Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN
Supplement to Application
November 14, 2018

Attachment 3

Sound Analysis

by Hankard Environmental, Inc.
November 12, 2018

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Pre-Construction Noise Analysis

for the proposed

Hardin Solar II Energy Center

November 12, 2018

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Contents

Figures

Tables

Executive Summary

This report describes the results of an analysis of the noise levels that are expected to be generated from the construction and operation of the Hardin Solar II Energy Center (Project). The proposed Project represents a second phase of the 150 megawatt (MW) Hardin Solar Energy Center. Like the first phase, the Project is a photovoltaic solar electrical generation facility to be located in Hardin County, Ohio, about 65 miles northwest of Columbus. The Project has a maximum generating capacity of 170 MW and is located adjacent to the proposed Hardin Wind Energy Center. During construction, the Project will generate noise from the operation of typical equipment such as bulldozers, excavators, and cranes. The primary sources of noise from the operation of the Project include inverters and solar tracker motors, as well as transformers at the substation where the Project will interconnect with the transmission grid.

Noise emissions from the Project are subject to the provisions of the Ohio Administrative Code, Chapter 4906-4. The Code requires the Project to (1) measure existing ambient (background) noise levels prior to construction, and (2) predict noise levels from the construction and operation of the Project at sensitive receptor locations. The Project is required to compare operational noise levels at noise-sensitive receptors (e.g. residences) located within one mile of the Project to a standard consisting of the ambient noise level plus five decibels.

Ambient noise levels were measured in the fall of 2009 at one location near the proposed solar facility as a part of the Hardin Wind Energy Center application. Data from this measurement was used to calculate the average daytime and nighttime noise levels of 48 dBA and 41 dBA, respectively. This results in daytime and nighttime noise level standards of 53 dBA and 46 dBA, respectively (ambient plus 5 dB). A mathematical model of noise levels from the construction and operation of the Project was generated and used to predict worst-case (loudest) noise levels at each of the 347 noise-sensitive receptors located within approximately one mile of the Project. Noise levels were also predicted at several locations along the Project property boundary.

During construction, the loudest noise levels expected at the noise-sensitive receptors range from about 60 to 66 dBA, with the loudest activity being pile driving. Much of the time construction noise levels will be lower than this range. These levels are below standards typically applied to construction noise by agencies such as the U.S. Federal Highway Administration. Construction will be limited to daytime hours to the extent practicable, will take place for approximately 12 to 18 months overall, but will occur near any one receptor location for only a few weeks at a time.

The primary sources of noise from the operation of the Project are the solar inverters located throughout the site, the solar tracking motors associated with each panel, and two off-site transformers. The loudest daytime operational noise level of 49 dBA is predicted at one residence on the southeast portion of the Project. All predicted levels are below the 53 dBA daytime standard. The loudest nighttime operational noise level when the solar tracker motors are offline is predicted to be 46 dBA at three residences in the central and southeast portions of the Project. All predicted levels meet the 46 dBA nighttime standard.

1. Introduction

This report describes the results of a pre-construction noise analysis conducted by Hankard Environmental for the proposed Hardin Solar II Energy Center (Project). The proposed Project is a photovoltaic solar electrical generation facility to be located in Hardin County, Ohio, about 65 miles northwest of Columbus, as shown in Figure 1-1. The solar facility has a maximum generating capacity of 170 megawatts (MW), and is located adjacent to the proposed Hardin Wind Energy Center.

The noise analysis demonstrates that the Project satisfies the requirements of Chapter 4906-4 of the Ohio Administrative Code, *Certificate Applications for Electric Generation Facilities.* Section 4906-4-08 (A)(3) requires the Project to provide a study of pre-construction (existing) noise levels, a description of construction and operational noise levels at the nearest property boundary and at all noise-sensitive receptors located within approximately one mile of the Project property boundary, and the measures that will be taken by the Project to mitigate noise emissions.

The following sections describe the noise regulation applicable to the Project, the Project site and the location of noise sensitive receptors, the results of the pre-construction ambient noise study, the methods and data used to predict construction and operation noise emissions, the predicted construction and operational noise levels, and the mitigative measures to be employed.

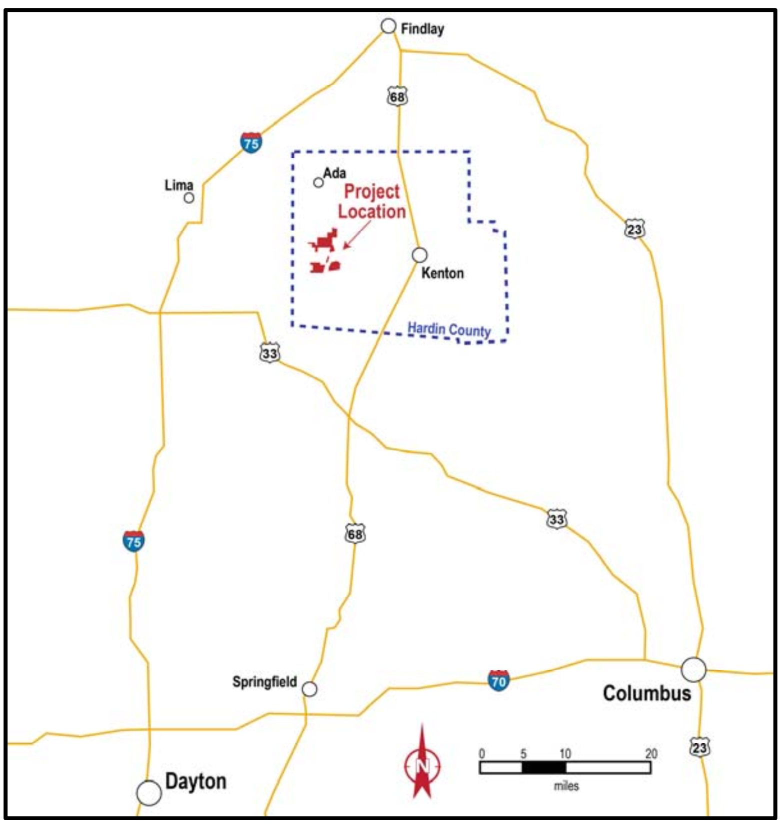

Figure 1-1. General Location of the Proposed Hardin Solar II Energy Center

2. Applicable Regulation

Chapter 4906-4 of the Ohio Administrative Code, *Certificate Applications for Electric Generation Facilities,* sets forth the rules governing standard certificate applications for electrical generation facilities. Section 4906-4-08, *Health and Safety, Land Use and Ecological Information*, describes the noise information required as part of a certificate application. Specifically, Paragraph (A)(3) requires:

(3) The applicant shall provide information on noise from the construction and operation of the facility.

(a) Describe the construction noise levels expected at the nearest property boundary. The description shall address:
- (i) Blasting activities.
- (ii) Operation of earth moving equipment.
- (iii) Driving of piles, rock breaking or hammering, and horizontal directional drilling.
- (iv) Erection of structures.
- (v) Truck traffic.
- (vi) Installation of equipment.

(b) Describe the operational noise levels expected at the nearest property boundary. The description shall address:
- (i) Operational noise from generation equipment. In addition, for a wind facility, cumulative operational noise levels at the property boundary for each non-participating property adjacent to or within the project area, under both day and nighttime operations. The applicant shall use generally accepted computer modeling software (developed for wind turbine noise measurement) or similar wind turbine noise methodology, including consideration of broadband, tonal, and low-frequency noise levels.
- (ii) Processing equipment.
- (iii) Associated road traffic

(c) Indicate the location of any noise-sensitive areas within one mile of the proposed facility, and the operational noise level at each habitable residence, school, church, and other noise-sensitive receptors, under both day and nighttime operations.

(d) Describe equipment and procedures to mitigate the effects of noise emissions from the proposed facility during construction and operation, including limits on the time of day at which construction activities may occur.

(e) Submit a preconstruction background noise study of the project area that includes measurements taken under both day and nighttime conditions.

3. Project Site

The Project is located in Marion and Roundhead townships in Hardin County, Ohio. Figure 3-1 shows the Project site, including the locations of the solar panels and inverters, the substation, and the Project boundary. The site is bordered to the north by County Road 100, to the south by State Route 150, to the east by County Road 75, and to the west by State Route 235. Figure 3-1 also shows the location of the 347 noise-sensitive receptors within approximately one mile of the Project. The noise-sensitive receptors include 342 residences, two cemeteries, one school, the school's outdoor fields, and one church. The land use immediately surrounding the Project is a mix of agricultural and rural residential.

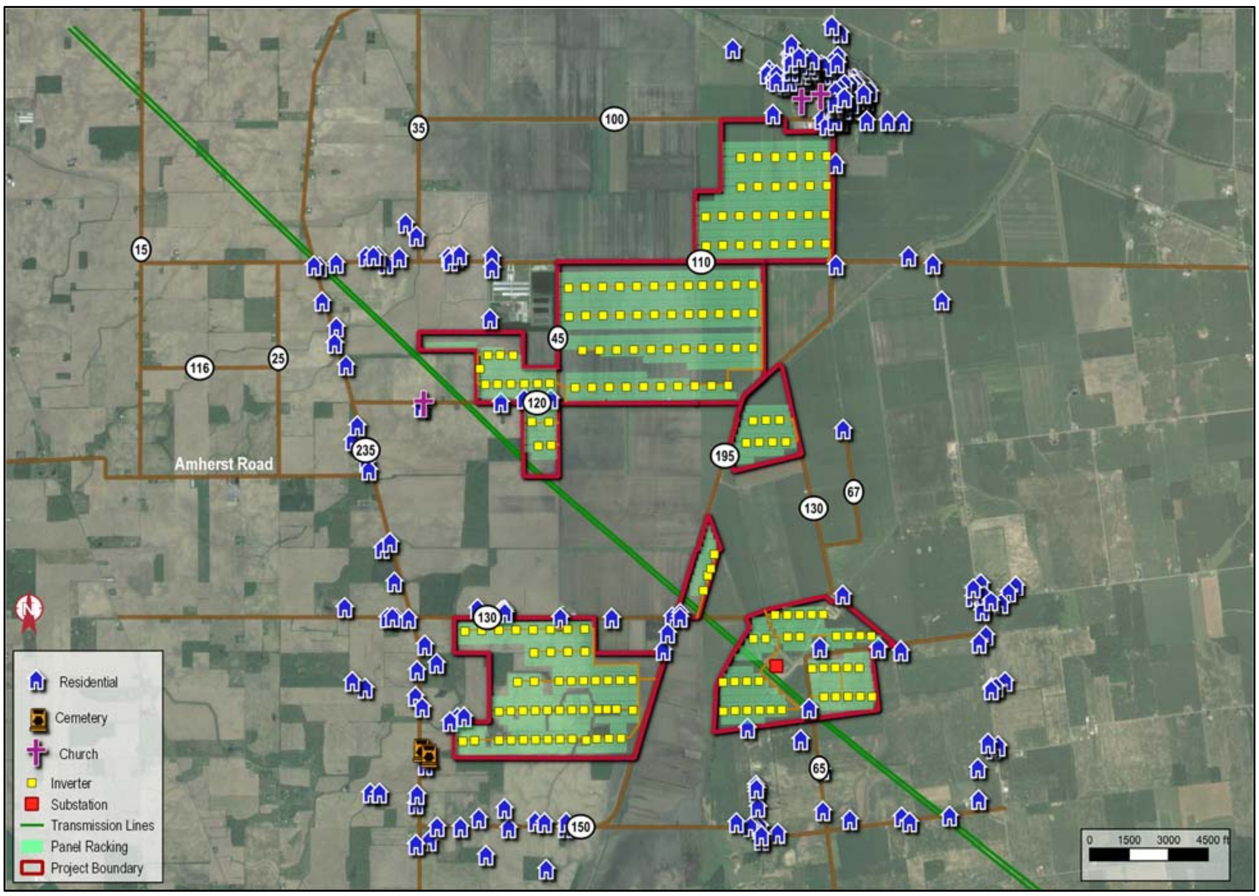

Figure 3-1. Proposed Hardin Solar II Energy Center Layout

4. Pre-Construction Background Noise Study

A background (ambient) noise level survey was conducted in the fall of 2009 as part of the Hardin Wind Energy Center project (*Hardin Wind Farm Baseline Sound Survey Report*, Tetra Tech, December 2009). From this report, Monitoring Position 4 was selected as representative of conditions near the solar Project. As shown in Figure 4-1, background noise measurements were taken on a residential property (Receptor H-2051) approximately one mile to the east of the southwest corner of the Project. Data was collected for approximately three weeks, from November 10 through December 1, 2009. Figure 4-2 shows the measured noise levels over that period. After removing all the times when it was precipitating or stormy, the daytime (7:00 am to 7:00 pm) and nighttime (7:00 pm to 7:00 am) average noise levels were calculated to be 48 dBA and 41 dBA, respectively. Note that no ground wind speed data was available, and thus no noise data was removed due to high ground winds.

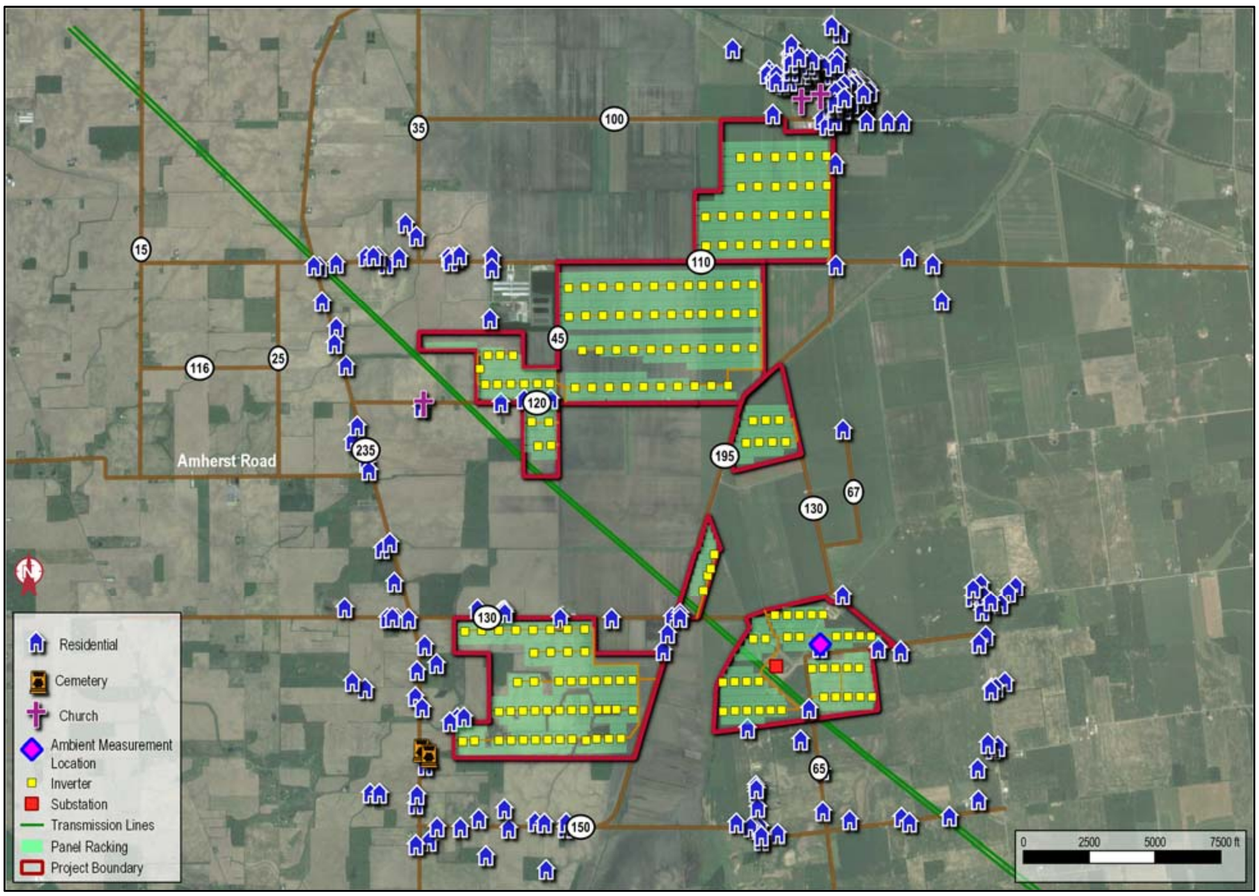

Figure 4-1. Background (Ambient) Noise Measurement Location

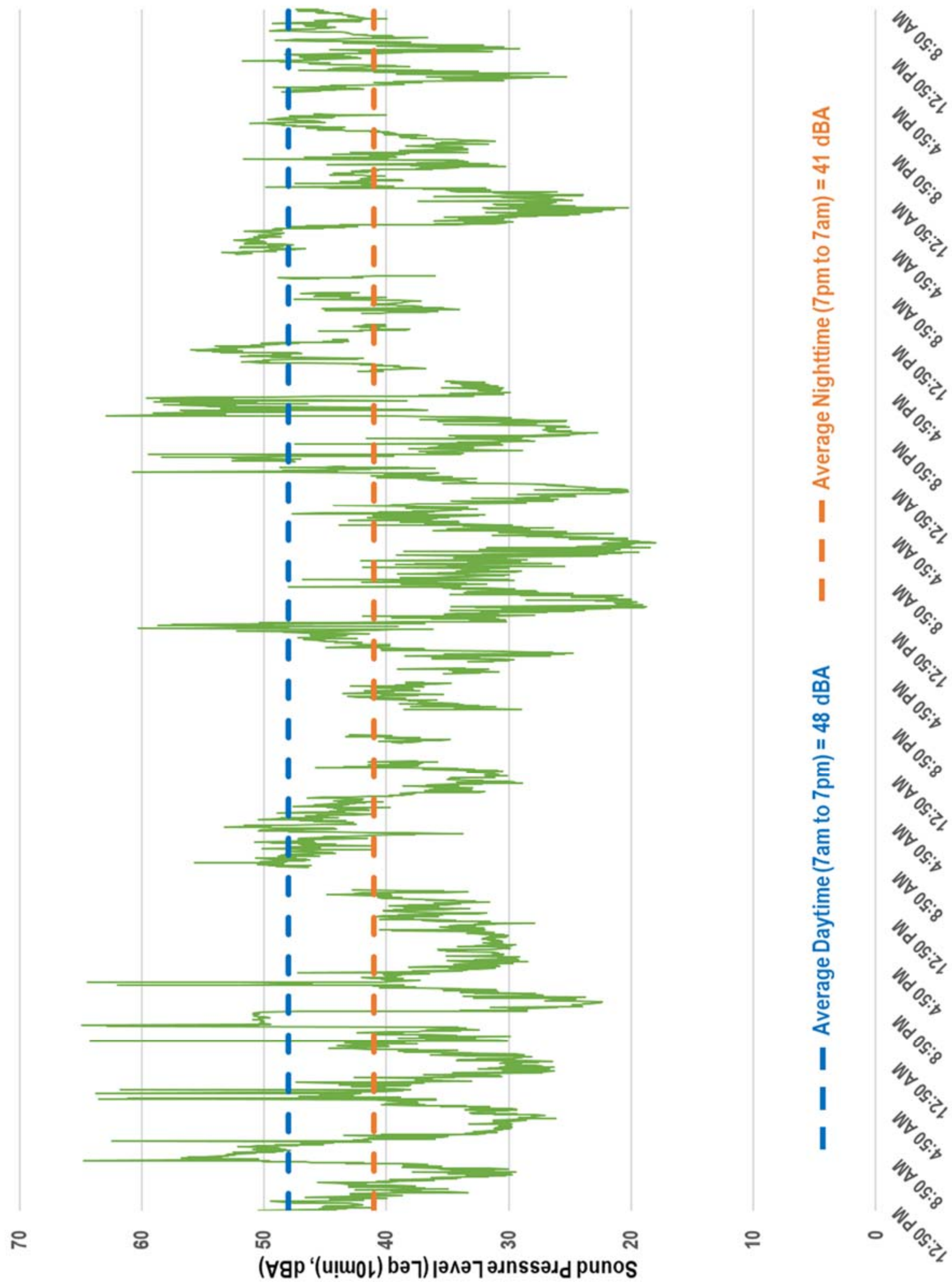

Figure 4-2. Measured Background Noise Levels (November 10 to December 1, 2009)

5. Noise Modeling Method

Noise levels from the proposed Project were predicted using the International Organization for Standardization (ISO) Standard 9613-2, *Attenuation of Sound During Propagation Outdoors - Part 2: General method of calculation*. The calculations were implemented using the SoundPLAN v7.4 acoustical modeling software program. There are a number of parameters in the ISO 9613-2 method, including the locations of the noise sources and receivers, noise source spectral characteristics, terrain and ground type, and atmospheric propagation conditions. The ISO method assumes optimal acoustic propagation in all directions, specifically that a "well-developed, moderate ground-based temperature inversion" is present or, equivalently, that all receptors are downwind of all noise sources at all times. The sections below describe the specific ISO 9613-2 settings used in this analysis to predict the noise levels from the four phases of construction noise and the one operational phase.

Terrain and Ground Effect

The terrain in the acoustic model was defined using Digital Elevation Model (DEM) data from the U.S. Geological Survey (USGS) National Elevation Dataset. The acoustical effect of the ground was modeled using the ISO 9613-2 General Method. This method requires the selection of ground factors for the ground near the source, near the receiver, and in between. A ground factor of 0.0 represents a completely reflective surface such as pavement, which would result in a higher level of sound reaching a receiver. A ground factor of 1.0 represents absorptive ground such as thick grass or fresh snow, resulting in a lower level of sound reaching the receiver. For this project, a ground factor of 0.5 was used because it is expected that native grasses will be planted after construction. Actual ground conditions could, at rare times, be 0.0 when the ground is completely frozen and bare, but would generally be closer to 0.5 when the ground is covered with vegetation or is bare and unfrozen.

Atmospheric Conditions

The air temperature, relative humidity, and atmospheric pressure were set to standard-day conditions of 10°C, 70%, and 1 atmosphere, respectively. Per ISO 9613-2, these values result in the least amount of atmospheric sound absorption and the highest levels of sound reaching the receivers.

Receptors

In the SoundPLAN model, prediction points (receptors) were located along the Project boundary, as well as at the 347 noise-sensitive receptors within approximately one mile of the Project boundary. Of these receptors, 342 are residential, two are cemeteries, one is a school, one is a school's outdoor fields, and one is a church. Prediction locations are shown in Figures 5-1 to 5-3. In accordance with ISO 9613-2, the height above the ground for each receptor was set to 5 feet.

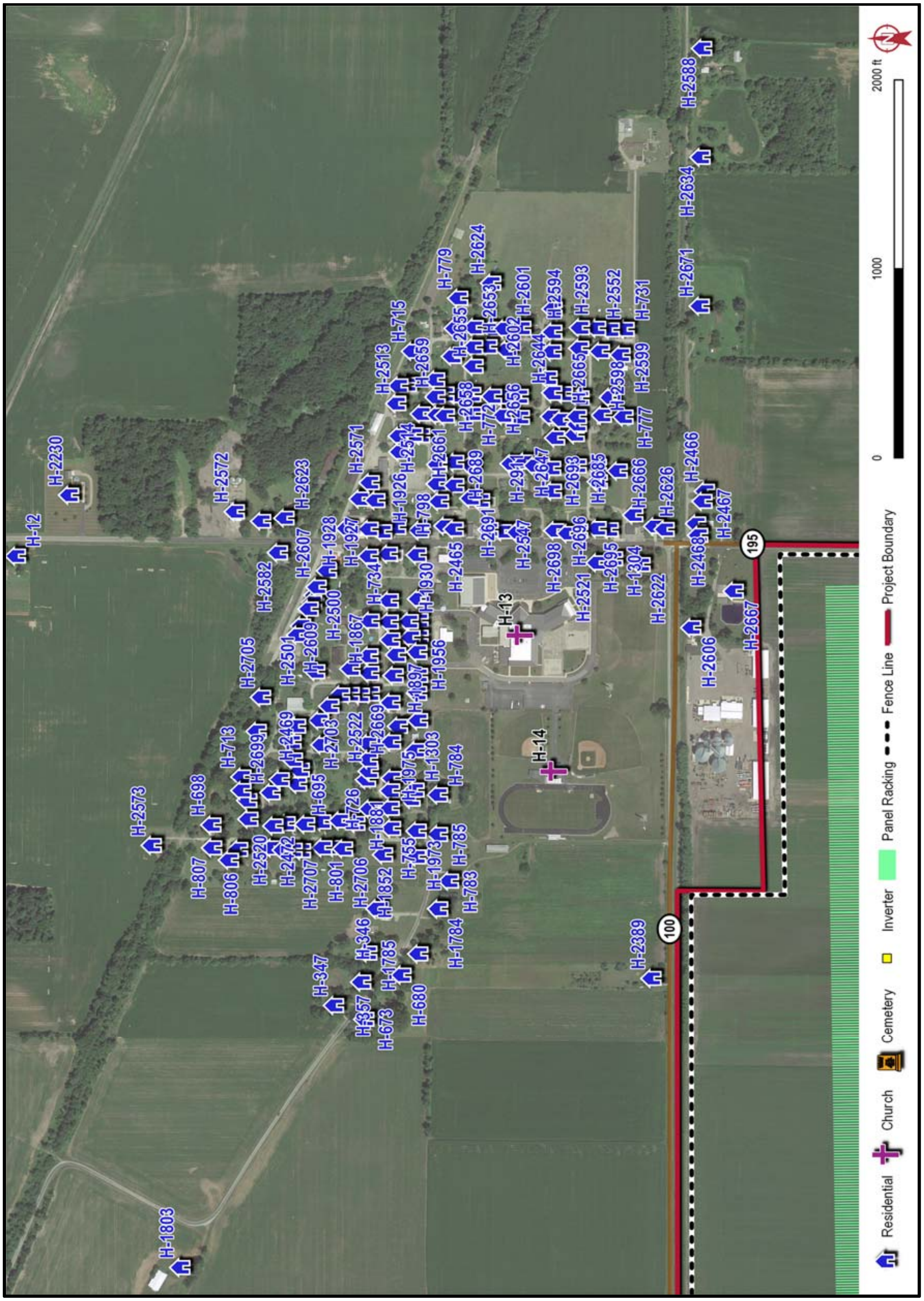

Figure 5-1. Noise-Sensitive Receptors – Northern Area

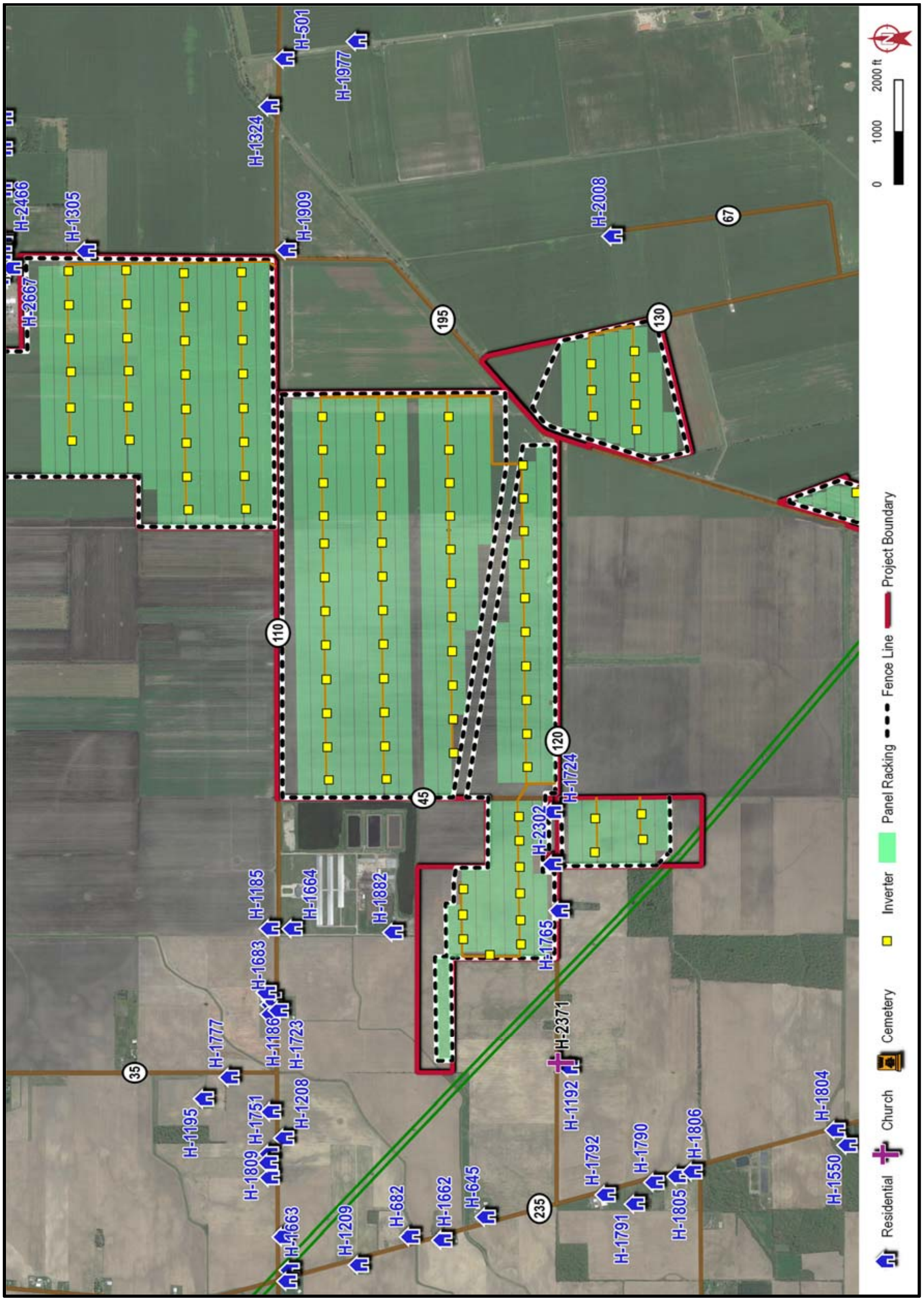

Figure 5-2. Noise-Sensitive Receptors – Central Area

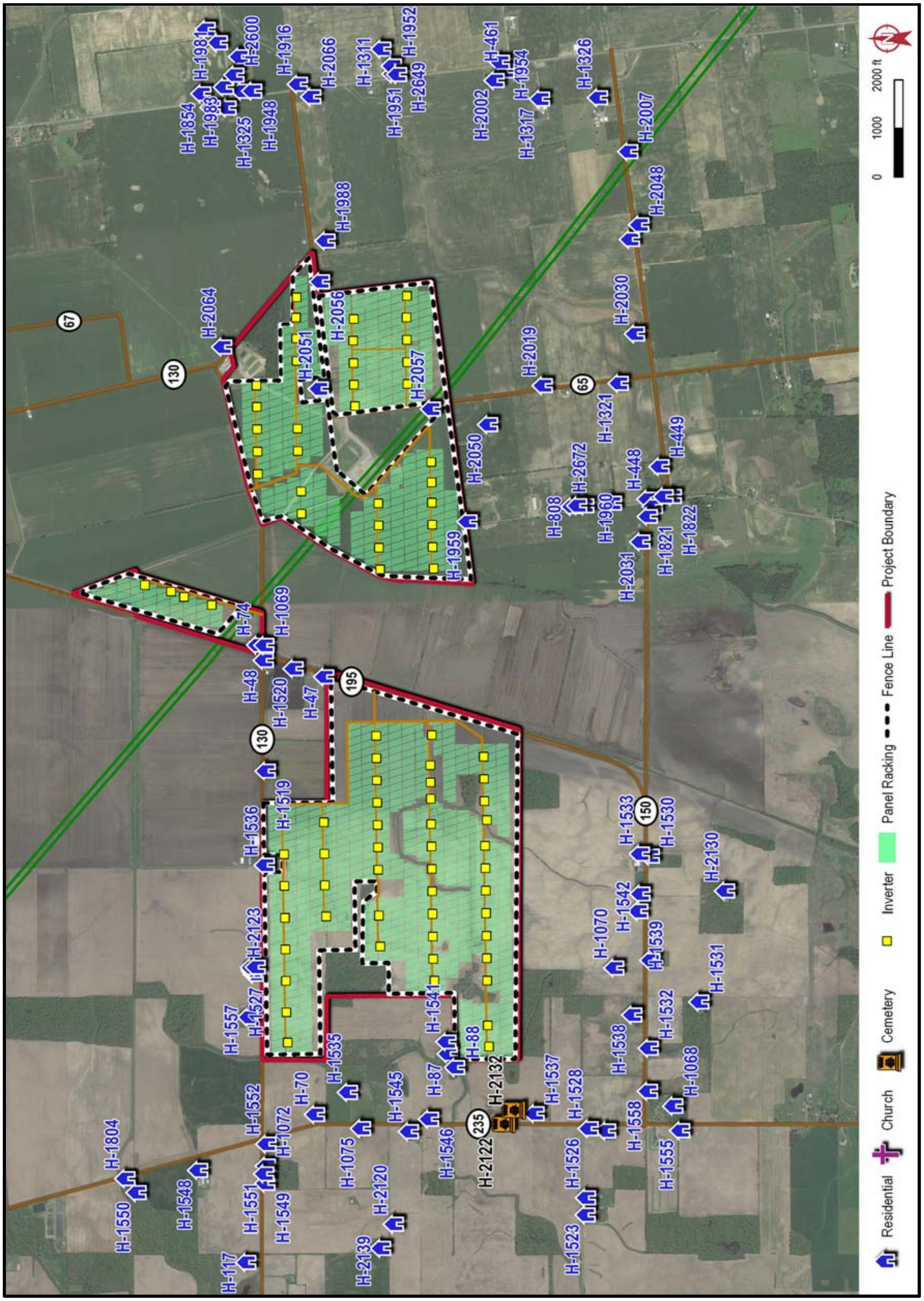

Figure 5-3. Noise-Sensitive Receptors – Southern Area

Construction Noise Sources

Noise levels were predicted for the four phases of construction: site preparation, civil work, mechanical assembly, and electrical work. Table 5-1 lists the equipment associated with each phase, as well as the number of units to be employed, the sound power level of each unit, and the percent of time that each piece of equipment is expected to be used at full capacity (the usage factor). Construction noise source levels were generally based on measurements of construction equipment made by Hankard Environmental on previous projects. The usage factors were taken from the Federal Highway Administration's (FHWA) Roadway Construction Noise Model (RCNM) v1.1. All construction noise sources were modeled at 10 feet above the ground.

Table 5-1. Noise Source Characteristics of Construction Equipment

Phase	Equipment Type (quantity)	Usage Factor (%)	Octave Band Sound Power Level (dB)									Overall Sound Power Level (dBA)
			31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	
1 Site Preparation	Bulldozer (1)	40%	116	111	116	116	105	107	104	95	85	112
	Excavator (2)	40%	103	112	112	107	99	97	95	92	85	104
	Motor Grader (2)	40%	100	99	110	104	101	110	103	94	89	112
	Water Truck (1)	40%	103	107	112	103	106	104	98	94	85	108
	Dump Truck (1)	40%	98	112	105	103	97	98	96	90	82	103
2 Civil Work	Roller (1)	40%	--	138	128	115	101	98	97	94	90	116
	Dump Truck (1)	40%	98	112	105	103	97	98	96	90	82	103
	Excavator (2)	40%	103	112	112	107	99	97	95	92	85	104
	Trencher (1)	50%	109	114	114	108	105	102	101	95	87	108
	Motor Grader (2)	40%	100	99	110	104	101	110	103	94	89	112
	Water Truck (1)	40%	103	107	112	103	106	104	98	94	85	108
3 Mechanical Assembly	Pile Driving (1)	20%	128	130	132	121	125	126	124	119	111	130
	Pickup Truck (2)	40%	100	114	107	105	99	101	98	92	84	105
	Man Lift (2)	20%	102	108	101	92	92	93	94	87	81	99
	Crane (1)	16%	---	139	117	104	102	100	96	90	85	114
	Backhoe/Loader (1)	40%	105	102	111	101	99	101	99	96	91	106
4 Electrical Work	Pickup Truck (2)	40%	100	114	107	105	99	101	98	92	84	105
	Flatbed Truck (1)	40%	100	114	107	105	99	101	98	92	84	105
	Man Lift (1)	20%	102	108	101	92	92	93	94	87	81	99
	Small Generator (1)	50%	103	110	108	108	105	104	103	102	98	110
	Compressor (1)	40%	106	113	111	111	108	107	106	105	101	113

Operational Noise Sources

Noise sources associated with the operation of the Project include 177 inverters located throughout the Project site, approximately 24,946 single-axis solar trackers on the site, and two 175 MVA transformers located off-site at the substation about one mile away. Table 5-2 lists the sound power levels for each source. Note that while noise from the solar inverters and transformers may occur a night, the solar panels are in a fixed position at night and thus the solar trackers are silent.

The overall sound power level for the inverters was based on data for the SMA 2.5 MW Inverter – Model SC2200. The solar tracker motor overall sound power level was provided by the manufacturer, and we assumed a typical electrical motor spectrum. The sound power levels of the transformers were estimated using the procedures outlined in NEMA TR 1-1993 and IEEE C57.12.90-1993. The inverters and transformers were modeled at 10 feet above the ground, and all solar tracker motors were modeled at approximately four feet above the ground. It was assumed that all operational equipment would be in use at all times, with the solar trackers operating according to the schedule described in Section 7 below. It was also assumed that the inverters would be operating at full power.

Table 5-2. Noise Source Characteristics of Operational Equipment

Equipment Type	Equipment Quantity	Usage Factor (%)	Octave Band Sound Power Level (dB)									Overall Sound Power Level (dBA)
			31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz	8,000 Hz	
Solar Inverter	177	100%	--	86	87	89	88	83	81	86	75	91
Solar Tracker Motor	24,946	100%	54	71	69	69	66	65	64	63	59	71
Transformer (175 MVA)	2	100%	95	101	103	97	98	92	86	82	75	98

6. Predicted Construction Noise Levels

Noise levels from construction of the proposed Project were predicted along the Project property boundary, as well as at the 347 noise-sensitive receptors located within approximately one mile of the Project boundary. Noise levels were predicted for each of the four primary phases of construction. The first phase is site preparation, which is expected to last approximately nine weeks. The second phase is civil work, which involves grading (thirty weeks), the construction of access roads (thirty weeks), and final grading and landscaping (four weeks). The third phase is the installation of piers, racks, and modules, and is expected to last about ten months. The final phase is the electrical work, which consists of connecting all the equipment and is expected to last about eleven months. Some of this work will be conducted concurrently, although in different areas of the site, resulting in an approximate overall schedule of 12 to 18 months.

For each phase of construction, noise levels were predicted assuming that all equipment associated with that phase were operating simultaneously. While construction will take place throughout the Project area, the worst-case scenario is when it is taking place near receptors. To assess this, noise levels were predicted assuming construction was taking place at the six representative locations shown in Figure 6-1. The results of the predictions are listed in Table 6-1. Noise levels ($L_{eq\text{-}1hr}$) along the boundary of the Project range from 31 to 67 dBA, with pile driving being the loudest activity. Noise levels ($L_{eq\text{-}1hr}$) predicted at the nearest residences to each construction area range from 24 to 66 dBA, and again pile driving is the loudest activity. Construction noise level predictions at each receptor are provided in Appendix A.

These levels are worst-case, as they assume that all of the equipment associated with each phase is operating close to the Project boundary. Much of the time, noise levels will be far lower when (1) some or all the equipment is idling or off, (2) construction takes place farther into the interior of the Project area, or (3) atmospheric conditions are less conducive to sound propagation than the worst-case condition modeled here. In terms of construction noise mitigation (reduction), the primary measure is to limit construction to daytime only to the extent practicable, particularly for loud operations taking place near the Project boundary. Secondly, the contractor should be required to use well-maintained equipment, particularly with respect to mufflers. Finally, a construction noise or general complaint telephone hotline should be established.

Table 6-1. Predicted Construction Noise Levels

Construction Phase	$L_{eq\text{-}1hr}$ (dBA)			
	Property Line		Noise Sensitive Receptors	
	Minimum	Maximum	Minimum	Maximum
1 – Site Preparation	33	60	26	58
2 – Civil Work	41	61	36	59
3 – Mechanical Assembly (w/o pile driving)	38	56	32	54
3 – Mechanical Assembly (w/ pile driving)	43	67	36	66
4 – Electrical Work	31	56	24	55

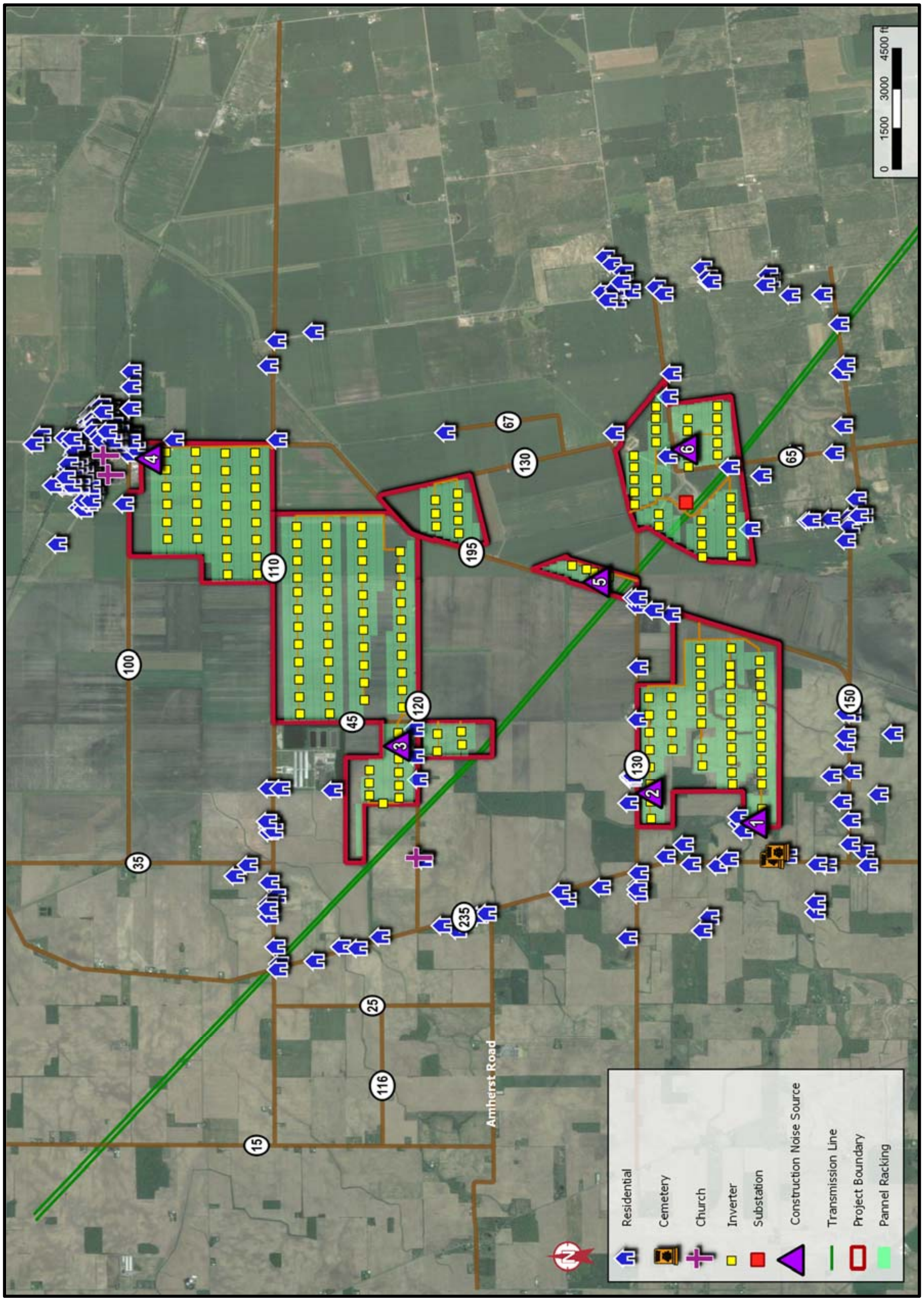

Figure 6-1. Construction Activity Areas for Noise Predictions

7. Predicted Operational Noise Levels

The primary noise sources associated with the operation of the Project include the 177 pad-mounted inverters and the approximately 24,9467 panel-mounted single-axis solar trackers, and the two 175 MVA transformers located at the substation. The inverters typically operate 24 hours per day, but are expected to be loudest during the daytime when under full load. The solar tracking motors operate for 5 to 10 seconds every 1 to 2 minutes during daylight hours, and then reset to a stowed position with panels parallel to the ground at night. Worst-case operational noise levels were predicted along the Project boundary and at the 347 noise-sensitive receptors located within approximately one mile of the Property boundary. During the daytime, all sources were assumed to be operating at their loudest levels. At night, the inverters were assumed to still emit noise, but the tracking motors were off.

Figures 7-1 and 7-2 show the predicted worst-case operational noise levels at the forty receptors with the loudest predicted levels during the daytime and nighttime, respectively. As shown, the predicted worst-case levels are equal to or less than the respective noise level limits (53 dBA daytime and 46 dBA nighttime). Overall, predicted worst-case noise levels ($L_{eq\text{-}1hr}$) at the 342 nearby residences, two cemeteries, two school buildings, and one church range from 26 dBA to 49 dBA, with an average of 35 dBA during the daytime hours. During the nighttime hours, the maximum predicted level is reduced to 46 dBA due to the solar tracking motors not operating. The loudest location is residence H-2051, which is located in the southeast portion of the Project off Dodds Road. Two other residences (H-2302 and H-1724) in the central portion of the Project are predicted to have worst-case noise levels of 46 dBA at night. See Appendix B for a list of predicted operational noise levels at all receptors.

The daytime and nighttime operational noise levels are depicted graphically in Figures 7-3 and 7-4, respectively. Shown are the 53 dBA and 46 dBA noise levels contours. Along the property boundary, the predicted worst-case operational noise levels are as high as 55 dBA during the daytime hours and 49 dBA during the nighttime hours. These levels are predicted at boundary locations where adjacent land use is agricultural or undeveloped, which are not considered noise-sensitive. Noise levels adjacent to residential locations are below 49 dBA during the daytime and at or below 46 dBA during the nighttime.

The Project should not use equipment with rated sound power levels exceeding those listed in Table 5-2. All maintenance activities should be conducted during daytime hours using well-maintained and properly muffled vehicles and equipment.

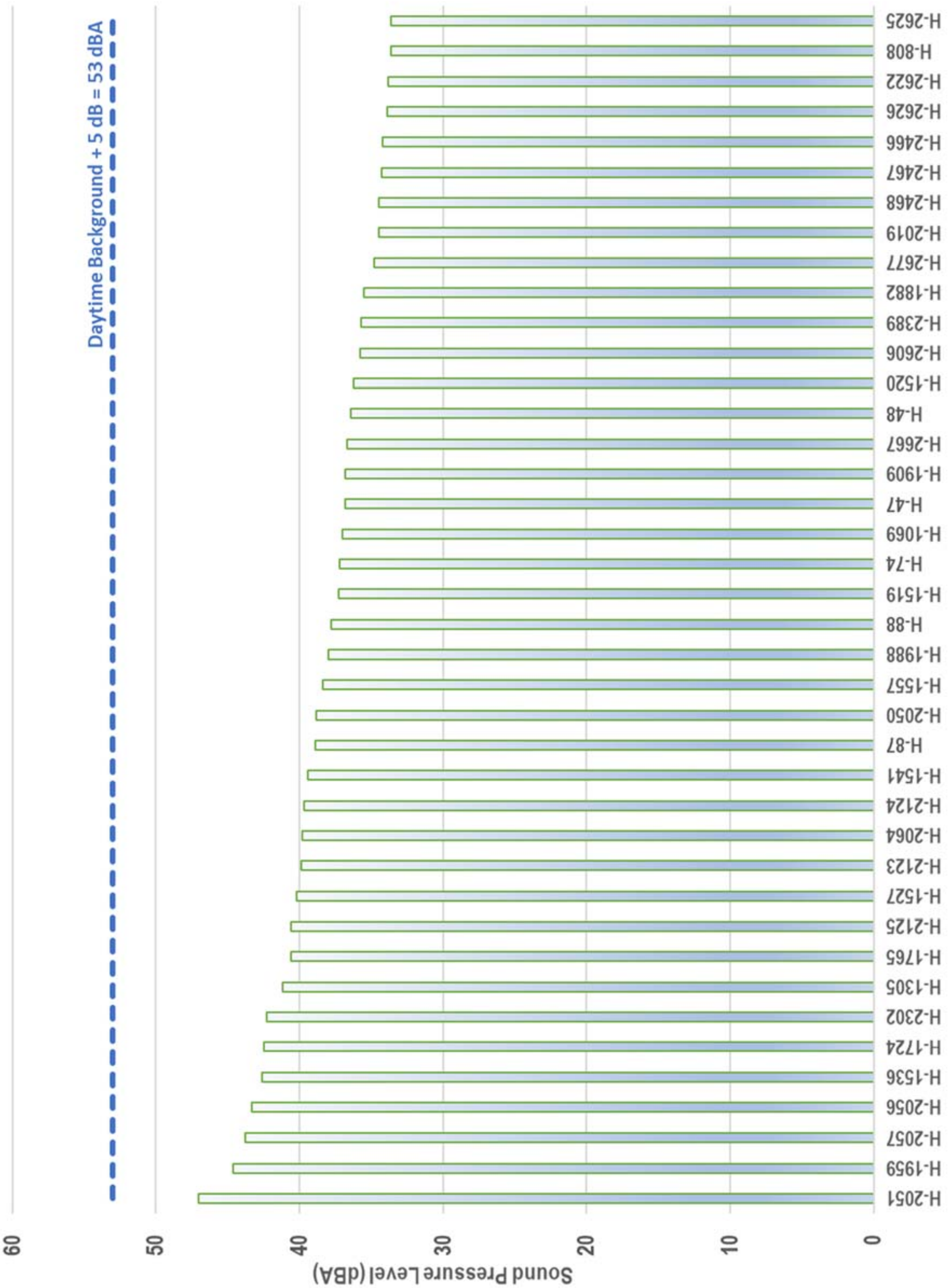

Figure 7-1. Predicted Loudest Daytime Operational Noise Levels and OPSB Limits

Figure 7-2. Predicted Loudest Nighttime Operational Noise Levels with OPSB Limits

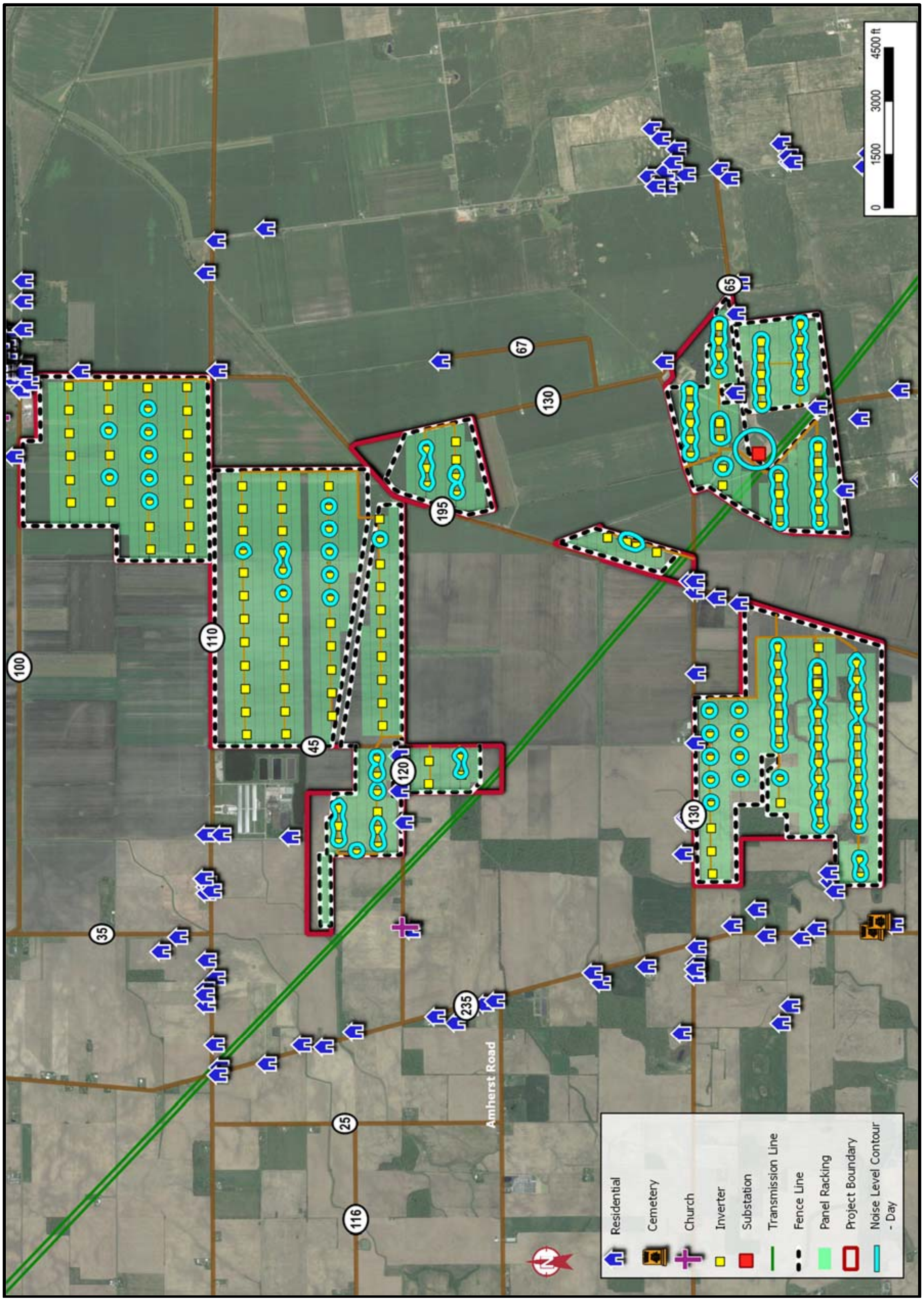

Figure 7-3. Predicted Daytime Operational Noise Level Contours

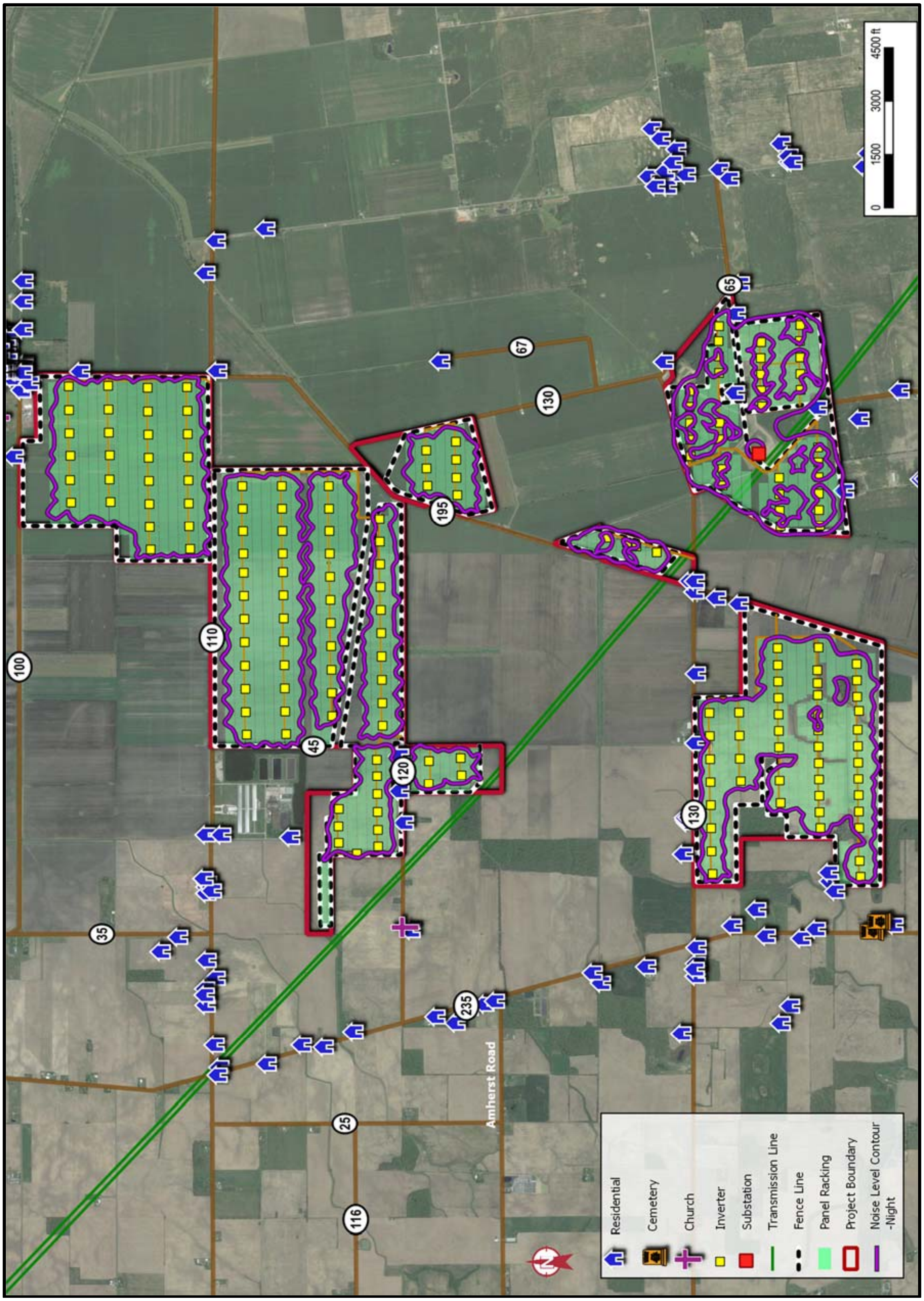

Figure 7-4. Predicted Nighttime Operational Noise Level Contours

APPENDIX A

Predicted Construction Noise Levels

Table A-1. Predicted Construction Noise Levels

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
Property Line	Worst Case	60	61	56	67	56
H-11	Residence	40	45	41	50	38
H-12	Residence	36	42	38	46	34
H-13	School	47	51	46	57	45
H-14	School	47	52	47	57	45
H-47	Residence	44	48	45	54	42
H-48	Residence	50	52	50	60	48
H-70	Residence	43	48	44	52	41
H-74	Residence	53	54	52	63	51
H-87	Residence	56	56	52	63	51
H-88	Residence	55	55	51	62	50
H-117	Residence	35	42	38	45	33
H-346	Residence	41	47	42	52	39
H-347	Residence	40	45	41	50	38
H-357	Residence	40	46	41	50	38
H-420	Residence	30	38	34	39	27
H-448	Residence	33	41	38	43	31
H-449	Residence	33	41	37	43	31
H-461	Residence	31	38	35	40	28
H-501	Residence	33	40	36	42	30
H-645	Residence	31	39	36	41	29
H-673	Residence	40	45	41	50	38
H-674	Residence	29	37	33	38	26
H-680	Residence	41	46	42	51	39
H-682	Residence	29	37	34	39	27
H-689	Residence	44	49	44	54	42
H-695	Residence	41	46	42	51	39
H-696	Residence	41	47	42	52	39
H-697	Residence	41	46	42	51	39
H-698	Residence	39	45	40	49	37
H-713	Residence	40	45	41	50	38
H-714	Residence	45	49	45	55	43
H-715	Residence	42	47	42	52	39
H-718	Residence	43	48	43	53	41
H-724	Residence	43	48	43	53	41
H-725	Residence	41	46	42	51	39
H-726	Residence	42	47	43	52	40
H-731	Residence	46	49	45	55	43
H-732	Residence	45	49	45	55	42
H-733	Residence	43	47	43	52	40
H-734	Residence	43	48	43	53	41
H-738	Residence	43	47	43	52	40

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-739	Residence	42	47	42	52	40
H-740	Residence	43	48	43	53	41
H-741	Residence	42	47	42	52	40
H-747	Residence	44	49	44	54	42
H-750	Residence	44	48	43	53	41
H-752	Residence	42	47	43	52	40
H-753	Residence	41	47	42	52	39
H-754	Residence	41	47	42	52	39
H-755	Residence	42	48	43	53	40
H-767	Residence	46	50	45	56	43
H-772	Residence	44	48	43	53	41
H-773	Residence	44	48	44	54	41
H-776	Residence	47	51	46	56	44
H-777	Residence	47	51	46	57	45
H-778	Residence	48	52	47	57	45
H-779	Residence	42	47	42	52	39
H-780	Residence	43	48	43	53	41
H-783	Residence	43	48	43	53	41
H-784	Residence	44	49	44	54	42
H-785	Residence	43	48	44	54	41
H-786	Residence	43	49	44	54	41
H-797	Residence	44	49	44	54	42
H-798	Residence	44	48	44	54	41
H-799	Residence	44	49	44	54	42
H-800	Residence	48	52	47	58	45
H-801	Residence	41	46	42	51	39
H-802	Residence	41	46	42	51	39
H-803	Residence	40	46	41	51	38
H-804	Residence	40	45	41	50	38
H-805	Residence	39	45	40	49	37
H-806	Residence	39	45	40	49	37
H-807	Residence	39	45	40	49	37
H-808	Residence	36	43	39	46	34
H-1067	Residence	39	45	41	49	37
H-1068	Residence	38	44	40	47	35
H-1069	Residence	52	53	51	62	50
H-1070	Residence	42	47	43	52	40
H-1072	Residence	39	45	41	49	37
H-1075	Residence	43	48	44	52	40
H-1185	Residence	35	42	38	44	32
H-1186	Residence	34	41	37	43	31
H-1192	Residence	37	43	39	47	34
H-1195	Residence	29	38	34	39	27
H-1208	Residence	30	38	34	40	27

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-1209	Residence	28	36	33	38	25
H-1291	Residence	42	48	43	53	40
H-1303	Residence	43	48	43	53	41
H-1304	Residence	49	54	49	60	47
H-1305	Residence	55	55	51	62	50
H-1307	Residence	42	47	42	52	40
H-1311	Residence	31	39	35	41	29
H-1314	Residence	50	54	48	60	47
H-1317	Residence	31	39	35	41	29
H-1321	Residence	35	42	38	44	32
H-1324	Residence	35	41	37	44	31
H-1325	Residence	33	40	36	42	30
H-1326	Residence	29	38	34	39	27
H-1519	Residence	43	47	44	52	40
H-1520	Residence	47	50	47	57	45
H-1523	Residence	38	43	39	47	35
H-1525	Residence	41	46	42	50	38
H-1526	Residence	38	44	40	47	35
H-1527	Residence	56	58	53	65	52
H-1528	Residence	42	47	42	51	39
H-1530	Residence	36	43	39	46	34
H-1531	Residence	37	43	39	47	35
H-1532	Residence	40	46	41	50	38
H-1533	Residence	37	44	40	47	35
H-1535	Residence	45	49	45	54	42
H-1536	Residence	46	50	46	55	42
H-1537	Residence	46	50	45	55	43
H-1538	Residence	41	47	42	51	39
H-1539	Residence	39	45	41	48	36
H-1541	Residence	57	57	53	64	52
H-1542	Residence	38	44	40	48	36
H-1545	Residence	45	48	44	53	41
H-1546	Residence	46	50	45	55	43
H-1548	Residence	38	44	40	47	35
H-1549	Residence	39	45	41	48	36
H-1550	Residence	36	43	39	45	33
H-1551	Residence	39	45	41	48	36
H-1552	Residence	41	46	42	50	38
H-1555	Residence	37	43	39	46	34
H-1557	Residence	50	54	49	60	48
H-1558	Residence	40	45	41	49	37
H-1564	Residence	33	41	37	43	31
H-1662	Residence	30	38	35	40	27
H-1663	Residence	27	36	32	37	24

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-1664	Residence	36	42	38	45	33
H-1682	Residence	33	40	37	43	30
H-1683	Residence	34	41	37	43	31
H-1723	Residence	34	41	37	43	31
H-1724	Residence	57	59	54	66	55
H-1751	Residence	29	37	34	39	27
H-1759	Residence	27	36	33	37	25
H-1765	Residence	47	51	47	58	46
H-1777	Residence	30	38	35	40	28
H-1784	Residence	42	48	43	53	41
H-1785	Residence	41	46	42	51	39
H-1786	Residence	41	47	42	52	40
H-1790	Residence	33	41	37	42	30
H-1791	Residence	32	40	37	42	30
H-1792	Residence	32	40	37	42	30
H-1803	Residence	35	42	38	45	33
H-1804	Residence	36	43	39	45	33
H-1805	Residence	33	41	37	43	31
H-1806	Residence	33	41	37	43	31
H-1808	Residence	30	38	34	40	28
H-1809	Residence	29	37	33	39	26
H-1817	Residence	26	36	32	36	24
H-1821	Residence	33	41	38	43	31
H-1822	Residence	33	41	37	42	30
H-1852	Residence	42	47	43	52	40
H-1854	Residence	32	39	35	41	29
H-1867	Residence	43	48	43	53	41
H-1868	Residence	44	49	44	54	42
H-1881	Residence	43	48	43	53	41
H-1882	Residence	41	46	42	50	38
H-1896	Residence	43	48	44	54	41
H-1897	Residence	43	48	43	53	41
H-1898	Residence	44	48	44	54	41
H-1904	Residence	43	48	43	53	41
H-1905	Residence	42	47	43	52	40
H-1909	Residence	37	42	39	46	34
H-1916	Residence	32	40	36	42	30
H-1917	Residence	44	49	44	54	42
H-1918	Residence	44	49	44	54	42
H-1924	Residence	44	48	44	54	41
H-1925	Residence	43	48	43	53	41
H-1926	Residence	43	48	43	53	40
H-1927	Residence	42	47	43	52	40
H-1928	Residence	42	47	42	52	40

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-1929	Residence	44	49	44	54	42
H-1930	Residence	44	49	44	54	41
H-1931	Residence	43	48	43	53	41
H-1932	Residence	43	48	43	53	41
H-1933	Residence	43	48	43	53	41
H-1934	Residence	42	47	43	52	40
H-1947	Residence	32	40	36	42	30
H-1948	Residence	32	40	36	42	30
H-1951	Residence	32	39	36	42	30
H-1952	Residence	32	39	35	41	29
H-1954	Residence	30	38	34	40	28
H-1955	Residence	43	48	43	53	41
H-1956	Residence	44	49	44	54	42
H-1957	Residence	44	49	44	54	42
H-1958	Residence	44	49	44	54	42
H-1959	Residence	40	46	42	50	38
H-1960	Residence	36	43	39	45	33
H-1961	Residence	35	42	38	44	32
H-1973	Residence	43	48	43	53	41
H-1974	Residence	42	48	43	53	40
H-1975	Residence	43	48	43	53	41
H-1977	Residence	31	39	35	40	28
H-1981	Residence	30	38	34	40	28
H-1983	Residence	32	39	35	41	29
H-1984	Residence	42	48	43	53	41
H-1985	Residence	31	39	35	41	29
H-1988	Residence	41	46	42	51	39
H-2002	Residence	31	39	35	41	29
H-2007	Residence	30	38	34	40	28
H-2008	Residence	32	41	37	42	30
H-2018	Residence	32	39	36	42	30
H-2019	Residence	39	45	40	48	36
H-2025	Residence	32	40	36	42	30
H-2030	Residence	34	41	37	43	31
H-2031	Residence	33	41	38	43	31
H-2048	Residence	31	39	35	41	29
H-2050	Residence	42	47	43	52	39
H-2051	Residence	58	58	53	65	53
H-2056	Residence	45	49	45	55	43
H-2057	Residence	48	52	47	57	45
H-2064	Residence	43	48	43	52	40
H-2066	Residence	33	40	36	43	31
H-2120	Residence	39	44	40	48	36
H-2122	Cemetery	46	50	45	55	43

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-2123	Residence	56	57	53	64	52
H-2124	Residence	56	57	53	64	51
H-2125	Residence	57	58	53	65	52
H-2130	Residence	34	42	38	44	32
H-2132	Cemetery	47	51	46	56	44
H-2139	Residence	37	43	40	46	34
H-2230	Residence	37	43	38	47	34
H-2286	Residence	34	41	37	43	31
H-2302	Residence	53	57	54	66	55
H-2371	Church	37	43	39	47	35
H-2389	Residence	45	50	45	55	43
H-2465	Residence	44	49	44	55	42
H-2466	Residence	52	55	50	61	49
H-2467	Residence	52	55	50	61	49
H-2468	Residence	52	56	51	62	50
H-2469	Residence	41	46	42	51	39
H-2471	Residence	41	46	42	51	39
H-2472	Residence	40	46	41	50	38
H-2494	Residence	40	45	41	50	38
H-2495	Residence	40	45	41	50	38
H-2496	Residence	44	49	44	54	42
H-2498	Residence	47	52	47	57	45
H-2499	Residence	41	47	42	52	39
H-2500	Residence	41	47	42	51	39
H-2501	Residence	41	46	42	51	39
H-2502	Residence	40	46	41	50	38
H-2503	Residence	42	47	42	52	39
H-2511	Residence	42	47	42	52	40
H-2512	Residence	42	47	42	52	39
H-2513	Residence	42	47	42	52	40
H-2514	Residence	43	47	43	53	40
H-2515	Residence	43	48	43	53	40
H-2518	Residence	41	46	42	51	39
H-2519	Residence	40	45	41	50	38
H-2520	Residence	40	46	41	50	38
H-2521	Residence	49	53	48	59	47
H-2522	Residence	42	47	43	53	40
H-2547	Residence	46	50	45	56	43
H-2548	Residence	46	51	46	56	44
H-2549	Residence	45	50	45	55	43
H-2550	Residence	46	50	45	55	43
H-2552	Residence	45	49	44	54	42
H-2553	Residence	43	47	43	53	40
H-2556	Residence	43	47	43	53	40

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-2566	Residence	45	49	45	55	42
H-2567	Residence	45	49	44	54	42
H-2569	Residence	43	47	43	52	40
H-2571	Residence	42	47	42	52	40
H-2572	Residence	40	45	40	50	37
H-2573	Residence	38	44	39	48	36
H-2582	Residence	41	46	41	51	38
H-2588	Residence	41	45	41	50	37
H-2590	Residence	44	49	44	54	42
H-2591	Residence	45	49	44	54	42
H-2593	Residence	45	49	44	54	42
H-2594	Residence	44	48	44	54	41
H-2595	Residence	44	48	43	53	41
H-2596	Residence	45	49	44	54	42
H-2597	Residence	45	49	44	55	42
H-2598	Residence	46	49	45	55	43
H-2599	Residence	46	50	45	55	43
H-2600	Residence	32	39	35	41	29
H-2601	Residence	44	48	43	53	41
H-2602	Residence	43	47	43	53	40
H-2603	Residence	43	47	43	52	40
H-2605	Residence	47	50	46	56	44
H-2606	Residence	53	58	52	64	52
H-2607	Residence	42	47	42	52	39
H-2608	Residence	41	46	42	51	39
H-2609	Residence	41	47	42	51	39
H-2622	Residence	51	55	50	61	48
H-2623	Residence	41	46	41	51	38
H-2624	Residence	42	47	42	52	40
H-2625	Residence	51	54	49	61	48
H-2626	Residence	51	55	50	61	49
H-2634	Residence	43	47	42	52	40
H-2643	Residence	46	50	45	55	43
H-2644	Residence	45	49	45	55	43
H-2645	Residence	45	49	44	55	42
H-2646	Residence	46	50	45	55	43
H-2647	Residence	46	50	45	56	43
H-2648	Residence	46	50	45	56	43
H-2649	Residence	32	39	36	42	30
H-2652	Residence	43	47	43	52	40
H-2653	Residence	43	48	43	53	41
H-2654	Residence	43	47	43	53	40
H-2655	Residence	43	48	43	53	41
H-2656	Residence	44	48	44	54	41

Receiver	Description	Phase 1: Site Preparation (dBA)	Phase 2: Civil Work (dBA)	Phase 3: Mechanical Assembly (dBA)		Phase 4: Electrical Work (dBA)
				No Pile Driving	With Pile Driving	
H-2657	Residence	43	48	43	53	41
H-2658	Residence	43	48	43	53	40
H-2659	Residence	43	47	43	53	40
H-2660	Residence	43	47	43	52	40
H-2661	Residence	43	48	43	53	41
H-2662	Residence	43	48	43	53	41
H-2663	Residence	47	51	46	56	44
H-2664	Residence	46	50	46	56	44
H-2665	Residence	46	50	46	56	44
H-2666	Residence	48	52	47	58	46
H-2667	Residence	56	59	54	66	54
H-2668	Residence	43	48	43	53	41
H-2669	Residence	42	48	43	53	40
H-2670	Residence	42	47	43	52	40
H-2671	Residence	46	50	45	55	43
H-2672	Residence	36	43	39	46	33
H-2677	Residence	53	56	51	63	50
H-2678	Residence	42	48	43	53	40
H-2685	Residence	47	51	46	57	45
H-2689	Residence	44	48	44	54	41
H-2690	Residence	44	48	44	53	41
H-2691	Residence	45	49	44	55	42
H-2692	Residence	45	50	45	55	43
H-2693	Residence	46	51	46	56	44
H-2694	Residence	47	51	46	57	44
H-2695	Residence	49	53	48	59	47
H-2696	Residence	49	53	48	59	46
H-2697	Residence	48	52	47	58	46
H-2698	Residence	48	52	47	58	45
H-2699	Residence	40	46	41	50	38
H-2700	Residence	40	46	41	51	38
H-2701	Residence	41	47	42	52	39
H-2702	Residence	42	47	42	52	40
H-2703	Residence	42	47	42	52	40
H-2704	Residence	41	46	42	51	39
H-2705	Residence	40	46	41	50	38
H-2706	Residence	41	47	42	51	39
H-2707	Residence	40	46	41	50	38
H-2708	Residence	40	46	41	50	38
H-2899	Residence	33	41	37	43	30
H-2910	Residence	43	48	43	53	41
H-2911	Residence	46	50	45	56	43

APPENDIX B

Predicted Operational Noise Levels

Table B-1. Predicted Operational Noise Levels

Receptor	Description	Daytime (dBA)	Nighttime (dBA)	Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-11	Residence	28.1	25.3	H-747	Residence	29.9	27.1
H-12	Residence	24.8	22.2	H-750	Residence	29.2	26.5
H-13	School	31.8	28.9	H-752	Residence	28.7	26
H-14	School	33.2	30.1	H-753	Residence	29.5	26.7
H-47	Residence	36.8	33.6	H-754	Residence	28.8	26
H-48	Residence	36.4	32.8	H-755	Residence	30.4	27.5
H-70	Residence	31.8	29.4	H-767	Residence	30.7	28
H-74	Residence	37.2	33.3	H-772	Residence	29.2	26.5
H-87	Residence	38.9	35.1	H-773	Residence	29.4	26.7
H-88	Residence	37.8	34.4	H-776	Residence	31.2	28.5
H-117	Residence	24	22	H-777	Residence	31.6	28.8
H-346	Residence	30.2	27.3	H-778	Residence	31.8	28.9
H-347	Residence	29.6	26.7	H-779	Residence	28.2	25.5
H-357	Residence	30	27.1	H-780	Residence	30.2	27.3
H-420	Residence	24.8	21.4	H-783	Residence	31.4	28.4
H-448	Residence	29.8	26.3	H-784	Residence	31.1	28.1
H-449	Residence	29.2	25.7	H-785	Residence	31.2	28.2
H-461	Residence	25.9	22.1	H-786	Residence	30.6	27.7
H-501	Residence	26.8	24.3	H-797	Residence	29.8	27
H-645	Residence	23.7	21.4	H-798	Residence	29.4	26.7
H-673	Residence	30	27.1	H-799	Residence	29.7	27
H-674	Residence	22.6	20.3	H-800	Residence	32	29.1
H-680	Residence	30.6	27.7	H-801	Residence	29.5	26.7
H-682	Residence	22.5	20.2	H-802	Residence	29.3	26.5
H-689	Residence	29.9	27.1	H-803	Residence	29	26.2
H-695	Residence	28.8	26	H-804	Residence	28.6	25.8
H-696	Residence	29.1	26.3	H-805	Residence	28.1	25.4
H-697	Residence	28.6	25.9	H-806	Residence	28	25.3
H-698	Residence	27.7	25	H-807	Residence	27.8	25.1
H-713	Residence	28	25.3	H-808	Residence	33.6	29.7
H-714	Residence	30.2	27.4	H-1067	Residence	29.7	27.5
H-715	Residence	28.1	25.4	H-1068	Residence	25.7	23.6
H-718	Residence	30	27.1	H-1069	Residence	37	33.2
H-724	Residence	30.6	27.7	H-1070	Residence	31.6	29.3
H-725	Residence	29.3	26.4	H-1072	Residence	28.2	26.1
H-726	Residence	29.8	27	H-1075	Residence	30.7	28.4
H-731	Residence	30.5	27.8	H-1185	Residence	29.9	27.4
H-732	Residence	30.3	27.6	H-1186	Residence	27.7	25.3
H-733	Residence	28.7	26	H-1192	Residence	29.6	27.3
H-734	Residence	29.2	26.5	H-1195	Residence	23.6	21.3
H-738	Residence	28.7	26	H-1208	Residence	24.1	21.7
H-739	Residence	28.5	25.8	H-1209	Residence	21.1	18.8
H-740	Residence	30.2	27.4	H-1291	Residence	29.8	26.9
H-741	Residence	29.8	26.9	H-1303	Residence	30.7	27.7

Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-1304	Residence	33.1	30.1
H-1305	Residence	41.2	38.3
H-1307	Residence	28.4	25.8
H-1311	Residence	26.3	22.6
H-1314	Residence	33	30.1
H-1317	Residence	26.2	22.5
H-1321	Residence	30.4	26.7
H-1324	Residence	28.8	26.3
H-1325	Residence	28	24.5
H-1326	Residence	24.8	21.2
H-1519	Residence	37.3	34.6
H-1520	Residence	36.2	32.9
H-1523	Residence	24.6	22.6
H-1525	Residence	27.3	25.2
H-1526	Residence	25.2	23.2
H-1527	Residence	40.2	37.5
H-1528	Residence	28.1	25.9
H-1530	Residence	30.4	28.2
H-1531	Residence	26.9	24.7
H-1532	Residence	28.2	26
H-1533	Residence	30.9	28.7
H-1535	Residence	32.9	30.4
H-1536	Residence	42.6	40.5
H-1537	Residence	31.1	28.7
H-1538	Residence	29.7	27.5
H-1539	Residence	30.8	28.6
H-1541	Residence	39.4	35.8
H-1542	Residence	30.8	28.6
H-1545	Residence	30.7	28.4
H-1546	Residence	31.6	29.2
H-1548	Residence	27	24.9
H-1549	Residence	27.4	25.3
H-1550	Residence	25.4	23.4
H-1551	Residence	27.8	25.7
H-1552	Residence	29.4	27.2
H-1555	Residence	24.8	22.7
H-1557	Residence	38.4	35.8
H-1558	Residence	27	24.9
H-1564	Residence	29.5	26.1
H-1662	Residence	22.7	20.4
H-1663	Residence	20.1	17.9
H-1664	Residence	30.6	28.1
H-1682	Residence	27.4	25
H-1683	Residence	27.9	25.5

Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-1723	Residence	27.8	25.3
H-1724	Residence	42.5	38.8
H-1751	Residence	23.3	21
H-1759	Residence	21.1	18.8
H-1765	Residence	40.6	37.3
H-1777	Residence	24.7	22.3
H-1784	Residence	31.2	28.3
H-1785	Residence	30.1	27.2
H-1786	Residence	30.9	27.9
H-1790	Residence	24.2	22.1
H-1791	Residence	23.7	21.6
H-1792	Residence	24.2	22
H-1803	Residence	27.1	24.3
H-1804	Residence	25.7	23.6
H-1805	Residence	24.3	22.2
H-1806	Residence	24.4	22.3
H-1808	Residence	24.6	22.3
H-1809	Residence	23	20.7
H-1817	Residence	19.8	17.6
H-1821	Residence	29.7	26.3
H-1822	Residence	28.7	25.4
H-1852	Residence	30.3	27.4
H-1854	Residence	27	23.6
H-1867	Residence	29.5	26.7
H-1868	Residence	30.4	27.5
H-1881	Residence	30.3	27.4
H-1882	Residence	35.5	33
H-1896	Residence	29.9	27.1
H-1897	Residence	29.9	27.1
H-1898	Residence	29.6	26.9
H-1904	Residence	29.5	26.7
H-1905	Residence	30	27.1
H-1909	Residence	36.8	33.8
H-1916	Residence	27.7	24.1
H-1917	Residence	30.1	27.2
H-1918	Residence	30.1	27.3
H-1924	Residence	29.5	26.8
H-1925	Residence	29.2	26.4
H-1926	Residence	29	26.3
H-1927	Residence	28.8	26.1
H-1928	Residence	28.5	25.8
H-1929	Residence	30	27.2
H-1930	Residence	29.9	27.1
H-1931	Residence	29.7	26.9

Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-1932	Residence	29.6	26.8
H-1933	Residence	29.3	26.5
H-1934	Residence	29.2	26.5
H-1947	Residence	27.5	24
H-1948	Residence	27.6	24.1
H-1951	Residence	27.3	23.6
H-1952	Residence	27	23.2
H-1954	Residence	25.6	21.9
H-1955	Residence	29.5	26.7
H-1956	Residence	30.2	27.4
H-1957	Residence	30.3	27.5
H-1958	Residence	30.5	27.6
H-1959	Residence	44.6	38
H-1960	Residence	32.9	29
H-1961	Residence	31.4	27.8
H-1973	Residence	30.8	27.9
H-1974	Residence	30.3	27.4
H-1975	Residence	30.1	27.3
H-1977	Residence	25.7	23.3
H-1981	Residence	25.4	22
H-1983	Residence	27.1	23.7
H-1984	Residence	30.8	27.9
H-1985	Residence	26.1	22.6
H-1988	Residence	38	33.4
H-2002	Residence	26.4	22.6
H-2007	Residence	25.5	21.9
H-2008	Residence	31.5	28.8
H-2018	Residence	27.6	23.9
H-2019	Residence	34.5	30.3
H-2025	Residence	27.7	24.3
H-2030	Residence	29.2	25.4
H-2031	Residence	30	26.7
H-2048	Residence	27	23.3
H-2050	Residence	38.8	34.2
H-2051	Residence	47	41.2
H-2056	Residence	43.3	38.3
H-2057	Residence	43.8	38.3
H-2064	Residence	39.8	35.7
H-2066	Residence	28.4	24.7
H-2120	Residence	26.1	24
H-2122	Cemetery	31	28.6
H-2123	Residence	39.9	37.2
H-2124	Residence	39.7	37.1
H-2125	Residence	40.6	37.9

Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-2130	Residence	26.9	24.7
H-2132	Cemetery	31.9	29.5
H-2139	Residence	25.1	23.1
H-2230	Residence	25.1	22.5
H-2286	Residence	27.9	25.5
H-2302	Residence	42.3	39
H-2371	Church	30.1	27.7
H-2389	Residence	35.7	32.3
H-2465	Residence	30	27.2
H-2466	Residence	34.2	31.2
H-2467	Residence	34.3	31.3
H-2468	Residence	34.5	31.5
H-2469	Residence	28.8	26.1
H-2471	Residence	28.7	25.9
H-2472	Residence	28.8	26
H-2494	Residence	28.2	25.5
H-2495	Residence	28.2	25.4
H-2496	Residence	29.6	26.9
H-2498	Residence	31.7	28.8
H-2499	Residence	28.4	25.7
H-2500	Residence	28.4	25.7
H-2501	Residence	28.4	25.6
H-2502	Residence	28.1	25.4
H-2503	Residence	28.5	25.7
H-2511	Residence	28.3	25.6
H-2512	Residence	28.2	25.5
H-2513	Residence	28.3	25.6
H-2514	Residence	28.7	26
H-2515	Residence	28.9	26.2
H-2518	Residence	29	26.2
H-2519	Residence	27.4	24.7
H-2520	Residence	28.6	25.8
H-2521	Residence	32.8	29.8
H-2522	Residence	29.9	27
H-2547	Residence	30.8	28
H-2548	Residence	31.1	28.2
H-2549	Residence	30.4	27.6
H-2550	Residence	30.5	27.8
H-2552	Residence	30.1	27.4
H-2553	Residence	28.8	26.1
H-2556	Residence	29	26.2
H-2566	Residence	30.1	27.3
H-2567	Residence	29.8	27.1
H-2569	Residence	28.6	25.9

Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-2571	Residence	28.5	25.8
H-2572	Residence	27	24.4
H-2573	Residence	27	24.3
H-2582	Residence	27.7	25.1
H-2588	Residence	27.7	25.2
H-2590	Residence	29.6	26.9
H-2591	Residence	29.8	27.1
H-2593	Residence	29.9	27.2
H-2594	Residence	29.6	26.9
H-2595	Residence	29.4	26.7
H-2596	Residence	29.8	27.1
H-2597	Residence	30.1	27.4
H-2598	Residence	30.4	27.7
H-2599	Residence	30.8	28
H-2600	Residence	26.8	23.3
H-2601	Residence	29.2	26.5
H-2602	Residence	28.8	26.2
H-2603	Residence	28.6	26
H-2605	Residence	31.1	28.4
H-2606	Residence	35.8	32.4
H-2607	Residence	28.4	25.7
H-2608	Residence	28.4	25.6
H-2609	Residence	28.4	25.7
H-2622	Residence	33.8	30.7
H-2623	Residence	27.6	25
H-2624	Residence	28.4	25.8
H-2625	Residence	33.6	30.6
H-2626	Residence	33.9	30.9
H-2634	Residence	29	26.4
H-2643	Residence	30.4	27.7
H-2644	Residence	30.3	27.5
H-2645	Residence	30	27.3
H-2646	Residence	30.5	27.7
H-2647	Residence	30.8	28
H-2648	Residence	30.7	27.9
H-2649	Residence	27.3	23.5
H-2652	Residence	28.6	25.9
H-2653	Residence	28.9	26.3
H-2654	Residence	28.8	26.1
H-2655	Residence	29	26.3
H-2656	Residence	29.5	26.8
H-2657	Residence	29	26.3
H-2658	Residence	28.8	26.2
H-2659	Residence	28.7	26.1

Receptor	Description	Daytime (dBA)	Nighttime (dBA)
H-2660	Residence	28.6	25.9
H-2661	Residence	28.9	26.2
H-2662	Residence	29	26.3
H-2663	Residence	31	28.3
H-2664	Residence	31	28.2
H-2665	Residence	30.9	28.1
H-2666	Residence	32.2	29.3
H-2667	Residence	36.7	33.3
H-2668	Residence	29.6	26.8
H-2669	Residence	29.5	26.7
H-2670	Residence	29.3	26.5
H-2671	Residence	31.1	28.4
H-2672	Residence	33.3	29.4
H-2677	Residence	34.8	31.7
H-2678	Residence	29.8	27
H-2685	Residence	31.4	28.6
H-2689	Residence	29.5	26.8
H-2690	Residence	29.3	26.6
H-2691	Residence	30	27.3
H-2692	Residence	30.6	27.8
H-2693	Residence	31	28.2
H-2694	Residence	31.3	28.4
H-2695	Residence	32.7	29.8
H-2696	Residence	32.5	29.5
H-2697	Residence	32.1	29.2
H-2698	Residence	32	29.1
H-2699	Residence	28.5	25.7
H-2700	Residence	28.6	25.8
H-2701	Residence	29	26.2
H-2702	Residence	29.2	26.4
H-2703	Residence	29.1	26.3
H-2704	Residence	28.7	25.9
H-2705	Residence	28.1	25.4
H-2706	Residence	29.6	26.8
H-2707	Residence	28.9	26.1
H-2708	Residence	28.8	26
H-2899	Residence	29.1	25.7
H-2910	Residence	29	26.3
H-2911	Residence	30.7	27.9

Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN
Supplement to Application
November 14, 2018

Attachment 4

Updated Exhibit R to Application

Viewshed Analysis and Aesthetic Resources Inventory

by TRC Environmental Corporation
November 2018

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SUMMARY OF THE VIEWSHED ANALYSIS AND AESTHETIC RESOURCES INVENTORY

Hardin Solar II Energy Center Project

Hardin County, Ohio

November 2018

TRC Project No. 302899.MOD1.0000

Prepared For:

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Jesse Papez
Senior GIS Specialist

Results you can rely on

CONFIDENTIAL BUSINESS INFORMATION

TABLE OF CONTENTS

List of Tables

List of Figures

ACRONYMS

2D	Two Dimensions/Dimensional
3D	Three Dimensions/Dimensional
ESRI	Earth Systems Research Institute (GIS software company)
Ft	Feet
GIS	Geographic Information System
GPS	Global Positioning System
HSE	Hardin Solar Energy II LLC
KOP	Key Observation Point
LBRS	Land Based Response System
LiDAR	Light Detection and Ranging
LAS	LiDAR Data File naming convention (i.e. *.las)
MW	Megawatt
m	Meter
NRHP	National Register of Historic Places
OAC	Ohio Administration Code
OGRIP	Ohio Geographically Referenced Information Program
OPSB	Ohio Power Siting Board
TRC	TRC Environmental Corporation
U.S.	United States
USGS	United States Geological Survey

1.0 INTRODUCTION

On behalf of Hardin Solar Energy II LLC (HSE), TRC Environmental Corporation (TRC) has prepared this Visual Impact Assessment as part of the environmental studies conducted for the Hardin Solar II Energy Center Project (Project). The proposed solar facility will generate up to 170 megawatts (MW) of power. The Project Area is the area which HSE will propose to include within their Ohio Power Siting Board (OPSB) application for a certificate of environmental compatibility and public need, issued by the OPSB. In total, the Project Area is approximately 3,388 acres (1,371 hectares), including 396 acres (160 hectares) of underground collection corridors. The privately-owned land is located approximately 2.5 miles (3.9 kilometers) southeast of Alger, in Hardin County, Ohio. The Project Area is bisected by Township Road 120 (east/west) and is bounded by Township Road 100 on the north, County Road 65 on the east, and neighboring landowners to the south and west in Marion, McDonald, and Roundhead Township, Hardin County, Ohio. The current land use / land cover on the Project site and solar panel layout location is primarily agricultural farmland with some small patches of forest and grassland.

Visual and aesthetic impacts were assessed within a visual study area extending out to a 2 mile (3.2 km) radius from the proposed site boundary. Based on desktop review of aerial photography and topographic data and maps, the Project area and surrounding areas are typical of northwest Ohio. This area primarily rural agricultural area, with generally flat topography. The Scioto River cuts through the study area and appears to have been channelized into straight sections through the Project area, likely for irrigation or other agricultural purposes. The Village of McGuffey also falls within the visual study area. This village has a population of approximately 500, is primarily residential, and includes the Upper Scioto Valley School campus, which comprises a large portion of the footprint of the village. The southern-most edge of the school property is approximately 650 feet (200 m) from the northern edge of proposed development for this Project.

2.0 VIEWSHED ANALYSIS

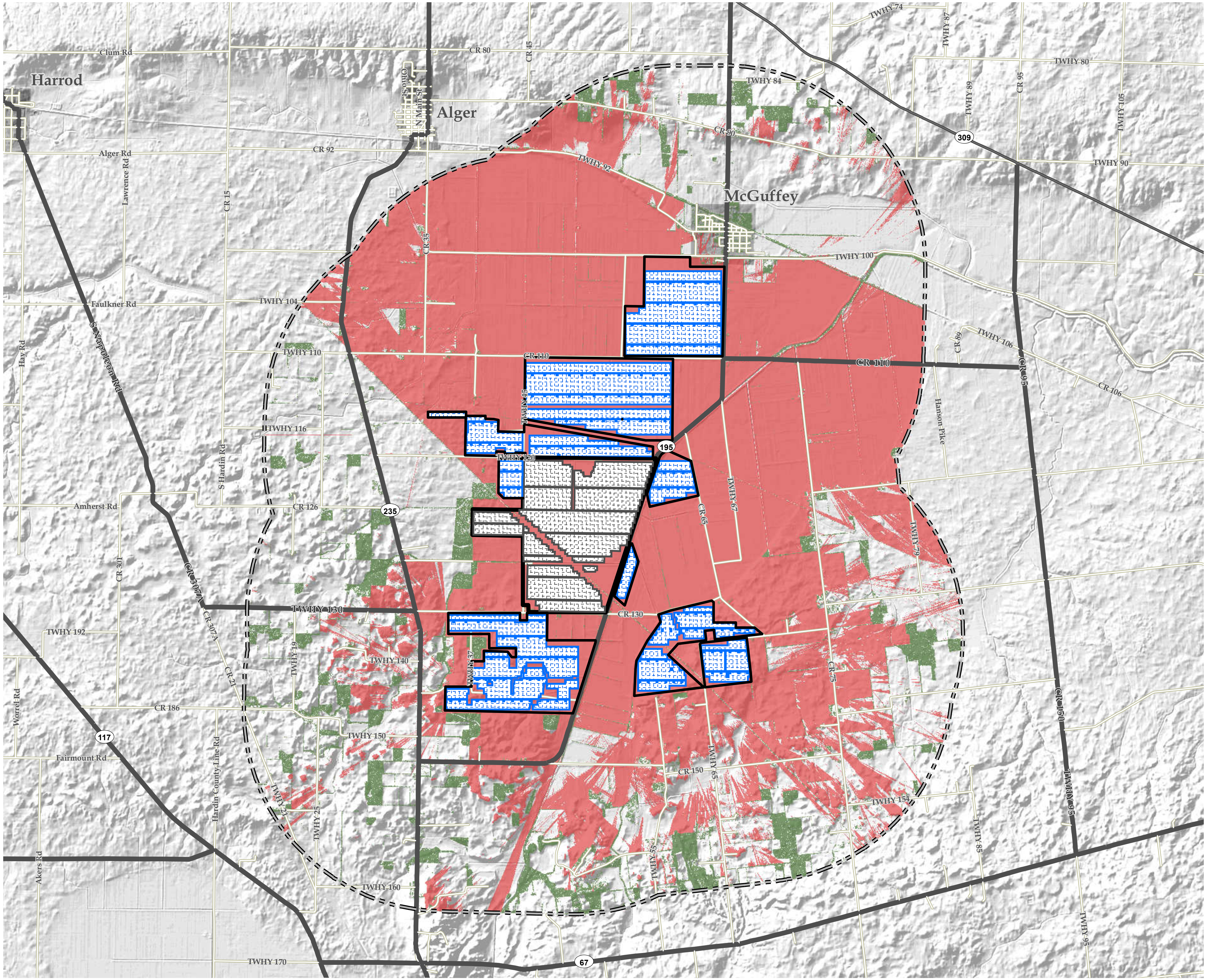
A viewshed analysis out to 2 miles (3.2 km) was conducted. Due to the inherent low-profile nature of solar projects it is unlikely that locations shown as visible by the computer model greater than 2 miles from the site are representative of what the human eye can perceive. This analysis is a GIS analytical technique that allows for the determination and location of where project features, such as solar panels, fences, or substations will be likely to be visible in the surrounding area of the site. The results of the viewshed analysis are combined with other sensitive location information such as historic places, national forests, state parks, or other key observation points (KOPs) that are identified, and are typically displayed over a topographic map or aerial photo. The GIS combination of KOP locations and the viewshed analysis information assists in understanding the potential for project visibility at sensitive resource locations and provides a better understanding of the potential visual impacts the Project may have.

2.1 VIEWSHED METHODOLOGY

Light Detection and Ranging (LiDAR) data provided by the Ohio Geographically Referenced Information Program (OGRIP) was used for the analysis (Ohio, 2006). The LiDAR survey for Hardin County was conducted in 2006. Forested, vegetated areas, and structures were extracted from the first-return subset of the LiDAR data and was separated from the bare-earth (topographic) surface information. The site review shows no significant tall vegetation present; thus the vegetated surface model was used to conduct a viewshed analysis without accounting for any clearing during construction.

Environmental Systems Research Institute, Inc. (ESRI) Spatial Analyst GIS software was used to develop the viewshed model. X, Y and Z data representing the typical height of the solar panels were incorporated into the model with the LiDAR terrain information. The component height information was based on specifications for the NEXTracker, Inc. NEXTrackerSPT solar panels. An assumed panel height of 13.5' (4.1m) (NEXTracker, 2015), and an assumed fence height of 7' (2.1m) was used for this analysis. The results of the 2-mile model including vegetation can be found on **Figure 1**.

TRC Results you can rely on



LEGEND

- PROJECT BOUNDARY
- 2-MILE SETBACK FROM PROJECT AREA
- PROPOSED SOLAR RACK AREA (HARDIN SOLAR II)
- PROPOSED SOLAR RACK AREA (HARDIN SOLAR I)
- AREAS WITH POTENTIAL SITE VISIBILITY
- AREAS WITH OBSTRUCTED VIEW OF SITE
- TREE COVER/VEGETATED AREA

NOTES

1. TOPOGRAPHIC INFORMATION FROM LiDAR LAS DATA PROVIDED BY OHIO GEOGRAPHICALLY REFERENCED INFORMATION PROGRAM (OGRIP).
2. THE VIEWSHED ANALYSIS WAS CONDUCTED USING THE DATA EXTRACTED FROM THE LiDAR DATA. VEGETATION AREAS ARE REPRESENTED AS THE DIFFERENCE BETWEEN THE FIRST-RETURN SURFACE AND THE BARE-EARTH SURFACE. AN OBSERVER HEIGHT OF 5.5' WAS USED FOR THE ANALYSIS.
3. SOLAR FACILITIES WERE MODELED USING A PANEL HEIGHT OF 13.5' AND A FENCE HEIGHT OF 7'.
4. INFORMATION PRESENTED HERE IS THE RESULTS OF A DESKTOP ANALYSIS AND HAS NOT BEEN GROUND-TRUTHED.

0 5,000 10,000 Feet

1 " = 5,000 '

1:60,000

PROJECT:

HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

TITLE:

VIEWSHED ANALYSIS
WITHIN 2 MILES OF PROJECT SITE

DRAWN BY:	J. PAPEZ	PROJ NO.:	302899
CHECKED BY:	M. MOLNAR		
APPROVED BY:	T. ENGLE	**FIGURE 1**	
DATE:	NOVEMBER 2018		

TRC

921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
www.trcsolutions.com

FILE NO.: HSII_VIA_F1_11x17.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Ohio North FIPS 3401 (Meter)
Map Rotation: 0

Plot Date: 11/1/2018, 10:25:00 AM by JPAPEZ -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\INVENERGY\302899-HARDIN_WIND_SOLAR_II\HSII_VIA_F1_11x17.mxd

2.2 Assumptions and Limitations of the Viewshed Model

The viewshed analysis identifies cells (raster pixels) that contain elevation information and computes the differences along the terrain surface between an observer at any point within the study area and a target (e.g. substation component) (ESRI 2017). The analysis is a clear line of sight and therefore certain factors in the interpretation of results need to be considered:

1. The model does not account for the limitations of human vision at greater distances or atmospheric conditions that may cause reduced visibility. Additionally, at increasing distances away from project features, they will appear smaller and less detailed and will have a reduced visual impact even if shown as visible in the model.

2. Because an area may show visibility, it does not mean the entirety of a substation component will be seen. In many cases for this project, the existing tree stands and buildings in the area provide visual impediments for all or lower portion of the facility.

3. The viewshed model assumes that any vegetation is opaque and therefore represents a leaf-on condition. During leaf-off conditions or where ground level vegetation is sparse, visibility may be possible where the model did not indicate.

4. The model was developed with the assumption that a viewer would not see the Project if standing amongst tree groups.

5. Due to the large size of the Project and many panel locations, it was not readily possible to model every individual structure for the viewshed analysis, as such perimeter and high feature points were used for conducting the viewshed analysis.

2.3 Viewshed Analysis Results and Discussion

The Project study area is generally on and surrounded by agricultural farmland and is very flat, with approximately 130 feet (40 m) of elevation change within the two-mile search area based on LiDAR topography. With this flat, open setting there is increased potential for site visibility in the surrounding area. Given the lack of any significant forested land on the Project site, site clearing should have little impact on the visibility of the Project.

The detailed viewshed analysis utilizing vegetation and other non-terrain obstructions within 2 miles of the site, as described in Section 2.2 results are shown in **Figure 1**.

3.0 VISUAL RESOURCE INVENTORY

An inventory of publicly accessible KOPs was compiled for the area within two miles of the site boundary. Resources such as recreational areas, listed NRHP, bikeways, campgrounds, churches, schools, or other community landmark locations were evaluated and shown along with the results of the viewshed analysis in **Figure 2**. This list of resources was generated from a review of public sources including: Ohio Department of Natural Resources GIS Mapping Services (ODNR 2017), Ohio Location Based Response System (LBRS) Landmarks (OGRIP 2015), Google Earth Pro (2018), and USGS 7.5 Minute Quadrangle maps (USGS 1960, 1961). Architectural Resources listed in Table 1 are based on points listed by the Ohio History Connection (2018), which have not yet been evaluated for listing in the NRHP and may not actually have any significant aesthetic importance. **Table 1** summarizes the findings.

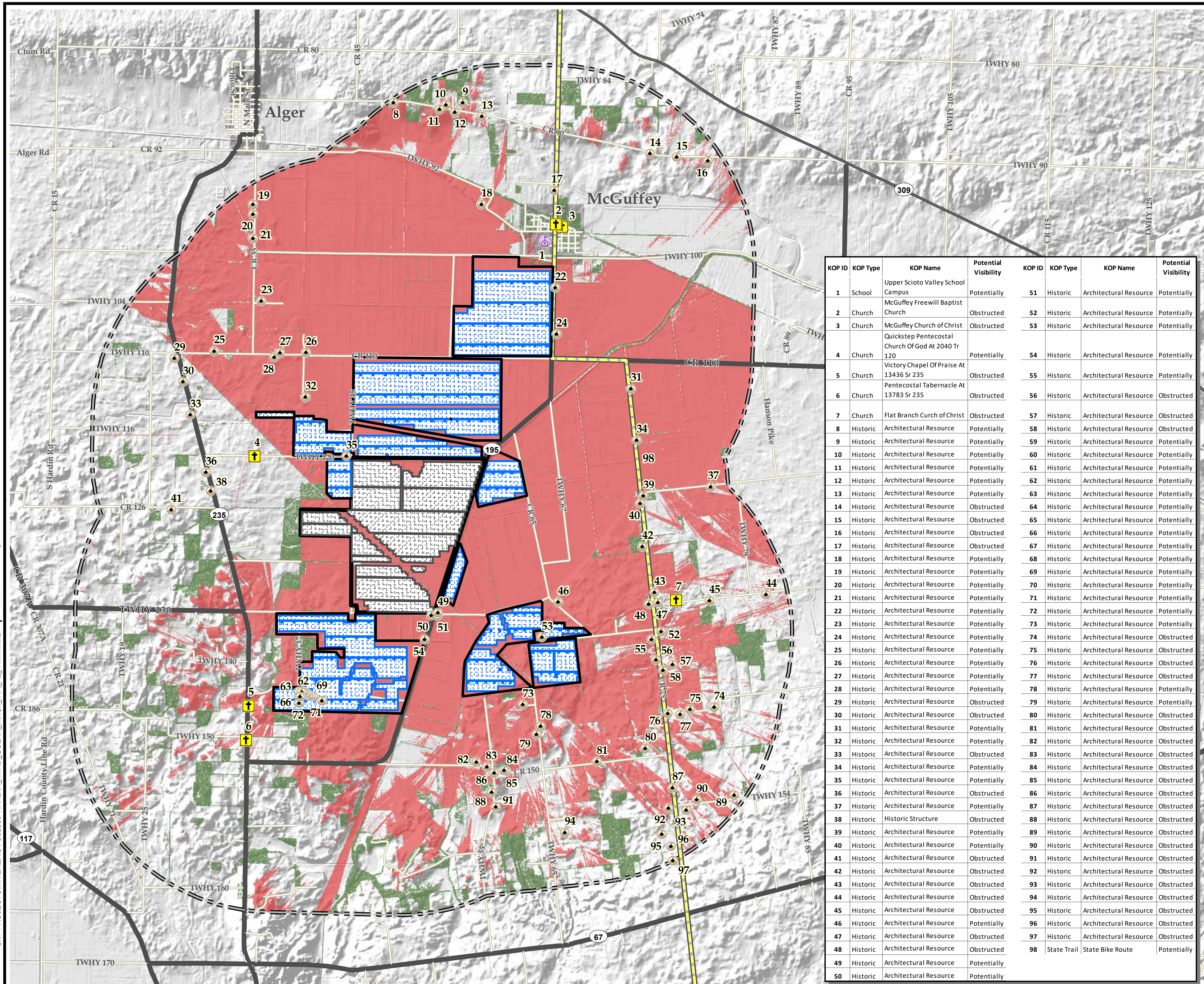
Table 1. Visual Resources Inventory within Two Miles (3.2 km) of Project Site

KOP ID	KOP Type	KOP Name	Potential Visibility
1	School	Upper Scioto Valley School Campus	Potentially
2	Church	McGuffey Freewill Baptist Church	Obstructed
3	Church	McGuffey Church of Christ	Obstructed
4	Church	Quickstep Pentecostal Church of God At 2040 Tr 120	Potentially
5	Church	Victory Chapel of Praise At 13436 Sr 235	Obstructed
6	Church	Pentecostal Tabernacle At 13783 Sr 235	Obstructed
7	Church	Flat Branch Church of Christ	Obstructed
8	Historic	Architectural Resource	Potentially
9	Historic	Architectural Resource	Potentially
10	Historic	Architectural Resource	Potentially
11	Historic	Architectural Resource	Potentially
12	Historic	Architectural Resource	Potentially
13	Historic	Architectural Resource	Potentially
14	Historic	Architectural Resource	Obstructed
15	Historic	Architectural Resource	Obstructed
16	Historic	Architectural Resource	Obstructed
17	Historic	Architectural Resource	Obstructed
18	Historic	Architectural Resource	Potentially
19	Historic	Architectural Resource	Potentially
20	Historic	Architectural Resource	Potentially
21	Historic	Architectural Resource	Potentially
22	Historic	Architectural Resource	Potentially
23	Historic	Architectural Resource	Potentially
24	Historic	Architectural Resource	Potentially
25	Historic	Architectural Resource	Potentially
26	Historic	Architectural Resource	Potentially
27	Historic	Architectural Resource	Potentially
28	Historic	Architectural Resource	Potentially
29	Historic	Architectural Resource	Obstructed
30	Historic	Architectural Resource	Obstructed
31	Historic	Architectural Resource	Potentially
32	Historic	Architectural Resource	Potentially
33	Historic	Architectural Resource	Obstructed

KOP ID	KOP Type	KOP Name	Potential Visibility
51	Historic	Architectural Resource	Potentially
52	Historic	Architectural Resource	Potentially
53	Historic	Architectural Resource	Potentially
54	Historic	Architectural Resource	Potentially
55	Historic	Architectural Resource	Potentially
56	Historic	Architectural Resource	Obstructed
57	Historic	Architectural Resource	Obstructed
58	Historic	Architectural Resource	Obstructed
59	Historic	Architectural Resource	Potentially
60	Historic	Architectural Resource	Potentially
61	Historic	Architectural Resource	Potentially
62	Historic	Architectural Resource	Potentially
63	Historic	Architectural Resource	Potentially
64	Historic	Architectural Resource	Potentially
65	Historic	Architectural Resource	Potentially
66	Historic	Architectural Resource	Potentially
67	Historic	Architectural Resource	Potentially
68	Historic	Architectural Resource	Potentially
69	Historic	Architectural Resource	Potentially
70	Historic	Architectural Resource	Potentially
71	Historic	Architectural Resource	Potentially
72	Historic	Architectural Resource	Potentially
73	Historic	Architectural Resource	Potentially
74	Historic	Architectural Resource	Obstructed
75	Historic	Architectural Resource	Obstructed
76	Historic	Architectural Resource	Obstructed
77	Historic	Architectural Resource	Obstructed
78	Historic	Architectural Resource	Potentially
79	Historic	Architectural Resource	Potentially
80	Historic	Architectural Resource	Obstructed
81	Historic	Architectural Resource	Obstructed
82	Historic	Architectural Resource	Obstructed
83	Historic	Architectural Resource	Obstructed

KOP ID	KOP Type	KOP Name	Potential Visibility
34	Historic	Architectural Resource	Potentially
35	Historic	Architectural Resource	Potentially
36	Historic	Architectural Resource	Obstructed
37	Historic	Architectural Resource	Potentially
38	Historic	Historic Structure	Obstructed
39	Historic	Architectural Resource	Potentially
40	Historic	Architectural Resource	Potentially
41	Historic	Architectural Resource	Obstructed
42	Historic	Architectural Resource	Obstructed
43	Historic	Architectural Resource	Obstructed
44	Historic	Architectural Resource	Obstructed
45	Historic	Architectural Resource	Obstructed
46	Historic	Architectural Resource	Potentially
47	Historic	Architectural Resource	Obstructed
48	Historic	Architectural Resource	Obstructed
49	Historic	Architectural Resource	Potentially
50	Historic	Architectural Resource	Potentially

KOP ID	KOP Type	KOP Name	Potential Visibility
84	Historic	Architectural Resource	Obstructed
85	Historic	Architectural Resource	Obstructed
86	Historic	Architectural Resource	Obstructed
87	Historic	Architectural Resource	Obstructed
88	Historic	Architectural Resource	Obstructed
89	Historic	Architectural Resource	Obstructed
90	Historic	Architectural Resource	Obstructed
91	Historic	Architectural Resource	Obstructed
92	Historic	Architectural Resource	Obstructed
93	Historic	Architectural Resource	Obstructed
94	Historic	Architectural Resource	Obstructed
95	Historic	Architectural Resource	Obstructed
96	Historic	Architectural Resource	Obstructed
97	Historic	Architectural Resource	Obstructed
98	State Trail	State Bike Route	Potentially



KOP ID	KOP Type	KOP Name	Potential Visibility	KOP ID	KOP Type	KOP Name	Potential Visibility
1	School	Upper Scioto Valley School Campus	Potentially	51	Historic	Architectural Resource	Potentially
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5	Church	Victory Chapel Of Praise At 13436 Sr 235	Obstructed	55	Historic	Architectural Resource	Potentially
6	Church	Pentecostal Tabernacle At 13783 Sr 235	Obstructed	56	Historic	Architectural Resource	Obstructed
7	Church	Flat Branch Curch of Christ	Obstructed	57	Historic	Architectural Resource	Obstructed
8	Historic	Architectural Resource	Potentially	58	Historic	Architectural Resource	Obstructed
9	Historic	Architectural Resource	Potentially	59	Historic	Architectural Resource	Potentially
10	Historic	Architectural Resource	Potentially	60	Historic	Architectural Resource	Potentially
11	Historic	Architectural Resource	Potentially	61	Historic	Architectural Resource	Potentially
12	Historic	Architectural Resource	Potentially	62	Historic	Architectural Resource	Potentially
13	Historic	Architectural Resource	Potentially	63	Historic	Architectural Resource	Potentially
14	Historic	Architectural Resource	Obstructed	64	Historic	Architectural Resource	Potentially
15	Historic	Architectural Resource	Obstructed	65	Historic	Architectural Resource	Potentially
16	Historic	Architectural Resource	Obstructed	66	Historic	Architectural Resource	Potentially
17	Historic	Architectural Resource	Obstructed	67	Historic	Architectural Resource	Potentially
18	Historic	Architectural Resource	Potentially	68	Historic	Architectural Resource	Potentially
19	Historic	Architectural Resource	Potentially	69	Historic	Architectural Resource	Potentially
20	Historic	Architectural Resource	Potentially	70	Historic	Architectural Resource	Potentially
21	Historic	Architectural Resource	Potentially	71	Historic	Architectural Resource	Potentially
22	Historic	Architectural Resource	Potentially	72	Historic	Architectural Resource	Potentially
23	Historic	Architectural Resource	Potentially	73	Historic	Architectural Resource	Potentially
24	Historic	Architectural Resource	Potentially	74	Historic	Architectural Resource	Obstructed
25	Historic	Architectural Resource	Potentially	75	Historic	Architectural Resource	Obstructed
26	Historic	Architectural Resource	Potentially	76	Historic	Architectural Resource	Obstructed
27	Historic	Architectural Resource	Potentially	77	Historic	Architectural Resource	Obstructed
28	Historic	Architectural Resource	Potentially	78	Historic	Architectural Resource	Potentially
29	Historic	Architectural Resource	Obstructed	79	Historic	Architectural Resource	Potentially
30	Historic	Architectural Resource	Obstructed	80	Historic	Architectural Resource	Obstructed
31	Historic	Architectural Resource	Potentially	81	Historic	Architectural Resource	Obstructed
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35	Historic	Architectural Resource	Potentially	85	Historic	Architectural Resource	Obstructed
36	Historic	Architectural Resource	Obstructed	86	Historic	Architectural Resource	Obstructed
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38	Historic	Historic Structure	Obstructed	88	Historic	Architectural Resource	Obstructed
39	Historic	Architectural Resource	Potentially	89	Historic	Architectural Resource	Obstructed
40	Historic	Architectural Resource	Potentially	90	Historic	Architectural Resource	Obstructed
41	Historic	Architectural Resource	Obstructed	91	Historic	Architectural Resource	Obstructed
42	Historic	Architectural Resource	Obstructed	92	Historic	Architectural Resource	Obstructed
43	Historic	Architectural Resource	Obstructed	93	Historic	Architectural Resource	Obstructed
44	Historic	Architectural Resource	Obstructed	94	Historic	Architectural Resource	Obstructed
45	Historic	Architectural Resource	Obstructed	95	Historic	Architectural Resource	Obstructed
46	Historic	Architectural Resource	Potentially	96	Historic	Architectural Resource	Obstructed
47	Historic	Architectural Resource	Obstructed	97	Historic	Architectural Resource	Obstructed
48	Historic	Architectural Resource	Obstructed	98	State Trail	State Bike Route	Potentially
49	Historic	Architectural Resource	Potentially				
50	Historic	Architectural Resource	Potentially				

LEGEND

- PROJECT BOUNDARY
- 2-MILE SETBACK FROM PROJECT AREA
- PROPOSED SOLAR RACK AREA (HARDIN SOLAR II)
- PROPOSED SOLAR RACK AREA (HARDIN SOLAR I)
- AREAS WITH POTENTIAL SITE VISIBILITY
- AREAS WITH OBSTRUCTED VIEW OF SITE
- TREE COVER/VEGETATED AREA

POTENTIAL AESTHETIC RESOURCES/KEY OBS. POINTS (KOP)

- SCHOOL
- CHURCH
- HISTORIC STRUCTURE
- STATE BIKE ROUTE

NOTES

1. TOPOGRAPHIC INFORMATION FROM LIDAR LAS DATA PROVIDED BY OHIO GEOGRAPHICALLY REFERENCED INFORMATION PROGRAM (OGRIP).
2. THE VIEWSHED ANALYSIS WAS CONDUCTED USING THE DATA EXTRACTED FROM THE LiDAR DATA. VEGETATION AREAS ARE REPRESENTED AS THE DIFFERENCE BETWEEN THE FIRST-RETURN SURFACE AND THE BARE-EARTH SURFACE. AN OBSERVER HEIGHT OF 5.5' WAS USED FOR THE ANALYSIS.
3. INFORMATION PRESENTED HERE IS THE RESULTS OF A DESKTOP ANALYSIS AND HAS NOT BEEN GROUND-TRUTHED.
4. ARCHITECTURAL RESOURCE POINTS ARE BASED ON PREVIOUSLY SURVEYED INFORMATION FROM THE OHIO HISTORY CONNECTION WEBMAP.

0 5,000 10,000 Feet

1 " = 5,000 '
1:60,000

PROJECT:
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

TITLE:
VIEWSHED ANALYSIS AND POTENTIAL AESTHETIC RESOURCES

DRAWN BY:	J. PAPEZ	PROJ NO.:	302899
CHECKED BY:	M. MOLNAR		
APPROVED BY:	T. ENGLE		**FIGURE 2**
DATE:	NOVEMBER 2018		

921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
www.trcsolutions.com

FILE NO.: HSII_VIA_F2_11x17.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Ohio North FIPS 3401 (Meter)
Map Rotation: 0
Plot Date: 11/1/2018, 10:24:48 AM by JPAPEZ -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\INVENERGY\302899-HARDIN_WIND_SOLAR_II\HSII_VIA_F2_11x17.mxd

4.0 VISUAL SIMULATIONS

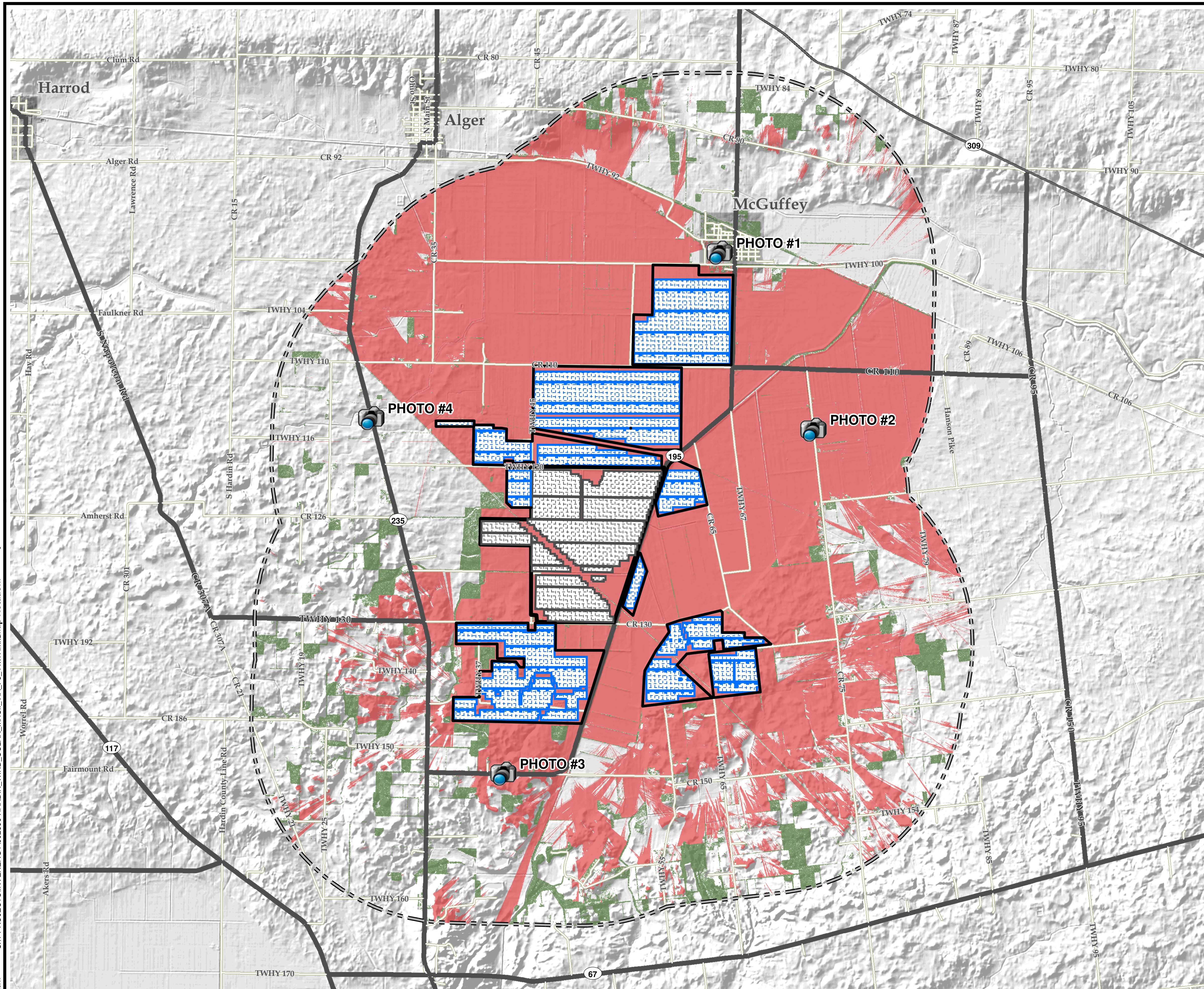
Field surveys were conducted on July 24, 2018 to acquire photographs for simulations. Four photographs are presented as simulations. Attempts were made to take photographs that provided the most unobstructed views possible at north, south, east, and west positions and/or in areas where the viewshed maps represent visibility that is proximal to the Hardin Solar II Energy Center.

4.1 METHODOLOGY

Photographs were taken with a Nikon Coolpix W100 digital camera. Coordinates of camera locations intended for simulations were recorded using a sub-meter Global Positioning System unit (GPS), as well as other reference points within the view. These reference locations were later used to refine the placement of the facility within the simulation photographs. Heights of select high reference points were measured with a tape measure or survey rod. The photograph locations are shown on **Figure 3**.

To create visual simulations, 3DS MAX 2016 software was used to correctly dimension a model of the Hardin Solar II Energy Center into the digital photographic image from each viewpoint location. The 3d model of the facility was created by TRC using engineering specifications (NEXTracker, Inc. NEXTrackerSPT solar panels) (NEXTracker, 2015), along with a 2D solar array and perimeter fencing location provided by Hardin Solar Energy II, LLC. The simulation model was further developed to position the viewer at the selected vantage point. For a given vantage point, the visualization software is capable of providing and adjusting a camera view that matches that of the actual photograph. From the field effort, the documented camera coordinate (x, y, z) positions were entered into the model. Reference locations, which are existing visible objects in the photograph such as light posts, building corners, trees, gate posts or utility poles were obtained by GPS to assist with refined placement of the proposed Project within the photograph. In some instances, GIS terrain modeling and analysis helped in locking in the 3D facility model within the photograph. Ground point elevations of the camera location and other referenced objects were obtained from the 2006 LiDAR LAS data provided by Ohio Geographically Referenced Information Program (OGRIP) (Ohio 2006).

The day and time of the photographs were also recorded and typically exist as electronic information embedded in the respective digital photograph files. This information was used to adjust for sun angle in the simulation software in order to represent lighting conditions for the time of day and year.



LEGEND

PHOTO SIMULATION LOCATION

PROJECT BOUNDARY

2-MILE SETBACK FROM PROJECT AREA

PROPOSED SOLAR RACK AREA (HARDIN SOLAR II)

PROPOSED SOLAR RACK AREA (HARDIN SOLAR I)

AREAS WITH POTENTIAL SITE VISIBILITY

AREAS WITH OBSTRUCTED VIEW OF SITE

TREE COVER/VEGETATED AREA

NOTES

1. TOPOGRAPHIC INFORMATION FROM LiDAR LAS DATA PROVIDED BY OHIO GEOGRAPHICALLY REFERENCED INFORMATION PROGRAM (OGRIP).
2. THE VIEWSHED ANALYSIS WAS CONDUCTED USING THE DATA EXTRACTED FROM THE LiDAR DATA. VEGETATION AREAS ARE REPRESENTED AS THE DIFFERENCE BETWEEN THE FIRST-RETURN SURFACE AND THE BARE-EARTH SURFACE. AN OBSERVER HEIGHT OF 5.5' WAS USED FOR THE ANALYSIS.
3. SOLAR FACILITIES WERE MODELED USING A PANEL HEIGHT OF 13.5' AND A FENCE HEIGHT OF 7'.
4. INFORMATION PRESENTED HERE IS THE RESULTS OF A DESKTOP ANALYSIS AND HAS NOT BEEN GROUND-TRUTHED.

0 5,000 10,000 Feet

1 " = 5,000 '

1:60,000

PROJECT:

HARDIN SOLAR ENERGY II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

TITLE:

VISUAL SIMULATION PHOTOGRAPH LOCATIONS

DRAWN BY:	J. PAPEZ	PROJ NO.:	302899
CHECKED BY:	M. MOLNAR		
APPROVED BY:	T. ENGLE		**FIGURE 3**
DATE:	NOVEMBER 2018		

TRC

921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
www.trcsolutions.com

FILE NO.: HSII_VIA_F3_11x17.mxd

TRC - GIS

Plot Date: 11/1/2018, 10:24:52 AM by JPAPEZ -- LAYOUT: ANSI B(11"x17")
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Coordinate System: NAD 1983 StatePlane Ohio North FIPS 3401 (Meter)
Map Rotation: 0

4.2 DISCUSSION OF SIMULATIONS

As noted with the viewshed mapping results (**Figures 1 through 3**), views from the north, east, and south of the Hardin Solar II Energy Center will have the least obstructed views in the viewshed. From select areas to the west and southwest, views will be limited due to forested land. Throughout the area small patches of trees and vegetation may obstruct some views, but the extent of visual obstructions is minimal and likely to be lessened during leaf-off conditions.

Figures 4 & 5: Photo Location #1: Upper Scioto Valley School Campus, 1,200 feet (366 m) south of the Project

Photo location #1 is from the parking lot west of the main school building, approximately 1,200 feet (366 m) north of the proposed edge of the solar array. The photo was taken on July 24, 2018 at 9:55am. The proposed-conditions simulation (Figure 5) shows that the solar facility is likely to be seen from this perspective between the gaps in buildings of the feed mill to the south of W Cottonwood Rd. The view between these structures is likely representative of views elsewhere on the school campus where observers may be located (baseball diamonds, track, and football field). This view is somewhat closer to the facility than the other locations mentioned, thus the visual vertical size of features will be larger than from locations farther away.

Figures 6 & 7: Photo Location #2: County Road 75, 1.3 miles (2.1 km) east of the Project

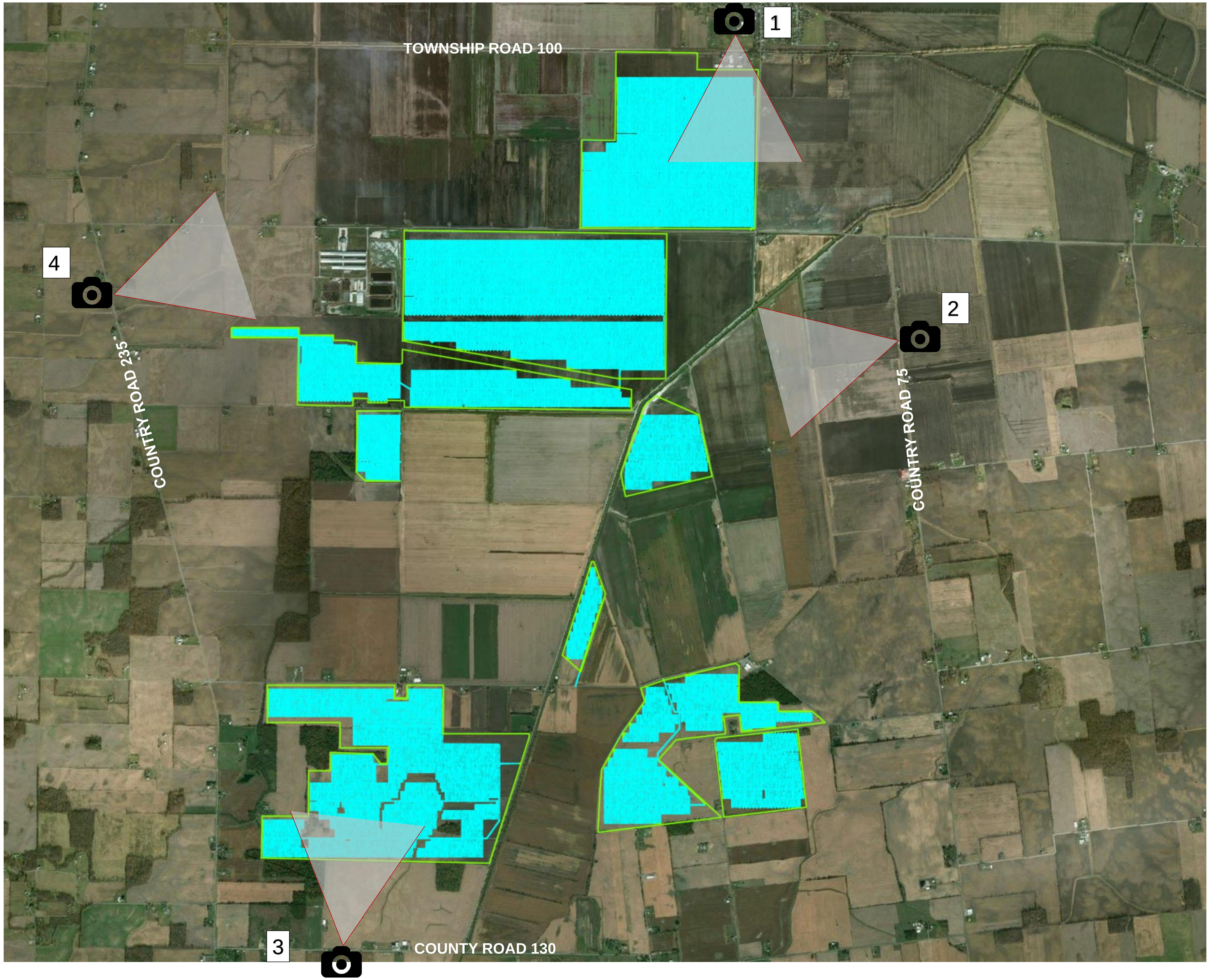
Photo location #2 is from County Road 75, south of County Road 110, approximately 1.3 miles (2.1 km) from the proposed southwest edge of the solar array. The photo was taken on July 24, 2018 at 10:21am. At this location the proposed solar facility may be visible along the horizon. The vertical profile from this distance will be narrow. The simulated photo has an enhanced enlargement of the simulated facility shown to show additional detail. It is possible that with atmospheric haze or when tall crops, like corn, are growing the facility may not be visible from this vantage point.

Figures 8 & 9: Photo Location #3: State Road 195, 0.5 miles (0.8 km) south of the Project

Photo location #3 is from State Road 195, east of State Road 235, approximately 0.5 miles (0.8 km) from the proposed southern edge of the solar array. The photo was taken on July 24, 2018 at 10:39am. At this location the proposed solar facility may be visible in the field and along the horizon. The vertical profile from this distance will be relatively narrow. It is possible that with atmospheric haze or when tall crops, like corn, are growing the facility may not be clearly visible from this vantage point.

Figures 10 & 11: Photo Location #4: State Road 235, 1.0 miles (1.6 km) west of the Project

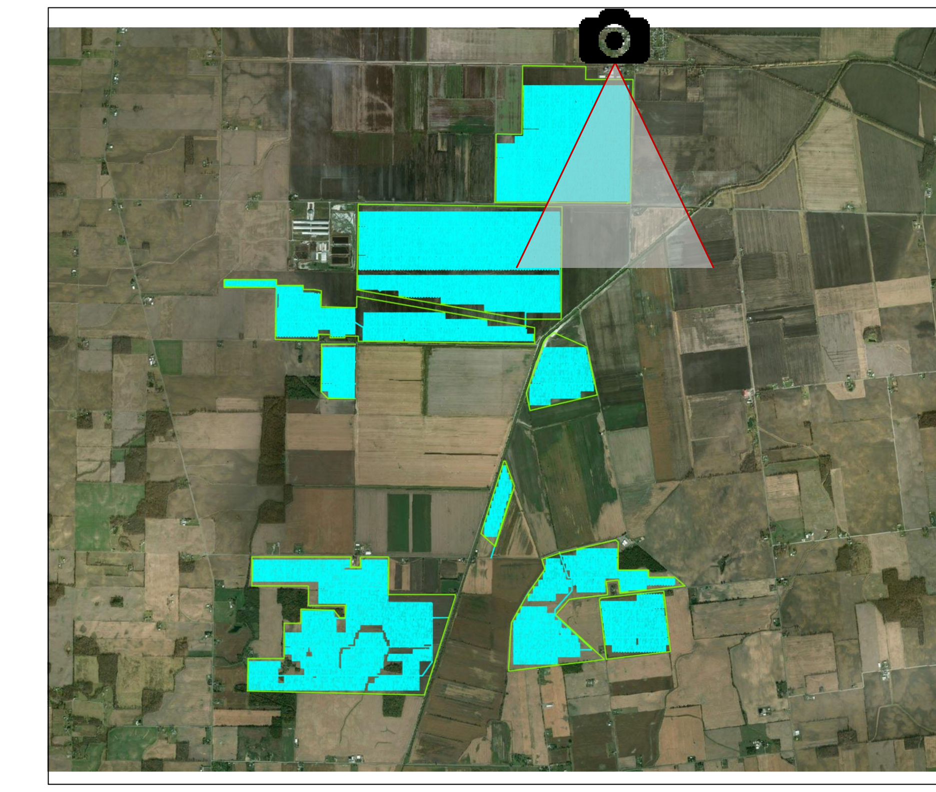
Photo location #4 is from State Road 235, approximately half way between County Road 110 and 120, approximately 1.0 miles (1.6 km) from the proposed western edge of the solar array. The photo was taken on July 24, 2018 at 12:42pm. At this location the proposed solar facility may be visible along the horizon on the right side of the photo. The vertical profile from this distance will be relatively narrow. The simulated photo has an enhanced enlargement of the simulated facility shown to show additional detail. It is possible that with atmospheric haze or when tall crops, like corn, are growing the facility may not be visible from this vantage point.



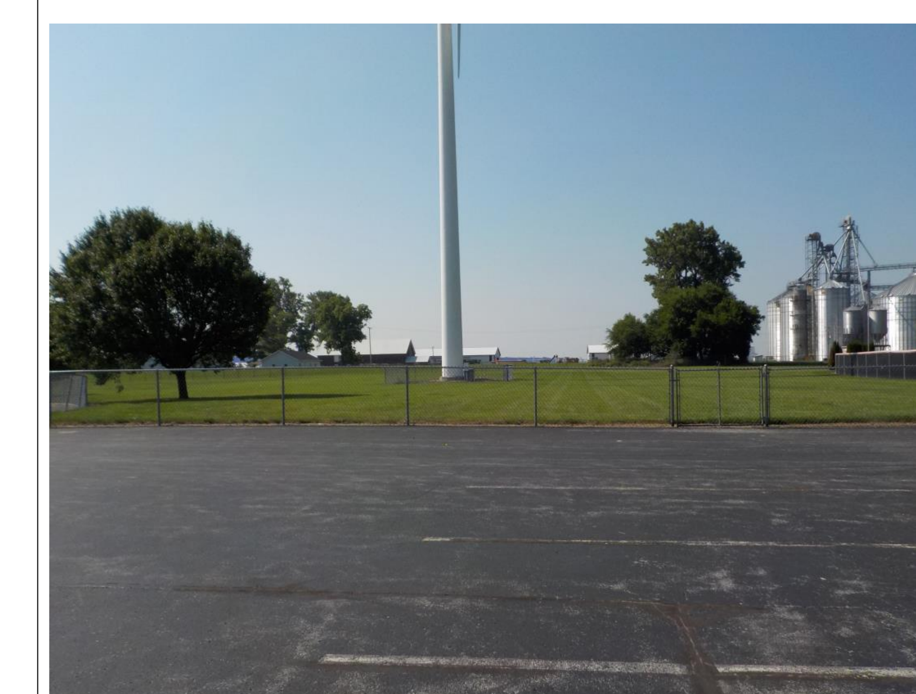
HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

FIGURE 1. PHOTO LOCATION MAP

VIEWPOINT LOCATION MAP



PROPOSED CONDITIONS



TECHNICAL INFORMATION

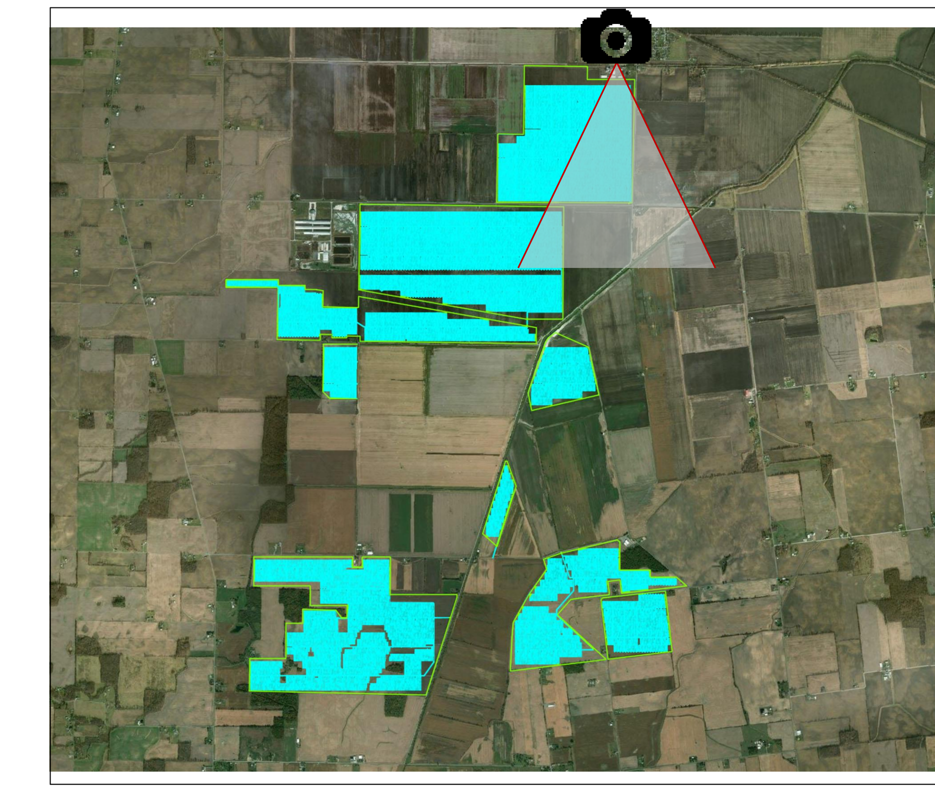
Viewpoint Coordinates in	1,611,301 E
OH NAD83 North State Feet	375,793 N
Viewpoint Location	Location 1
Viewer Eye Elevation	974 ft msl
Distance to Project	1,106 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/9:55 am

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

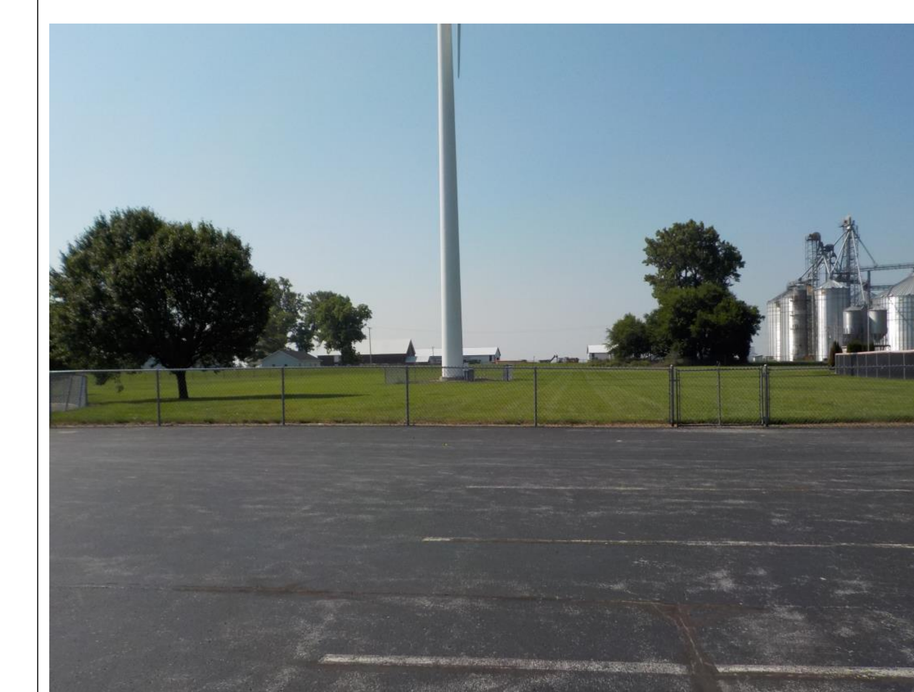
FIGURE 2. PHOTO LOCATION 1: EXISTING CONDITIONS

TRC Results you can rely on

VIEWPOINT LOCATION MAP



EXISTING CONDITIONS



TECHNICAL INFORMATION

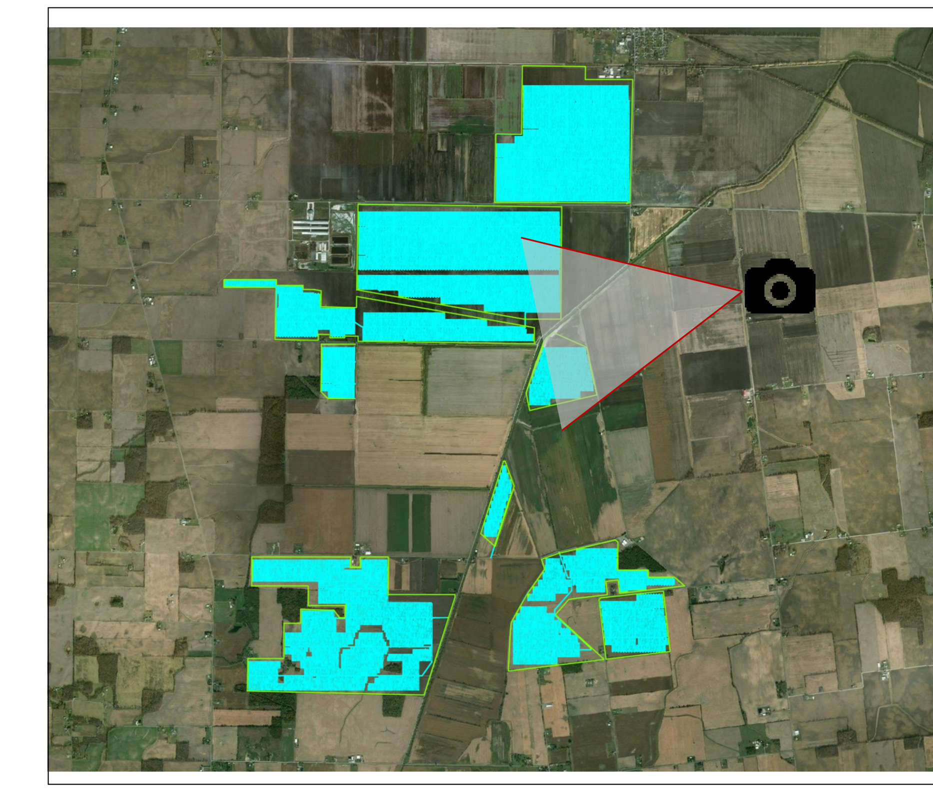
Viewpoint Coordinates in	1,611,301 E
OH NAD83 North State Feet	375,793 N
Viewpoint Location	Location 1
Viewer Eye Elevation	974 ft msl
Distance to Project	1,106 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/9:55 am

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

FIGURE 3. PHOTO LOCATION 1: PROPOSED CONDITIONS

TRC Results you can rely on

VIEWPOINT LOCATION MAP



PROPOSED CONDITIONS

TECHNICAL INFORMATION

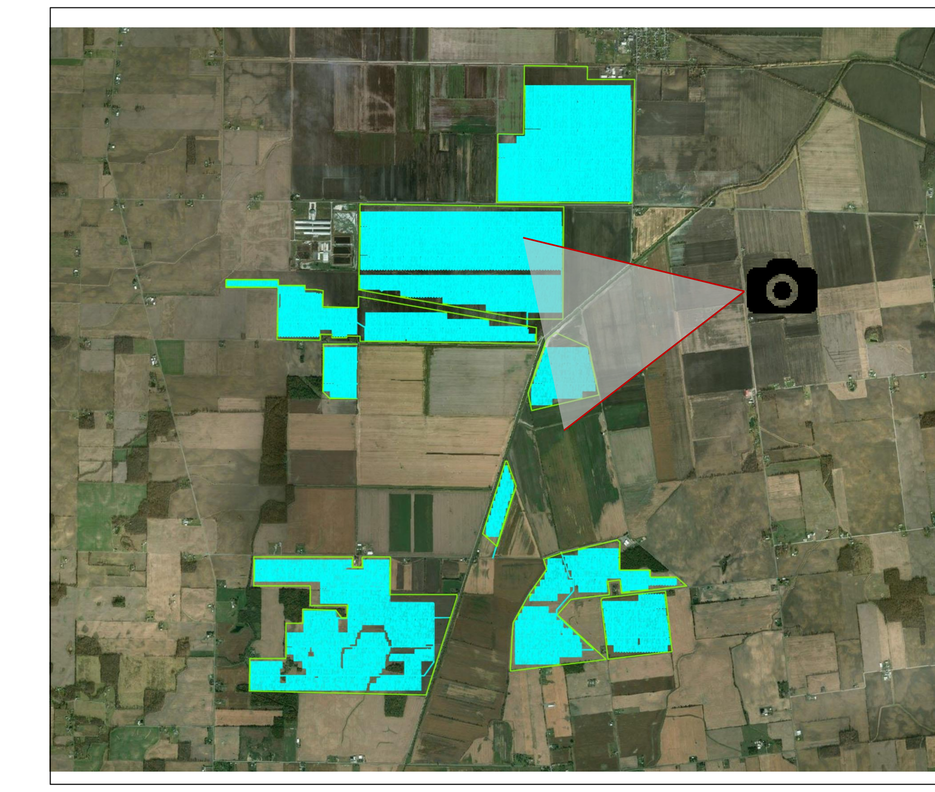
Viewpoint Coordinates in	1,616,188 E
OH NAD83 North State Feet	366,599 N
Viewpoint Location	Location 2
Viewer Eye Elevation	974 ft msl
Distance to Project	6,106 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/10:21 am

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

FIGURE 4. PHOTO LOCATION 2: EXISTING CONDITIONS

TRC Results you can rely on

VIEWPOINT LOCATION MAP



EXISTING CONDITIONS

TECHNICAL INFORMATION

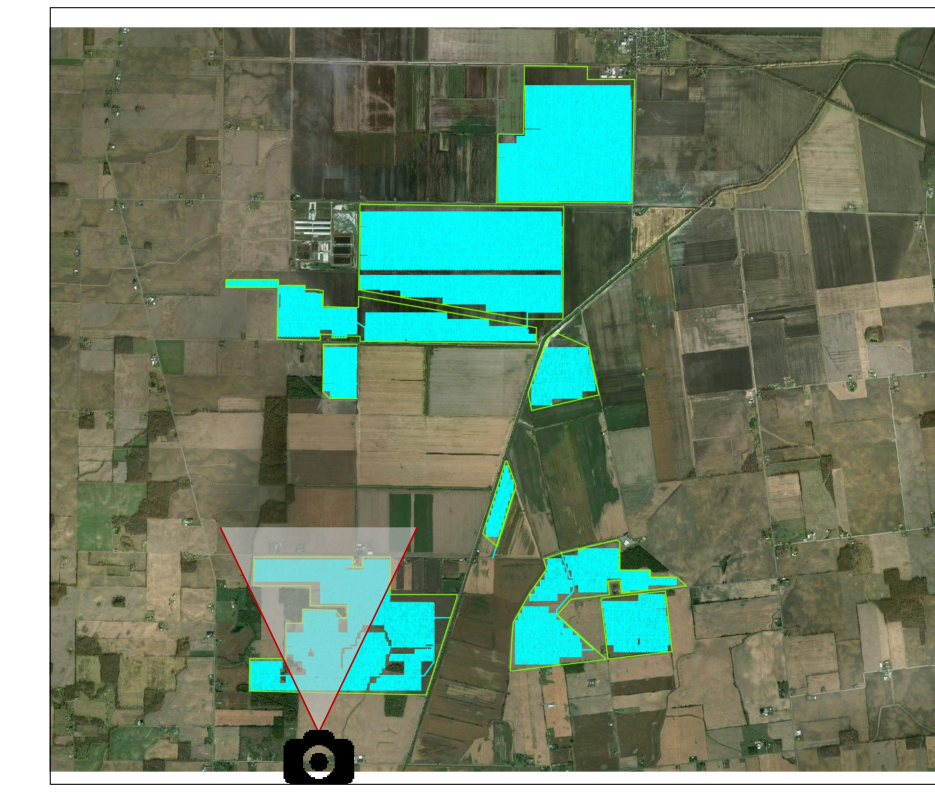
Viewpoint Coordinates in	1,616,188 E
OH NAD83 North State Feet	366,599 N
Viewpoint Location	Location 2
Viewer Eye Elevation	974 ft msl
Distance to Project	6,106 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/10:21 am

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

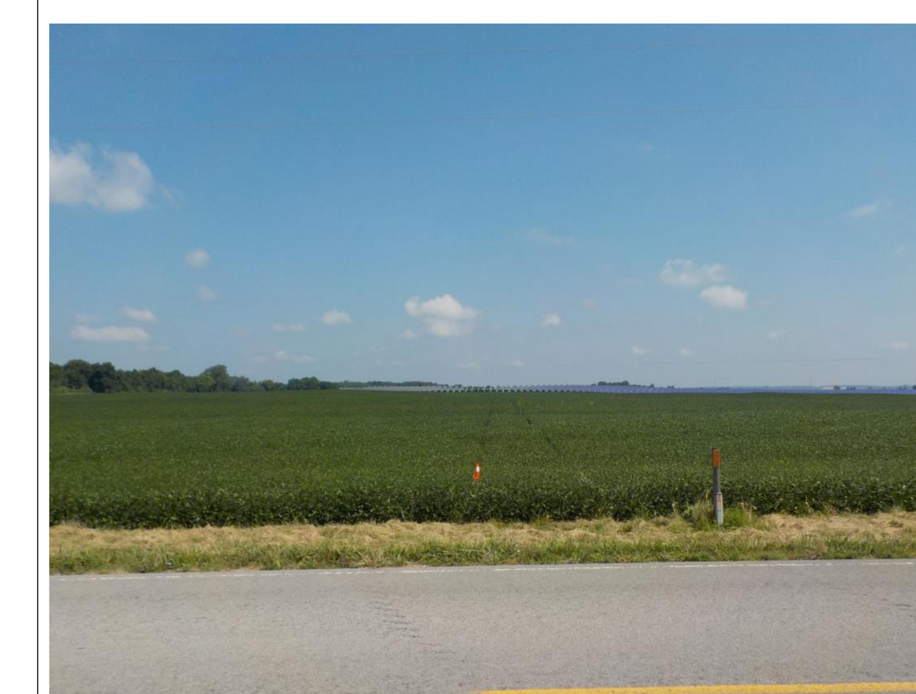
FIGURE 5. PHOTO LOCATION 2: PROPOSED CONDITIONS

TRC Results you can rely on

VIEWPOINT LOCATION MAP



PROPOSED CONDITIONS



TECHNICAL INFORMATION

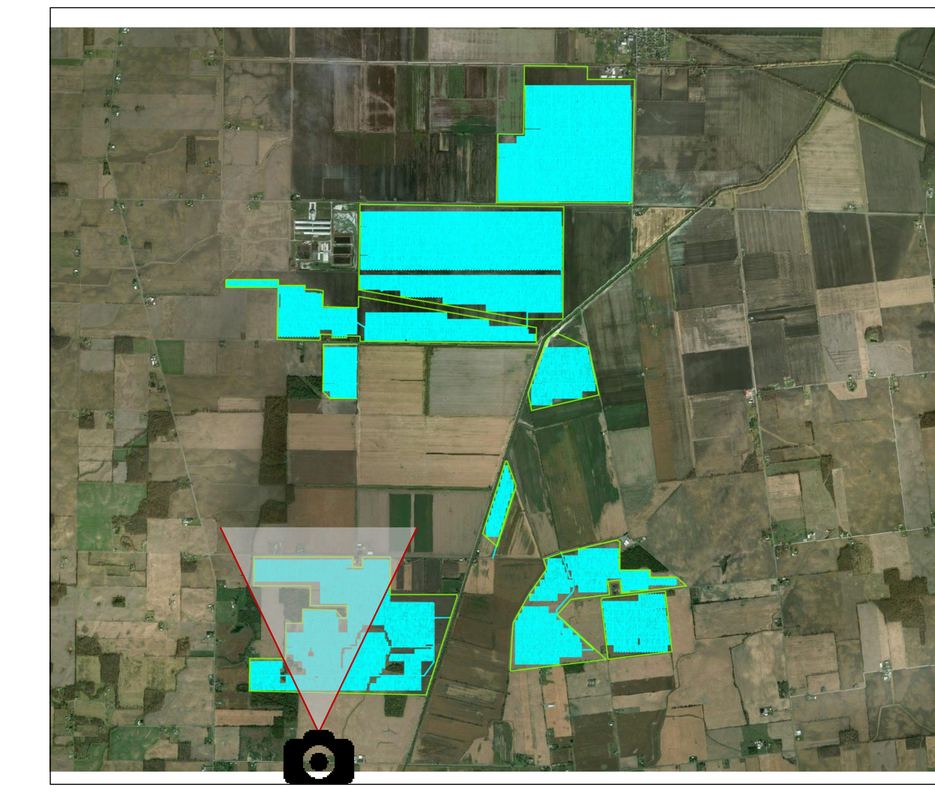
Viewpoint Coordinates in	1,599,978 E
OH NAD83 North State Feet	348,685 N
Viewpoint Location	Location 3
Viewer Eye Elevation	1,010 ft msl
Distance to Project	2,638 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/10:39 am

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

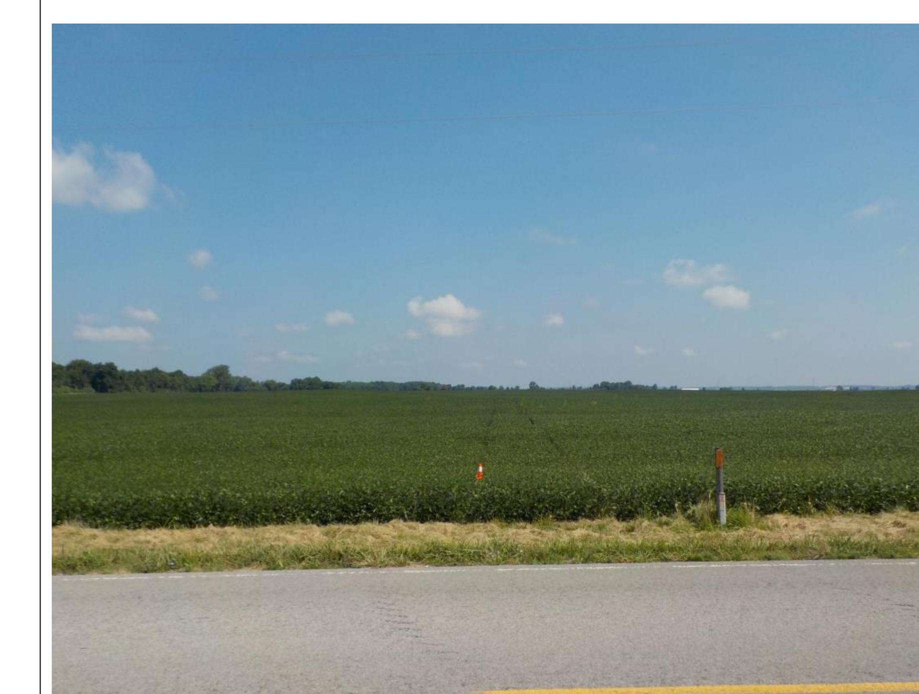
FIGURE 6. PHOTO LOCATION 3: EXISTING CONDITIONS

TRC
Results you can rely on

VIEWPOINT LOCATION MAP



EXISTING CONDITIONS



TECHNICAL INFORMATION

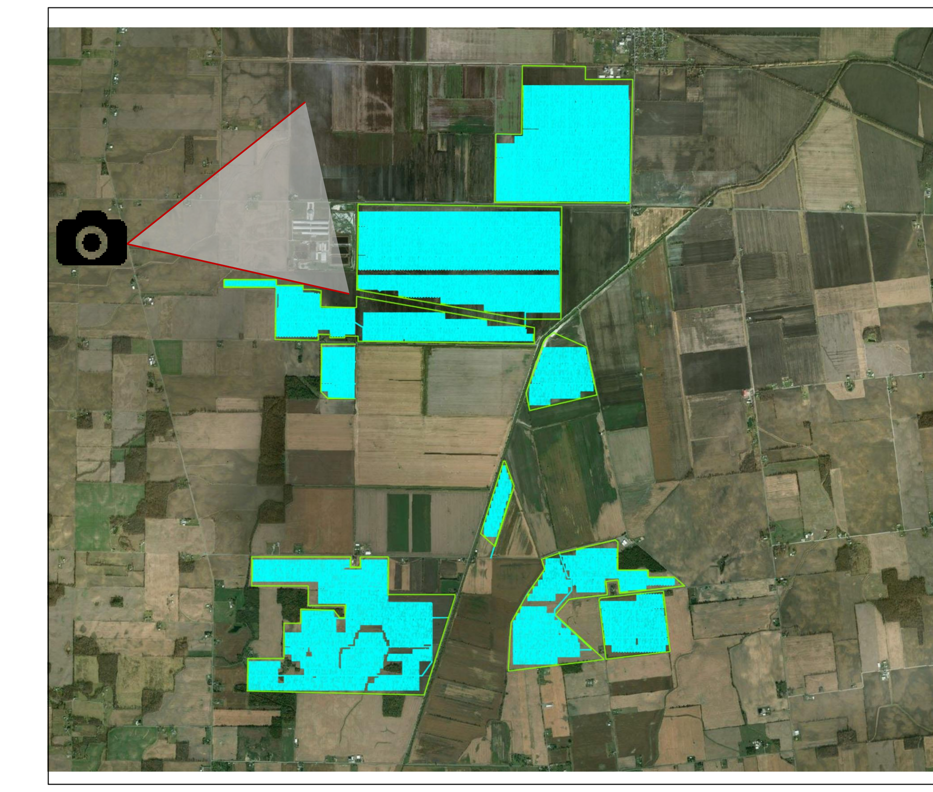
Viewpoint Coordinates in	1,599,978 E
OH NAD83 North State Feet	348,685 N
Viewpoint Location	Location 3
Viewer Eye Elevation	1,010 ft msl
Distance to Project	2,638 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/10:39 am

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

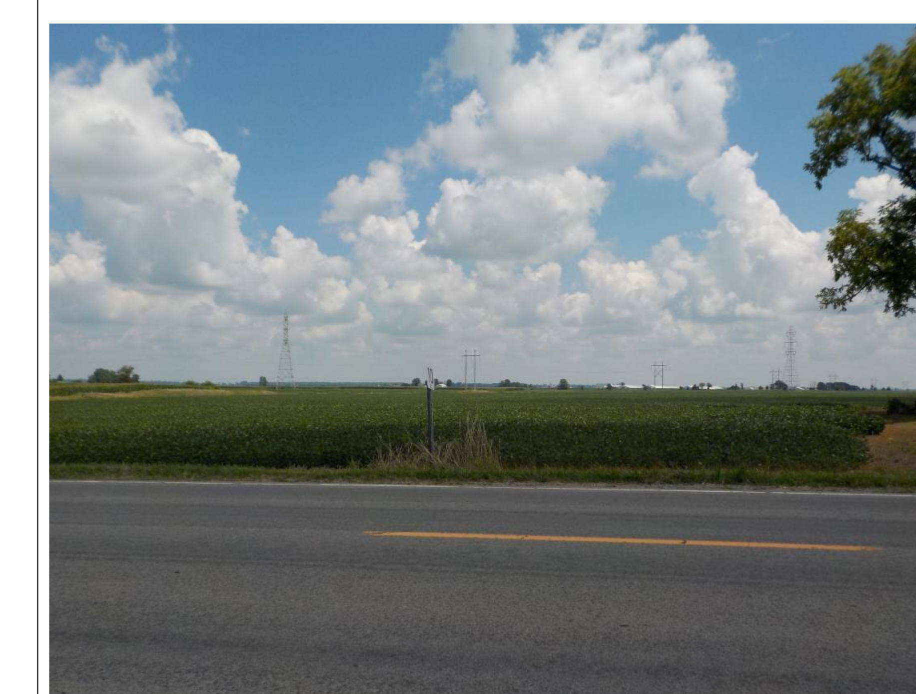
FIGURE 7. PHOTO LOCATION 3: PROPOSED CONDITIONS

TRC Results you can rely on

VIEWPOINT LOCATION MAP



PROPOSED CONDITIONS



TECHNICAL INFORMATION

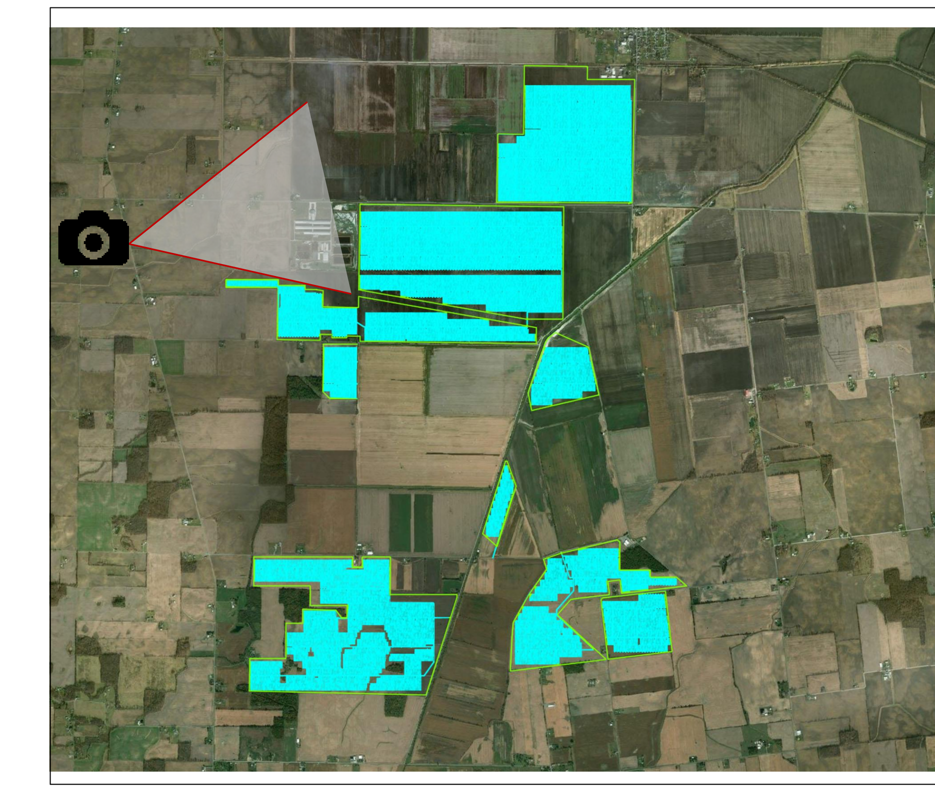
Viewpoint Coordinates in	1,593,068 E
OH NAD83 North State Feet	367,223 N
Viewpoint Location	Location 4
Viewer Eye Elevation	995 ft msl
Distance to Project	8,346 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/12:42 pm

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

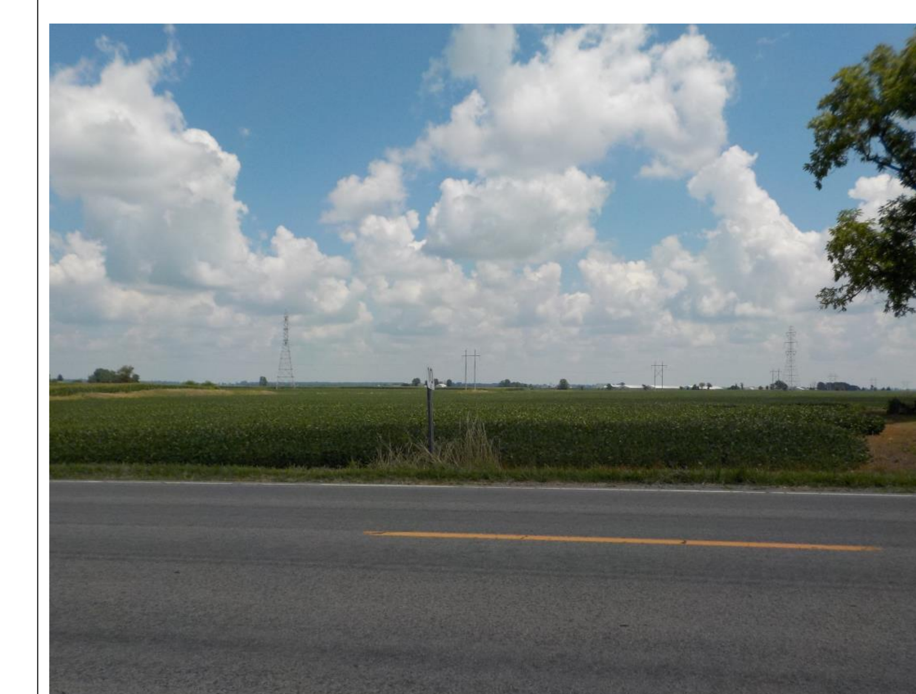
FIGURE 8. PHOTO LOCATION 4: EXISTING CONDITIONS

TRC Results you can rely on

VIEWPOINT LOCATION MAP



EXISTING CONDITIONS



TECHNICAL INFORMATION

Viewpoint Coordinates in	1,593,068 E
OH NAD83 North State Feet	367,223 N
Viewpoint Location	Location 4
Viewer Eye Elevation	995 ft msl
Distance to Project	8,346 ft
Camera Model	COOLPIX W100 V1.5
Lens Setting	30 mm
Date/Time	7-24-2018/12:42 pm

HARDIN SOLAR II ENERGY, LLC
HARDIN SOLAR ENERGY CENTER PROJECT
CONFIDENTIAL BUSINESS INFORMATION

FIGURE 9. PHOTO LOCATION 4: PROPOSED CONDITIONS

TRC
Results you can rely on

4.3 CONCLUSION OF SIMULATIONS

Given the remote location of the site and the limited neighbors, the overall visual impact of the proposed facility remains minimal. The vegetation to the west of the Hardin Solar II Energy Center may shield the site from significant views from that direction, and the expanse of agricultural fields to the north, east and south minimize visual impacts. Views of the Project will likely be possible from various locations within the Village of McGuffey. Given the low-profile nature of solar projects and the lack of exiting major aesthetic or scenic resources in the study area, the aesthetic impacts of views of this Project should be minimal. Additional landscaping screening may be desired along the nearest edges of the Project to the Village of McGuffey if local concerns arise.

5.0 REFERENCES CITED

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Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN
Supplement to Application
November 14, 2018

Attachment 5

Updated Figure 03-2

Project Area Aerial

November 9, 2018

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
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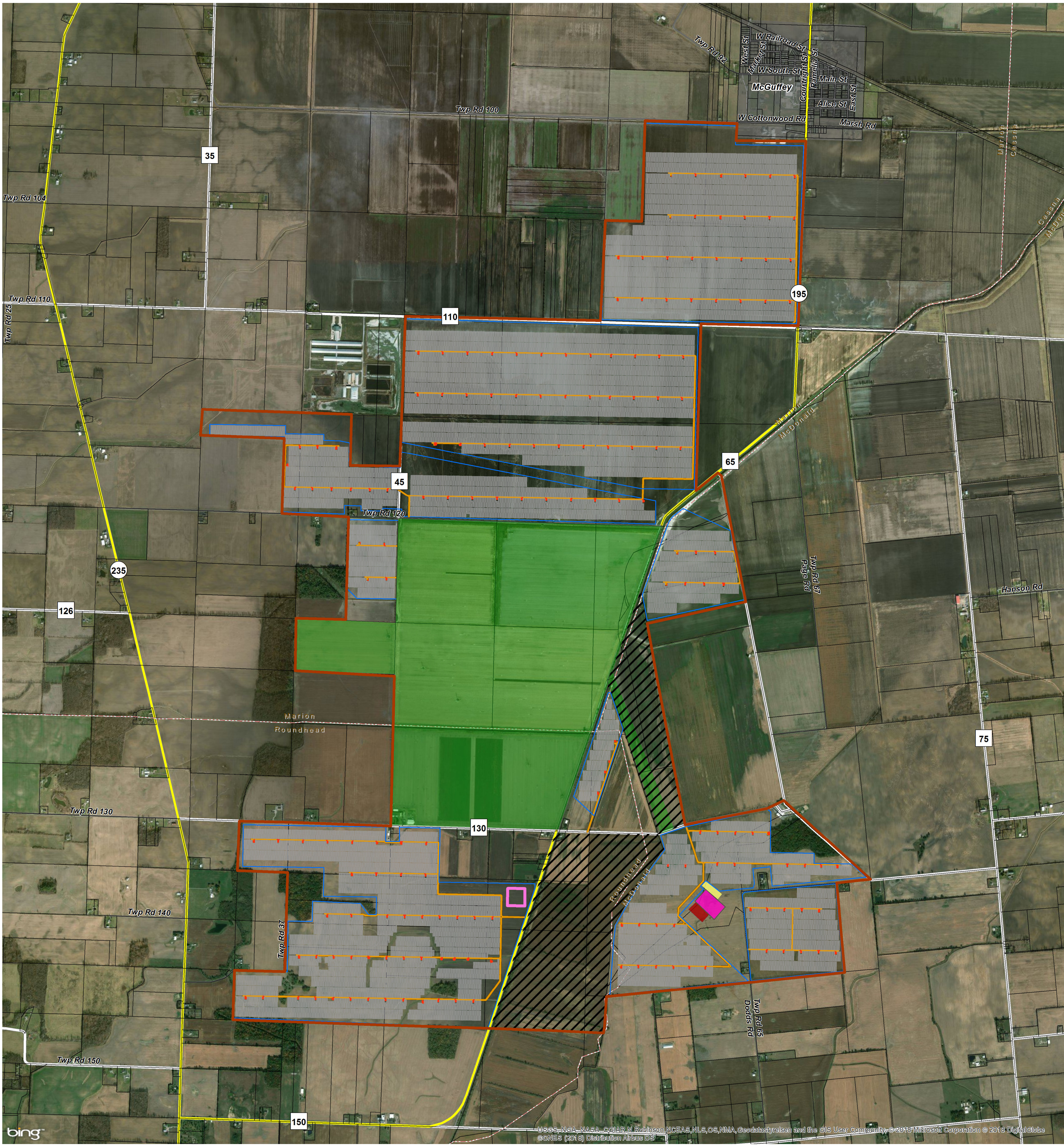
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

Date Saved: Friday, November 9, 2018 10:40:50 AM Prepared By: DBates Coordinate System: NAD 1983 UTM Zone 17N Path: J:_MXDs\US\OH_Solar\HardinSolar\OPSB_2018\hardinsolar_02_project_area_aerial_ArchC.mxd



Legend

Preliminary Project Fenceline	Project Substation Area	Proposed Project Boundary
Preliminary Access Roads	Preliminary Storage Facility	Township
Preliminary Racking	Interconnection Substation	Parcel
Preliminary Inverter	Underground Collection Cable Route	Municipal Boundary
Preliminary O&M Building	Permitted Phase 1	

Road Classification

- US/State Route
- County Road
- Local Road
- Dirt/Unpaved Road

1,500 0 1,500

Feet

1:20,000

Project Area Map

Hardin Solar II Energy Center | Hardin County, Ohio

Rev. 00

November 09, 2018

Invenergy