



**CONSULTING ENGINEERING REPORT
CONCERNING THE EFFECTS UPON
RECEIVED BROADCAST SIGNALS
DUE TO THE CONSTRUCTION OF A
WIND TURBINE FARM
In Your County
Near
Your State**

Gentle Wind, LLC

May 23, 2011

**By: Ralph E. Evans III
Evans Associates, LLC
216 Green Bay Road
Thiensville, WI 53092
262-242-6000
iii@evansassoc.com
evansassociates.com**



**CONSULTING ENGINEERING REPORT
CONCERNING THE EFFECTS UPON
RECEIVED BROADCAST SIGNALS
DUE TO THE CONSTRUCTION OF A
WIND TURBINE FARM
In Your County
Near
Your State
Gentle Wind, LLC**

I. INTRODUCTION

This Consulting Engineering Report describes the results of a study and analysis to determine whether the consumer reception of any broadcast facilities might be adversely impacted as a result of the construction of a Gentle Wind turbine farm near Your State, referred to as the Gentle Wind Project. This document identifies broadcast stations that are likely to be serving the area around the planned turbines, contains an assessment of the possible extent of receiver interference caused by the wind turbines, and describes mitigation methods that could be used in cases of actual interference that could be expected to occur.

The wind turbines to be used have a hub height of 100 meters above ground and a blade diameter of 100 meters. Thus, the total height will be 150 meters above ground level to the tip of one blade at the 12:00 position.

II. ANALYSIS

There are no broadcast AM or FM transmitting stations within 3 kilometers of any planned turbine site. Therefore, distortion of the radiation patterns of these types of facilities is not expected.

W----, channel 5 assigned to Your State, is located approximately 1.4 miles from the closest Gentle turbine. The multipath effect that may be caused to home reception of broadcast TV signals in the area is analyzed in the paragraphs below.

TV FACILITIES

The following full service analog and digital TV facilities have been identified as placing a predicted FCC primary service signal over at least part of the turbine area, based on calculations using both the FCC method and the Longley-Rice propagation prediction method. The distances given are to the center of the Gentle Wind farm:



| Reference Search Radius of TV Facilities Centered on Wind Turbine 33 | | | | | | | | | |
|--|----------|-------------|--------------------|------------------|---------------|---------------|-------------------|------------|------------|
| Call Letter | Channel | City | Latitude | Longitude | Distance (KM) | Distance (MI) | Bearing (Azimuth) | Power (kW) | HAAT (M) |
| W---- | 5 | City | 41° 44' 41" | 84° 1' 6" | 5.39 | 3.35 | 264.68° | 10 | 155 |
| WT-- | 11 | City | 41° 40' 22" | 83° 22' 47" | 48.53 | 30.15 | 99.92 | 16.9 | 305 |
| WT-- | 13 | City | 41° 41' 0" | 83° 24' 49" | 45.54 | 28.3 | 99.10° | 14.6 | 305.4 |
| WT-- | 13 | City | 41° 41' 0" | 83° 24' 49" | 45.54 | 28.3 | 99.10° | 16.7 | 305.4 |
| WD----- | 18 | City | 41° 39' 12" | 83° 32' 53" | 35.41 | 22 | 107.43° | 4 | 0 |
| W3--- | 23 | City | 41° 38' 49" | 83° 36' 18" | 31.18 | 19.37 | 111.33° | 8 | 0 |
| W2----- | 28 | City | 41° 39' 12.8" | 83° 41' 34.2" | 24.18 | 15.02 | 116.07° | 1 | 0 |
| WG----- | 29 | City | 41° 39' 26" | 83° 25' 55" | 44.62 | 27.73 | 103.11° | 49.5 | 313.6 |
| W5--- | 32 | City | 41° 39' 12" | 83° 32' 53" | 35.41 | 22 | 107.43° | 49 | 0 |
| W3--- | 38 | City | 41° 38' 49" | 83° 36' 18" | 31.18 | 19.37 | 111.33° | 17.27 | 0 |
| WU-- | 46 | City | 41° 39' 22" | 83° 26' 41" | 43.62 | 27.1 | 103.60° | 110 | 356 |
| WU-- | 46 | City | 41° 39' 22" | 83° 26' 41" | 43.62 | 27.1 | 103.60° | 200 | 356 |
| WM----- | 48 | City | 41° 39' 13" | 83° 31' 49" | 36.82 | 22.88 | 106.68° | 11 | 0 |
| WN----- | 49 | City | 41° 40' 3" | 83° 21' 22" | 50.57 | 31.42 | 100.18° | 59 | 409 |
| WN----- | 49 | City | 41° 40' 3" | 83° 21' 22" | 50.57 | 31.42 | 100.18° | 118 | 409 |
| NEW | 50 | City | 41° 39' 5" | 83° 32' 8" | 36.47 | 22.66 | 107.26° | 15 | 0 |
| WD----- | 68 | City | 41° 39' 12" | 83° 32' 53" | 35.41 | 22 | 107.53° | 6.6 | 0 |

Table 1 – TV Tabulation

Based on this consultant’s analysis, the local facilities serving the city will be the primary subjects of study because they are most likely to experience multipath distortion from nearby metallic objects. These effects will most likely be localized, however, and the relatively small number of cases that occur can be easily mitigated at the viewer’s receiver. The single exception to this mitigation category is WL--, channel 5. This station is very close to several of the turbines in the Gentle Wind Project, and requires a more detailed analysis (see below):

Turbine Tabulation

| Number | TV to Turbines Miles | Kilometers | Bearing N deg E |
|---------------|---------------------------------|-------------------|----------------------------|
| 1 | 3.96 | 6.38 | 24.21 |
| 2 | 3.78 | 6.08 | 26.67 |
| 3 | 3.53 | 5.68 | 28.57 |
| 4 | 4.30 | 6.92 | 32.18 |
| 5 | 4.20 | 6.76 | 34.71 |
| 6 | 4.10 | 6.60 | 37.35 |
| 7 | 4.02 | 6.47 | 40.15 |
| 8 | 3.19 | 5.13 | 20.57 |
| 9 | 2.98 | 4.80 | 24.23 |
| 10 | 2.84 | 4.57 | 27.65 |
| 11 | 2.61 | 4.19 | 30.57 |
| 12 | 2.41 | 3.87 | 34.12 |
| 13 | 2.14 | 3.44 | 37.31 |
| 14 | 1.99 | 3.20 | 42.62 |
| 15 | 1.58 | 2.54 | 45.85 |
| 16 | 1.61 | 2.59 | 53.54 |
| 17 | 1.55 | 2.49 | 61.57 |
| 18 | 1.47 | 2.37 | 70.47 |
| 19 | 1.41 | 2.28 | 80.70 |
| 20 | 1.42 | 2.29 | 91.61 |

Table 2 – TV to Turbine Tabulation¹

The closest WL---to-turbine spacing is 1.41 miles. It is also noted that the turbine fan turns through the center of radiation of the channel 5 transmitting antenna.

The proximity of the wind farm to WL-- will unavoidably cause multipath distortion over an area primarily to the east of the TV station. WL-- employs a cardioid directional antenna to increase its signal toward the city at the expense of radiation to the west. Based upon 50% propagation 50% of the time, the multipath will be primarily confined to the following approximate area:

¹ Note: This is the latest turbine arrangement as of the date of this report.



Figure 1 – Possible Impact Area

Interference is especially likely for residential viewers in and around the project area that have to point their outdoor antennas through the turbines toward WL--, that utilize “rabbit ears” type antennas, or who own TV sets more than approximately 5 years old. WM--’s signal may periodically exhibit some “pixelization” and “freezing” within the designated area due to multipath reception. Mitigation measures, as described in this report, could reduce the incidence of TV signal anomalies, but would most likely involve the fabrication of a “stealth” blade, an unproven technology.

Mitigation Measures

Most of the multipath effect should be dissipated for locations farther than approximately 30 to 35 miles of the TV station. This estimate is based upon Evans’ experience with similar turbine farms² and a TV interference “tool” that tabulates the re-radiation contribution from each turbine, obtains the root-sum-square total, and compares it to the direct signal. Overlaying the tool predictions with a map of minor civil divisions, the result is approximately 310,000 households that would be potentially affected by interference from 10% to 50% of the time. Of this number, approximately 70% of the residences in the Toledo market utilize cable or satellite services,

² Especially Mars Hill in Maine, TVA on Buffalo Mountain, and Fond du Lac Wisconsin.



leaving a net of 93,000 households that will most likely require mitigation.

On this scale, mitigation at the viewer’s location is probably not feasible. Based upon this consultant’s experience, it is the rotating blades (with their internal metal support structure and lightning suppression) that cause the major portion of the multipath interference³. It may be possible to fabricate “stealth” blades that would have the following characteristics:

1. GRP Glass with carbon reinforced blade supporting structure (or other non-metallic).
2. Lightning protection wire “detuned” for channel 5 using coaxial capacitive sleeves.

The second item will have the most effect. If desired, Evans is capable of pursuing this solution.

With regard to the other TV stations, the majority of modern TV sets with good outdoor antennas should successfully handle the described anomalies. The most likely necessary mitigation measure would be to install a directional high(er)-gain outside antenna to increase the strength of the direct wave and reduce reflections.

FM FACILITIES

The following full-service FM stations each place a predicted primary signal over at least a portion of the turbine property (according to the FCC, *only* stations providing predicted service are entitled to protection):

| Reference Search Radius of 30 KM of Wind Turbine 33 | | | | | | | | | |
|---|---------|------|-------------|-------------|---------------|---------------|-------------------|------------|----------|
| Call Letter | Channel | City | Latitude | Longitude | Distance (KM) | Distance (MI) | Bearing (Azimuth) | Power (kW) | HAAT (M) |
| WX-- | 202 | City | 41° 39' 26" | 83° 36' 57" | 29.93 | 18.6 | 109.93° | 0.1 | 58 |
| WY-- | 203 | City | 41° 33' 29" | 84° 11' 8" | 28.7 | 17.83 | 222.25° | 10 | 89 |
| W2---- | 205 | City | 41° 53' 55" | 84° 3' 40" | 18.83 | 11.7 | 331.87° | 0.01 | 22.8 |
| WY-- | 207 | City | 41° 38' 55" | 83° 42' 22" | 23.45 | 14.57 | 118.47° | 2.45 | 93 |
| W2---- | 211 | City | 41° 53' 55" | 84° 3' 40" | 18.83 | 11.7 | 331.87° | 0.01 | 23.8 |
| NEW | 221 | City | 41° 41' 13" | 83° 43' 40" | 20.04 | 12.45 | 110.2° | 0.019 | 94 |
| W2---- | 225 | City | 41° 52' 30" | 83° 58' 0" | 14.01 | 8.7 | 355.64° | 0.025 | 48.5 |
| NEW | 232 | City | 41° 36' 0" | 84° 12' 26" | 26.84 | 16.68 | 231.83° | 0.025 | 22 |
| WQ-- | 237 | City | 41° 48' 15" | 84° 5' 25" | 12.88 | 8.01 | 298.39° | - | - |
| WQ-- | 237 | City | 41° 48' 15" | 84° 5' 25" | 12.88 | 8.01 | 298.39° | 3 | 91 |

Table 3 – FM Tabulation

³ At Mars Hill, extensive tests were conducted with the rotors on and then off, verifying this statement.



Because of the “capture effect” supported by the “discriminator” in FM receivers, significant disruptions to the above-listed primary FM facilities is not expected. There do not appear to be any “unique” services that could be lost as a result of construction of the wind farm. Although the received signal may vary with the blade rotation at some receive locations in the immediate area, good quality FM radios will most likely factor out such time-varying signals. In those relatively few cases where significant impact is caused (e.g. when a listener is located within 0.50 mile of a turbine), home FM radios could be connected to rooftop TV receive antennas to pull in a stronger direct signal. Mobile or portable receivers would only need to be moved slightly to pick up a stronger signal (for instance, radios using line cords for antennas).

AM FACILITIES

A search of the FCC’s database revealed no AM facilities within the required notification distance of 3 kilometers beyond the nearest turbine.

There should therefore be no reasonable expectations of disruptions in transmitted radiations on the AM band due to the presence of the turbines. Occasionally, depending upon ground and atmospheric conditions, local AM receivers tuned to distant stations and located within approximately one mile of the turbines may experience slight signal variations, but such anomalies are not recognized by the FCC or the standards of good engineering practice as a significant disruption. Usually, the receiver’s automatic gain control can keep the audio reasonably uniform.

III. CONCLUSIONS

The following conclusions have been reached as a result of the analysis undertaken with respect to the UPC wind project:

1. Based upon FCC database information, no significant impact is expected to the reception of AM or FM broadcast facilities. A few receive locations may experience signal fluctuations in time with the blade rotors, but the receiver AGC should be able to manage these variations. In a few cases, it might be necessary to utilize outside antennas within nearby homes.
2. Some minor impact may be caused to local over-the-air TV receivers (other than channel 5) in and near the project area, especially if viewers are not using good quality high-gain outside antennas.
3. Significant impact is expected to viewers of channel 5 within the Toledo BTA. Mitigation may be possible, but the necessary techniques are untried.

It is the opinion of the consultant that an impact to some consumer receivers is possible, but manageable and amenable to mitigation.



**Evans Associates
Gentle Wind, LLC
Broadcast Impact Study**

Respectfully Submitted,

A handwritten signature in blue ink that reads "Ralph E. Evans III". The signature is fluid and cursive, with a distinct loop at the end.

Ralph E. Evans III
Senior Communications Consultant

May 23, 2011