority of models at the 1 to 2 MW range. These turbines may be connected individually or in multiples in a wind farm. They are typically mounted on self-standing (unguyed) hollow steel towers with nacelles at heights of 60/80/100 meters. Typically these types of installations would have a formal Interconnection Agreement with the host utility and would have a Power Purchase Agreement with the end user/purchaser of the energy generated.
Tony Mason	New Brunswick	Transport Canada	3-Dec-07	Transport Canada is concerned about acceptable siting, lights and paint (colour) of wind turbines. There is a great deal of interpretation of the recommendations in the Canadian Aviation Regulations Standard 621.19 across the country. Currently there is a review of the standards that is being considered by the Justice Department. Mr. Mason recommends that the Aeronautical Obstruction Clearance Form 26-0427 (0005-01) be filled out and sent into the regional office of TC for review. With regard to lighting, TC strongly recommends lighting for structures over 150 m and would suggest lighting for towers between the heights of 90-150 m. In the CAR Standard 621.19 there is a recommendation that blades be painted orange and white but this is no longer suggested since the painting scheme causes the blade to be less visible. Instead a solid white colour is recommended.
Paul Pinard and Darrell Perala, Aeronautical Information Services	Ontario	Nav Canada	Dec. 13 and 14, 2007	Discussion with Aeronautical Information Services at Nav Canada focussing on when a wind turbine developer needs to contact the department about a proposed turbine development. Nav Canada needs to know specifically about any turbines proposed within a 10 km radius of an airport and outside of a 10 km radius of any proposed built structure taller than 30.5 m (100ft). Potential developers need to fill out the Land Use Proposal Submission Form and send to the department. Nav Canada notes that the impacts of wind turbines on radar and other communication systems are continuing to emerge as wind turbines, especially wind farms, are becoming more prevalent. With regard to small wind turbines, the department needs to know about proposed installations over 30.5m so that they can be plotted on their land use maps and be entered into their database for reference for future developments. Although the form could be overly technical for some small wind farm developers the department essentially is looking for total turbine height and the coordinates of the proposed development. Developers can contact Nav Canada at 1-866-577-0247 or landuse@navcanada.ca for further information or assistance. Essentially, Nav Canada is interested in plotting structures on their land use maps (national database of towers) and preventing any potential interference with radar systems.
Mark Elderkin	Nova Scotia	Department of Natural Resources	17-Dec-07	One of the authors of the current NS guidelines; believes location choice makes a wind farm acceptable or not in terms of impact on wildlife (inclusive of birds and bats). Bats are less of an issue on coastal areas because they are more centrally located here in NS, while areas which should be avoided to protect birds are staging areas for migrating song birds, extreme fog areas, lower Digby Neck, and Cape Sable Island. Also presents the idea that high places in the province are serving as connectivity corridors for mammals as a result of all of the low land being taken up by roads and developments. Notes that the an evaluation of the cumulative sum of any proposed project is asked for to mitigate natural avoidance of any areas by mammals.

Part 4 - Summary of Governmental Bodies and Documents Consulted

**The following government (municipal and *provincial*) bodies were consulted as part of this research project either by phone interview, web search and/or email correspondence.

Nova Scotia	
Department of Environment and Labour	
Department of Natural Resources	
County of Pictou	
District of Clare	
District of Digby	
Annapolis District Planning Commission	
District of Guysborough	
District of Yarmouth	
County of Colchester	
District of Argyle	www.munargyle.com/~munargyl/index.php?option=com_docman&task=cat_view&gid=23&
District of Barrington	www.barringtonmunicipality.com/land%20use%20by-law.pdf
Region of Queens Municipality	www.regionofqueens.com/documents/1st%20Draft.pdf
Halifax Regional Municipality	www.halifaxregionalplanning/documents/HRMWindEnergyStudyReport.DOC
	www.halifax.ca/council/agendasc/documents/061121ca10-1-3.pdf
Town of Truro	http://truro.ca/documents/MPSOfficeConsolidation-May10_001.pdf
	http://truro.ca/documents/LUBOfficeConsolidation-May10_001.pdf
Cape Breton Regional Municipality	http://www.cbrm.ns.ca/portal/services/departments/planning/documents/CBRMMPSwitha
	http://www.cbrm.ns.ca/portal/services/departments/planning/documents/CBRMLUBwitham
County of Cumberland	http://www.cumberlandcounty.ns.ca/bylaws/2005-01.pdf
	http://www.cumberlandcounty.ns.ca/bylaws/2007-03.pdf
County of Kings	www.countykings.ns.ca/comdev/mps/sections/mps-5-4.pdf
	www.countykings.ns.ca/comdev/lub/sections/section1.pdf
District of Lunenburg	http://www.modl.ca/component/option,com_docman/Itemid,380/task,cat_view/gid,101/
Municipality of East Hants	
Prince Edward Island	
Provincial Planning Act	
City of Charlottetown	www.city.charlottetown.pe.ca/files/Zoning_%20Development_Bylaw_July_2007.pdf
Ontario	
Ministry of the Environment	
City of Windsor	
Township of Frontenac Islands	
Township of Prince	
Municipality of Grey Highlands	www.greycounty.ca/files/pagecontent/County%20Modified%20LOPA%2010-Oct11-2007.pdf
Township of Huron-Kinloss	www.huronkinloss.com/documents/downloads/officialplan.pdf
Prine Edward County	www.pecounty.on.ca/government/planning_services/pdf/1816-2006ZoningBylaw.pdf
County of Bruce	www.brucecounty.on.ca/planning.php
	www.brucecounty.on.ca/downloads/planning/Staff-
Manitoba	
Portage Community Planning Services Regional Office	
Regional Municipality of Cartier	
Alberta	
Department of Infrastructure and Transportation	
Alberta Energy and Utilities Board	http://www.mdpinchercreek.ab.ca/WECS%20Review.pdf
Municipal District of Taber	
Municipal District of Pincher Creek	
British Columbia	
Ministry of Energy, Mines and Petroleum Resources	
Peace River Regional District	

APPENDIX B

Model By-laws

Jacques
Whitford

Model Land Use By-law for Wind Energy

Introduction

This Model By-law is intended to be a guideline for drafting a Land Use By-law (LUB) for Wind Energy or amending an existing LUB to incorporate wind energy. It is a 'how to' document written for municipal planners. Provisions have been set out to illustrate the variety of options available within the framework of the Municipal Government Act (MGA). The provisions set out are not mandatory or exhaustive. The Model By-law provides examples and options to assist municipal planners in developing provisions that suit the needs of the municipality. Each municipality will make its own decisions on which option(s) to choose. Explanatory comments are provided, where appropriate, immediately after the LUB provision. They are printed in italics and enclosed in a box. Everything printed in italics and enclosed in a box is information for the reader and not intended to be placed in the actual LUB.

Prior to the creation of or amendment to an LUB to address wind energy the Municipal Planning Strategy will have to be established or revised to provide the policy for wind energy development in accordance with the MGA.

Some of the material for this Model By-law is taken from the Local Government Resource Handbook prepared by Service Nova Scotia. If the municipality does not already have a LUB in place we suggest that the Handbook be consulted. It can be found on the internet at: http://www.gov.ns.ca/snsmr/muns/manuals/PDF/LGRH/LocalGovernmentResourceHandbook_5.6.pdf

This Model By-law is part of the document entitled Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities. The full document will be referred to as the "Report" in the explanatory notes contained in this By-law.

Contents

Part 1 Title and Purpose

Part 1 is a general LUB provision and will only be necessary if an LUB is not already in place.

1.1 This By-law shall be known as the Land Use By-law for _____________ (i.e. name municipality or planning area) and shall apply to all lands within the municipal boundaries (or planning area).

1.2 The purpose of this By-law is to carry out the land use development policies found in the Municipal Planning Strategy in accordance with the provisions of the *Municipal Government Act*, by regulating the development of wind turbines.

Section 1.2 on "Purpose" is not essential. It is included to provide a clear link to the municipal planning strategy and because it helps in interpreting the various sections of the By-law. If the LUB covers more than just wind turbines section 1.2 should be a more generic statement.

Part 2 Definitions

The following definitions were taken from a number of sources and provide a fairly broad range. It may not be necessary to include all of the definitions in the LUB. The LUB should only define terms that are used in the text of the LUB.

"array" means two or more wind turbines that are physically interconnected;

"blade" means the part of the wind turbine that rotates in the wind and extracts kinetic energy from the wind;

"blade clearance" means in reference to a horizontal axis rotor, the distance from grade to the bottom of the rotor's arc;

"decommission" means the final closing down of a development or project or the point at which it has reached the end of its operational life and the process by which the site is restored to an agreed use or condition;

"guy wire" means a cable or wire used to support a tower;

"habitable dwelling" means structures designed to accommodate people including residential, commercial, institutional, industrial and recreational buildings, but not including accessory structures such as sheds and storage areas;

"horizontal axis rotor" means a wind energy conversion system, typical of conventional or traditional wind turbines;

"kilowatt or (kW)" means a measure of power for electrical current;

"large scale wind turbine or LWT" means a wind turbine which has a power generation capacity of greater than 100 kW;

There is great variation in how turbines are classified according to nameplate capacity. Municipalities have chosen either no classification, two classifications (large and small) or several classifications (for example, large, medium, small and mini) based on different criteria. NSPI's net metering program aligns with the small scale category and is applicable to power generators rated less than 100kW so defining large scale as greater than 100kW reflects the current Nova Scotia context. For further information on this topic please refer to Section 1.3 the Report.

"mini wind turbine or MWT" means a wind turbine which has power generation capacity of no greater than 10 kW;

The differences among turbines under 100kW (defined in these by-laws as small wind turbines) can be significant so a category of mini is used to differentiate between the levels of regulation that may be needed for turbines no greater than 10kW. For further information on this topic please refer to Section 1.3 of the Report.

"nacelle" means the frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather;

"nameplate capacity" means the manufacturer's maximum rated output of the electrical generator found in the nacelle of the wind turbine;

"rotor's arc" means the largest circumferential path traveled by the wind turbine's rotor blade.

"rotor clearance" means the distance between the bottom tip of the blade and the ground;

"remediation' means the process to return a site to as close to its original natural state as possible;

"separation distance" means the distance measured from the base of the wind turbine tower to any specified building, structure, road or natural feature.

"setback" means the distance measured from the base of the wind turbine tower to property lines;

"shadow flicker" occurs when the sun is low on the horizon and the blades pass between the sun and an observer creating a flickering;

"small scale wind turbine or SWT" means a wind turbine which has a power generation capacity of not less than 10 kW and no greater than 100 kW;

NSPI's net metering program aligns with the small scale category and is applicable to power generators rated less than 100kW so this definition of defining small scale as no greater than 100kW is used to reflect the current Nova Scotia context. For further information on this topic please refer to Section 1.3 of the Report.

"vertical axis rotor" means a wind energy conversion system where the rotor is mounted on an axis perpendicular to the earth's surface;

"watercourse" means a lake, river, stream, ocean or other body of water;

"wetland" means land commonly referred to as a marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land's surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation and biological activities adapted to wet conditions;

"wind energy conversion system" means equipment, machinery and structures utilized in connection with the conversion of wind to electricity. This includes, but is not limited to, all transmission, storage, collection and supply equipment, substations, transformers, site access, service roads and machinery associated with the use. A wind energy conversion system may consist of one or more wind turbines;

"wind farm" means an array of large scale wind turbines;

There is great variation in how wind farms are classified both according to the number of turbines on a site and to the overall power generation capacity of the turbines. Usually the term wind farm refers to an array of large scale commercial wind turbines, however, a municipality may choose to include an array of SWT in the definition of "wind farm". The wind turbines on a wind farm would usually be connected to the transmission or a local distribution grid. For further information on this topic please refer to Section 1.3 of the Report.

"wind monitoring or meteorological tower" means a tower used for supporting an anemometer, wind vane and other equipment to assess the wind resource at a predetermined height above the ground;

"wind turbine" means a structure that produces power by capturing the kinetic energy in surface winds created by the sun and converting it into energy in the form of electricity and includes the wind turbine tower, rotor blades and nacelle;

"wind turbine height" means the height from grade to the highest vertical extension of a wind turbine at the top of the rotor's arc;

"wind turbine tower" means a freestanding structure or a structure attached to guy wires that serves to support other parts of the wind turbine.

Part 3 Administration

Sections 3.1, 3.2, 3.3 and 3.4 are general and will already exist if an LUB is already in place.

Administration

3.1 The Development Officer shall administer this By-law.

Development Permit

3.2 (a) Unless otherwise stated in this By-law, no person shall undertake or cause or permit to be undertaken, a wind turbine development on a lot within ___________ (name municipality or planning area) without first obtaining a development permit from the Development Officer.

(b) The Development Officer shall only issue a development permit in conformance with this By-law, a site plan approved in conformance with this By-law, or an approved development agreement, except where a variance is granted or in the case of a nonconforming use or structure, in which case a permit shall be granted in conformance with the *Municipal Government Act*.

(c) Unless otherwise stated on the development permit, a development permit shall expire within 12 months from the date issued if the development has not commenced.

(d) If following the issuance of a development permit, new or corrected information respecting the permit application is brought to the attention of the Development Officer, the Development Officer may revoke the development permit.

Decision in Writing

3.3 Any decision of the Development Officer to refuse the issuance of a development permit or to revoke a development permit shall be served personally, by mailing it to the person at the latest address shown on the assessment roll, by electronic mail or by facsimile.

3.4 A notice, decision or other document is deemed to have been served on the third day after it was sent.

No Development Permit Required

3.5 A development permit is not required for a mini wind turbine, however all other provisions of this By-law, including but not limited to sections 6.2 and 6.5, must be met.

In most instances a MWT will be used for residential purposes, small businesses or farms. Given the small size of the MWT a municipality may not consider a permit to be necessary. However, this is an option only and simply not including this provision in the By-law will make MWT subject to the requirement for a development permit.

Application for a Development Permit

3.6 (a) Every application for a development permit shall be accompanied by a sketch or plan, in duplicate, drawn to an appropriate scale and showing:

i. the shape and dimensions of the lot to be used;
ii. the proposed location, including measurements of the lot frontage and front, side and rear yards of any building or structure proposed to be constructed;
iii. the distance from the lot boundaries, dimension, and height of any building or structure proposed to be constructed;
iv. the distance from the lot boundaries and size of every building or structure already constructed, or partly constructed, on the lot;
v. the distance from every building or structure already constructed, partly constructed or proposed to be constructed on the lot to every habitable dwelling on abutting lots;
vi. the proposed location and dimension of any parking space, loading space, driveway, and landscaped area;
vii. the location of any watercourse(s) and wetland areas and the location of any existing or proposed building or structure in relation to the watercourse or wetland;
viii. any other information the Development Officer deems necessary to determine whether or not the proposed development conforms to the requirements of this By-law.

(b) Where the Development Officer is unable to determine whether the proposed development conforms to this By-law, the Development Officer may require that the plans submitted under clause (a) be based upon a survey certified and stamped by a Nova Scotia Land Surveyor.

Section 3.6 is a general LUB provision and should only be required if an LUB is not already in place.

Information Requirements for a Wind Turbine Development Permit

3.7 Every application for a development permit for a wind turbine shall be accompanied by:

(a) Project definition including installed turbine(s) capacity, targeted long term production levels, scale elevations or photos of turbines showing total height, tower height, rotor diameter and colour;

(b) Site plan showing all buildings, boundaries and natural features and alterations of site;

(c) Turbine manufacturer's specifications and professional engineer's design and approval of turbine base;

(d) Analysis of visual impact including the cumulative impact of other wind turbines and impact of overhead transmission lines, mitigation measures for shadow or reflection of light onto adjacent sensitive land uses;

Deciding whether something is visually intrusive is more difficult to quantify than most other impacts where quantitative measurements can be compared to specific guidelines or requirements. For this reason municipalities will benefit from comprehensive information on how the wind turbine(s) and associated structures might impact local residents. Analysis of visual impacts is an emerging area. For further explanation, refer to sections 2.15, 3.3.11 and 4.2.10 of the accompanying report.

(e) Analysis of noise impact including a map indicating all lands and sensitive receptors impacted by the ______dBA emission level (or ______dBA above background) emission level (or other noise level specified in by-laws) and estimated noise levels at property lines and receptors;

Noise is a controversial issue and there are drawbacks to both the decibel limit approach and the separation distance approach. The literature review has shown a 35dBA or 5dBA above the current background noise levels regulation as being a viable option. Research shows that this is a conservative guideline, but one that will limit challenges resulting from noise emissions. For further explanation, refer to sections 2.7, 3.3.7, and 4.2.7 of the Report.

(f) Analysis of impact of the wind turbine(s) on bird nesting sites, bird migration areas and bat migration areas.

The impacts of wind turbines on bird and bat mortality can be significantly reduced if projects are planned carefully and mitigation strategies are implemented. An initial site evaluation and an assessment of local knowledge can provide the basis to predict the effects a wind energy development might have on resident and migratory bird and bat species in the area. For more information refer to section 2.2 of the Report.

(g) Impacts to the local road system including required approaches from public roads;

(h) Study to determine impact and mitigation for identified natural heritage features;

(i) Copies of documentation of approvals from Transport Canada for turbines taller than 20 metres and Nav Canada for turbines taller than 30.5 metres;

For further explanation of requirements of Transport Canada and Nav Canada concerning aviation safety refer to sections 2.1, 3.3.3, 3.3.8, 4.2.3 and 4.2.8 of the Report.

(j) Copies of all documentation required for *Canadian Environmental Assessment Act* and *Nova Scotia Environment Act* and regulations if applicable;

This refers to federal and provincial requirements for environmental impact assessments (EIA). An EIA may be required by the federal government if a federal body, money, land or regulatory authority is required. An EIA by the provincial government will be required if the wind turbine(s) produces 2 megawatts or more of energy or if the construction of the facility disrupts 2 ha or more of a wetland.

(k) Evidence of notification to DND, Nav Canada, Natural Resources Canada or other applicable agencies regarding potential radio, telecommunications, radar and seismoacoustic interference if applicable;

For further explanation of the issues related to potential interference of wind turbines with these systems refer to sections 2.12, 3.3.7, and 4.2.7 in the Report.

(l) Evidence and results of public notification if conducted;

Item 6.3(g) and 6.4(i) require the applicant to notify members of the public who reside within a certain radius of the proposed development. For more information on the role of public notification and consultation in wind energy development refer to section 3.4 of the Report.

(m) When placed on agricultural land, evidence of the continued use of prime agricultural land for farm use;

Item 3.7(m) is in keeping with the MGA Statement of Provincial Interest Regarding Agricultural Land.

(n) Emergency response plans for site safety; and

(o) Decommissioning and reclamation plan.

Items 3.7(n) and (o) help to ensure the municipality that the applicant has considered emergency response such as a fuel leak, blade throw or turbine collapse as well as the expected life of the turbine(s) and how it will be decommissioned. It is important to recognize that the municipality does not have the authority to require a decommissioning plan to be carried out. If the project is subject to a provincial EIA (i.e. 2 MW or greater) a decommissioning plan is likely to be part of the approval issued by the provincial government. The provincial government, in this context, does have the authority to enforce compliance with the decommissioning plan as it is laid out in the provincial approval.

The list of information requirements in section 3.7 reflects a broad range of items that should be considered when placing a wind turbine.

Signature of Applicant

3.8 The application for a development permit shall be signed by the registered owner of the lot or by the owner’s agent duly authorized in writing to act for the owner.

This is a general LUB provision, and should only be required if a LUB is not already in place. Getting the owners authorization is suggested as being a good practice although it is recognized it may not be practical. Sometimes all that is needed is a copy of the construction agreement.

Application Fee

3.9 Every application for a development permit or an application for a Land Use By-law amendment, development agreement, site plan approval or a variance, shall be accompanied by a cheque payable to the municipality in the amount specified in Appendix ‘A’ of this By-law.

This is a general LUB provision, and should only be required if a LUB is not already in place.

Notice to Property Owners

3.10 (a) When an application has been received to amend this By-law for a site specific purpose, enter into a development agreement, or amend a development agreement, all property owners within ________ metres of the subject property shall be notified of the application by the clerk.

(b) The notification set out in clause (a) shall be in addition to the advertisement for public hearing and shall be delivered to all affected property owners by mail prior to the public hearing.

This is a general LUB provision, and should only be required if an LUB is not already in place. The MGA requires notification of property owners within 30 metres of the subject property for a variance or site plan approval. In the case of a development agreement for a large scale wind turbine or an array of turbines it might be advisable to extend the boundary to encompass those that may be affected by noise or visual intrusion from the turbine(s).

Effective Date

3.11 This By-law shall take effect upon the date of publication of the notice advertising the new by-law or amendment.

Part 4 Zones and Zoning Maps

4.1 For the purposes of this By-law the municipality is divided into the following zones, the boundaries of which are shown on the attached Schedule 'A'. Such zones may be referred to by the corresponding symbols shown below.

Zones	**Symbol**
General Development Zone	GD

Zoning map

4.2 Schedule 'A' is the Zoning Map and forms part of this By-law.

Part 4 is a general LUB provision and should only be required if a LUB is not already in place.

Part 5 Development Agreements

Development agreements can be looked at as mini land use by-laws applying to just one development. Development standards are negotiated within the parameters of the supporting policy found in the municipal planning strategy and the applicable sections of the MGA. A development agreement can override the LUB. Development agreements stay with the land until discharged by council, even after a sale of the property, and must be filed in the local Registry of Deeds. Development agreements offer more direct Council control over development but they are time consuming and costly to both the municipality and the developer and should only be used where necessary.

Section 225(1) of the MGA specifies that the supporting policy must clearly indicate the types of development to be considered by agreement, the area where they are to be located, and the criteria council shall have regard to when considering requests for development agreements. The Act also requires that developments to be considered by development agreement be identified in the LUB. While not required, development agreements should contain a "sunset clause" which would allow Council to discharge the agreement, after a specified period of time, if the development has not proceeded. Without such a clause in the agreement Council can only discharge the agreement with the consent of the property owner.

Development agreements and amendments to development agreements require a public hearing and are appealable to the Utility and Review Board. If the agreement identifies items that are not considered substantive, amending these items does not require a public hearing although they are still appealable and a newspaper notice is still required. (MGA s. 230)

Developments to be Considered by Development Agreement

5.1 The following developments may be considered only by development agreement in accordance with the *Municipal Government Act* and the Municipal Planning Strategy:

(a) a wind farm.

This particular model by-law requires a development agreement for wind farms only. However, a municipality can require a development agreement for MWT, SWT, LWT and/or wind farms. The development agreement requires a greater investment of time and resources but may be an appropriate alternative to permit as of right where the proposed development needs a more detailed assessment than that which can be provided via a permit application. For example a wind turbine that is planned for a sensitive area, or a wind turbine that is large in scale (i.e. has a large footprint) but produces a small amount of energy.

It is important to recognize that a wind energy project that produces 2 megawatts or more of energy will trigger the provincial Environmental Assessment Regulations. If this is the case extensive information will be collected and assessed during the EIA process, making the detailed nature of the development agreement a duplication of effort. To that end a development agreement might be appropriate for a wind turbine or array of turbines that produce greater than 200 kW but less than 2000 kW of energy, recognizing that the EIA process will kick-in at 2000 kW.

The decision to use a development agreement sits with the municipality. If a development agreement is used than the other provisions of the LUB do not apply to that development.

Development agreements may be appealed to the Board by an aggrieved person, the applicant, an adjacent municipality, a village in which an affected property is situated or the Director as per section 247 of the MGA.

Development Permits for Development Agreements

5.2 A development permit may be issued for a development listed in this Part, pursuant to the *Municipal Government Act*, provided:

(a) the development agreement has been approved by Council,

(b) the appeal period has lapsed or any appeals that may have been lodged have been dealt with by the Utility and Review Board and the ruling was in favour of the development; and,

(c) the development conforms to the terms of the development agreement.

Part 6 General Provisions for All Zones

Permitted Uses

6.1 All developments are permitted in the General Development (GD) Zone.

This provision is intended for a municipality that does not have an LUB in place and has only one zone. Where an LUB exists with multiple zones the municipality will have to consider which zones are appropriate for wind turbines. Some zones may be appropriate for MWT or SWT but not for LWT or wind farms.

Mini Wind Turbines

6.2 Mini wind turbines shall be permitted in the GD Zone subject to the following criteria:

(a) The total wind turbine height shall not exceed ______metres.

Total turbine height varies according to wind turbine models and to changing technology. Considerations for height restrictions relate to visual impacts, safety and how the height affects separation distances if using a formula that is based on numeric value times the height of the turbine. A common height restriction for MWT is 20m. For further information refer to sections 1.3, 2.15, 3.3.5, and 4.2.5 of the Report.

(b) The rotor clearance shall be a minimum of ______metres from grade.

The rotor clearance is a safety issue and recommendations for clearance start at 8m. For further information refer to section 3.3.3 of the Report.

(c) The wind turbine shall be setback no less than ______times the total turbine height from the property line.

Setbacks and separation distances for mini turbines based on safety issues have not been clearly documented. If noise regulations are met, the major considerations of this separation are related to physical safety: blade throw, ice throw, structural failure, etc. A 1.5 to 3 times the total turbine height suggested guideline is drawn from the literature. Municipalities need to check the manufacturer's recommendations for safety practices related to siting and installation of the specific wind turbine model. For further information refer to sections 2.3, 2.6, 3.3.3 and 4.2.3 of the Report.

(d) The minimum separation distance for the wind turbine and all associated structures from a watercourse is ______metres.

A 30 metre separation distance from watercourses is generally recommended to protect the aquatic ecosystem from damage and contamination, however, individual circumstances, such as steepness of slope or vegetation cover, may allow for a lesser distance or require a larger one. This provision must be supported by the municipal planning strategy.

(e) The minimum separation distance for the wind turbine from a public road is ______times the total turbine height.

Refer to the explanation for item 6.2 (c), above. For further information refer to sections 2.3, 2.6, 3.3.3 and 4.2.3 of the Report.

Small Scale Wind Turbines

6.3 Small scale wind turbines shall be permitted in the GD Zone subject to the following criteria:

(a) The total wind turbine height shall not exceed ______metres.

As discussed in the explanation box for item 6.2 (a) recommended wind turbine heights vary. A maximum 60m height for SWT is common in the literature and reflects safety concerns and visual impacts. For further information refer to sections 1.3, 2.15, 3.3.5, and 4.2.5 of the Report.

(b) The rotor clearance shall be a minimum of ______metres from grade.

Recommended minimum clearance is 8 m, as discussed in the explanation for item 6.2(b), above.

(c) The wind turbine shall be setback no less than ______of the total turbine height from the property line.

As discussed in the explanation for 6.2(c), above, there is little documentation on appropriate setbacks and separation distances for MWT and SWT to address safety issues. A 1.5 to 3 times the total turbine height is a suggested guideline drawn from the literature. For further information refer to sections 2.3, 2.6, 3.3.3, 3.3.10 and 4.2.3 of the Report.

(d) The minimum separation distance for the wind turbine from a habitable dwelling on the same property is _____ times the total height of the turbine.

This provision, as with (c) above is intended to address safety concerns, therefore a 1.5 times the total turbine height is suggested. Not all municipalities require separation distances for dwellings on the same site, but leave it for the property owner to address. For further information refer to sections 2.3, 2.6, 3.3.3 and 4.2.3 of the Report.

(e) The minimum separation distance for the wind turbine and all associated structures from a watercourse is ______metres.

As discussed in the explanation for item 6.2(d) a 30 metre distance is suggested. This provision must be supported by the municipal planning strategy.

(f) The wind turbine shall be separated by no less than ______times the total tower height from a public road.

As discussed in the explanation for item 6.2(c) a 1.5 to 3 times the total turbine height suggested guideline is drawn from the literature. For further information refer to sections 2.3, 2.6, 3.3.3, 3.3.10 and 4.2.3 of the Report.

(g) Neighbours within a ______metre radius of the lot on which the wind turbine sits must be notified prior to construction of the wind turbine.

Although there is no clear recommendation for notifying neighbors within a certain radius, a suggested guideline would be 200m radius of the lot. This recommendation will help to ensure that those potentially affected by noise, visual interference, etc will have been consulted prior to construction.

Other Considerations for MWT and SWT

A municipality may also chose to include a requirement to maintain a separation distance between the wind turbine and the nearest habitable dwelling. This provision should not be necessary where separation distances are provided to address noise, as in item 6.5(i) below. For further explanation on this topic refer to sections 3.3.9 and 4.2.9 of the Report.

Other considerations for MWT and SWT that may be addressed in a by-law include whether or not to allow these turbines to be mounted on or attached to other structures and whether or not to limit the number of turbines on a single lot.

Large Scale Wind Turbines

6.4 Large scale wind turbines shall be permitted in the GD Zone subject to the following criteria:

(a) The total wind turbine height shall not exceed ______metres.

Total turbine height varies according to wind turbine models and to changing technology. A restriction to consider would be 120m. Considerations for height restrictions relate to visual impacts, safety and how the height affects separations distances if using a formula that is based on numeric value times the height of the turbine. Many municipalities do not restrict height for large scale turbines. If safety separation guidelines are met through other regulations, then visual impact may be a factor in restricting height. A typical large scale wind turbine currently in use in Canada would be between 100 and 120 metres. For further information refer to sections 1.3, 2.15, 3.3.5, and 4.2.5 of the Report.

(b) The rotor clearance shall be a minimum of ______metres from grade.

The rotor clearance is a safety issue and recommendations for clearance start at 8m. For further information refer to sections 3.3.3 and 4.2.3 of the accompanying document.

(c) The wind turbine shall be setback no less than ______times the total turbine height from the property line.

It is important to recognize that this setback is not intended to address noise and visual affects on habitable dwellings. Those concerns are addressed in item 6.5(i). However, where the adjoining property does not have a habitable dwelling and the municipality is concerned about protecting future land use on adjoining properties this setback may need to be greater. A recommendation is 2 to 3 times the total turbine height. Due to lot sizes this may restrict the development of wind turbines so municipalities will need to balance the rights to protect future land uses of adjoining properties with facilitating development of wind energy in their municipality based on local context.

Where a larger setback is selected a provision to allow the setback to be waived where adjoining property owners are in agreement may be necessary, see 6.6 below. For further information refer to sections 2.3, 2.6, 3.3.3, 3.3.10 and 4.2.3 of the Report.

(d) The minimum separation distance for the wind turbine from a habitable dwelling located on the same property is ______times the total turbine height.

This provision is intended to protect the dwelling and its occupants from damage or injury due to blade throw, ice throw, tower collapse, etc. Not all municipalities require separation distances for dwellings on the same site but leave it for the property owner to address. A separation distance of 1.5 total turbine height is a suggested guideline. For further information refer to sections 2.3, 2.6, 3.3.3 and 4.2.3 of the Report.

(e) The minimum separation distance for the wind turbine and all associated structures from a watercourse is ______metres.

A 30 metre separation distance from watercourses is generally recommended to protect the aquatic ecosystem from damage and contamination, however individual circumstances, such as steepness of slope or vegetation cover, may allow for a lesser distance or require a larger one. This provision must be supported by the municipal planning strategy.

(f) The minimum separation distance for the wind turbine from a public road is ______metres.

As noise is not a consideration at a public road, the major considerations of this separation are related to physical safety: blade throw, shadow flicker, ice throw, structural failure, etc. A recommended separation distance is 2 to 3 times the total turbine height. For further information refer to Section 2.3, 2.6, 3.3.3, 3.3.10 and 4.2.3 of the Report.

(g) All outdoor storage associated with a wind turbine facility shall be screened from view from adjacent properties and public highways.

This regulation relates to minimizing the visual impact of the wind turbine facility.

(i) Neighbors within a ______km radius of the lot on which the large scale wind turbine sits must be notified prior to construction.

The more inclusive the planning stage is in notifying the public the more public acceptance the project is likely to receive. There have been documented cases of public complaints from residents living 1.5km away. Notifying neighbors up to 2km takes into consideration all potential residents that may be affected by a wind turbine development.

Site Plan Approval Option

As discussed in Part 5 a municipality may choose to require a Development Agreement for a MWT, SWT, LWT or wind farm.

The MGA also provides the authority for a site-plan approval where it is provided for in the municipal planning strategy.

An example of a site-plan approval provision in the LUB is as follows:

6.4 A development permit shall not be issued for a large scale wind turbine unless a site plan has been approved, pursuant to the requirements prescribed in Appendix X of the LUB, and provided the applicant agrees in writing to carry out the terms of the site plan.

(a) a site plan shall be prepared by a qualified professional of sufficient detail to address all of the matters identified in Appendix X;

(b) a site plan submitted in accordance with Appendix will be circulated to all property owners within _______ metres of the property.

All of the other requirements currently listed in section 6.4 could still be included in the LUB. An Appendix with detailed requirements for the site plan must also be included. It is important to recognize that in accordance with the MGA (section 231) site-plan approval can only deal with specific items such as the location of structures on the lot, outdoor lighting, signs, walkways, driveways, parking areas, etc.

General Provisions for Wind Turbines in All Zones

6.5 All wind turbines in all zones shall meet the following criteria:

(a) A wind turbine shall be finished in a non-reflective matte and in an unobtrusive colour.

This provision relates to ensuring aviation safety and reducing visual impacts. For further information refer to sections 2.1, 2.15, 3.3.3, and 3.3.12 in the Report.

(b) A wind turbine tower shall not contain any commercial advertising. The hub or nacelle may display only the manufacturer's name or logo. Site signs shall be limited to those which identify the wind power facility, locate access points and provide safety information.

This provision relates to reducing visual impacts. For further information refer to sections 2.15, 3.3.12 and 4.2.11 in the Report.

(c) A wind turbine shall not be provided with artificial lighting except for lighting that is required to meet federal or provincial regulation.

Any additional lighting may be detrimental to birds, bats, and other wildlife habitat while also producing wasteful light pollution. For further information on refer to sections 2.2, 2.15, 3.3.12 and 4.2.11 in the Report.

(d) All power lines on the site of the wind turbine to the substation or grid will be underground.

This provision relates to reducing visual impacts and reduces the potential for bird/bat mortality. For further information refer to sections 2.15, 3.3.11and 4.2.10 in the Report.

(e) Any climbing apparatus associated with the wind turbine shall be a minimum of ______metres above grade.

This provision relates to safety and a suggested value is 3.5m. For further information refer to sections 3.3.3 and 4.2.3 in the Report.

(f) A locked device shall be installed on the tower to preclude access to the top of the tower.

(g) A wind turbine tower that is not of a monopole design must be surrounded by a fence of not less than ______metres in height.

Turbine towers that are not of a monopole design can be easier to climb and, in order to reduce risk of injury to the public, fencing is recommended. A value of 1.8m is taken from the research. Municipalities will need to use their discretion as to whether this is a burdensome requirement for mini and small wind turbine developments. Comparison to other similar structures (communication antennas, for example) and municipal requirements for fencing may be useful in deciding about regulation in this area. For further information refer to sections 3.3.3 and 4.2.3 in the Report.

(h) A wind turbine shall not cause greater than 30 hours of shadow flicker per year of a maximum of 30 minutes per day based on actual/real predicted values.

Shadow flicker is the visual impact that results when the sun passes behind the blades of a wind turbine and casts a shadow which then flickers as the blades rotate. Shadow flicker is dependent on the weather conditions (sun is shining or not), geographical position, topography, the time of day and the time of year. This is an emerging concern so regulation is developing. There are several options suggested to both mitigate the impacts of shadow flicker and to reduce the exposure of residents to its impact. For further explanation, refer to sections 2.10, 3.3.3, and 4.2.3 of the Report.

(i) The mean value of sound pressure level from a wind turbine shall not exceed ______dBA or ______dBA above the background noise levels at the nearest habitable dwelling.

As discussed in the explanation for item 3.7(e) noise and sound pressure emitted by wind turbines is not entirely understood and is therefore controversial. The literature review shows a 35dBA or 5dBA above the current background noise levels regulation being a viable option. For further explanation, refer to sections 2.7, 3.3.7, and 4.2.7 of the Report.

(j) Any guy wires associated with a wind turbine must be clearly visible to a height of _____metres above the guy wire anchor lines.

A greater number of guy wires create an increased hazard for bird, bat, small plane, or human collisions. Essential guy wires need to be clearly visible to a recommended height of 2m to help reduce the risk. For further explanation, refer to sections 2.2, 3.3.3, and 4.2.3 of the Report.

(k) All structures associated with the wind turbine, including guy wire anchors shall be setback no less than 3 metres from the property line.

Waiver of Setbacks for Wind Turbine Development

6.6 The setback requirements from a property line contained in sections 6.3(c) and 6.4(c) shall be waived where the adjoining property will be used for wind turbine development and the turbines on both properties will be connected to the same array.

This provision is intended to ensure that wind turbine development on adjoining properties is not hindered by property line setbacks. A municipality may wish to consider obtaining some form of assurance from the property owners to ensure that the wind turbine development occurs.

Part 7 Special Overlay Zones

Special overlay zones are designed to apply one or more additional requirements that are area specific not use specific. The overlay may encompass an area that contains several different zones. Any development will be required to comply with the requirements of the specific zone as well as the requirements of the overlay zone.

To use special overlay zones for wind energy development the municipality should use a constraints and opportunities mapping exercise. The constraints and opportunities to be considered include proximity to residential areas and institutional uses, wind strength, proximity to airport and military bases, parklands, habitat and environmentally sensitive areas, archeological sites, birds and bats nesting habitats, construction hazards, geology, and proximity to existing roads and power lines.

The result of the exercise may be a simple map designating various zones representing various levels of overall suitability for wind energy development. Provisions can be included in the LUB to facilitate wind energy in some areas while requiring extra caution in other areas. For more information see section 4.1.1, option 3 of the Report.

7.1 Notwithstanding any other provision in this By-law, a wind farm located within the Wind Energy District as shown on Schedule ‘A’, the zoning map, shall not be required to obtain a development agreement.

7.2 When a developer chooses the optional bonus provided for in section 7.1 the developer shall clearly indicate the “Wind Energy District” on the final plans submitted with the application for a development permit.

Items 7.1 and 7.2 provide an example of a special overlay zone for wind energy development. To encourage developers to use this zone, the municipality has suspended the requirement in 5.1 of the Model By-law.

Part 8 Site Plan Approval District Overlay Zone

Site-plan approval was described in section 6 as an alternative in some instances to development permit as of right.

Site plan approval may also be employed as a separate overlay zone. The area covered by the overlay may span one or more zone areas and the standards are set out in a separate section of the By-law. When a person applies for a development permit in a site plan control area they must also submit a site plan showing the details of the site as required by the By-law. A statement, on the site plan itself or on a separate attached paper, stating that all work shown on the plan shall be carried out, must be signed by the applicant before the site plan can be approved by the Development Officer.

For more information on site plan approvals see Part 31 of the Local Government Resource Handbook Model By-law.

8.1 Any wind turbine located within the Site Plan Approval District, as shown on Schedule ‘A’, the zoning map shall be subject to site plan approval.

8.2 In addition to any other applicable requirements found elsewhere in this By-law, the following requirements shall apply to all uses subject to site plan approval:

(a) list of requirements as authorized by the MGA.

As described at the end of item 6.4, above it is important to recognize that in accordance with the MGA (section 231) site-plan approval can only deal with specific items such as the location of structures on the lot, outdoor lighting, signs, walkways, driveways, parking areas, etc.

8.3 Within any site plan approval district, an application for a development permit shall be accompanied by an application for site plan approval including a plan or sketch in sufficient detail to address all of the matters identified in Section 8.2.