

Land Use Planning for Wind Energy Systems in Manitoba



Final Report to
Manitoba Intergovernmental Affairs on
Land Use Planning for Wind Energy Systems
in Manitoba

October 9, 2009

EDS Consulting
Winnipeg, MB

TABLE OF CONTENTS

1. INTRODUCTION.....	1
1.1 Purpose of this Paper	1
1.2 Wind Energy Systems	2
1.2.1 Commercial Wind Energy Systems.....	2
1.3 Wind Energy in Manitoba.....	3
1.3.1 St. Leon Wind Farm	3
1.3.2 Government Objectives for Wind Energy Development.....	4
2. THE REGULATORY FRAMEWORK	5
2.1 Two Approvals	5
2.1.1 The Environment Act	5
2.1.2 The Planning Act.....	5
2.2 The Planning Framework.....	7
2.2.1 Development Plan	7
2.2.2 Zoning By-law.....	8
3 WIND ENERGY SYSTEMS.....	9
3.1 How a Wind Turbine Works	9
3.2 What’s Involved with a Wind Farm	10
3.3 Development Considerations.....	12
3.3.1 Safety.....	12
3.3.2 Nuisance Considerations	15
3.3.3 Environmental Considerations	18
3.3.4 Esthetic Considerations	20
4 LOCAL POLICY FOR WIND ENERGY	24
4.1 Background Study.....	24
4.2 Public Consultation and Involvement	25
4.3 Development Plan Content.....	26
4.3.1 Objective and Policies	26
4.3.2 Protection of Sensitive Land Uses (Limitations and Rationale).....	27
4.3.3 Direction for Zoning By-laws.....	28

5	DEVELOPMENT CONTROLS FOR WIND ENERGY	29
5.1	Options for the Zoning By-law	29
5.1.1	Option 1 - Permitted Use	29
5.1.2	Option 2 - Conditional Use.....	30
5.1.3	Option 3 - Rezoning	31
5.1.4	Recommended Approach	32
6	APPENDICES	33
6.1	Appendix A – Zoning By-law Provisions.....	33
6.1.1	Separation distances from habitable buildings	33
6.1.2	Setbacks from property lines	34
6.1.3	Setbacks from Public Roads	34
6.1.4	Turbine Tower Height	34
6.1.5	Signage	35
6.1.7	Lighting	35
6.1.8	Setbacks from Water Bodies	36
6.1.9	Other Standards	36
6.2	Appendix B – Definitions	38
6.2.1	Wind Energy System Definitions	38
6.2.2	Associated Wind Energy Definitions	39
6.3	Appendix C - Development Agreements	41
6.3.1	Legislative Requirements	41
6.3.2	Specific Development Agreement Provisions	42
6.4	Appendix D – Bibliography	44

Figures

Figure 1	Primary Components of a Wind Turbine	10
Figure 2	Illustration of Setback Distances for Safety and Sound	23
Figure 3	GIS Mapping Example	24
Figure 4	Diagram Showing Total Turbine Height	40

Tables

Table 1	Overview of Jurisdictional Responsibilities	6
Table 2	CanWEA Recommended Sound Criteria	16
Table 3	Summary of Major Development Considerations	22
Table 4	Summary of Zoning By-law Options	32
Table 5	Summary of Zoning By-law Standards	37

Images

Image 1	A New Dawn – St. Leon Wind Farm	2
Image 2	St Leon Wind Farm	4
Image 3	Cellular Communication Tower near High Bluff	9
Image 4	Tower Base	9
Image 5	Wind Turbine and Farmland	11
Image 6	St. Leon Wind Farm Substation	11
Image 7	Wind Turbine Safety Lighting	14
Image 8	Respecting Waterfowl Habitat	18
Image 9	Typical Service Road Requirement	19
Image 10	Height above trees to capture steady wind	21
Image 11	Panoramic View – St. Leon Wind Farm	25
Image 12	Signage on Nacelle	35
Image 13	Tubular Monopole Tower	36

1. INTRODUCTION

Wind energy is a growing industry in Canada. Canada has a developable wind resource of about 50,000 MW, enough to supply about 20% of Canada's electricity needs. Wind energy produces no air pollution or greenhouse gas emissions and delivers substantial economic benefits to rural communities through investment and job creation, lease income for landowners, and a new tax base for municipal governments.

Wind energy generating systems are not typically contemplated in conventional development plans and zoning by-laws. As the wind energy industry is just beginning to develop in Manitoba and as many municipalities will face the challenge of regulating this new form of development, this is an opportune time to offer information to assist municipalities in developing local policy and development controls for wind energy development. Wind energy systems require municipal land use approval in addition to federal/provincial environmental assessment and licensing. Clear land use planning policies and development standards at the municipal level will address the issue of uncertainty for both wind energy developers and the general public.

1.1 *Purpose of this Paper*

The purpose of this document is to provide practical guidance to Manitoba municipalities and planning districts to help them plan for potential wind energy development; develop a local framework for evaluating wind power proposals; and promote best practices for the development of wind power facilities. These guidelines are based on a review of practices carried out in selected jurisdictions in Canada and the United States, as well as policies and standards adopted by Manitoba municipalities. This document is not intended to serve as a landowner's guide to wind energy development.

In order to develop appropriate municipal policies and regulations around wind energy development, it is important to understand the potential of the wind resource and the potential impacts wind energy development will have on the community and the environment. To avoid jurisdictional duplication, it is also important to distinguish those matters that are primarily a municipal responsibility from those that are addressed by other bodies such as the Federal and Provincial government and the wind energy industry itself. Suggested guidelines in this document focus primarily on those matters appropriately controlled at the municipal level.

The guidelines contained in this document should be viewed as a benchmark from which a *local planning authority*¹ can develop a planning and decision-making framework that

¹ A local planning authority - means the council of a municipality, the board of a planning district, the resident administrator of a local government district or a planning commission as defined under *The Planning Act*.

balances the broader objectives of sustainable renewable energy development with local conditions and community values.



Image 1 – A New Dawn – St. Leon Wind Farm

1.2 Wind Energy Systems

There are basically two kinds of wind energy systems, large scale *commercial wind energy systems* (also referred to as wind farms) intended solely for commercial sale and distribution of electrical power, and *on-site use wind energy systems* (or small wind energy systems) intended to primarily serve the electrical needs of the on-site user or consumer (either “behind-the-meter” or “off-grid”) and not intended to produce power for resale. The focus of this document is on municipal guidelines for commercial wind energy systems.

1.2.1 Commercial Wind Energy Systems

Commercial wind energy systems can vary considerably in size and scale depending on the physical features of the land, the wind resource available and the amount of energy to be generated. These large-scale commercial systems may include dozens or hundreds of turbines, sized to provide power for commercial sale to an electric utility transmission and distribution grid. Given the usually large scale of wind farms, they tend to be located outside of densely populated or urban areas.

Key siting prerequisites for large-scale commercial wind energy facilities are:

1. Strong, steady winds throughout the year,
2. Good road access and
3. Proximity to the electricity grid.

The turbines typically used for large-scale wind farms are large, slowly rotating 3-bladed machines that generally produce from 1.5 to 2.5 MW of output each. The most common turbine has a generator and rotor blades mounted on top of a rolled steel tower 80 metres in height. New designs and improved technologies are leading to the development of larger and quieter turbines with greater output capacities.

1.3 Wind Energy in Manitoba

Manitoba has attributes that make it a good location for harnessing this sustainable energy source, including an excellent wind resource and wind sites that are accessible to transportation networks and the electrical grid. Improvements in technology have lowered the cost of wind-generated power so that wind power can now more easily compete with traditional sources of generation. Because wind power is variable, it must be firmed and shaped so it can be supplied to customers when needed. Combining wind power with Manitoba's hydraulic electric system provides that capability. When the wind is blowing, water can be stored in reservoirs. When the wind is calm, water can be released to generate power at the dam site ensuring that customers get firm power on demand. Locating wind farms in various regions across the Province further enhances the capacity to deliver a consistent power supply. Also, Manitoba's wind regime is most productive in the winter months when peak demand for power occurs.

1.3.1 St. Leon Wind Farm

Manitoba has one major wind farm, developed in two stages, which came into full operation in March 2006. It is located near the community of St. Leon (pop 120), about 150 kilometres (km) southwest of the City of Winnipeg.

A total of 63 wind turbines have been erected over a 93 square kilometer area, involving 50 landowners in the Rural Municipality (R.M.) of Lorne and R.M. of Pembina. The St. Leon Wind Farm is capable of delivering up to 99 MW, enough power to supply 35,000 homes, or a city the size of Brandon. Manitoba Hydro has a power purchase agreement with the St. Leon Wind Energy Project to purchase wind power for up to 25 years. The project, which cost \$210-million to develop and build, is estimated to result in \$100 million in operational expenditures. A 99 MW wind farm such as St. Leon has the capability to reduce 370,000 tonnes of carbon dioxide per year, the same positive environmental impact as taking 70,000 cars off the road or planting 1.7 million trees.



Image 2 - St. Leon Wind Farm

1.3.2 Government Objectives for Wind Energy Development

The Province of Manitoba supports and encourages projects that promote renewable energy development, improve energy efficiency and manage resource use to ultimately reduce Manitoba's greenhouse gas emissions and assist the province in meeting its Kyoto commitment. Wind energy is a clean, completely renewable energy source with relatively few environmental impacts. Over the next decade, Manitoba plans to develop up to 1000 MW of electricity from wind power.

2. THE REGULATORY FRAMEWORK

2.1 Two Approvals

Wind energy systems need approval at both the provincial level and municipal level for a development to proceed. The Province is responsible for the environmental decision under *The Environment Act* and local government for the land use decision under *The Planning Act*. Both Acts embrace the principles of public notice and opportunity for public input.

Manitoba has an agreement with Canada whereby any respective environmental processes are coordinated with the appropriate Federal agencies. The objective is to allow a proponent to prepare a single Environmental Assessment (EA), which can be filed and reviewed concurrently to satisfy both Federal and Provincial requirements. Projects registered under the Federal ecoENERGY for Renewable Power (ERP) program trigger the Canadian Environmental Assessment Act (CEAA). Natural Resources Canada administers ERP funding and therefore is the responsible authority (RA) under the CEAA.

2.1.1 The Environment Act

The Environment Act protects the environment and ensures that the planning, construction and operation of developments occur in an environmentally responsible manner. *The Act* outlines an environmental assessment and licensing process by the Province for those developments listed in the Classes of Development Regulation under *The Act*. Electrical generating facilities are listed as a development in the Regulation and require an environmental assessment and license. Proponents of wind energy developments must file an Environment Act Proposal with the Manitoba Conservation Environmental Assessment & Licensing Branch. Commercial wind energy projects also require an environmental assessment (EA) to be filed in support of the Proposal. To expedite the Environment Act process, the Proposal and supporting EA can be filed at the same time. Environmental consultants retained by the proponent generally undertake the EA. The Environmental Assessment & Licensing Branch provides guidance in preparing the EA and steering the proponent through the EA process.

Information on the Manitoba environmental assessment and licensing process, including requirements for filing a proposal, and applicable Environment Act application fees is available on the Manitoba Conservation website.

2.1.2 The Planning Act

The Planning Act provides the framework for land use planning in Manitoba and defines the basic structure and tools for planning by local government. *The Act* enables the formation of planning districts and planning commissions and the adoption of regional

planning strategies, development plans and zoning by-laws. The Provincial Land Use Policies (PLUPs), a regulation under *The Planning Act*, reflect the Province's interest in land and resource use in Manitoba and are used by departments and agencies in the review of planning by-laws proposed by local government.

The process for the local land use approval of a development will vary depending on whether a development plan amendment, zoning amendment or conditional use or other approval is required. In most instances a public notice is required as well as notice by mail to property owners within a specified distance of a proposal. The planning district board or council holds a public hearing. There are also avenues to appeal some decisions to the Municipal Board or a district board, depending on the local planning structure.

Public consultation and community involvement is an important component of *The Planning Act* and will be particularly important with respect to wind energy development so that the issues around the potential impacts of wind energy development are thoroughly discussed and well understood. Consultation with the community and departments and agencies allows proposed policies to be considered from a variety of perspectives, which can help identify potential problems early in the process and help gain support for proposed wind energy development policies and regulations. For this reason, it is strongly recommended that local planning issues respecting wind energy developments be identified and resolved well in advance of filing an Environment Act Proposal. The regulatory framework involves the consideration of development projects from Federal, Provincial and municipal perspectives, each with their own areas of responsibility.

The Table 1 provides an overview of the approval requirements and associated jurisdictional responsibility for a wind energy development.

Table 1 – Overview of Jurisdictional Responsibilities for Wind Energy Development

Approval Requirement	Responsible Jurisdiction
Land Use	Municipal Government
Environmental Impacts (Environmental Assessment) - pollutants to air, water, land - wildlife, fisheries, noise, surface water, groundwater, socio-economic	Federal (Canadian Environmental Assessment Agency) Provincial [Coordinated by Manitoba Department of Conservation]
Aeronautical Safety	Transport Canada, Navigation Canada
Electromagnetic Interference	Navigation Canada Department of National Defense Environment Canada Industry Canada
Turbine Safety	Canadian Standards Association (CSA)

2.2 The Planning Framework

A planning framework comprises the administrative tools (guidelines, policies and regulations) that a *local planning authority* adopts and uses to control development.

A good planning framework should fulfill the following criteria:

1. Support for long-term goals and strategic objectives. The community planning process should, first and foremost, be focused on the long-term sustainability of the community, environment and economy;
2. Take into account public interests such as renewable energy and climate change;
3. Take into account local interests (linking ‘bottom-up’ planning efforts with the establishment of long-term strategic priorities);
4. Allow for public participation (a citizen-based participatory planning process) that involves a broad base of citizens, including public and private sector leaders, community interest groups and multi-disciplinary professionals.
5. Seek the best available information on the issues of concern to the community and appropriately resource the process.

These criteria will serve as useful benchmarks. As a *local planning authority* develops its policies and regulations for wind energy development, it will be able to evaluate how its “wind energy”-planning framework measures up to the above criteria.

The main administrative tools available to a *local planning authority* include the Development Plan and Zoning By-law.

2.2.1 Development Plan

A development plan is essentially a planning policy document that provides a comprehensive and long-term perspective of community goals and aspirations. A development plan directs sustainable land use and development in the planning district or municipality by setting out the plans and policies respecting its physical, social, environmental and economic objectives and sets out measures for implementing the plan.

Provincial departments and agencies review proposed development plans to ensure they are generally consistent with provincial policies. As such, an adopted development plan reflects a blend of local and provincial policy interests respecting future land use for the planning area. The development plan also serves as a guide for land use regulation tools available under the zoning by-law.

2.2.2 Zoning By-law

The zoning by-law enables a council or planning district board to adopt specific regulations for the use and development of land. Where the development plan is a statement of the board or council's intent respecting future development, the zoning by-law provides the principal mechanism for implementing the objectives and policies set out in the development plan.

A zoning by-law must be generally consistent with the development plan and any secondary plan. This ensures that the regulations that apply to the use and development of land will direct development in a manner that supports the broader goals and objectives set out in the development plan.

3 WIND ENERGY SYSTEMS

3.1 How a Wind Turbine Works

A wind turbine is a rotating machine that converts wind energy into electricity through the use of a wind turbine generator. Aerodynamic modeling is used to determine the optimum tower height, control systems, number of blades, and blade shape.



Image 3 - Cellular Communication Tower near High Bluff (height = 120 m)

The Wind turbine tower foundation is a concrete steel-reinforced base that requires over 30 truckloads of concrete and may extend 10 to 15 metres underground. The base of each turbine is about four metres in diameter. The tower is a hollow stem column constructed in four sections for easier transport. The **nacelle** [pronounced (nə-sēl')] sits on top of the tower and houses the gearbox, generator and control system. The nacelle can be swiveled to keep the blades in the best position to catch the wind and the pitch of the blades can be varied to maximize

The typical turbines used for large-scale wind farms in Canada are large horizontal axis wind turbines that have a generator and 3 slowly rotating blades mounted on top of a rolled steel tower and have a nameplate capacity ranging between 1.5 to 2.5 MW of output each. Each turbine is about 80 metres high and equipped with three 41-metre blades.

At its highest point a single turbine (with blades) reaches about 120 metres (400 ft). This is about as tall as a cellular communication tower one might encounter in rural Manitoba, such as the one at the junction of the Perimeter Highway and PTH #6 or the one located near High Bluff shown here.



Image 4 - Tower Base (Scale - Tool Box = 15 in.)

the effect of the wind. Wind turbines are mounted on 80-meter hub heights (or greater) to minimize the frictional impact that trees and buildings have on the wind speeds.

Power is generated in the nacelle to which the rotor hub and blades are attached. As the blades turn, they make a series of powerful magnets spin inside large coils of wire. The blades turn only about 14 times per minute and a gearbox increases the speed so the magnets spin past the coils of wire more than 1,200 times per minute. Moving the magnets past the coiled wire causes electrons to move, creating electricity. Cables carry the electricity down the inside of the tower and then underground to a nearby substation and then enters the electricity grid. Typically blades begin to turn when wind speeds reaches 13 km/hr. The control system will shut off the blades when winds get too strong (at about 90 km/hr) to avoid over speed damage. Wind turbine generators have minimum temperature operating limits which apply in cold climate areas that experience temperatures below -33°C . Wind turbines are also protected from ice accumulation (which can cause high structure loads and damage) by use of internal heaters, different lubricants, and special alloys for structural elements.

3.2 What's Involved with a Wind Farm

Reliable wind resources and local topography are key factors in choosing a potential wind energy project site. Wind turbines are strategically located and arrayed over the project area based on wind resource data. Rotors are continuously orientated to changing wind direction to maximize potential available energy. Wind turbines must be set apart from each other to avoid turbulence. The industry standards for spacing of wind turbines generally range from 1.5 to 5 times the rotor diametres apart (about 123 to 450 m).

Temporary access roads during construction and permanent service roads for maintenance and repairs of the wind turbines are required in the development of a wind farm. It is estimated that less than five percent of the total land area for a wind farm is used for service roads so, in a typical rural agricultural setting, 95% of the farmland can still be used for farming.

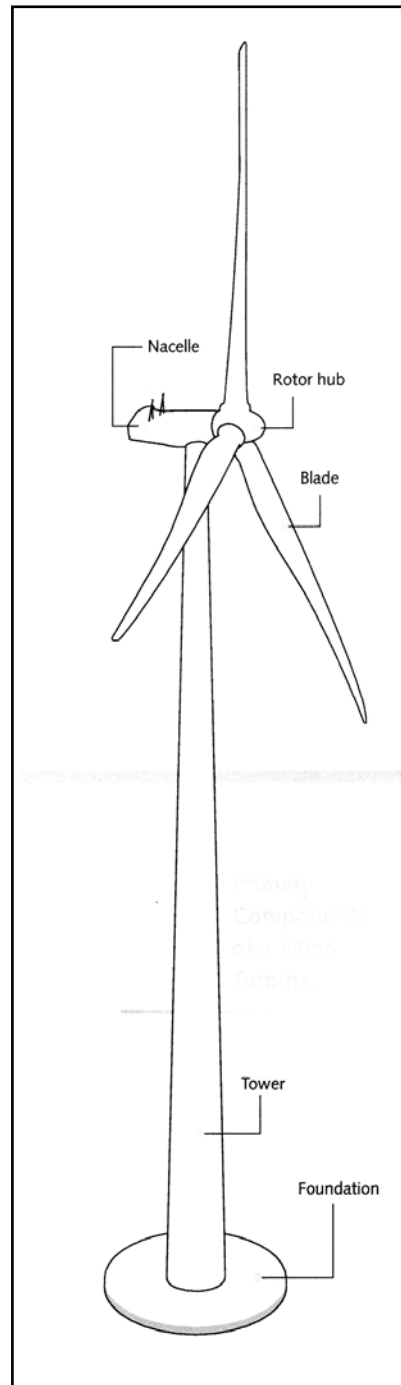


Figure 1 – Primary Components of a Wind Turbine

Underground cables trenched to a depth of about 1.5 metres will collect power generated by each of the turbines. Where cables must cross public roads they are usually drilled under the existing road to minimize road disturbance or trenched across roads and roads rebuilt to municipal specifications. A new substation and interconnecting transmission line is also required to collect the energy and distribute it to the electricity grid.

Commercial wind energy systems have a life expectancy of several decades and, once constructed, can be expected to remain in operation for a long period of time. The economic/design life of a typical wind farm is up to 25 years, with an overall project life expectancy of 40 years. At the end of its economic life, the facilities will likely be upgraded or refurbished to extend its lifespan well beyond the 40-year time frame.



Image 5 – Wind Turbine and Farmland



Image 6 – St. Leon Wind Farm Substation

3.3 Development Considerations

Wind energy generation is a clean renewable alternative and offers reduced greenhouse gas emissions. Wind energy development contributes to energy security and provides economic development opportunities and tax and income benefits to local municipalities and landowners.

Large-scale commercial wind energy developments are long term and capital intensive in nature and the impacts of these developments must be carefully planned. In order for a local planning authority to put appropriate land use planning policies and standards in place, it is first important to understand the potential impacts and distinguish those that a municipality has the authority/ability to control. This section reviews the major potential impacts associated with wind energy systems and discusses four ways in which these are regulated, including engineering standards, environmental assessment, detailed site planning and operating procedures. This section also summarizes related land use planning tools that complement the primary control mechanism.

3.3.1 Safety

Engineering standards and operating procedures are the primary means of addressing safety matters related to the risk of ice throw, blade failure and tower failure.

All modern wind turbines are subject to certification standards for their safe design and operation. Matters of safety related to ice throw, blade and tower failure are continually being addressed by the industry itself and by certification agencies. Manufacturing defects have been significantly reduced over the last decade by improved quality controls in the industry and full-scale testing of blade and tower design for certification.

Well-established standards and codes for these structures exist in Europe. The regulatory environment in Canada is evolving. Presently, CSA is working with this industry sector to adapt the European standards and model codes for use in Canada. The intent is to harmonize as much as possible with the existing European standards and supplement them to address design issues for low temperature and icing conditions in various Canadian regions.

Ice Throw

Icing of wind energy structures can occur at those times of the year when freezing rain is experienced. Manitoba is characterized as having low to moderate climatic conditions for icing to occur.

When icing does occur, there is a potential risk of injury to the public from fragments of ice thrown from the rotating blades of an operating turbine, and those who may stand under a stationary wind turbine.

Studies have shown that if ice builds up on turbine blades, ice fragments can potentially be thrown from rotating blades a distance of 50 metres to over 125 metres from a turbine, depending on a number of factors such as blade design, the tip speed of the rotor, height of the tower, the size of the ice fragment, wind speed and direction. The critical distance (the distance beyond which there is a negligible risk of injury from ice throw) is considered to be approximately 220 metres.

Ice build-up affects turbine performance, and hence project economics. Modern wind turbine blades are designed to be very aerodynamic and smooth to inhibit ice build-up and equipped with a number of mechanisms (imbalance sensor, output calculations) that prevent operation of a turbine in icing conditions and help prevent rotor blade damage and dangerous ice throw. Reduction of icing on a wind turbine operating under icing conditions are also significantly improved by use of blade-heating systems to avoid ice accretion on blades in regions where frequent icing occurs.

Blade Failure

The main causes for blade failure are over-speed, lightning strikes and manufacturing defects. While over-speed can occur through human interference, redundancies are built into turbine control systems so that if one system fails, the other system will control rotor speed. Overall, the probability of blade failure or blade loss is low and therefore the safety risk to the public is low.

Tower Failure

Turbine tower failure (collapse of all or portion of tower) is an extremely uncommon occurrence that would only occur due to faulty construction and severe storm damage. Lightning protection systems are now also a standard in modern wind turbines. A properly constructed turbine poses negligible risk of collapse.

Planning Measures

As a compliment to engineering standards, turbine safety can be enhanced with appropriate setbacks from property lines, public roads and buildings. Wind energy turbines should be properly certified and installed as per the manufacturer's specifications by qualified personnel. A local planning authority may also consider asking a proponent to put up signs alerting anyone in the area of potential risks.

The separation distances from residential dwelling due to sound nuisance (see Figure 2 on page 23) far exceed safety-related setbacks mentioned previously. Regulations adopted related to sound from wind turbines and residential dwellings will, in most cases, provide more than sufficient distance to ensure public safety due to potential ice throw, blade and tower failure.

Aviation

Federal requirements and guidelines address matters related to aviation including the safe operation of airports and the safety of flying aircraft. Several federal agencies are primarily responsible for navigational and telecommunications facilities. Transport Canada is the federal government department responsible for most of the transportation policies and programs to ensure that the national transportation system is safe, efficient and accessible to all its users. Navigation Canada (NAV Canada) is responsible for civil air navigation services and ensures the safety of aircraft flying in domestic Canadian airspace and international airspace designated to Canada. As part of NAV Canada's safety role, it ensures that land use adjacent to or at an airport does not interfere with navigational or telecommunications facilities and the safety of the flying public. The Department of National Defense (DND) also becomes involved where defense radar facilities are potentially impacted.

Transport Canada requires an aeronautical obstruction clearance application showing the geographic coordinates and height of any new structure that exceeds 20 metres in height or any new structure within 6 km of an airport or 2 km of a radar, radio navigation or radio communication antenna, in order to identify proposals that may conflict with Air Regulations and to determine lighting and marking requirements. NAV Canada and DND also require notification of turbine developments within 10 km of federally licensed airports. NAV Canada requests notification of any proposed structure taller than 30.5 metres.

While these matters are a federal responsibility, a local planning authority can support these requirements by identifying and protecting airports and aircraft landing areas in the development plan. A local planning authority may also want to require a proponent to provide documentation that the development is in compliance with applicable air safety regulations respecting location, height, lighting, and markings.



Image 7 – Wind Turbine Safety Lighting

Aerial Crop Spraying

Some aerial applicators are reluctant to operate within a wind farm or within 1½ miles of a wind turbine tower due to potential safety and insurance risks. Transport Canada allows aerial crop spraying in and around wind farms providing the pilot believes it is safe to do so. Discussions between the Canadian Aerial Applicators Association and Transport Canada are ongoing in an attempt to address this issue.

Because flying among wind turbines does add to the risk, a proponent will usually accommodate and cooperate with landowners who aerial spray their crops. Safety risks can be reduced by having the turbines turned off at the time aerial spraying occurs typically during calm wind conditions, when little or no electrical power is being generated. Rotor blades can also be oriented so as to accommodate efficient field spraying flight patterns. The bottoms of the blades are at least 40 metres off the ground.

This is an issue largely to be addressed by the proponent with affected landowners in or near the project area, through appropriate agreements. If options have not been thoroughly examined and addressed at the outset, the establishment of a wind farm in an agricultural area that relies on aerial spraying of crops may restrict this activity and impact the farming operation.

3.3.2 Nuisance Considerations

Sound

The provincial environmental licensing process is the primary means for addressing noise impacts, which is one of the main concerns with respect to wind energy development.

The impact of noise depends on the type of wind turbine, the sensitivity of the surrounding land uses, the existing background sound levels, wind speed and direction, topography, weather and other climatic conditions. Sound is most often measured as sound pressure levels, commonly expressed as dBA². During operation a wind energy facility will create sound due to the mechanical noise produced by the wind turbine generator and movement of the rotor blades through the air. Technological improvements in recent years by turbine manufacturers have significantly reduced mechanical noise, with better designs of towers, nacelles and gearboxes to reduce noise and vibrations.

The most prominent sound emanating from a modern wind turbine will be a pulsing ‘whooshing’ sound created by the rotation of the blades through the air. Under test conditions, the typical 1.5 – 2.5 MW turbine will generate a sound level of 45 decibels (dBA) at a distance of about 300 metres. By comparison, 40 dBA is a normal rural nighttime level or a quiet office and 50 dBA is considered equivalent to an urban daytime

² “dB” means decibels and is a measurement for sound pressure and “A” refers to a weighted adjustment of measured sound that matches perception by the human ear.

level. A 60 dBA sound level equates to normal speech at 3 ft. A sound level of 80 dBA equates to a power drill. dBA levels 100 or higher represent sounds similar to a bar or night club or a jet aircraft at take off.

The provincial Environmental Assessment review addresses the impact of noise from wind turbines on the basis of a performance standard (i.e. sound pressure levels achieved at a receptor point). The actual distance from a receptor will vary depending on weather a single or several wind turbines are present and depending on the sound output from the particular wind turbine manufacturer. As turbine manufacturers continue to reduce the sound output from wind turbines, they will affect “distance from a receptor” requirements in ensuing environmental assessment reviews.

The Province of Ontario’s noise guidelines for wind turbines put in place a noise limit of 45 dBA for turbines within urban and suburban areas and a limit of 40 dBA for rural areas. These sound level limits increase with wind speed, acknowledging that the higher wind speeds increase ambient sound levels, which tend to mask noise generated by wind turbines. CanWEA recommends a sliding scale for acceptable sound, based on Ontario’s Sound Guidelines, starting at 40 dBA at 4 m/s (metres per second), rising to 53 dBA at 11 m/s. Manitoba’s Environmental Assessment utilizes the sliding scale sound levels as recommended by CanWEA.

Table 2 - CanWEA Recommended Sound Criteria for Wind Turbines

Wind Speed [m/s]*	4	5	6	7	8	9	10	11
Wind Turbine Noise Criteria [dBA]	40	40	40	43	45	49	51	53

* 1 m/s = 3.6 Km/h

Sound modeling for environmental assessments in Manitoba has shown that a setback of 500-550 metres from a receptor (an occupied dwelling) is sufficient to ensure that the sound criteria can be met.

The environment license requirements can be complemented by identifying and buffering sensitive lands in the development plan and establishing clear policy as to where wind energy development will and will not be considered. The zoning by-law should also set prescribed separation distances from habitable buildings in areas where wind energy development will be allowed and mutual separation distances of habitable buildings from existing or approved wind energy systems. Early awareness and consultation between the proponent and landowners during the planning stage is also very important in addressing noise mitigation.

Shadow Flicker

Detailed site planning is the primary means for addressing concerns with shadow flicker.

Shadow flicker is defined as the effect of the sun flashing through the rotating blades of a wind turbine. The rotating wind turbine blades can cast moving shadows that cause a flickering effect. This can occur when it is not cloudy; the sun is low in the sky, and shines on a residence from behind a turbine rotor. When the shadow of the turbine blades passes across the building, light appears to flick on and off as the turbine rotates. When this flicking shadow is viewed through a relatively narrow opening such as a window it is referred to as shadow flicker.

Research suggests that the frequencies at which persons can become disturbed or irritated by such an effect is at about 2.5 hertz³. The maximum frequency effect from a commercial wind turbine is usually less than 1 hertz, and is therefore well below that considered to be the cause of nuisance. The distance between a wind turbine and a potential shadow flicker receptor affects the intensity of the shadows cast by the blades, and therefore the intensity of flickering. Shadows cast close to a turbine will be more intense and distinct because a greater proportion of the sun's disc is intermittently blocked. Similarly, flickering is more intense if created by the area of a blade closer to the hub and further from the tip. At 500 metres and more, shadow flicker occurs only at sunrise and sunset. At 900 metres and more, shadow flicker is considered to be insignificant. Buildings to the north and south of the wind farm are less likely to be affected by shadow flicker than those to the east and west.

There are no guidelines in place in Canada for shadow flicker impact and most local planning authorities do not explicitly regulate shadow casting. Developers are able to predict very accurately the probability of when and for how long there may be a flicker effect. By using astronomy and trigonometry they can compute either a likely, or a "worst case" scenario.

Early awareness and consultation at the planning stage between the proponent and landowners is the key to addressing this issue. Proper modeling, siting and design can alleviate the impact. Where shadow casting does occur, turning off the turbine can further mitigate the impact during the short time when shadow flicker will affect a dwelling, and/or rotating the blades so as to be perpendicular to the sun. Establishing a vegetative buffer between the turbine and affected dwelling is also effective.

Electromagnetic Interference

The effect of wind turbines on electromagnetic waves will usually be limited. Potential electromagnetic interference effects can be calculated from information about affected telecommunications transmitting or receiving stations, local conditions, turbine design and location. The potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimized, if not eliminated, through appropriate turbine design and strategic siting. The siting of wind turbines in the 'line of sight' between transmitters and receivers should be avoided.

³ **hertz** (symbol: **Hz**) - is a measure of frequency, informally defined as the number of events occurring per second. The most common use for *hertz* is to describe frequency of rotation, in which case a speed of 1 Hz is equal to one cycle per second.

Proponents typically consult with appropriate Federal and Provincial departments and other agencies to avoid and mitigate any potential telecommunication interference issues. Electromagnetic interference from commercial wind energy facilities is addressed in the Federal/Provincial environmental assessment process.

3.3.3 Environmental Considerations

Wildlife

There are several ways that wind turbines may interfere with wildlife, particularly birds and bats. One can be the impact on their natural habitat and another is collision with the turbine and blades. The limited research that has been done in this area shows conflicting results. Recent research in the United States indicates that across the US an average of 2.3 birds per turbine per year have fatal encounters with wind turbines. Comparison data shows that a far greater number of birds are killed by collisions with high-rise buildings, vehicles or high-tension wires than by wind turbines. As an illustration, during the first year of operation, the wind turbine in Exhibition Place in Toronto killed two birds. By comparison, high-rise structures in downtown Toronto are estimated to kill 10,000 birds every year.



Image 8 – Respecting Waterfowl Habitat

Studies led by researchers at the University of Calgary are continuing to examine the cause of bat deaths at a number of western Canadian wind farms in order to reduce or prevent this occurrence. An overview of bat mortality studies in the United States suggested that bat fatalities average 3.4 bats per turbine per year. Bat fatality rates are

highest in forested environments and lowest in open areas. The majority of mortalities occur in late summer and early fall, the peak occurring in August during the migration period. While migratory tree bats are most at risk, there are regional differences. More study and research is necessary to determine what affect wind energy development has on the bat population.

Modern wind farms that are sited with sensitivity to bird and bat migration routes, staging areas and habitat should not have significant adverse effect on bird and bat populations. As research into the interactions of birds and bats with wind turbines continues it will add to the body of knowledge of these impacts. Wind energy projects should be planned carefully and mitigation strategies implemented as directed by the Environmental Assessment process. An initial site evaluation, 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 resident and migratory bird and bat species in an area.

The impacts on wildlife undergo extensive review and evaluation under the Federal and Provincial Environmental Assessment and License process. A local planning authority can complement the environmental review by identifying and protecting wildlife and avian habitats, migration routes, staging and nesting areas in the development plan.

Construction/Operation

The construction phase has the greatest potential impact on the site and surrounding environment, potentially effecting soil quality, groundwater, noise nuisance and air emissions from machinery and vehicles, but for a relatively short period of time. A 99 MW project, for example, is expected to employ 75 – 150 people at any one time for a period of up to 15 months.



Image 9 – Typical Service Road Requirement

Typically, temporary access roads and permanent service roads are constructed for the service and maintenance of a commercial wind energy system. Site access will generally use existing roads section roads and half section lines for access, as much as possible, to minimize impacts of the project. Access roads are typically 5 m (16 ft) wide and service roads about 3.7 m wide. New required service roads are constructed along the planned rows of turbines. Some existing public roads may need to be altered to accommodate the weight and size of large vehicles. There may also be stream/drainage channel crossing construction associated with permanent roads and temporary crossing paths for

moving construction equipment. Excavations will be required for turbine foundations (10 – 15 m depth) and for underground collection cables.

A proponent normally prepares a traffic management plan in consultation with provincial and municipal authorities regarding specific transportation routes to be used during construction to minimize impacts on local transportation infrastructure. The delivery of turbines may require changes to local traffic flow due to the large cranes and heavy vehicles. Each turbine will require about 30 truckloads of cement for the foundation and 8 truckloads for the delivery of equipment. An additional average traffic of 20 vehicles per day can be expected during the construction phase of a typical 99 MW wind farm.

Sites will also be required for storage of materials and equipment, vehicle parking, hazardous materials (oil, gasoline, diesel and propane), waste collection and disposal and staging areas for installation of generators. Material required during construction that needs to be hauled in and stored on site includes gravel for roads, concrete for turbine foundations, water for dust control, and materials for erosion controls. There will also be requirements for emergency response plans such as medical emergencies, possible fires and spills of hazardous materials.

Once the construction phase is complete and the wind farm is in operation there will not be any further requirements for roads, cables, transformers, substation or transmission lines or other buildings during the life of the project. Traffic associated with the operation and maintenance will be minimal. Occasional heavy equipment may be required for maintenance and repair. A typical wind energy turbine requires maintenance about twice a year, including an oil change and lubrication. It takes about a day and a half to service one wind generator. Maintenance activity will be restricted to existing roads, turbine sites and yard storage sites. Additional traffic generated during operation of a wind farm is negligible.

Potential impacts on the environment (soil, groundwater and surface water, air) are regulated by environmental protection practices and plans as per the provincial environmental assessment license and there should be no further municipal requirements for these aspects. A local planning authority may, however, require a development agreement to address remediation for any municipal road/drain/culvert damage that occurs during construction, medical emergency and fire response services, and disposal of non-reusable waste and sanitary waste.

3.3.4 Esthetic Considerations

Visual

Most commercial wind energy systems are located in open rural areas and therefore tend to have a strong visual prominence. Wind energy facilities will have a degree of visual impact on the landscape. The visual impact of wind turbines is subjective. Some will perceive the turbines as a negative on the landscape; others may view them as a symbol

of sustainability. The closer a wind farm is to settlement areas or major transportation routes, the more visual impact issues may be raised by citizens.

Aspects such as siting and location, spatial extent and scale, spacing of turbines, height of turbines, colour and lighting and the location and scale of other buildings or structures (including transmission lines) in the vicinity and cumulative effects, will affect visual impact perception. While visual impact may be addressed in a proponent's environmental assessment report, there are no regulatory requirements in Canada with respect to preserving visual landscape quality. There are methodologies available that can be used to evaluate visual resources in order to identify areas of scenic quality and sensitivity.



Image 10 – Height above trees to capture steady wind

If visual impact is of particular concern to the community, the local planning authority can consider undertaking an evaluation of visual resources and identify in the development plan those publicly significant scenic or historic landscapes where greater sensitivity may be required if a wind energy facility is proposed nearby or areas where wind turbines will not be permitted. The protection of significant landscapes should be identified early in the planning process so that potential developers are aware of these constraints and are not caught purchasing or leasing land for the installation of wind turbines. In the Bruce County Development Plan, for example, commercial scale wind energy systems are not permitted within the Niagara Escarpment to preserve its scenic quality.

Where wind energy facilities are permitted, the potential visual impacts can be reduced by locating wind turbines more in line with dominant topographical features such as ridge lines or other features such as transmission lines. While spacing turbines to respond to landscape characteristics and not overly dominating a landscape will reduce visual impacts, care should be taken not to jeopardize the performance and efficiency of the wind farm operation.

Table 3 summarizes how major development considerations associated with wind energy development are dealt with. The primary control mechanisms include engineering standards, environmental assessment, detailed site planning and operating procedures. There are also related land use planning tools that can compliment these primary control mechanisms.

Table 3 – Summary of Major Development Considerations

Consideration	Primary Control Mechanism				Related Land Use Planning Tools
	Engineering Standards/Certification	Environmental Assessment	Detailed Site Planning	Operating Procedures	
Safety:	√			√	Setbacks and yard requirements in Zoning By-law
Aviation		√		√	Identify and avoid airports/aircraft landing areas in Development Plan
Crop Spraying				√	Development Agreement
Sound		√			Mutual separation from sensitive uses and from habitable buildings
Shadow Flicker			√		Mutual separation distances
Electromagnetic	√	√			Not applicable
Wildlife		√			Identify and avoid wildlife corridors or significant habitat in Development Plan
Construction/Operation		√		√	Development Agreement
Visual			√		Identify significant or historic vistas in Development Plan

Figure 2, below, illustrates the use of setback distances address safety considerations and nuisance from sound.

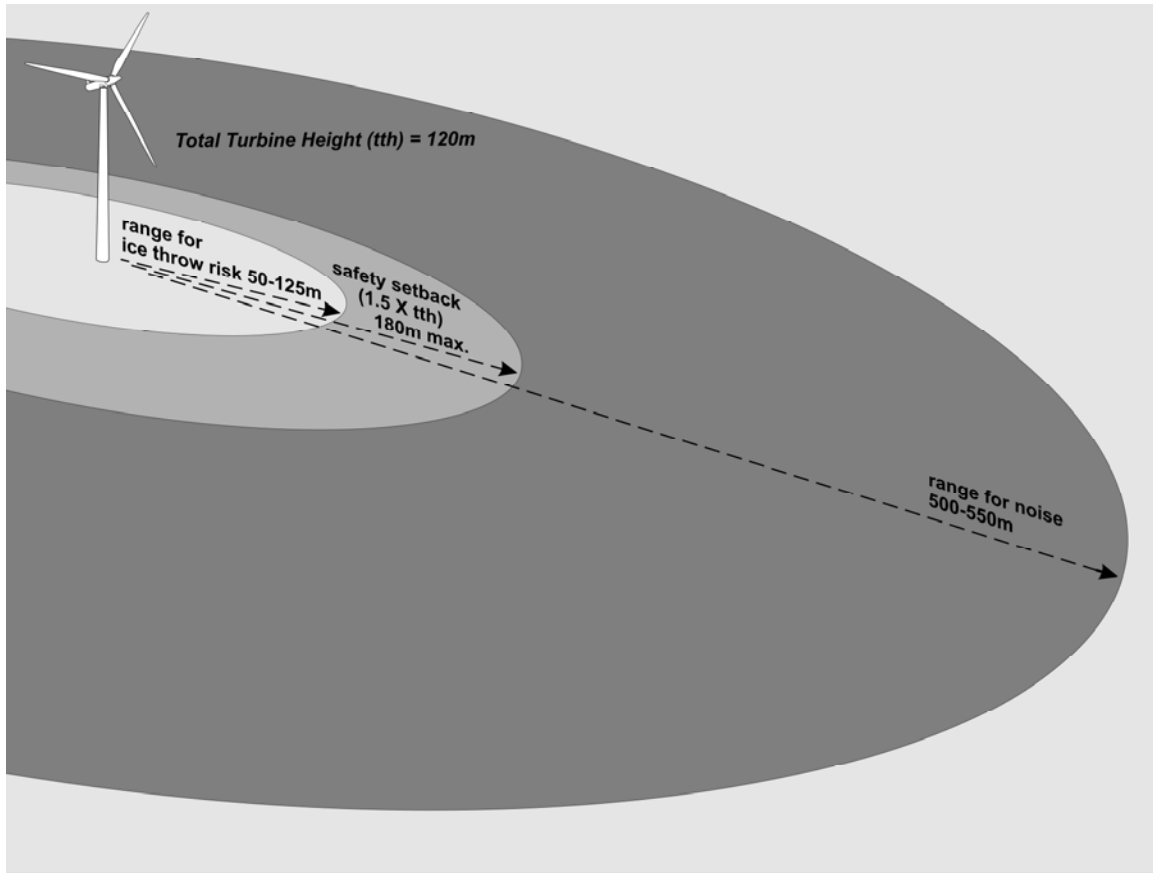


Figure 2 – Illustration of Setback Distances for Safety and Sound Nuisance

4 LOCAL POLICY FOR WIND ENERGY

The main policy issue for a development plan is to identify the areas where commercial wind energy systems may be permitted, limited or prohibited and involves the collection of data/information and preparation of background studies as well as consultation with the community, government departments and agencies. A knowledge-based, reasoned approach to determining policies and standards is essential in achieving effective land use planning documents.

4.1 Background Study

Background research should focus on identifying existing and future land uses that are potentially sensitive to impacts from wind energy development as well as constraints on wind energy development such as environmentally sensitive areas, areas of crop production requiring aerial spraying, or areas of significant scenic or historic value.

A constraints mapping process using geographic information system (GIS) analysis can be an effective tool for policy planning purposes where the appropriate information is available in a spatial format. Use of GIS spatial information is also helpful for evaluating the impact of alternative regulatory options (e.g. different separation distances) that a local planning authority may want to consider in its zoning by-law. A GIS constraints mapping approach is strongly recommended to local planning authorities as an effective tool for developing policies and standards with respect to wind energy development.

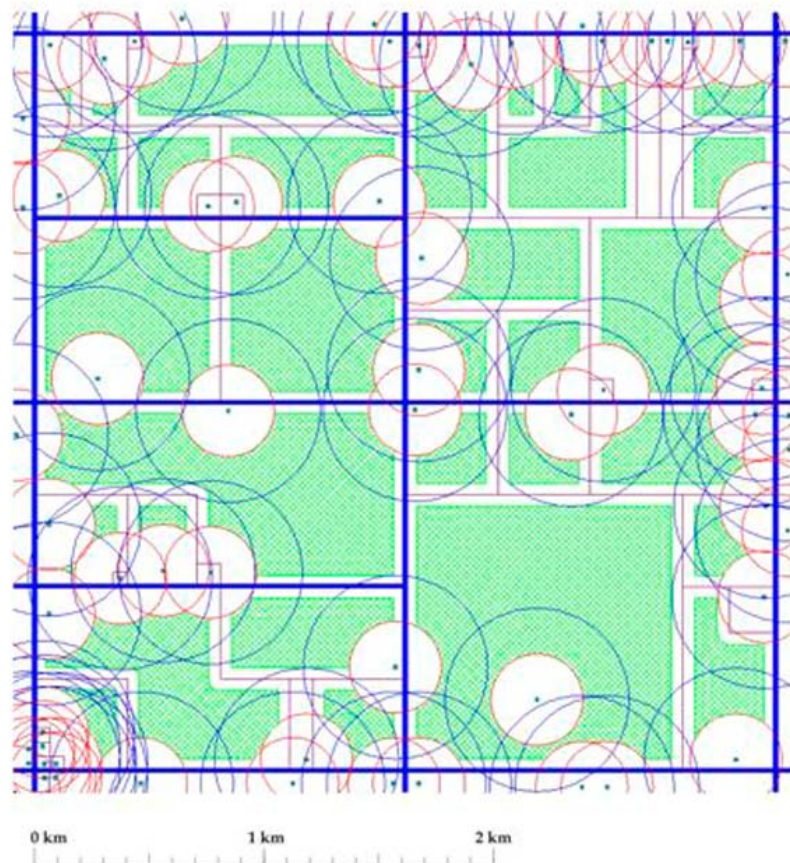


Figure 3 – GIS Mapping Example showing hypothetical separation distance and setback options from habitable buildings and roadways

Land uses sensitive to wind energy development would include existing residential areas, urban centers, rural residential clusters, recreational areas, airports and aircraft landing areas. Given the operating life expectancy of a wind farm, the development plan should clearly outline the community's long-term land needs for urban and residential expansion to ensure that these sensitive land uses are not negatively impacted by wind energy development, now and in the future, and that communities are able to expand and grow unimpeded by wind energy development. It is important to identify these areas up front and then protect them with clear development plan policies.

Constraints on wind energy development are identified as wildlife habitat (forests, wetlands, breeding areas, prime feeding areas), migratory and staging areas, protected lands (endangered species), designated parks, historic/cultural or archeological sites, and wilderness reserves. Local knowledge about the environment can supplement the provincial assessment to help refine wind energy development policy and regulation.

There may be publicly significant scenic or historic landscapes in a planning area that merit protection from visual impacts such as a wind farm and these should be determined and protected in the development plan. The visual impact of wind turbines must be weighed against the overall long-term sustainable environmental and economic benefits that are realized from the use of this renewable energy resource. Assessing the visual aspect of a wind farm or wind turbine is largely subjective, but factors to be considered are the type of landscape and the existing infrastructure already in place.



Image 11 - Panoramic view – St. Leon Wind Farm

4.2 Public Consultation and Involvement

When contemplating wind energy development policies, a local planning authority should take some effort to design and implement a public involvement process and tailor the process in line with the scope, complexity and outcome of the task at hand. An

effective public consultation process should involve a broad base of citizens, including public and private sector leaders, community interest groups and multi-disciplinary professionals. The process should be clear about what's included in the discussions and what's not; what decisions will be made at the end and by whom. Setting clear timelines and format also will be important.

Meeting the minimum requirements under the legislation to hold one "public hearing" for the adoption of a development plan may not be enough to adequately deal with the issues related to wind energy development.

Meaningful community involvement and public consultation at the "front end" of the development plan planning process can greatly reduce the need for costly and time-consuming adversarial hearings later in the formal land use review and approval process or during the environmental assessment and licensing process.

4.3 Development Plan Content

A development plan sets out general and more specific objectives and policies intended to be met by the plan. With respect to wind energy development, the development plan should incorporate the following three main components:

- 1) objective and policy statements of the board or council with respect to renewable resources generally and wind energy resources specifically;
- 2) the identification and protection of all sensitive land uses, wild life habitats and significant landscapes together with the locations of and rationale for any limitations on wind energy development and;
- 3) direction as to how wind energy development will be dealt with in respective municipal zoning by-laws.

4.3.1 Objective and Policies

Examples of appropriate objective and policy statements with respect to renewable resources and wind energy resources in a development plan are:

General Resources Objective statement:

- ***This Plan promotes the 'sustainable' use of renewable and non-renewable resources to ensure that future residents enjoy the same quality of life as present citizens.***

Wind Energy Development Policy statement:

- *This Plan supports the development of wind energy systems for electricity production, as a source of renewable energy for the economic and environmental benefits of the planning district (municipality) and the Province.*

Or

- *This Plan considers wind energy to be an abundant, renewable and non-polluting energy resource, and therefore supports opportunities that convert kinetic energy of the wind into a useable form.*

4.3.2 Protection of Sensitive Land Uses (Limitations and Rationale)

A development plan should be clear about the areas where wind energy development will be prohibited or limited as a matter of policy. Some land uses may be considered sensitive or incompatible with wind energy development. These uses could include:

- Urban centres, settlements or built-up areas
- Designated rural residential or seasonal residential areas
- Designated parks or recreational areas
- Wildlife management areas, provincial parks or ecological reserves.

The nature and extent of separation distances of wind energy systems development from the various sensitive land uses should be described or indicated in the development plan as a matter of policy. The rationale for those limitations should be clearly stated for both the public and potential developers be aware of and to understand.

No Manitoba planning districts or municipalities have adopted separation distances for wind energy systems in their development plans, but some have incorporated them in the zoning by-law. The typical separation distance standard for wind turbines from designated residential areas adopted by municipalities in Manitoba is about 600 - 800 m. This appears to be in line with standards adopted by many other jurisdictions across Canada. Separation distances from designated wildlife management areas, provincial parks or ecological reserves can range from 800 m to as much as 1600 m (1 mile).

In some other jurisdictions, separation distances have been further refined to reflect distances from specific types of residential uses, such as a hamlet or estate residential (600 m), a rural residential cluster (four or more residential lots, each 2 acres or less (500 m), a travel trailer park or campground (400 m).

GIS mapping can be used to assess the impact of various options on the existing landscape to help determine separation distance standards that best balances the protection of sensitive land uses with the opportunity for wind energy development.

4.3.3 Direction for Zoning By-laws

The development plan should provide direction to the zoning by-law on the following matters:

1. Use Options - Outside of prohibited areas and their buffers as identified in the development plan, wind energy systems will be allowed subject to detailed regulations set out in the zoning by-law. The development plan should provide direction as to how wind energy systems will generally be treated in the zoning by-law. The options are that wind energy systems will:
 - a. be permitted (subject to meeting standards), or
 - b. require a conditional use, or
 - c. require a zoning by-law amendment (discussed further in section 5).
2. General Standards - The development plan should provide direction on standards to be used, including nature of distance measurements, and height restrictions, if any, etc.
3. Habitable Buildings – The development plan should provide direction as to whether a residential dwelling or all habitable buildings are to be protected from impacts of wind energy development. A habitable building refers primarily to a residence, but can also be broadened to include all structures designed to accommodate people including a commercial, institutional, industrial and recreational building (see definitions in Appendix B).
4. Mutual Separation – In areas where wind energy development may be permitted, it also becomes important to consider and adopt policies that protect the wind energy development, once established, from the intrusion of future land uses that may conflict with its operation, such as the addition of a habitable building in its vicinity. This will require a review of existing policies and provisions with respect to new single lot splits and building permits on existing parcels in or near an existing wind energy project.

A clear policy should be set providing direction on limitations with respect to the subdivision of land for residential purposes and the issuance of a building permit for a residential dwelling or habitable building in the vicinity of a wind energy turbine. If, for example, the separation distance standard for a wind turbine from a habitable building is 500 m, a mutual separation distance should be required for locating a residence or habitable building from an existing or approved wind energy turbine.

5 DEVELOPMENT CONTROLS FOR WIND ENERGY

The zoning by-law divides the municipality into zones each having a list of permitted uses and conditional uses, if any. A “permitted use” is a use of land or buildings that will be allowed provided the proposed development meets the other requirements set out in the zoning by-law. A use that is not listed in a zone is not permitted in that zone. A zoning by-law must prescribe development standards or requirements that will be applicable in each zone and the procedure for applying for a development permit.

5.1 *Options for the Zoning By-law*

The following three approaches are available for regulating wind energy development under a zoning by-law.

5.1.1 Option 1 - Permitted Use

Wind energy generating systems could be identified in the zoning by-law as a permitted use in specified zones appropriate to the use. The zoning by-law would also prescribe the development standards and requirements for the use. Where a development application for a permitted use is submitted that complies with all requirements of the zoning by-law and policies of the development plan, a development permit must be issued and the development allowed to proceed.

Implications

- Provides the developer with certainty that local approval will be granted provided the standards and requirements in the zoning by-law are met.
- Local approval process is expedited.
- Simple to administer. A wind energy generating system is considered as a single development and one development permit is issued.
- Limited ability to address site-specific concerns. May include specific sites with potential land use conflicts.
- Public input on possible wind energy development and appropriate policies and standards must be obtained during the adoption of the development plan and zoning by-law.
- No ability to require a formal development agreement with the developer.

This option works best where the main objective of the development plan is to facilitate wind energy development and where the local planning authority has, through consultation with the community, fostered an understanding and general community acceptance of the wind energy development policies and the standards to be applied.

5.1.2 Option 2 - Conditional Use

A “conditional use” is a use of land or buildings that may be allowed within a specified zone in a zoning by-law. A conditional use requires an application to be made and involves notice to surrounding landowners and a public hearing. The decision whether or not to allow the use is at the discretion of the council.

A conditional use can only be approved if council determines the proposed conditional use:

1. Will be compatible with the general nature of the surrounding area;
2. Will not be detrimental to the health or general welfare of the people living or working in the surrounding area, or negatively affect other properties or potential development in the surrounding area; and
3. Is generally consistent with the development plan and zoning by-law.

Under this approach wind energy generating systems would be identified as a conditional use in specified zones appropriate to the use. The zoning by-law would prescribe the standards and requirements for the use.

In addition to the development standards and requirements set out in the zoning by-law, a council can impose additional conditions on the approval of a conditional use. Council can also require the owner to enter into a development agreement with the municipality. A council could hold one hearing for an entire wind farm project and then issue one conditional use order specifying the particular conditions that may relate to each wind turbine comprising the wind farm.

Implications

- Each wind turbine is considered on a site-specific basis and considered on its merits and mitigation of potential adverse impacts.
- All persons have the opportunity to be heard at a public hearing.
- Provides the ability for the municipality to impose conditions and require the developer to enter into a development agreement.
- The decision of the council or planning district board on an application for approval of a conditional use is final and not subject to appeal.

- Allows a council or planning district board increased flexibility to respond to the concerns of individual landowners or address concerns related to specific wind turbines.
- Less certainty for the developer as to conditions of approval and whether all or some of the wind turbines will be approved.
- A longer period of time may be required for local review and approval.
- Administrative complexity to deal with conditions on a multitude of wind turbines all at one time, particularly for a large wind farm application, and the risk of having to repeat the same process to modify a condition.

This option works best where the main objective is to address more site-specific sensitivity to wind energy development. Under this option each wind energy development project undergoes a public review to ensure compatibility with the surrounding area. Control of the final outcome is retained at the municipal or district board level.

5.1.3 Option 3 - Rezoning

The third option is to require a proponent to apply for a zoning amendment for a wind energy development in a rural or agricultural zone and by creating a combined “Agriculture/Wind Farm (A-WF) Zone” or similar zone in the zoning by-law.

An Agriculture/Wind Farm Zone would include wind energy generating systems as a permitted use in the zone and establish appropriate development standards and requirements (including limiting land uses that may conflict with the wind farm use). The A-WF zone would come into effect by amending the zoning by-law map to zone specific land proposed for a wind farm project to the A-WF zone.

Implications

- Applications are considered on a case-by-case basis and approved on their merits and mitigation of potential adverse impacts.
- Provides for public notice and notice to surrounding landowners and the opportunity to make representation from the broader community at a public hearing.
- Provides the ability for a council or planning district board to impose conditions and require the developer to enter into a development agreement.
- Provides for an appeal of the decision of the local planning authority to an independent appeal body, either the planning district board or the Municipal Board of Manitoba, depending on the local planning structure.

- Less certainly for the developer as to whether approval will be granted.
- A longer period of time required amending the zoning by-law and dealing with potential appeals before the developer can obtain approval.

Table 4 – Summary of Zoning By-law Options

	Permitted Use	Conditional Use	Re-zoning
Certainty for the proponent	✓		
Timeliness	✓		
Local Decision	✓	✓	
Flexibility to impose Additional Conditions		✓	✓
Ability to require a Development Agreement		✓	✓
Public Notice/Hearing		✓	✓
Subject to Appeal			✓

5.1.4 Recommended Approach

The conditional use option represents a good planning framework as it provides the best overall benefit/balance for a local planning authority; it takes into account the broader public interests and local interests; ensures notice to affected land owners and their input for wind energy development; provides the opportunity to impose conditions and enter into a development agreement, as considered necessary; and keeps the decision-making local.

6 APPENDICES

6.1 Appendix A – Zoning By-law Provisions

Subsection 71(3) of *The Planning Act* sets out the matters that may be regulated or prohibited in a zoning by-law. Following are suggested development standards a municipality should consider adopting for wind energy development in a zoning by-law. Some of these standards may not be required depending on the policy direction provided in the development plan.

6.1.1 Separation distances from habitable buildings

1. *Separation distance from Habitable Building - The minimum separation distance between a wind turbine and the nearest habitable building shall be [500 – 550] metres.*

The main purpose for setting a separation distance from a habitable building is to mitigate the sound level a wind energy turbine may have on inhabitants in the vicinity.

The environmental assessment and license will assess the sound pressure levels or dBA generated by a proposed wind turbine and will determine the minimum acceptable distance that a wind energy turbine must be from a habitable building in order to comply with provincial guidelines.

Many jurisdictions have adopted simple distance setback requirements in rural areas. Some jurisdictions set a separation distance calculated as a multiple of total turbine height. Separation distances are measured from the base of the turbine tower to nearest outside wall of a habitable building or structure. Depending on the particulars of the site and the number of turbines proposed, separation distances in the neighborhood of 300 to 600 metres have been considered acceptable. In Manitoba, some municipalities have adopted separation distance standards of 1.5 to 2.0 times the total turbine height, or distances of 400 - 550 metres. A separation distance of 500 - 550 metres is sufficient to ensure sound criteria can be met.

When setting a separation distance standard, some local jurisdictions have made a distinction between residences or habitable buildings that are on the same parcel as a wind turbine and residences not on the same parcel. These jurisdictions usually require a minimum setback for safety purposes for residences or habitable buildings that are on the same parcel as a wind turbine. This practice is not recommended since *the requirements of the provincial environment license for acceptable dBA sound level at the exterior wall of the receptor will still have to be met.*

6.1.2 Setbacks from property lines

2. ***Property Line Setback - A wind turbine shall be set back no less than [1.5] times the total turbine height from the property line. (The setback requirement from a property line may 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.)***

Setbacks of a wind turbine from adjacent property lines are required primarily for reasons of safety. Structures should be set back far enough from a property line so that the adjacent property is not adversely affected by the potential hazard from ice throw or in the unlikely event that a tower collapses, or experiences blade failure.

Most jurisdictions adopt a multiple of the total turbine height as a basis to establish setbacks from property lines for tower collapse. CanWEA recommends a minimum distance for blade throw be the blade length plus 10 m from a property lines. The standard adopted by Manitoba municipalities and many jurisdictions elsewhere are generally in the range of 1.0 to 1.5 times the total turbine height. A property line setback standard of 1.5 times the total turbine height is considered acceptable.

The setback requirement from a property line can be waived where the adjoining property will be used as part of the same wind energy development. Under no circumstances, however, should a wind turbine, including the rotor arc of its blades, be permitted to encroach on adjacent property land or air space.

6.1.3 Setbacks from Public Roads

3. ***Public Road Setback - The minimum setback for a wind turbine from a public road shall be no less than [1.5] times the total turbine height.***

Setbacks from public roads are required to protect the public from the potential hazard from ice throw, tower collapse or blade failure. A recent Manitoba Municipal Board decision on an appeal to a local zoning by-law amendment to deal with wind energy development noted that the standard adopted by Manitoba municipalities and many jurisdictions elsewhere are generally in the range of 1.0 to 1.5 times the total turbine height, to account mainly for risk related to tower collapse.

A standard of 1.5 times the total turbine height for a setback from a public road is considered acceptable. This standard should not be waived or reduced.

6.1.4 Turbine Tower Height

4. ***Turbine Tower Height - A wind turbine tower shall not exceed the height recommended by the manufacturer, distributor or a qualified engineer.***

Regulating the height of turbines can be a controversial issue in some municipalities. Regulating turbine heights on commercial wind energy projects in a rural or agricultural area is not considered necessary or advisable to address nuisance or safety concerns, especially where the setback from property boundaries and other buildings or structures is based on a multiple of the total turbine height. Technological and efficiency improvements by the industry are leading to larger towers and blades, and quieter and more powerful wind turbine generators. Imposing height restrictions on commercial wind energy projects in rural areas may become problematic over time, resulting in a local planning authority having to consider numerous variation orders requesting relief from height restrictions where a proposal exceeds the standard.

A wind turbine tower should not exceed the height recommended by the manufacturer, distributor or a qualified engineer.

6.1.5 Signage

- 5. Signs - A wind turbine tower shall not contain any commercial advertising. The hub or nacelle may display only the manufacturer's, owner's or operator's name or logo. Site signs shall be limited to those that identify the wind power facility, locate access points and provide safety information.*

The nacelle of the wind energy turbine and the storage yard and substation are potential spots for commercial advertising. A local planning authority may already have sign requirements in their zoning by-law, which should be reviewed relative to wind energy development. Most local jurisdictions surveyed do not permit any commercial advertising on wind turbines and limit any display on the nacelle to the manufacturers, owner's or operator's name or logo. Site signs are generally limited to those that identify the wind energy facility and provide safety information.



Image 12 - Signage on Nacelle

6.1.7 Lighting

- 6. Lighting - A commercial wind turbine should not be provided with artificial lighting except for lighting that is required to meet federal or provincial regulations. [Note: all wind energy turbines are required to be registered with Navigation Canada identifying their location by latitude and longitude and total height. Navigation Canada may require markings and lighting for aircraft in commercial pathways and in search and rescue zones.]*

Lighting requirements for the safety of flying aircraft will be determined by NAV Canada and Transport Canada. The zoning by-law should limit any additional lighting to ensure that federal or provincial safety requirements are not compromised and also note that location and height must be registered with NAV Canada.

6.1.8 Setbacks from Water Bodies

8. *Water Body Setback - The minimum setback for the wind turbine and all associated structures from a water body is [30] metres.*

During the construction phase of a wind energy project there is a potential risk of contamination of nearby water bodies due to disturbance of the ground surface and vegetation, or spillage and run off of hazardous materials (oil, gasoline, diesel and propane). Potential impacts on the environment will be regulated by environmental protection practices and plans as per the environmental assessment license issued to the proponent. A local planning authority may want to supplement the environmental license requirements and adopt a setback of a wind energy turbine from water bodies to ensure the water bodies are not negatively impacted by the development. A frequent practice by local jurisdictions in Canada is to complement the environmental license and require a minimum setback of 30 metres from a water body.

6.1.9 Other Standards

The following are other additional standards that may be appropriate to address esthetic considerations:

9. *Tower Type - All commercial wind turbines shall be installed with a tubular, monopole type tower.*

10. *Ancillary Buildings – All equipment necessary for monitoring and operating a commercial wind turbine shall be contained within the tubular tower.*



Image 13 – Tubular Monopole Tower

11. *Power Lines - All power lines on the site of the wind turbine and to the substation shall be underground.*
12. *Turbine Color - A wind turbine tower color shall be a neutral shade with a non-reflective matte finish that blends with its background setting.*

Table 5 – Summary of Zoning By-law Standards for Wind Energy Development

CRITERION	STANDARD
Minimum Setback from Habitable Building	500 – 550 metres
Minimum Setback from Property Line	1.5 x total turbine height
Minimum Setback from Public Roads	1.5 x total turbine height
Signage	No commercial advertising signs – only name or logo on hub or nacelle
Lighting	Only as required by Federal/Provincial Regulation
Minimum Setback from Watercourse	30 metres
Tower Type	Tubular Monopole
Power Lines	Underground
Turbine Color	Neutral shade with a non-reflective matte finish

6.2 Appendix B – Definitions

6.2.1 Wind Energy System Definitions

There are two basic parameters used to define wind energy generating systems; one is on the basis of their size or rated capacity and the other on their use. The preference is that wind energy systems be defined primarily on the basis of their use; the two primary uses being a commercial wind energy system and an on-site use wind energy system.

1. Recommended definitions for wind energy systems based on use:

Wind Energy Generating System – is an electrical generating facility comprised of a wind turbine and accessory facilities, including but not limited to a generator, a transformer, storage, collection and supply equipment, underground cables, a substation, temporary or permanent wind-monitoring tower(s) and access road(s).

Commercial Wind Energy Generating System – is a wind energy generating system designed and built to provide electricity for commercial sale and distribution to the electricity grid.

On-Site Use Wind Energy Generating System – is a wind energy generating system intended to primarily serve the electrical needs of the on-site user or consumer (either behind the meter or off-grid) and not used to produce power for resale.

2. Alternative definitions for wind energy systems (if based on size or rated capacity):

Wind Energy Generating System – is an electrical generating facility comprised of a wind turbine and accessory facilities, including but not limited to a generator, a transformer, storage, collection and supply equipment, underground cables, a sub-station, temporary or permanent wind-monitoring tower(s) and access road(s).

Large Wind Energy Generating System – is a wind energy generating system consisting of one or more wind turbines with a combined rated capacity equal to or greater than 100 kW.

Small Wind Energy Generating System – is a wind energy generating system which has a rated capacity of less than 100 kW and which primarily provides power to an on-site user.

6.2.2 Associated Wind Energy Definitions

The following other definitions associated with wind energy development are taken from a variety of sources. Local planning by-laws should define terms that are used in the text of the by-laws. (It may not be necessary to include all of these definitions in the zoning by-law.)

“blade” means the part of a wind turbine that is part of the airfoil assembly and that extracts, through rotation, kinetic energy from the wind.

“blade clearance” means the distance from grade to the bottom of the rotor arc.

“dB(A)” - ‘dB’ means decibel and is a measurement for sound pressure. ‘A’ refers to a weighted adjustment of measured sound that matches perception by the human ear.

“habitable building” means all structures or facilities designed to accommodate people including residential (single and multi-unit dwellings), commercial (office buildings and commercial outdoor plazas), institutional (hospitals, nursing homes, schools, churches, community centers, daycare centers) and recreational facilities (recreational centers, outdoor public recreational areas, travel trailer parks, campgrounds, playgrounds, picnic areas), but not including accessory structures such as sheds.

“kilowatt or (kW)” means the measure of power for electrical current.

“meteorological tower” or **“wind monitoring tower”** are those towers that are erected primarily to measure wind speed and direction plus other data relevant to siting wind energy generating systems. The tower supports an anemometer, wind vane and other equipment to assess the wind resource at a set height above the ground.

“nacelle” means the frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather.

“rated capacity” or **“nameplate capacity”** means the manufacturer’s maximum rated output of the electrical generator of the wind turbine.

“rotor” means the blades and hub of the wind turbine that rotate during operation.

“rotor arc” means the largest circumference traveled by the wind turbine’s rotor blades.

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

“setback” means the distance measured from the base of the wind turbine tower to a property line, road, or watercourse.

“sub-station” means an electrical facility designed to collect and modify electrical energy produced by wind turbines for the purpose of supplying it to the electricity grid.

“**tower**” means the vertical structure above grade that supports the nacelle and rotor assembly, electrical generator and/or meteorological equipment.

“**tower foundation**” the tower support structure, below grade, that supports the entire weight of the wind turbine, usually extending 10 to 15 metres underground.

“**total turbine height**” means the height from finished grade to the highest vertical point of the swept rotor arc, in the case of a wind turbine with a horizontal axis rotor.

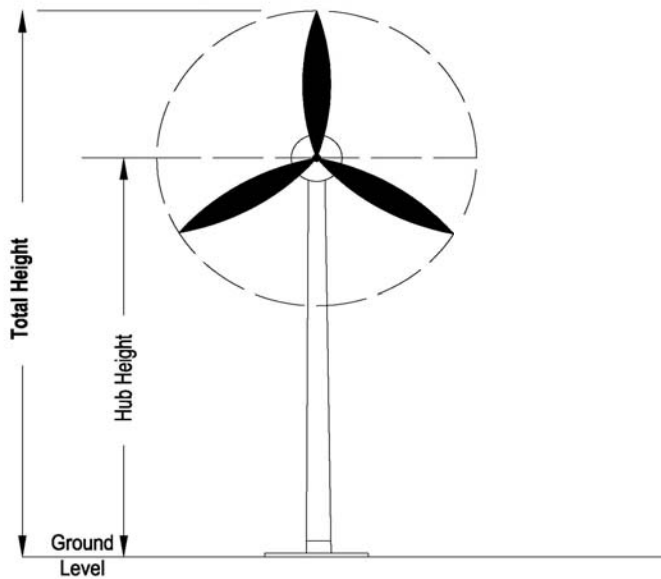


Figure 4 - Diagram showing total turbine height

“**water body**” means any body of flowing or standing water, whether naturally or artificially created, and whether the flow or presence of water is continuous, intermittent or occurs only during a flood, including but not limited to a lake, river, creek, stream, slough, marsh, swamp and wetland, including ice on any of them. (From The Water Protection Act)

“**wind farm**” means a wind energy generating system that entails the installation of two or more wind turbines that are physically interconnected, designed and built to provide electricity for commercial sale and distribution to the electricity grid.

“**wind turbine**” means a structure designed to convert wind energy into mechanical or electrical energy as a utility and includes the wind turbine tower, rotor blades and nacelle.

“**wind turbine generator**” a device designed to extract kinetic energy from the wind and supply it in the form of electrical energy that is suitable for use by the electrical grid.

6.3 Appendix C - Development Agreements

6.3.1 Legislative Requirements

The Planning Act provides for a local planning authority to enter into a development agreement a) as a condition to amending a zoning by-law, b) when approving an application for a conditional use, c) when granting a variance order and d) when approving a subdivision of land. The authority to require a development agreement in connection with these processes helps ensure that the costs associated with a specific development proposal do not fall disproportionately on the municipality. In the context of utility-grid wind energy development, the prospect of requiring a development agreement for a subdivision of land will be rare as most circumstances involve lease agreements between a proponent and the landowner. Also, *The Real Property Act* was amended in November 2007 to add a further easement category extended to wind turbines that would allow the registrar general to issue title for that interest in land, thereby exempting it from the subdivision approval process under *The Planning Act*.

Section 150 of *The Act* lists the matters that can be dealt with in a development agreement where it may be required for a rezoning, conditional use or variance order:

“Section 150

As a condition of amending a zoning by-law, making a variance order or approving a conditional use, a board, council or planning commission may, unless this Act provides otherwise, require the owner of the affected property to enter into a development agreement with the planning district or municipality in respect of the affected property and any contiguous land owned or leased by the owner dealing with one or more of the following matters:

- (a) the use of the land and any existing or proposed building⁴;*
- (b) the timing of construction of any proposed building;*
- (c) the siting and design, including exterior materials, of any proposed building;*
- (d) the provision of parking;*
- (e) landscaping, the provision of open space or the grading of land and fencing;*
- (f) the construction or maintenance — at the owner's expense or partly at the owner's expense — of works, including but not limited to, sewer and water, waste removal, drainage, public roads, connecting streets, street lighting, sidewalks,*

⁴ The term “building” as used under *The Planning Act* is defined to include a well, pipeline, conduit, cut, excavation, fill, transmission line and any structure or erection, and any part of any of those things. Please refer to *The Planning Act* for the complete definition for the word “building”.

traffic control, access and connections to existing services;

(g) the payment of a sum of money to the planning district or municipality in lieu of the requirement under clause (f) to be used for any of the purposes referred to in that clause;

(h) the dedication of land or payment of money in lieu thereof, where the application is for an amendment to a zoning by-law to permit a residential use, use for a mobile home park or an increase in residential density, in which case item 6 of section 135 applies to the dedication.”

Any development agreement entered into under *The Planning Act* may provide that it runs with the land, and when a caveat with a copy of such an agreement attached is filed in the appropriate land titles office, the agreement binds the owner of the land affected by it, and the owner's heirs, executors, administrators, successors and assigns. A development agreement can also be entered into before an order, approval or amendment to a by-law is made, but the agreement is not binding until the amendment has passed or the order or approval has been granted.

There is no opportunity for a development agreement under *The Planning Act* when a use is a permitted use or a permitted ancillary use under a zoning by-law. In this circumstance, the local planning authority will have to ensure that the zoning by-law clearly sets out all the conditions that will need to be met in order for the development officer to issue a development permit.

6.3.2 Specific Development Agreement Provisions

Specific development agreement provisions regarding a commercial wind energy system development should consider all or some of the following:

1. Roads
 - a. Construction and maintenance of any new municipal roads, approaches, drainage and culverts that may be required as part of the project as well as the standards that will apply.
 - b. Maintenance and repair of existing municipal roads due to the effects of heavy equipment and vehicular traffic during construction.
 - c. Dust control measures to be undertaken during construction
 - d. Maintenance and repair of road/channel crossings or municipal drains due to buried cable work undertaken during construction of the project.
2. Waste Removal – Conditions and requirements for disposing of waste to the municipal landfill as well as and sanitary waste during construction.
3. Emergency Services – Provision for and cost for municipal Fire and Ambulance services in the event of an emergency, if required.

4. Insurance – Confirmation that the developer has public liability insurance
5. Inspection and Certification - provisions to address the approval, inspection and certification of all wind energy turbines and other ancillary installations.
6. Use of Land - where appropriate, require the developer to cooperate with aerial applicators to address safety concerns.
7. Complaints dispute resolution - outline the process that will be used to resolve complaints from nearby residents concerning the construction or operation of the project.
8. Security for obligations by the developer for all municipal works to be undertaken.

6.4 Appendix D – Bibliography

- AIM PowerGen Corporation, “*Shadow Flicker*”, webpage accessed August 2008
<http://www.aimpowergen.com/files/Erieau/ELSC%20-%20Shadow%20Flicker.pdf>
- Algonquin Power, “*Alternative Fuels – St. Leon*”, webpage, accessed January, 2008
http://www.algonquinpower.com/business/facility/alternative_StLeon.asp
- Baker, David R., Phoenix Engineering, “*Enbridge Ontario Wind Power Project Shadow Flicker Assessment*”, September 2006
<http://www.enbridge.com/ontariowindpower/about-project/pdf/attachment3-revisedshadowflicker-2006.pdf>
- Bruce, County of, Ontario, “*County of Bruce Official Plan – 2006 Office Consolidation*”, January 2006
<http://www.brucecounty.on.ca/planning.php>
- Bruce, County of, Ontario, “*2008 County of Bruce Wind Farm Submission Requirements*”, Zoning By-law, May 2008
<http://www.brucecounty.on.ca/planning.php>
- Bureau of Land Management, Wind Energy EIS Public Information Centre Webpage,
<http://windeis.anl.gov/index.cfm>
- California Bureau of Land Management, Wind Energy Webpage,
<http://www.blm.gov/ca/st/en/prog/energy/wind.html>
- California Energy Commission, “*California Guidelines for Reducing Impacts on Birds and Bats from Wind Energy Development*”, September, 2007
<http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CTF.PDF>
- California Energy Commission, Public Interest Energy Research Program,
“*Permitting Setback Requirements for Wind Turbines in California*”, 2005,
<http://www.energy.ca.gov/2005publications/CEC-500-2005-184/CEC-500-2005-184.PDF>
- Canadian Standards Association, “*CSA Guide to Canadian wind turbine codes and standards*”, Draft version 1.2, January, 2008
<http://www.csa.ca/standards/energy/CSAGuidetoCanadianWindTurbineCodes.pdf>
- Canadian Standards Association, “*The Role of Standards in Adapting Canada’s Infrastructure to the Impacts of Climate Change*”, February, 2006

-
- http://www.csa.ca/climatechange/downloads/pdf/Impacts_of_Climate_Change_2006.pdf
- Canadian Wind Energy Association, “*Canadian Wind Energy Case Studies: Pincher Creek Alberta*”, January 2004
http://www.canwea.ca/images/uploads/File/Pincher_Creek_EN.pdf
- Canadian Wind Energy Association, “*Fact Sheet 6 – Wildlife – Birds, bats and wind energy*”, August, 2006
http://www.canwea.ca/images/uploads/File/NRCan_-_Fact_Sheets/6_wildlife.pdf
- Canadian Wind Energy Association, Municipalities Best Practice Webpage,
http://www.canwea.ca/municipalities/municipalities_best%20practices_e.php
- Canadian Wind Energy Association, “*Position on Setbacks for Large-Scale Wind Turbines in Rural Areas (MOE Class 3) in Ontario – Executive Summary*”, September, 2007
http://www.canwea.ca/images/uploads/File/FINAL-CanWEAPositionOnSetbacks-ExecutiveSummary_EN-2007-09-28.pdf
- Canadian Wind Energy Association, “*Position on Setbacks for Large-Scale Wind Turbines in Rural Areas (MOE Class 3) in Ontario*”, September, 2007,
<http://www.canwea.ca/images/uploads/File/FINAL-CanWEAPositionOnSetbacks-2007-09-28.pdf>
- Canadian Wind Energy Association, “*Responding to Concerns about Wind Energy*”, ppt, August 2007
[www.canwea.ca/images/uploads/File/CanWEA – Addressing_concerns_about_wind_energy.ppt](http://www.canwea.ca/images/uploads/File/CanWEA_-_Addressing_concerns_about_wind_energy.ppt)
- Craig, David, “*Wind Turbine Accident Compilations*”, 2006
<http://www.stopillwind.org/downloads/WindTurbineAccidentComp.pdf>
- Danish Wind Energy Association, “*Shadow Casting from Wind Turbines*”, June 2003,
<http://www.talentfactory.dk/en/tour/env/shadow/index.htm>
- Danish Wind Industry Association Webpage, accessed April, 2008
<http://www.windpower.org/en/core.htm>
- DeKalb County, Illinois Planning and Zoning Committee Meeting Minutes May 27, 2009, Review of a Special Use Permit for FPL Wind Energy (pages 7 & 8).
http://www.dekalbcounty.org/Mins_09/pzMay.html
- Enertrag UK Limited, “*Shadow Flicker*”, webpage accessed August 2008
<http://www.enertraguk.com/technical/shadow-flicker.html>
-

-
- Fillmore County, Minnesota, “*Wind Energy Conversion System Ordinance*”, 2007
http://www.co.fillmore.mn.us/zoning/documents/2008wind_energy_conversion_systems_ord.pdf
- Garrad and Hanson, “*Recommendations for Risk Assessments of Ice Throw and Blade Failure in Ontario*”, May 2007, Client Canadian Wind Energy Association
[http://www.canwea.ca/images/uploads/File/GH-RiskAssessment-38079or01a\(1\).pdf](http://www.canwea.ca/images/uploads/File/GH-RiskAssessment-38079or01a(1).pdf)
- HGC Engineering, “*Wind Turbines and Sound: Review and Best Practices Guidelines*”, February, 2007,
http://www.canwea.ca/images/uploads/File/CanWEA_Wind_Turbine_Sound_Study_-_Final.pdf
- Illinois Agricultural Aviation Association. Resolution, March 2009.
http://www.agaviation.com/wind_farms.htm
- Ireland, Department of Environment, Heritage & Local Government “*Wind Energy Development Guidelines*” 2004,
<http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownload,1633,en.pdf>
- Litman, Todd, “*Planning Principles and Practices*”, Victoria Transport Policy Institute, March 2007
<http://www.vtppi.org/planning.pdf>
- Longston, Kristopher, “*Planning For Wind Energy: Evaluating Municipal Wind Energy Land Use Planning Frameworks in Southwestern Ontario . . .*”, University of Waterloo, 2006
<http://uwspace.uwaterloo.ca/bitstream/10012/2905/1/kjlongst2006.pdf>
- Mackinaw City, Michigan, “*Wind Turbine Generators*”, November, 2003
<http://www.mackinawcity.org/wind-turbines-42/>
- Manitoba Cooperator, “*Windmills didn’t ground spray plane*”, June 21, 2007
http://www.mansea.org/pdf/MBC_Windmills_AD.pdf
- Manitoba Department of Conservation, “*Consultation on Sustainable Development Implementation (COSDI)*”, June 1999
<http://www.gov.mb.ca/conservation/susresmb/pub/cosdireport.html>
- Manitoba Department of Conservation, “*The Environmental Assessment and Licencing Process under The Manitoba Environment Act*”, Information Bulletin, March 2007
<http://www.gov.mb.ca/conservation/envapprovals/publs/env-assess-info.pdf>
-

-
- Manitoba Department of Conservation, “*Questions and Answers Regarding Manitoba’s Crown Land Policies for Wind Farms*”, 2008
<http://www.gov.mb.ca/conservation/wind-farms/index.html>
- Michigan, State of, “*Michigan Siting Guidelines for Wind Energy Systems*”, May 2007
http://www.michigan.gov/documents/Wind_and_Solar_Siting_Guidelines_Draft_5_96872_7.pdf
- National Wind Coordinating Committee, “*Avian Collisions with Wind Turbines – A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States*”, August 2001
http://www.nationalwind.org/publications/wildlife/avian_collisions.pdf
- National Wind Coordinating Committee, “*Overview of Available Bat Mortality Studies at Wind Energy Projects*”, February, 2004
http://www.nationalwind.org/events/wildlife/2004-2/presentations/Johnson_Bats.pdf
- National Wind Coordinating Committee, “*Technical Considerations in Siting Wind Development*”, NWCC Research Meeting, December 2005, Washington D.C., March 2006
<http://www.nationalwind.org/events/siting/proceedings.pdf>
- Navigation Canada, “*Land Use Proposals*”, webpage, accessed August 5, 2008
<http://www.navcanada.ca/NavCanada.asp?Language=en&Content=ContentDefinitionFiles\Services\LandUseProposal\default.xml>
- New Energy Economics: Unintended Effects of Wind Energy – Aerial Spraying. Cole Gustafson, NDSU Extension Service, ND Agricultural Experimental Station. May 7, 2009.
<http://www.ag.ndsu.edu/news/columns/biofuels-economics/new-energy-economics-unintended-effects-of-wind-energy-2013-aerial-spraying/>
- New York State Energy Research and Development Authority, “*Community Resources for Wind Development – Wind Energy Toolkit*” 2004
<http://www.powernaturally.org/Programs/Wind/toolkit.asp>
- Ontario, Province of, Ministry of the Environment. July 2004. Interpretation for Applying MOE NPC Technical Publications to Wind Turbine Generators,
www.ene.gov.on.ca/envision/gp/4709e.pdf
- Ontario Sustainable Energy Association, “*Ontario Landowner’s Guide to Wind Energy*”, 2005
<http://www.wind-works.org/articles/OSEA-Landowners-2005-r1-v3.pdf>
-

-
- Rogers, A.L., “*Wind turbine noise, infrasound and noise perception*”, Presentation provided by Renewable Energy Research Laboratory, University of Massachusetts at Amherst, January 2006.
<http://www.ceere.org/rerl>
- Stevens County, Minnesota, “*Interim Wind Energy Conversion Systems Ordinance*”, February, 2007
<http://www.co.stevens.mn.us/downloads/windenergy.pdf>
- Sustainable Energy Authority Victoria, “*Policy and planning guidelines for development of wind energy facilities in Victoria*”, Melbourne Australia, May 2003
<http://www.sustainability.vic.gov.au/resources/documents/WindEnergyGuidelines.pdf>
- TetrES Consulting Inc., report to Sequoia Energy Inc., “*Meridian Wind Energy Project – Environmental Impact Assessment*”, November 2006
- Transport Canada, “*Air Regulations and Programs*”, May 3, 2008
<http://www.tc.gc.ca/air/menu.htm>
- Union of Nova Scotia Municipalities, “*Model Wind Turbine By-laws and Best Practices for Nova Scotia Municipalities*”, Jacques Whitford, January 28, 2008
<http://www.unsm.ca/pdf/UNSM%20Wind%20By-Laws%20Best%20Practices%20January%2029%20complete.pdf>
- U.S. Department of Energy, “*Wind Energy Guide for County Commissioners*”, December 2004
<http://www.nrel.gov/docs/fy07osti/40403.pdf>
- Whitford, Jacques, “*Wind Energy Generation Master Plan for Halifax Regional Municipality*”, Draft Report, April 2006.