

# Setback Siting Guidelines for Wind Energy Projects



**Christopher Ollson, PhD**  
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## Dr. Ollson Qualifications

- Doctorate in Environmental Health Science
- Over 25 years in international environmental risk assessment and health consulting
- Owner of Ollson Environmental Health Sciences for the past 10 years
- Adjunct Professor University of Toronto
- 15 years of researching potential health impacts for those living in proximity to renewable energy and transmission lines
- Testified before numerous county commissions, state hearings, and court cases as a qualified expert in the field
- Involved in over 25 GW of renewable energy projects across 26 States.
- Consultant of record for State of Vermont during wind siting rule making and appeared before Senate Committees in Kansas, North Dakota and Indiana



## Wind turbines and human health

*Loren D. Knopper<sup>1\*</sup>, Christopher A. Ollson<sup>1</sup>, Lindsay C. McCallum<sup>1</sup>, Melissa L. Whitfield Aslund<sup>1</sup>, Robert G. Berger<sup>1</sup>, Kathleen Souweine<sup>2</sup> and Mary McDaniel<sup>2</sup>*

## Health-based audible noise guidelines account for infrasound and low-frequency noise produced by wind turbines

*Robert G. Berger<sup>1</sup>, Payam Ashtiani<sup>2</sup>, Christopher A. Ollson<sup>3</sup>, Melissa Whitfield Aslund<sup>3</sup>, Lindsay C. McCallum<sup>3,4</sup>, Geoff Leventhall<sup>5</sup> and Loren D. Knopper<sup>3\*</sup>*

Review Highly accessed Open Access

**Health effects and wind turbines: A review of the literature**

Loren D Knopper<sup>1\*</sup> and Christopher A Ollson<sup>2</sup>

McCallum et al. *Environmental Health* 2014, **13**:9  
<http://www.ehjournal.net/content/13/1/9>



RESEARCH Open Access

Measuring electromagnetic fields (EMF) around wind turbines in Canada: is there a human health concern?

Lindsay C. McCallum<sup>1,2</sup>, Melissa L. Whitfield Aslund<sup>2</sup>, Loren D. Knopper<sup>2</sup>, Glenn M. Ferguson<sup>2</sup> and Christopher A. Ollson<sup>2\*</sup>

Energy Policy 62 (2013) 44–50

Contents lists available at ScienceDirect

**Energy Policy**

ELSEVIER journal homepage: [www.elsevier.com/locate/enpol](http://www.elsevier.com/locate/enpol)

Projected contributions of future wind farm development to community noise and annoyance levels in Ontario, Canada  
Melissa L. Whitfield Aslund, Christopher A. Ollson, Loren D. Knopper \*



**Letter to Editor: Are the findings of “Effects of industrial wind turbine noise on sleep and health” supported?**

Christopher A. Ollson,  
Loren D. Knopper, Lindsay C. McCallum,  
Melissa L. Whitfield-Aslund

*Noise & Health, March-April 2013, Volume 15:63, 148-52*

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# Setback Recommendation

- OEHM recommends that West Hants Regional Municipality adopt into their By-law their previously established practice of using a 1 km setback to dwellings and 550 m to woods camps for existing projects.
  - Based on the available scientific literature, this is more than sufficient to ensure the protection of the public health and safety of their residents.
  - In fact, a lesser setback between 550 m to 1 km would be equally protective of public health and safety.
  - There is no scientific basis to increase these setbacks. It would afford no additional protection of public health and safety and would unduly restrict areas for development.

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# Siting Considerations for Wind Turbines

- Includes concerns around:

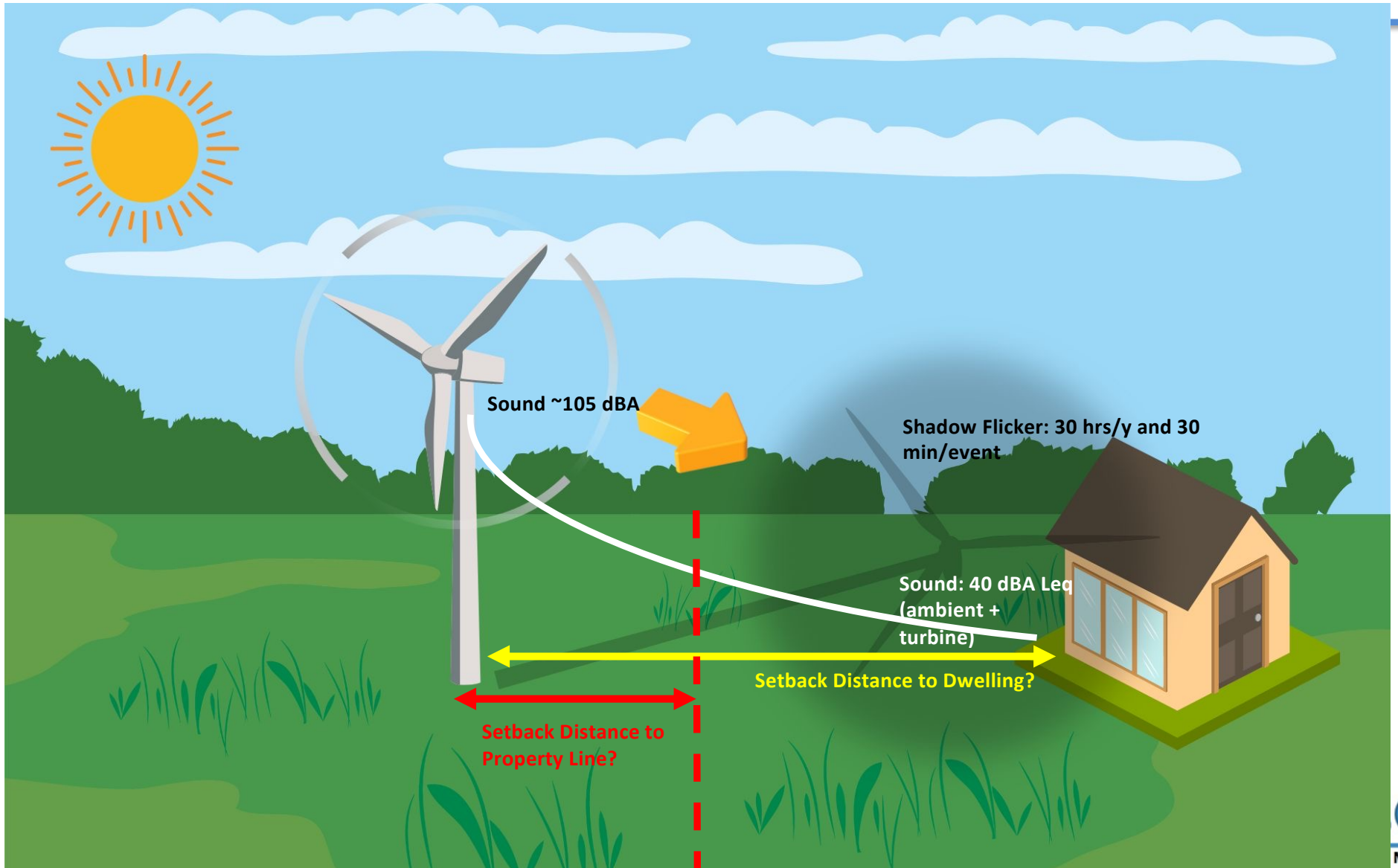
- Setbacks
- Shadow Flicker
- Audible Noise (sound you hear)
- Low Frequency Noise
- Infrasound (sound you don't hear)
- Ice Throw
- Blade Fragment Throw
- Tower Collapse
- Fire
- Stray Voltage
- BPA / PFAS
- Electromagnetic Fields (EMF)
- Livestock and Hunting

Engineering

Acoustics

HEALTH & SAFETY







# Other Jurisdiction Turbine Setbacks

Municipality	Minimum Setback for Wind Turbines from Residential Dwellings
<b>Nova Scotia</b>	
West Hants Regional Municipality	Precedent of 1000 m. (3,280 ft.) from dwelling for existing projects
Municipality of East Hants	4 times the height of the wind turbine
Municipality of the County of Kings	Only permitted in the "Large Scale Wind Turbine Overlay"; the boundaries of the overlay are a minimum of 3 km from dwellings existing on November 15, 2018.
Colchester County	2 km for wind turbines greater than 100 m. (328 ft.). If a wind turbine exceeds 200 m. (656 ft.) an increased setback of 7.5 m. (26.5 ft.) is required for every 1 m. (3.3 ft.) of additional height if the increased minimum setback is necessary to satisfy the maximum ambient degradation noise standard of the By-law.
Municipality of Yarmouth	1000 m. (3,280 ft.) or 6.5 times the height of the turbine, whichever is greater
Region of Queens Municipality	1.5 times the total height of the turbine from all property lines and watercourses
Municipality of the County of Annapolis	Only permitted within a "Wind Resource Areas"; requires a minimum of 1,000 m (3,280 ft.) .
Halifax Regional Municipality	550 m. (1,805 ft.)
Municipality of Cumberland	1000 m. (3,280 ft.) or 3.5 times the height of the turbine, whichever is greater
Municipality of the District of Digby	1000 m. (3,280 ft.)
Municipality of Pictou County	1000 m. (3,280 ft.)
Municipality of the County of Antigonish	1000 m. (3,280 ft.)

Municipality	Minimum Setback for Wind Turbines from Residential Dwellings
<b>Top Canadian Jurisdictions with Operating Wind Projects</b>	
Ontario	550 m from a residence
Quebec	Set by the municipalit� regionale de comt� (MRC) and typically governed by sound standard setback, most common 750 m
Alberta	Set by the counties. Typical setbacks to dwelling range from 800 m to 1000 m.

Municipality	Minimum Setback for Wind Turbines from Residential Dwellings
<b>United States Examples</b>	
North Dakota (State)	One and one-tenth times the height of the turbine from the property line of a nonparticipating landowner and three times the height of the turbine from an inhabited rural residence of a nonparticipating landowner, unless a variance is granted.
Wisconsin (State)	The lessor of 1,250 feet or 3.1 times the maximum blade tip height.
New York (State)	Non-participating, non-residential Structures 1.5 times, non-participating residences 2 times
Illinois (State)	1.1 times tip height to non-participating property lines, 2.1 times tip height to non-participating receptors.
Michigan (State)	2.1 times from occupied community buildings and residences on nonparticipating properties 1.1 times from non-participating property lines
Nebraska (County)	Varies county by county but most common between 300 m to 500 m
Kansas (County)	Varies county by county but most common between 300 m to 500 m

Typical setback to a dwelling is 500 m to 1km

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# State of Wind Turbine Research and Health Effects

- 20 years of research in the field
- Over 150 peer-reviewed research papers published in the field
- Findings support:
  - Sound levels 45 dBA
  - Shadow flicker <30 hours a year
  - Setbacks 1.1x tip height to roads, property lines, transmission lines, etc..
  - Setbacks 2-3x tip height to non-participating homes (based primarily on achieving sound limits) and no great than 1 km is required.

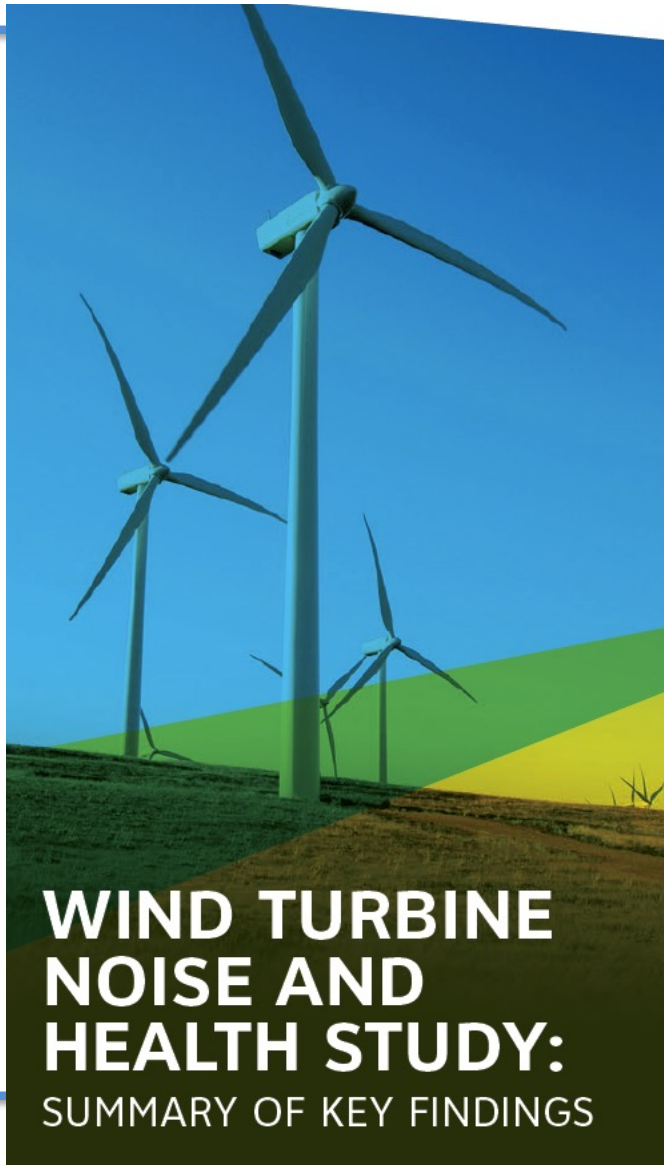
# Turbine Sound

The NSDECC's sound guideline requires:

- In establishing separation distances, a proponent must ensure that the wind farm design and turbine siting does not cause sound levels to exceed 40 dBA (A-weighted decibels) at the exterior of receptors.
- Cumulative sound from ambient background levels, all wind turbines in the proposed project + sound from any wind turbines from nearby projects.
- One of the most stringent (lowest) sound standards for wind projects in the world.



*Sound Standard 40 dBA = Ambient Sound 35 dBA + Wind Turbine Sound at home 38.4 dBA*



Health  
Canada

Santé  
Canada

2014

Largest study ever undertaken around the world.

The following were not found to be associated with wind turbine noise:

- a. self-reported sleep (e.g., general disturbance, use of sleep medication, diagnosed sleep disorders);
- b. self-reported illnesses (e.g., dizziness, tinnitus, prevalence of frequent migraines and headaches) and chronic health conditions (e.g., heart disease, high blood pressure and diabetes); and
- c. self-reported perceived stress and quality of life.

The overall conclusion to emerge from the study findings is that the study found no evidence of an association between exposure to WTN and the prevalence of self-reported or measured health effects beyond annoyance.



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Sound - 46 dBA  
Setback - 820 ft

# WIND TURBINE NOISE AND HEALTH STUDY: SUMMARY OF KEY FINDINGS

pii: sp-00087-15

<http://dx.doi.org/10.5665/sleep.5326>

## SLEEP DURATION/SLEEP QUALITY

### Effects of Wind Turbine Noise on Self-Reported and Objective Measures of Sleep

David S. Michaud, PhD<sup>1</sup>; Katya Feder, PhD<sup>1</sup>; Stephen E. Keith, PhD<sup>1</sup>; Sonia A. Voicescu, MSc<sup>1</sup>; Leonora Marro, MSc<sup>2</sup>; John Than, MSc<sup>2</sup>; Mireille Guay, MSc<sup>2</sup>; Allison Denning, MES<sup>3</sup>; Brian J. Murray MD, FRCP(C)/D, ABSM<sup>4</sup>; Shelly K. Weiss, MD, FRCP(C)<sup>5</sup>; Paul J. Villeneuve PhD<sup>6</sup>; Frits van den Berg, PhD<sup>7</sup>; Tara Bower, MSc<sup>8</sup>

### Exposure to wind turbine noise: Perceptual responses and reported health effects

David S. Michaud,<sup>a)</sup> Katya Feder, Stephen E. Keith, and Sonia A. Voicescu  
Health Canada, Environmental and Radiation Health Sciences Directorate, Consumer and Clinical Radiation Protection Bureau, 775 Brookfield Road, Ottawa, Ontario K1A 1C1, Canada



### Personal and situational variables associated with wind turbine noise annoyance

David S. Michaud,<sup>a)</sup> Stephen E. Keith, Katya Feder, and Sonia A. Voicescu  
Health Canada, Environmental and Radiation Health Sciences Directorate, Consumer and Clinical Radiation Protection Bureau, 775 Brookfield Road, Ottawa, Ontario K1A 1C1, Canada



### Self-reported and measured stress related responses associated with exposure to wind turbine noise

David S. Michaud,<sup>a)</sup> Katya Feder, Stephen E. Keith, and Sonia A. Voicescu  
Health Canada, Environmental and Radiation Health Sciences Directorate, Consumer and Clinical Radiation Protection Bureau, 775 Brookfield Road, Ottawa, Ontario K1A 1C1, Canada

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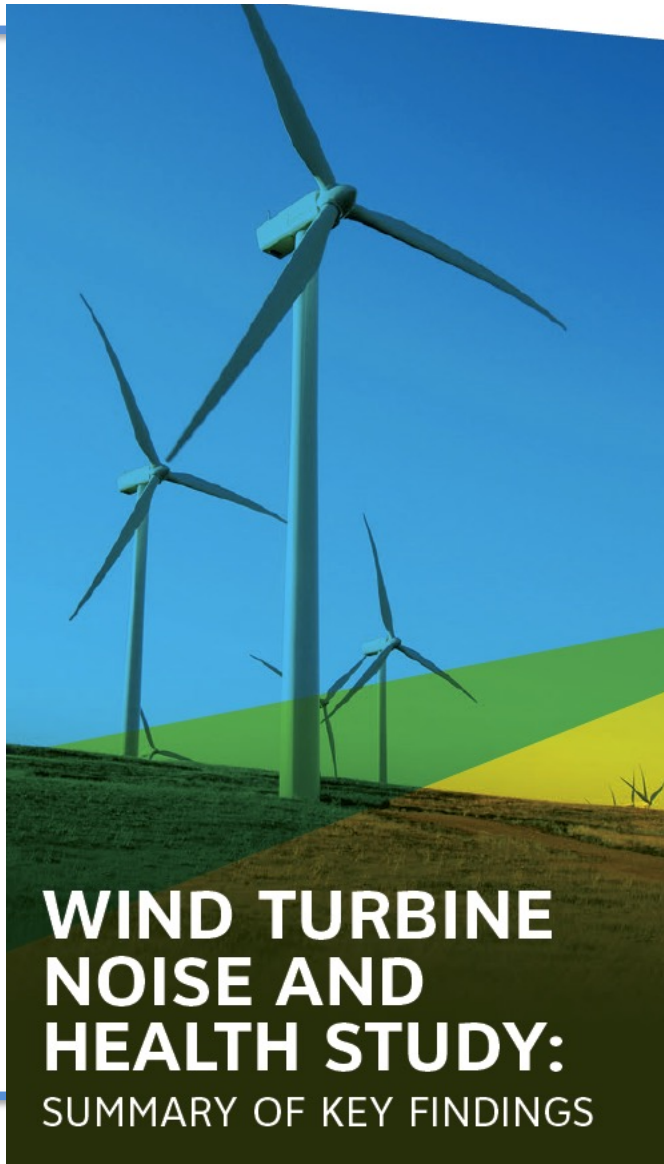
### An assessment of quality of life using the WHOQOL-BREF among participants living in the vicinity of wind turbines<sup>22</sup>

Katya Feder<sup>a</sup>, David S. Michaud<sup>a,\*</sup>, Stephen E. Keith<sup>a</sup>, Sonia A. Voicescu<sup>a</sup>, Leonora Marro<sup>b</sup>, John Than<sup>b</sup>, Mireille Guay<sup>b</sup>, Allison Denning<sup>c</sup>, Tara J. Bower<sup>d</sup>, Eric Lavigne<sup>e</sup>.



### Estimating annoyance to calculated wind turbine shadow flicker is improved when variables associated with wind turbine noise exposure are considered

Sonia A. Voicescu, David S. Michaud,<sup>a)</sup> and Katya Feder  
Health Canada, Environmental and Radiation Health Sciences Directorate, Consumer & Clinical Radiation Protection Bureau, 775 Brookfield Road, Ottawa, Ontario K1A 1C1, Canada



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Canada

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Canada

- The overall conclusion to emerge from the study findings is that the study found no evidence of an association between exposure to WTN and the prevalence of self-reported or measured health effects beyond annoyance.

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# LOW FREQUENCY NOISE AND INFRASOUND

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## What about Low Frequency Noise / Infrasound?

- Are Low Frequency Noise and Infrasound emitted from wind turbines?
  - YES
- Are they emitted at levels that pose a potential health concern?
  - NO
- Are audible sound limits (dBA) for wind turbines sufficient to protect for emitted Low Frequency Noise and Infrasound from wind turbines?
  - YES

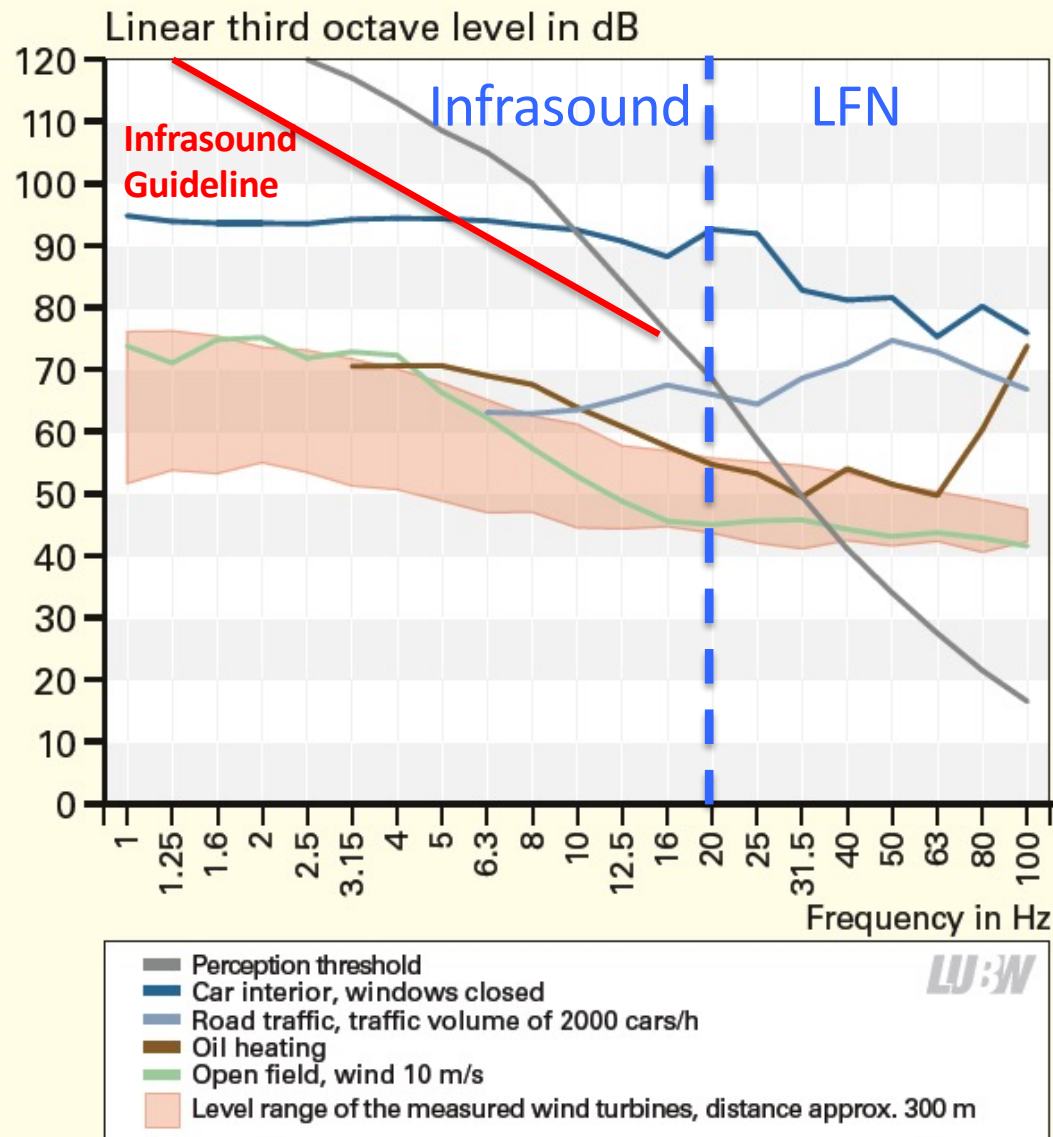


## Low-frequency noise incl. infrasound from wind turbines and other sources

Report on results of the measurement project 2013-2015



Baden-Württemberg



## Infrasound and Low Frequency Noise

## Wind Turbines and Other Sources

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# Low Frequency Noise / Infrasound

frontiers in  
**PUBLIC HEALTH**

**ORIGINAL RESEARCH ARTICLE**  
published: 24 February 2015  
doi: 10.3389/fpubh.2015.00031



Health-based audible noise guidelines account for infrasound and low-frequency noise produced by wind turbines

**Robert G. Berger<sup>1</sup>, Payam Ashtiani<sup>2</sup>, Christopher A. Ollson<sup>3</sup>, Melissa Whitfield Aslund<sup>3</sup>, Lindsay C. McCallum<sup>3,4</sup>, Geoff Leventhall<sup>5</sup> and Loren D. Knopper<sup>3\*</sup>**

<sup>1</sup> Intrinsic Health Sciences Inc., Mississauga, ON, Canada

<sup>2</sup> Aercoustics Engineering Limited, Mississauga, ON, Canada

<sup>3</sup> Intrinsic Environmental Sciences Inc., Mississauga, ON, Canada

<sup>4</sup> Department of Physical and Environmental Sciences, University of Toronto, Toronto, ON, Canada

<sup>5</sup> H.G. Leventhall – Consultancy, Surrey, UK

*Over-all, the available data from this and other studies suggest that health-based audible noise wind turbine siting guidelines provide an effective means to evaluate, monitor, and protect potential receptors from audible noise as well as Infrasound and Low Frequency Noise.*

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# Shadow Flicker

- Shadow flicker does not induce seizures.
- Wind turbines quite simply don't rotate fast enough.
- Shadow flicker is not a health concern

## The NSDECC's shadow flicker guideline requires:

- Shadow Flicker <30 hr/y and <30 min/day at dwellings.
- Cumulative shadow flicker from all wind turbines in the proposed project + shadow from any wind turbines from nearby projects.
- One of the most stringent (lowest) shadow flicker standards for wind projects around the world.



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# PHYSICAL SAFETY CONSIDERATIONS

## Technical Documentation Wind Turbine Generator Systems All Onshore Turbine Types



### General Description

#### Setback Considerations for Wind Turbine Siting

Setback considerations include adjoining population density, usage frequency of adjoining roads, land availability, and proximity to other publicly accessed areas and buildings.

Table 1 provides setback guidance for wind turbines given these considerations.

GE recommends using the generally accepted guidelines listed in Table 1, in addition to any requirements from local codes or specific direction of the local authorities, when siting wind turbines.

# GE Setback Recommendations

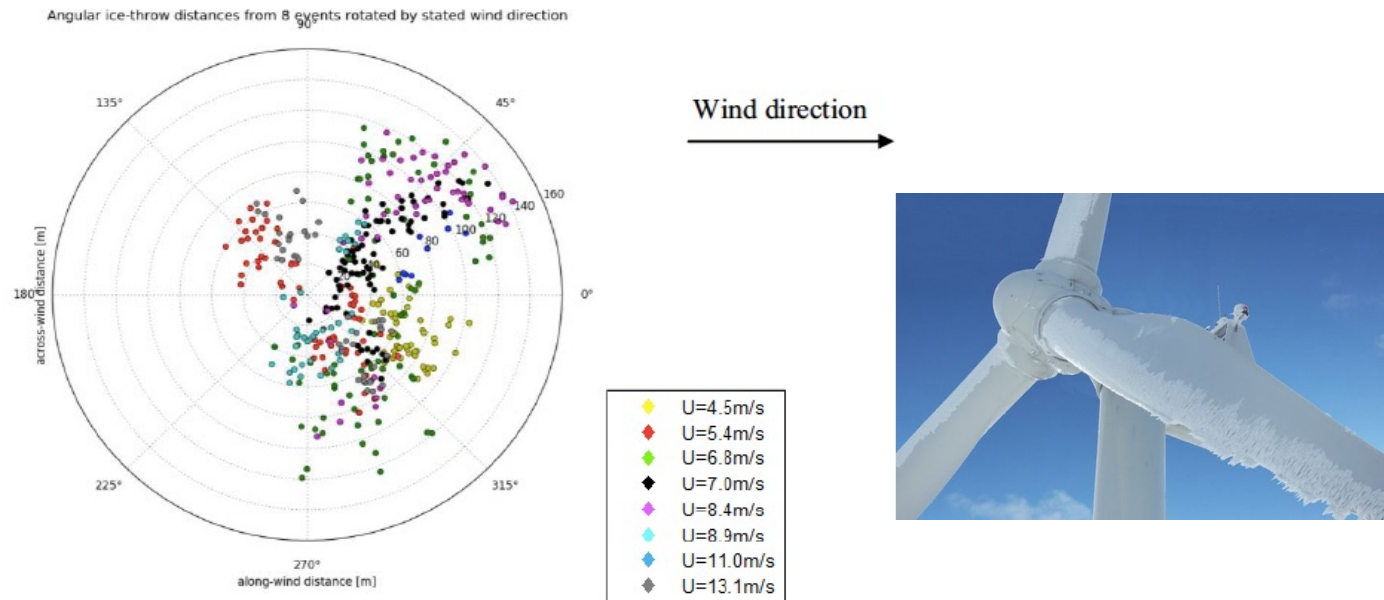
Setback Distance from center of turbine tower	Objects of concern within the setback distance
All turbine sites (blade failure/ice throw): 1.1 x tip height <sup>1</sup> , with a minimum setback distance of 170 meters	<ul style="list-style-type: none"> <li>- Public use areas</li> <li>- Residences</li> <li>- Office buildings</li> <li>- Public buildings</li> <li>- Parking lots</li> <li>- Public roads               <ul style="list-style-type: none"> <li>- Moderately or heavily traveled roads if icing is likely</li> <li>- Heavily traveled multi-lane freeways and motorways if icing is not likely</li> </ul> </li> <li>- Passenger railroads</li> </ul>
All turbine sites (tower collapse): 1.1 x tip height <sup>1</sup>	<ul style="list-style-type: none"> <li>- Public use areas</li> <li>- Residences</li> <li>- Office buildings</li> <li>- Public buildings</li> <li>- Parking lots</li> <li>- Heavily traveled multi-lane freeways and motorways</li> <li>- Sensitive above ground services<sup>2</sup></li> </ul>
All turbine sites (rotor sweep/falling objects): 1.1 x blade length <sup>3</sup>	<ul style="list-style-type: none"> <li>- Property not owned by wind farm participants<sup>4</sup></li> <li>- Buildings</li> <li>- Non-building structures</li> <li>- Public and private roads</li> <li>- Railroads</li> <li>- Sensitive above ground services</li> </ul>

# Risk Assessment of Ice Throw

PAPER · OPEN ACCESS

Understanding and acknowledging the ice throw hazard - consequences for regulatory frameworks, risk perception and risk communication

To cite this article: R. E. Bredesen *et al* 2017 *J. Phys.: Conf. Ser.* **926** 012001



**Figure 6.** 417 ice pieces from the IceThrower database for the considered V90 turbine with a tipheight of 140 m. The location of all ice pieces are rotated by the given wind direction for each given case. Events are listed A-H by colored markers for increasing wind velocities.

# Blade Fragment Throw

Source of Fatality	Annual Risk	Assumptions
Wind turbine - Direct impact by blade/fragment	$10^{-9}$	At 2x hub height from wind turbine
Wind turbine - Indirect impact by blade/fragment	$10^{-8}$	At 2x hub height from wind turbine
Cancer	$2.58 \times 10^{-3}$	Averaged over population. England & Wales 1999
Lightning	$5.35 \times 10^{-8}$	England & Wales 1995-1999
Mining Industry	$1.09 \times 10^{-4}$	GB 1996-2001
Construction Industry	$5.88 \times 10^{-5}$	GB 1996-2001
Agriculture	$5.81 \times 10^{-5}$	GB 1996-2001
Service Industry	$3.00 \times 10^{-6}$	GB 1996-2001
Fairground Rides	$4.79 \times 10^{-9}$	Assumes 4x rides per annum. UK 1996-2000
Road Accidents (all forms)	$5.95 \times 10^{-5}$	UK 1999
Rail Travel Accidents (per passenger journeys)	$2.32 \times 10^{-8}$	Fatality per passenger journeys GB 1996-1997
Rail Travel Accidents (annual risk - commuter)	$1.05 \times 10^{-5}$	Annual risk of fatality: 2 daily journeys, 45 weeks per year
Aircraft Accident (per passenger journeys)	$8.00 \times 10^{-9}$	Fatality per passenger journeys UK 1991-2000
Aircraft Accident (annual risk - holidaymaker)	$1.60 \times 10^{-8}$	Annual risk of fatality: 2 flights per annum



Health and Safety Executive

**Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines**

Prepared by **MMI Engineering Ltd** for the Health and Safety Executive 2013



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# Cumulative Effects

## Sound and shadow flicker

- standards and modeling require cumulative effect assessment of existing and proposed project turbines towards all dwellings.



## Visual Aspect

- In terms of the visual aspect of turbines on the horizon, beauty is truly in the eye of the beholder.
- There are numerous studies that describe that approximately 10% of the population living in proximity to a wind turbine will be annoyed by their presence. However, given that wind turbines do not impact property values, impact health or result in other impacts on quality of life OEHM does not believe that counties should use health or visual cue as the basis to increase setback distances to turbines.
- This would effectively be a roundabout way of zoning out wind turbines based on visual appearance.
- There are counties in Canada and the United States that host hundreds of wind turbines without impact on their communities.

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# Setback Recommendation

- OEHM recommends that West Hants Regional Municipality adopt into their By-law their previously established practice of using a 1 km setback to dwellings and 550 m to woods camps for existing projects.
  - Based on the available scientific literature, this is more than sufficient to ensure the protection of the public health and safety of their residents.
  - In fact, a lesser setback between 550 m to 1 km would be equally protective of public health and safety.
  - There is no scientific basis to increase these setbacks. It would afford no additional protection of public health and safety and would unduly restrict areas for development.



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