Ambient Sound Survey of the Blue Creek Wind Farm Project Area

TO: Heartland Wind, LLC Blue Creek Wind Farm Project Team

FROM: Mark Bastasch, P.E./CH2M HILL

DATE: April 30, 2010

Summary

This memorandum presents the ambient sound measurements collected for Heartland Wind, LLC's proposed Blue Creek Wind Farm (the Facility) in Paulding and Van Wert counties, Ohio. Ambient sound levels were collected over an approximately 10-day period at nine representative locations within the vicinity of the proposed Facility. Sound level metrics collected included L_{eq} (average) and L_{90} (residual or background) levels which were correlated with wind speeds measured at 100 meters (hub height of the proposed wind turbines). The resulting trends are as expected: noise levels are typically higher at locations proximate to major roads, are greater during the day than at night, and generally increase with increasing wind speed.

Instrumentation

Larson Davis 831, ANSI Type 1 precision sound level meters, were used for this survey. Microphones were field calibrated at the beginning and end of this survey with a Larson Davis CAL200 calibrator and the observed calibration drift was acceptable and less than 0.5 dB. The microphones were outfitted with oversized windscreens (ACO Model WS7-80T) to reduce self-induced wind noise across the microphone. The sound level meters were housed in waterproof enclosures and the microphones were mounted on a tripod at an approximate height of 6 feet within a Larson Davis environmental protection shroud. Each sound level meter was programmed to record a number of statistical parameters including A-weighted L_{eq} and L_{90} in 10-minute intervals to correlate with meteorological data collection efforts.

Three Davis Vantage Pro Weather Stations were deployed to document periods of rain within the project area. Periods of rain were excluded from the data analysis. Hub height (100 meter) wind speeds were collected and provided by Heartland Wind from their permanent onsite meteorological tower.

Monitoring Locations

The project area is primarily characterized as an agriculture area, with several major roadways (US 30 and US 127). The communities of Scott and Haviland represent two areas of comparatively increased residential density. A drain tile manufacturing facility is located within the community of Haviland and various agricultural equipment (such as, dryers, silos, and conveyors) is located sporadically throughout the project area. The monitoring

was conducted between March 18 and 29, 2010, a period when agricultural activities are minimal and deciduous trees were bare. Any potential sound from rustling of leaves or crops in the fields, as well as summer insects, was minimized by the timing of this survey. Higher ambient sound levels could reasonably be expected during the summer months, particularly at locations near fields or trees. Nine representative monitoring locations were selected within the project area and are identified in Table 1. The map in Appendix A depicts their locations within the project area as well as the specific location on each parcel. Photos of each monitoring location are provided in Appendix B.

Home 91 is located in the southwest project area, near US 30, a divided four-lane highway. A weather station was also located at this property.

Home 139 is also located in the southwest project area, but further removed from US 30 than Home 91.

Home 141 is located in the south east of the project area and removed from major roadways. Dirt bikes were noted to occasionally operate on a small track established by the neighbors to the south. A weather station was also located at this property.

Home 171 is located on US 127, a two-lane thoroughfare. The monitoring location was located in the backyard and set back at a distance further from the road than neighboring homes.

Home 240 is located towards the center the project and removed from major roadways.

Home 248 is also removed from major roadways and to the west of Home 240. A quarry is located approximately 0.5 mile to the west of Home 248 but quarry operations were not audible during the set up or removal of equipment.

Home 393 is located in the community of Scott, in the northeast portion of the project, and is approximately 0.5 mile from US 127.

Home 455 is located in the northern portion of the project and is removed from major roadways. It was noted that an automatic backup generator is automatically cycled on for brief testing every Wednesday morning.

Home 534 is located along State Route 114 (SR 114), the northern border of the project, in the community of Haviland. Traffic along SR 114 was observed to be significantly less than US 127 and the primary source of noise noted was associated with the drain tile manufacturing facility approximately 0.5 mile to the east.

TABLE 1

Sound Monitoring Locations

Home ID	Longitude	Latitude	Participation Status	Address	City/Town	Distance to Closest Turbine (ft)	Turbine ID
91	-84.68365006	40.9315185	Good Neighbor Agreement	7426 Pollock Rd.	Convoy	2,237	20
139	-84.66805265	40.94413862	Participant	4144 Dull Robinson Rd.	Convoy	1,755	35
141	-84.53408181	40.9467017	Participant	14933 Wetzel Rd.	Van Wert	1,393	E-21
171	-84.57200432	40.94656903	Good Neighbor Agreement	3949 US 127	Van Wert	1,967	139
240	-84.59798206	40.96090019	Good Neighbor Agreement	11657 Feasby Wisener Rd.	Van Wert	1,451	110
248	-84.63977989	40.96061721	Participant	9439 Feasby Wisener Rd.	Convoy	1,454	54
393	-84.57835537	40.99027754	Participant	12705 Rd. 12	Scott	3,123	128
455	-84.62050897	41.00379198	Good Neighbor Agreement	10526 Rd. 24	Haviland	2,437	90
534	-84.57716958	41.01936579	Non-Participant	12791 SR 114	Haviland	4,316	146

Monitoring Results

The measured L_{eq}, L_{90}, hub height (100 meter) wind speed and precipitation are plotted as time series for each monitoring location and are presented in Appendix C. Appendix C also contains the plots of day and nighttime L_{eq}, L_{90}, and L_{50} sound level metrics versus hub height wind speeds. The nighttime period was classified as between 10 p.m. and 4 a.m. with daytime period being the balance of the day. Periods of rain were excluded from these correlations.

The results indicate that the sound level at any single location will vary substantially over time and that while noise levels generally increase with increasing hub height wind speeds, the range in existing sound levels measured at any particular wind speed varies dramatically.

Cumulative Sound Levels

The level of sound emitted by wind turbines depend on the speed of the wind at hub height. When the winds are sufficient to generate power, commonly referred to as the cut-in wind speed - approximately 4 meters per second (m/s) at hub height (100 meters), the sound power level[1] of the Gamesa G90 is approximately 93 dBA. The sound power level of the turbine then increases with increasing wind speed to a maximum sound power level of approximately 106 dBA at 9 m/s. Once this wind speed and maximum sound power level is reached, the sound level of the turbine plateaus or no longer increases with increasing wind speed, while the ambient levels may continue to increase with increasing wind speed.

As noted above and depicted on figures in Appendix C, the range in existing sound levels at any particular wind speed varies. To evaluate the potential cumulative sound levels (existing plus project), the range in measured average sound level (L_{eq}) was determined for each monitoring location. Table 2 presents the range of existing sound levels measured at each of the monitoring locations under cut-in conditions (hub height winds of approximately 4 m/s). Table 3 presents the range of existing sound levels measured for the wind speed corresponding to when the turbines first reach their maximum sound emissions (hub height winds of approximately 9 m/s). The low existing sound level range corresponds to the quietest 10 percent of the measured average (L_{eq}) levels, the mid range to the median or 50th percentile and the high range to the loudest 10 percent. The cumulative sound level is computed by adding the predicted project level under cut-in conditions (Table 2) or maximum sound conditions (Table 3) to the measured existing levels.

[1] A sound power level (commonly abbreviated as PWL or Lw) is analogous to the wattage of a light bulb; it is a measure of the acoustical energy emitted by the source and is, therefore, independent of distance. It is not the same as what one hears or directly measures with a sound level meter. For example, a 60-watt light bulb emits 60 watts of power. It makes no difference to the wattage (power) where a person is viewing it from: the power is always 60 watts. A sound pressure level (commonly abbreviated as SPL or Lp) is analogous to the brightness or intensity of light experienced at a specific distance from a source. A 60-watt light bulb will have less brightness when view from a further distance away. That is, the power (60 watts) remains the same, but its intensity diminishes the further away one gets from it. Sound pressure is similarly attenuated by distance. Sound pressure is measured directly with a sound-level meter is associated with a particular location or distance from the sound source.

TABLE 2
Summary of Existing and Cumulative Sound Pressure Levels under Cut-In Winds (dBA)

Monitoring Location	Measured Levels *Range of Existing Ambient (Leq) Levels*			Predicted Project Sound Level	Predicted Cumulative Level Existing Plus Project (Leq) *Range of Existing Ambient (Leq) Levels*		
	Low	*Mid*	*High*		*Low*	*Mid*	*High*
H91	38	43	49	32	39	43	49
H139	33	40	45	34	36	41	45
H141	32	42	47	33	36	42	47
H171	46	50	54	34	47	50	54
H240	30	39	43	35	36	40	43
H248	29	35	44	35	36	38	45
H393	34	43	49	31	35	43	49
H455	35	40	44	35	38	41	44
H534	42	46	50	27	42	46	50

TABLE 3
Summary of Existing and Cumulative Sound Pressure Levels under Full Sound Power Conditions (dBA)

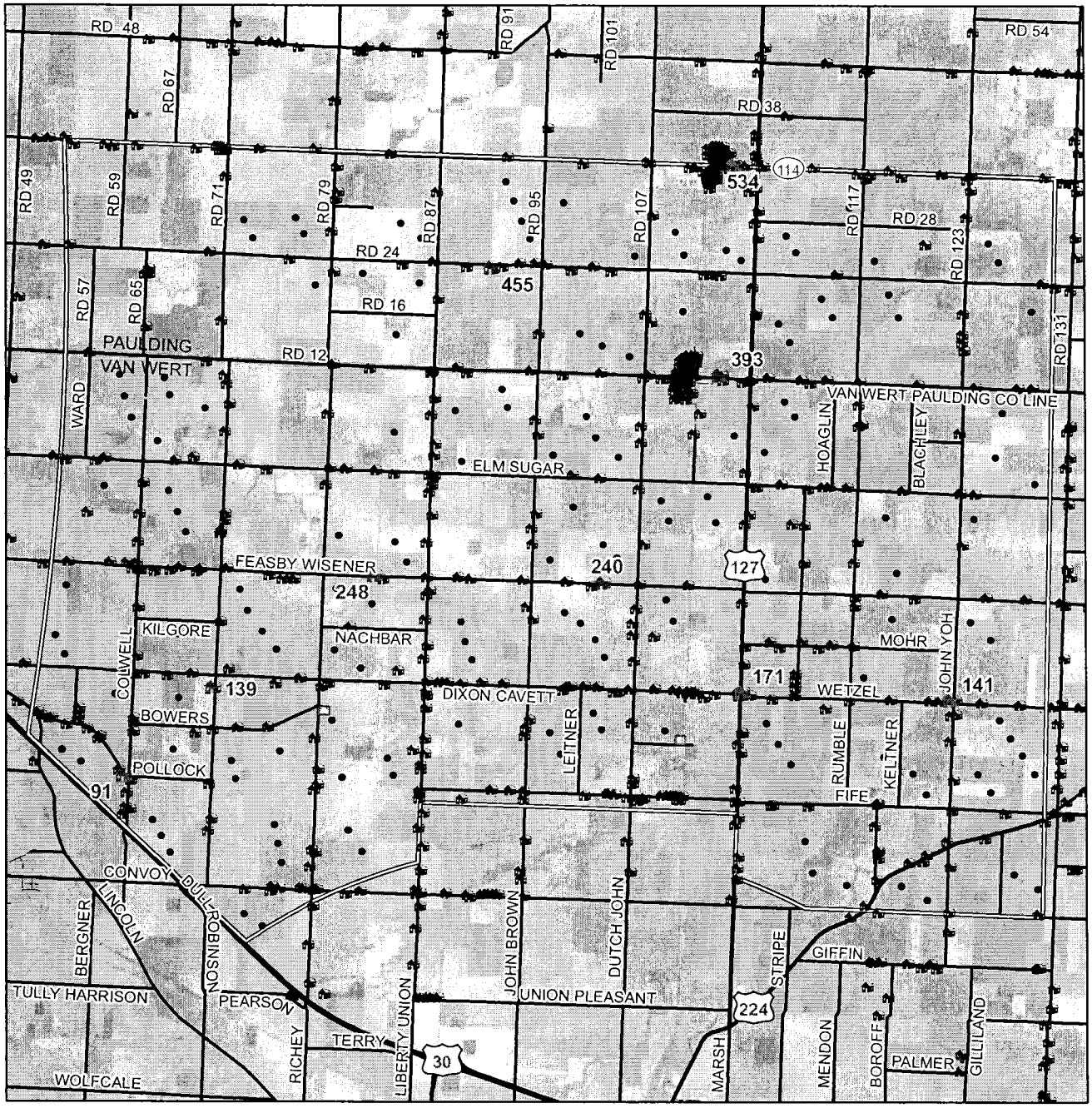
Monitoring Location	Measured Levels *Range of Existing Ambient (Leq) Levels*			Predicted Project Sound Level	Predicted Cumulative Level Existing Plus Project (Leq) *Range of Existing Ambient (Leq) Levels*		
	Low	*Mid*	*High*		*Low*	*Mid*	*High*
H91	38	45	50	47	47	49	52
H139	33	41	47	49	49	49	51
H141	32	41	49	48	48	49	52
H171	46	51	55	46	49	52	55
H240	34	42	48	50	50	50	52
H248	31	40	47	50	50	50	52
H393	37	43	48	46	46	48	50
H455	32	44	48	46	46	48	50
H534	42	48	52	42	45	49	52

Range of Predicted Sound Levels

As discussed in the December 2009 and April 2010 OPSB submittal, the prediction of maximum project sound levels was based on ISO 9613-2, *Acoustics – Sound Attenuation During Propagation Outdoors, Part 2: General Method of Calculation* (International Organization for Standardization [ISO], 1993) and utilized a mixed ground factor of G=0.5 with a receptor height of 4 meters (13 feet). It was noted that these modeling parameters yielded similar

results to hard ground conditions (G=0), with a receptor height of 1.5 meters (4.9 feet) when a potential +2 dBA term to account for vendor warranty is not considered. Appendix D presents the predict project levels under cut-in and full acoustic sound power for both a hard ground condition (G=0) and a fully absorptive or acoustically soft ground condition (G=1) with a receptor height of 1.5 meters (4.9 feet). The results for the fully absorptive ground (G=1) are approximately 6 dBA less than those under the hard ground (G=0) results. The hard ground results are consistent with previous provided predictions of maximum project sound levels. It is for these reasons the analysis was noted to be based on conservative components, ensuring that predicted receptor levels were not minimized.

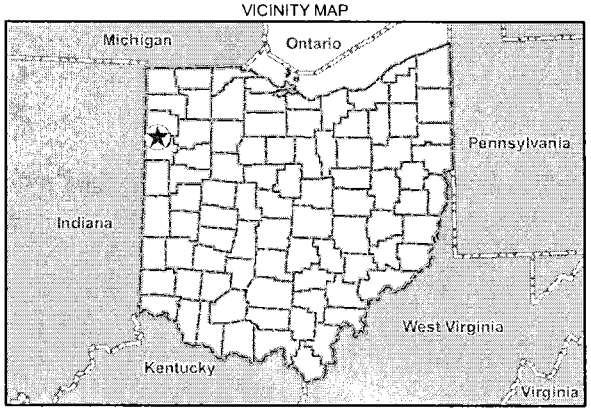
Appendix A
Monitoring Locations Overview



LEGEND

- Homes - Monitored
- Homes
- Proposed Turbine
- Proposed Collection Substation
- Site Area Boundary
- County Boundary

VICINITY MAP

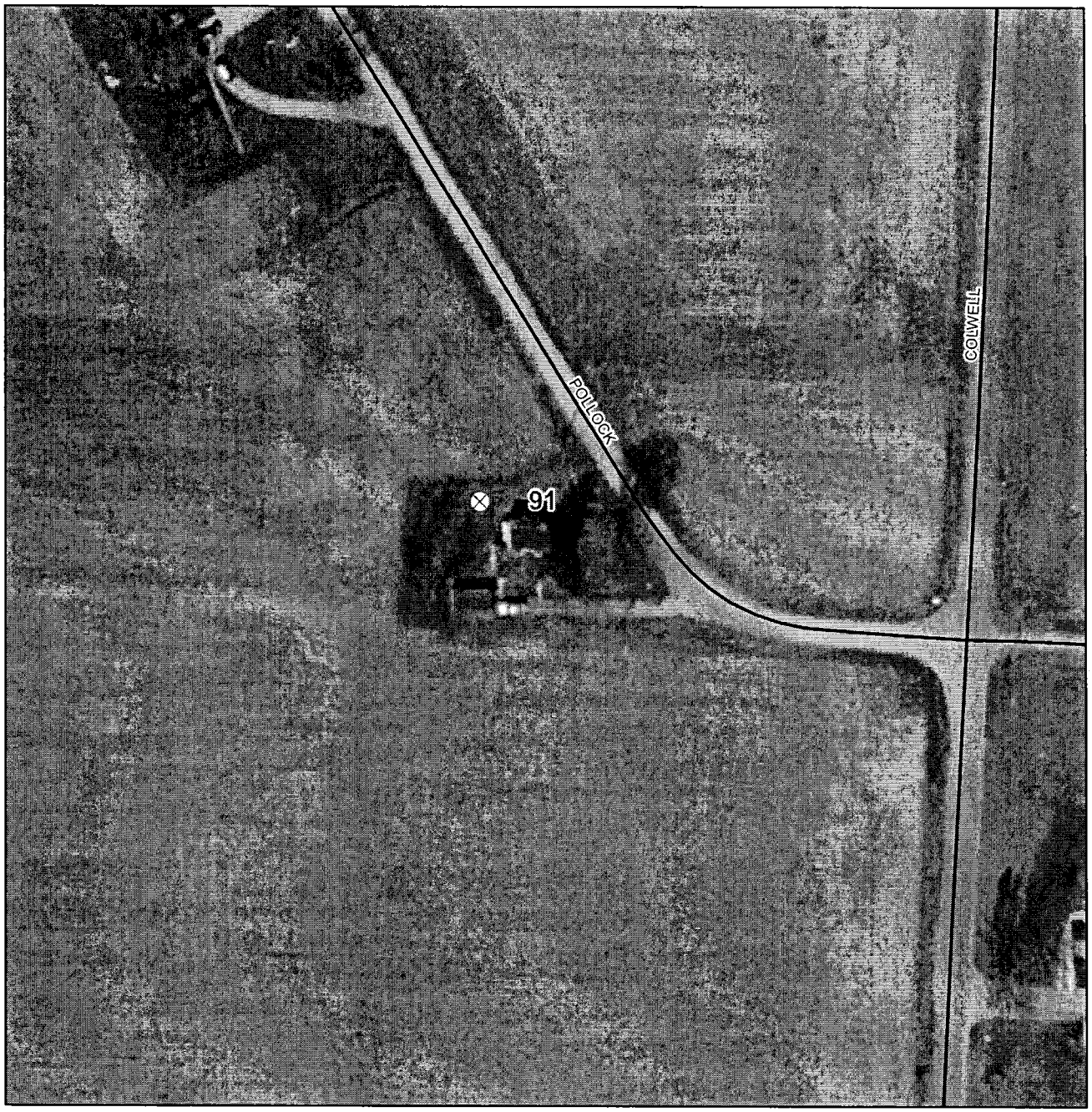


N

0 0.5 1 2

Miles

FIGURE A-1
Overview of Sound Monitoring Locations
Ambient Sound Survey
Blue Creek Wind Power Facility

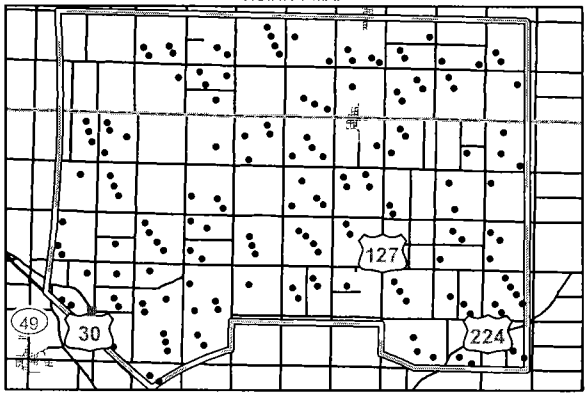


LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

Feet

FIGURE A-2

Home 91 - Location of Sound Level Meter

Ambient Sound Survey

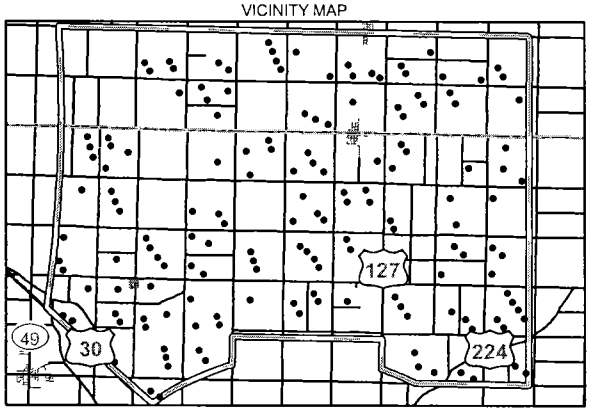
Blue Creek Wind Power Facility

LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

Feet

FIGURE A-3

Home 139 - Location of Sound Level Meter

Ambient Sound Survey

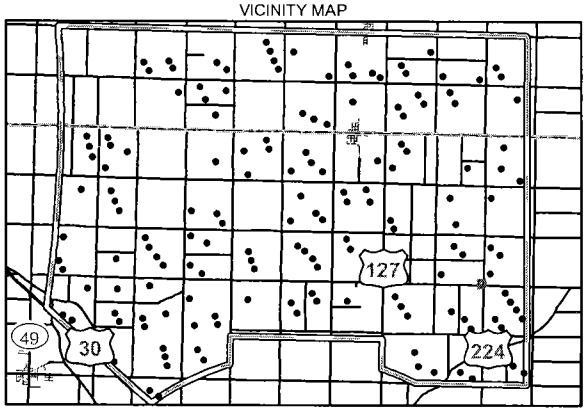
Blue Creek Wind Power Facility

LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

Feet

FIGURE A-4

Home 141 - Location of Sound Level Meter

Ambient Sound Survey

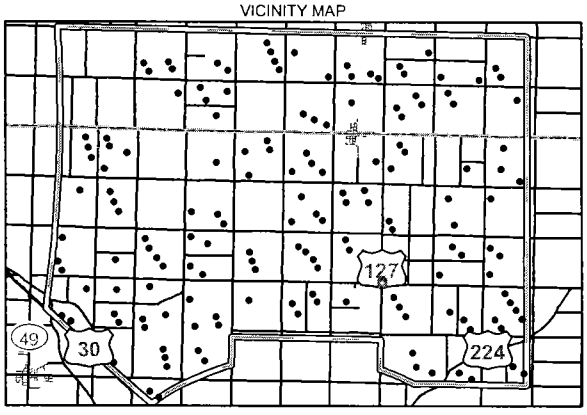
Blue Creek Wind Power Facility

LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

Feet

FIGURE A-5

Home 171 - Location of Sound Level Meter

Ambient Sound Survey

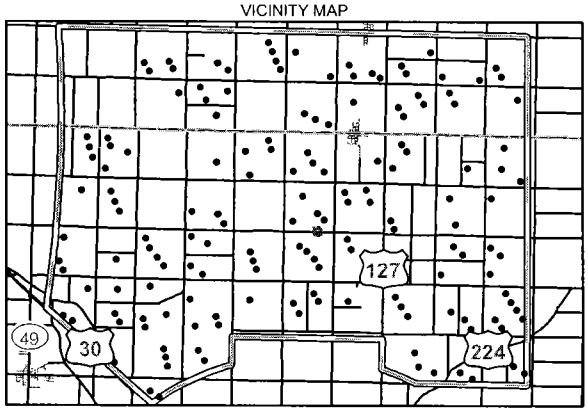
Blue Creek Wind Power Facility

LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

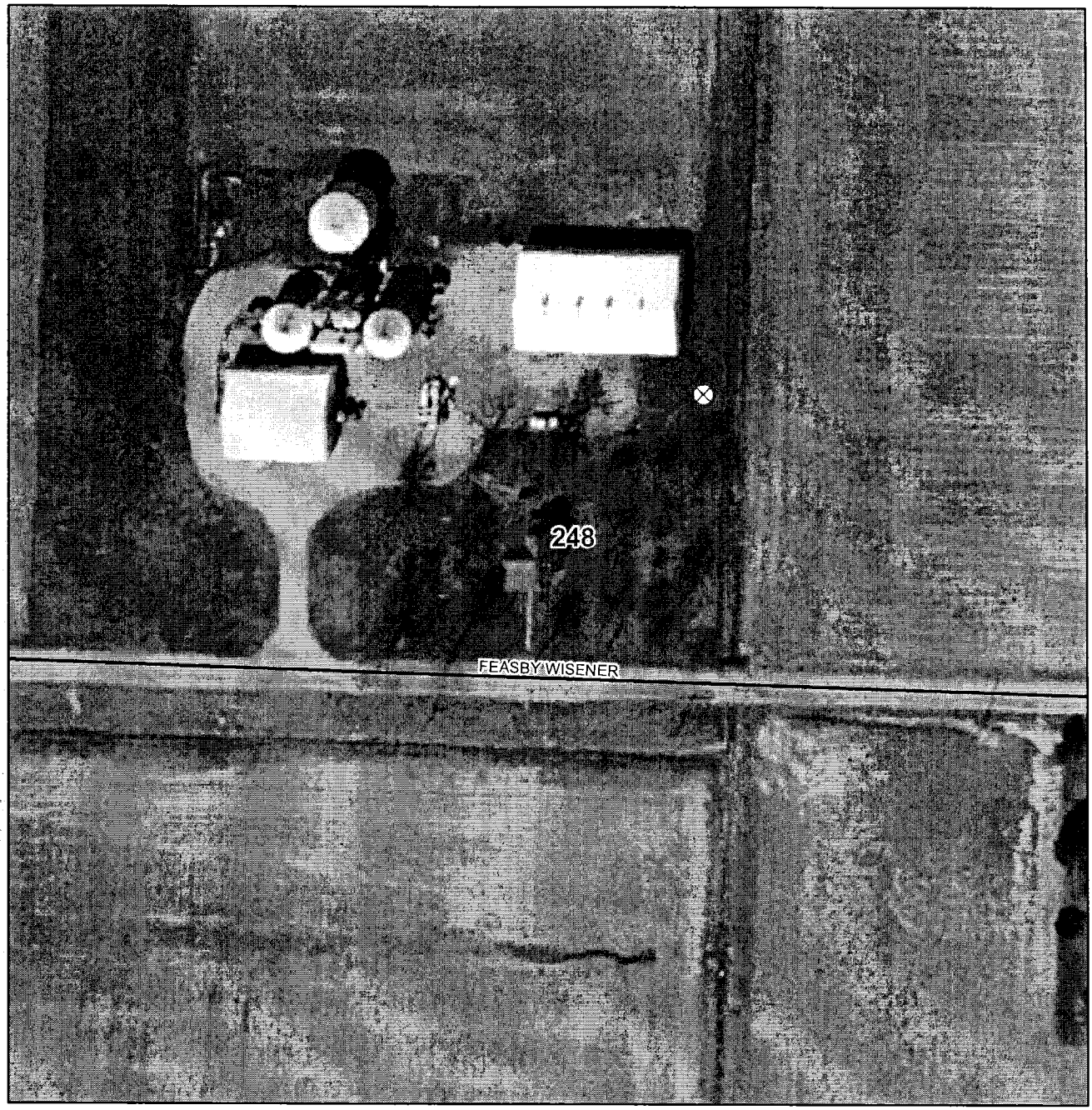
Feet

FIGURE A-6

Home 240 - Location of Sound Level Meter

Ambient Sound Survey

Blue Creek Wind Power Facility

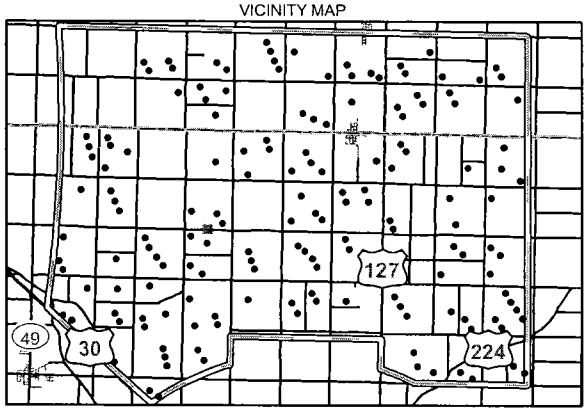


LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

Feet

FIGURE A-7

Home 248 - Location of Sound Level Meter

Ambient Sound Survey

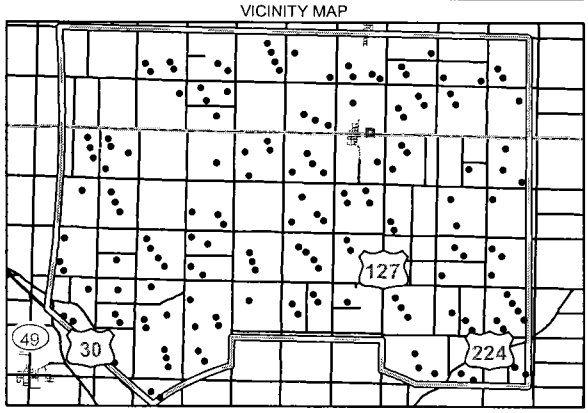
Blue Creek Wind Power Facility

LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

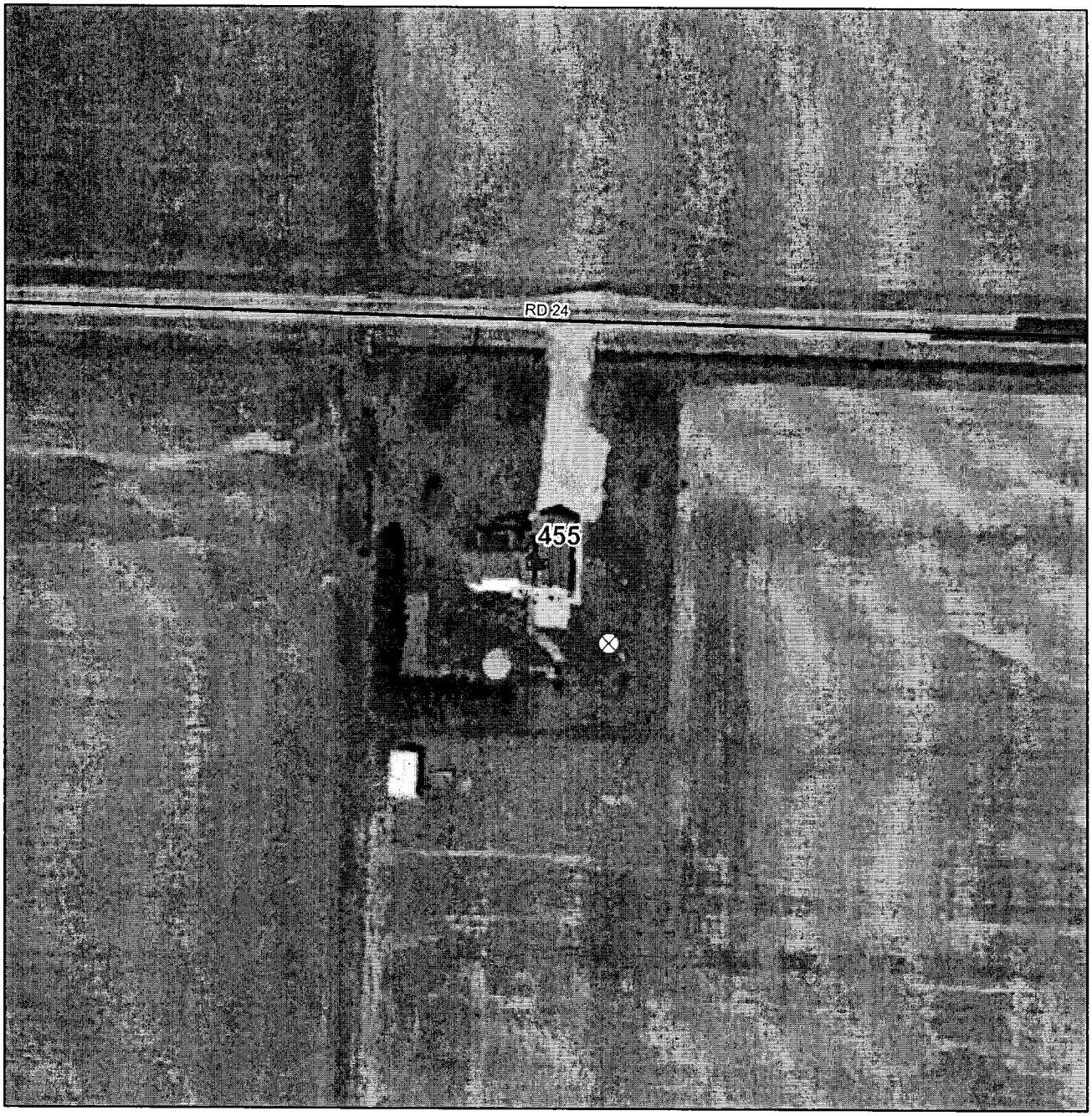
Feet

FIGURE A-8

Home 393 - Location of Sound Level Meter

Ambient Sound Survey

Blue Creek Wind Power Facility

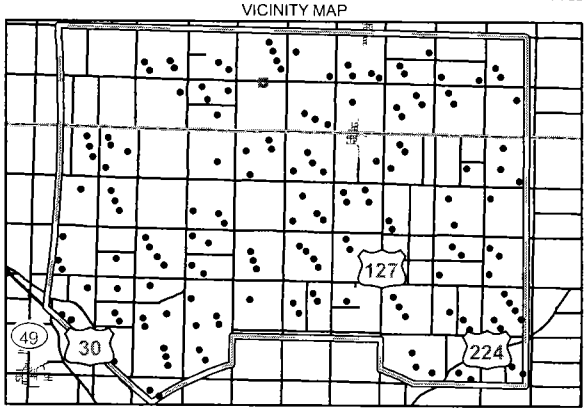


LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

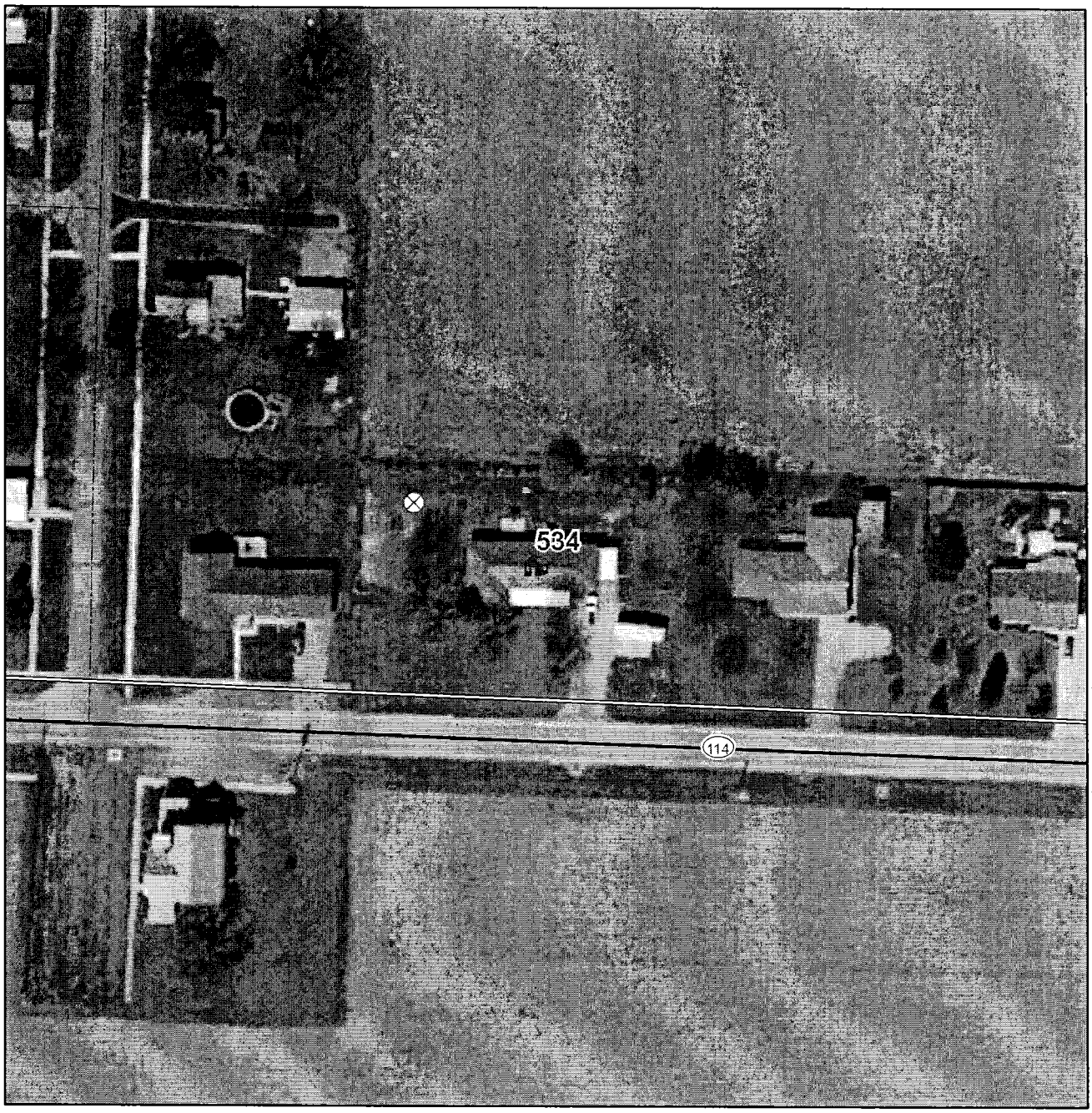
Feet

FIGURE A-9

Home 455 - Location of Sound Level Meter

Ambient Sound Survey

Blue Creek Wind Power Facility

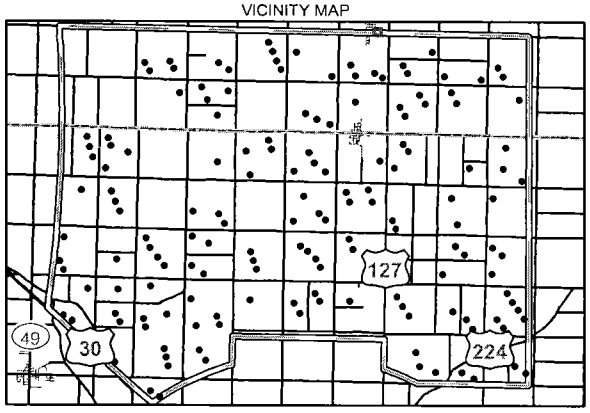


LEGEND

⊗ Sound Level Meter

Homes - Monitored

VICINITY MAP



N

0 25 50 100

Feet

FIGURE A-10

Home 534 - Location of Sound Level Meter

Ambient Sound Survey

Blue Creek Wind Power Facility

Summary: Correspondence submitting Responses to Staff Data Requests - Part 3 electronically filed by Teresa Orahood on behalf of Heartland Wind Energy LLC