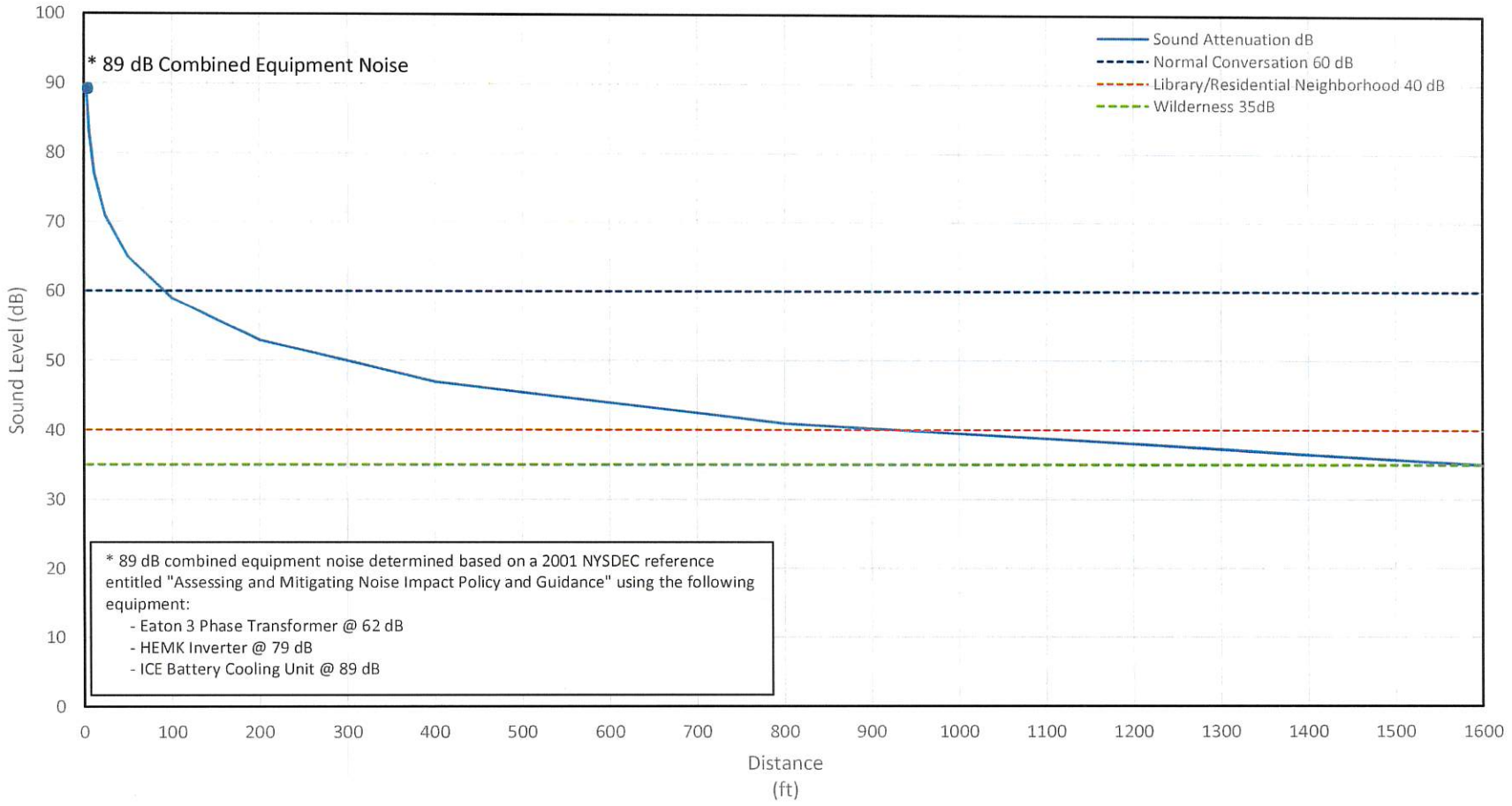
Oak Hill Solar Farm Central Electrical Equipment Sound Attenuation



Travis Mitchell <tmitchell@edpllp.com>

Sound Attenuation Study

Bill Pedersen <bpedersen@amp.energy> Tue, Aug 24, 2021 at 5:55 PM
To: Travis Mitchell <tmitchell@edpllp.com>, Kevin Foster <kfoster@amp.energy>, Nicole LeBlanc <nleblanc@amp.energy>, Gillian Black <gillian.black@edenrenewables.com>, Pallav Shah <pshah@amp.energy>

Hi Travis,

Thank you again for the help on the glare study revision. We wanted to run another last-minute request by you. How long would it take to create an equipment sound attenuation chart, similar to the one I have attached? If it is possible to receive it by the end of the week, could we receive an email proposal for the work?

We would be modeling one of our equipment pads with:
-inverter = 79 dB at 1 meter (cut sheet attached)
-Transformer = standard value, we see you used 62 Db for Eden
-battery = 84 dBa at 5 ft (chart attached, use the ECUA150 column)

The plan is to model a single equipment pad (not all 4) that we will say is closest to Lynn's property line. Let us know if this is something you think EDP can help us with.

Thanks,

Bill

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AMP_Wordmark_Color (1)

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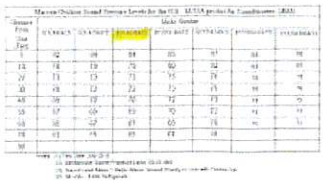
4 attachments



battery noise_Highlighted.PNG
126K

image001.jpg
2K

Sound Attenuation.pdf
812K

Power Electronics HEMK FS 3190K - spec sheet (2).pdf


65K

4 TECHNICAL INFORMATION

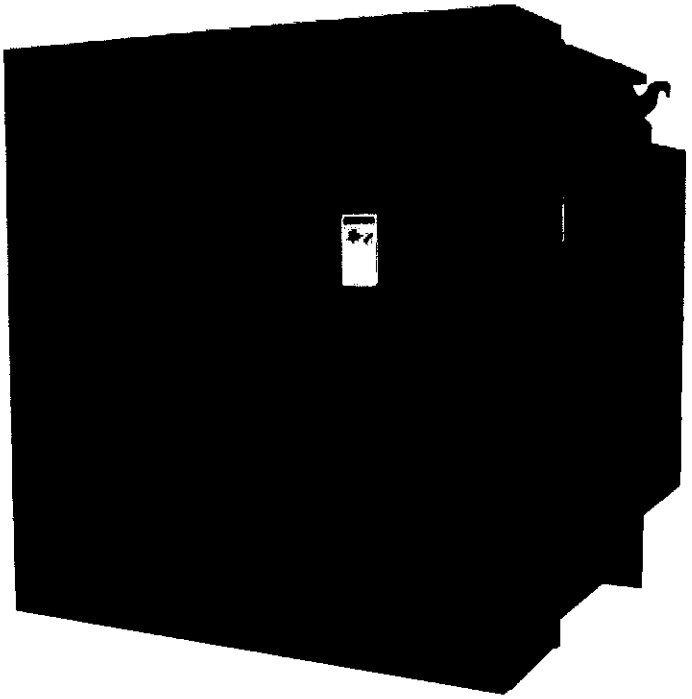
General information	
Tracker type	Single-axis horizontal tracker
System incline in north-south direction in relation to terrain slope	Parallel to the course of the terrain
Module layout	2 vertical or 4 horizontal (standard)
Output per machine	Approx. 80 kWp (module-specific), max. 240 PV modules
Tracking range	up to 120° (+/- 60°)
Lock position	In all holding positions (every 3°)
Storm position and night position	9°
Tracking interval	site-specific
Travel angle per interval	3°
Slope south/north	maximum 10°
Terrain slope east/west	maximum 10°
Covered area (GCR)	> 50 possible (site-specific)
Temperature range	- 25°C to +60°C / -13°F to140°F
Tracking method	Astronomical calculation based on location and time
Backtracking	Yes
Snow position	Yes
Maintenance position	Yes
Noise emission	< 70 dB(A)
Maximum operational mounted load	According the structural calculation

Dimensions (depending on module, construction site and/or design)		
Module area	Up to approx. 480 m²	up to approx. 5167 ft²
Drives per MWp	approx. 12-18 (site-specific)	

2.4 Mechanical and Environmental Specification

Operating Ambient Temperature:	-25 to +55°C (see derating curve)
Stand-by Temperature:	-40 to +60°C
Storage Temperature:	-40 to +70°C
Maximum Altitude:	1,000m above sea-level without de-rating
Relative Humidity:	95% non-condensing
Enclosure Rating:	Outdoor NEMA 3R (IP54)
Enclosure Dimensions:	33.5" x 39.4" x 80.5" (l x w x h)
Weight:	1,300 lbs.
Cable Connections:	Bottom or Side Entry
Cooling:	Forced air-cooled
Acoustic Rating:	<85dBA at 1m
Service Clearance:	28" front and back (Dwg. for detail)

Three-phase pad-mounted compartmental type transformer



General

At Eaton, we are constantly striving to introduce new innovations to the transformer industry, bringing you the highest quality, most reliable transformers. Eaton's Cooper Power series Transformer Products are ISO 9001 compliant, emphasizing process improvement in all phases of design, manufacture, and testing. In order to drive this innovation, we have invested both time and money in the Thomas A. Edison Technical Center, our premier research facility in Franksville, Wisconsin. Such revolutionary products as distribution-class UltraSIL™ Polymer-Housed Evolution™ surge arresters and Envirotemp™ FR3™ fluid have been developed at our Franksville lab.

With transformer sizes ranging from 45 kVA to 12 MVA and high voltages ranging from 2400 V to 46 kV, Eaton has you covered. From fabrication of the tanks and cabinets to winding of the cores and coils, to production of arresters, switches, tap changers, expulsion fuses, current limit fuses, bushings (live and dead) and molded rubber goods, Eaton does it all. Eaton's Cooper Power series transformers are available with electrical grade mineral oil or Envirotemp™ FR3™ fluid, a less-flammable and bio-degradable fluid. Electrical codes recognize the advantages of using Envirotemp™ FR3™ fluid both indoors and outdoors for fire sensitive applications. The bio-based fluid meets Occupational Safety and Health Administration (OSHA) and Section 450.23 NEC Requirements.

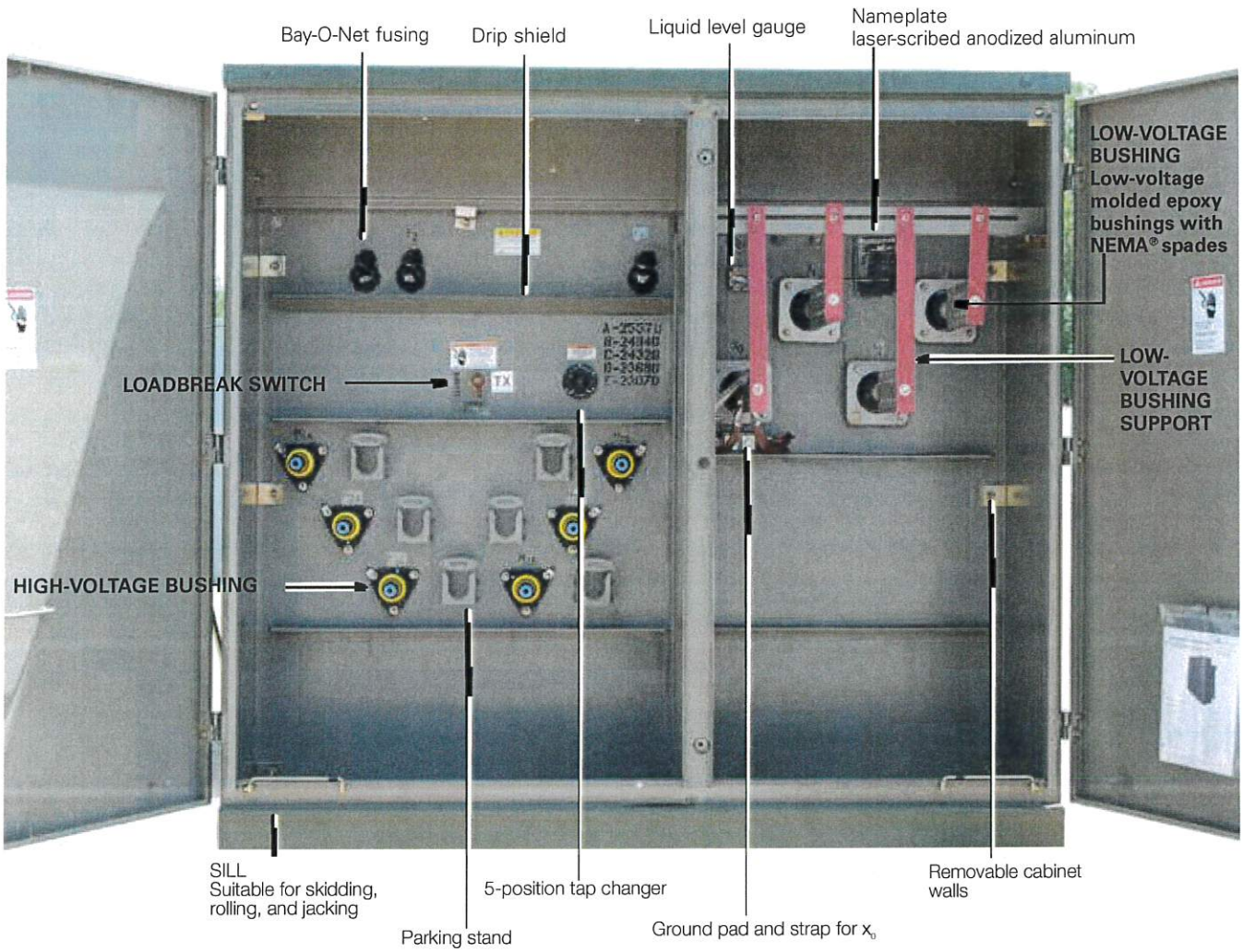


Figure 1. Three-phase pad-mounted compartmental type transformer.

Table 1. Product Scope

Type	Three Phase, 50 or 60 Hz, 65 °C Rise (55 °C, 55/65 °C), 65/75 °C, 75 °C
Fluid Type	Mineral oil or Envirotemp™ FR3™ fluid
Coil Configuration	2-winding or 4-winding or 3-winding (Low-High-Low), 3-winding (Low-Low-High)
Size	45 – 10,000 kVA
Primary Voltage	2,400 – 46,000 V
Secondary Voltage	208Y/120 V to 14,400 V
Specialty Designs	Inverter/Rectifier Bridge
	K-Factor (up to K-19)
	Vacuum Fault Interrupter (VFI)
	UL® Listed & Labeled and Classified
	Factory Mutual (FM) Approved®
	Solar/Wind Designs
	Differential Protection
	Seismic Applications (including OSHPD)
	Hardened Data Center

Eaton CA202003EN Three Phase Transformer

Table 2. Three-Phase Ratings

Three-Phase 50 or 60 Hz
kVA Available[1] 45, 75, 112.5, 150, 225, 300, 500, 750, 1000, 1500, 2000, 2500, 3000, 3750, 5000, 7500, 10000

[1]Transformers are available in the standard ratings and configurations shown or can be customized to meet specific needs.

Table 3. Impedance Voltage

	Low-voltage rating		
Rating (kVA)	**≤ 600 V**	**2400 Δ through 4800 Δ**	**6900 Δ through 13800GY/7970 or 13800 Δ**
45-75	2.70-5.75	2.70-5.75	2.70-5.75
112.5-300	3.10-5.75	3.10-5.75	3.10-5.75
500	4.35-5.75	4.35-5.75	4.35-5.75
750-2500	5.75	5.75	5.75
3750	5.75	5.75	6.00
5000		6.00	6.50

Note: The standard tolerance is ± 7.5%

Table 4. Audible Sound Levels

	NEMA® TR-1 Average
Self-Cooled, Two Winding kVA Rating	**Decibels (dB)**
45-500	56
501-700	57
701-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63
3001-4000	64
4001-5000	65
5001-6000	66
6001-7500	67
7501-10000	68

Table 5. Insulation Test Levels

KV Class	Induced Test 180 or 400 Hz 7200 Cycle	kV BIL Distribution	Applied Test 60 Hz (kV)
1.2	Twice Rated Voltage	30	10
2.5		45	15
5		60	19
8.7		75	26
15		95	34
25		125	40
34.5		150	50

Table 6. Temperature Rise Ratings 0-3300 Feet (0-1000 meters)

	Standard	Optional
Unit Rating (Temperature Rise Winding)	65 °C	55 °C, 55/65 °C, 75 °C
Ambient Temperature Max	40 °C	50 °C
Ambient Temperature 24 Hour Average	30 °C	40 °C
Temperature Rise Hotspot	80 °C	65 °C

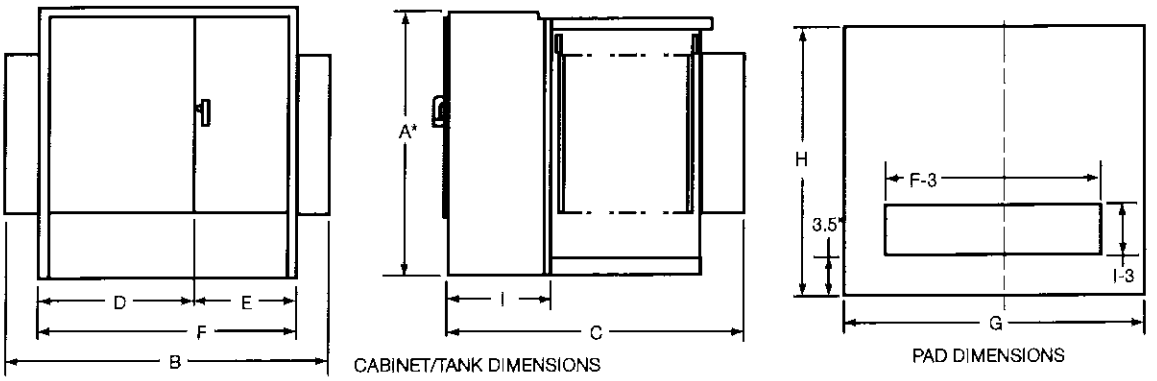


Figure 2. Transformer and pad dimensions.

* Add 9" for Bay-O-Net fusing.

Table 7. Fluid-filled—aluminum windings 55/65 °C Rise[1]

65° Rise	DEAD-FRONT—LOOP OR RADIAL FEED—BAY-O-NET FUSING OIL FILLED—ALUMINUM WINDINGS										
	OUTLINE DIMENSIONS (in.)									Gallons of Fluid	Approx. Total Weight (lbs.)
kVA Rating	A*	B	C	D	E	F	G	H	I		
45	50	68	39	42	26	68	72	43	20	110	2,100
75	50	68	39	42	26	68	72	43	20	115	2,250
112.5	50	68	49	42	26	68	72	53	20	120	2,350
150	50	68	49	42	26	68	72	53	20	125	2,700
225	50	72	51	42	30	72	76	55	20	140	3,150
300	50	72	51	42	30	72	76	55	20	160	3,650
500	50	89	53	42	30	72	93	57	20	190	4,650
750	64	89	57	42	30	72	93	61	20	270	6,500
1000	64	89	59	42	30	72	93	63	20	350	8,200
1500	73	89	86	42	30	72	93	90	24	410	10,300
2000	73	72	87	42	30	72	76	91	24	490	12,500
2500	73	72	99	42	30	72	76	103	24	530	14,500
3000	73	84	99	46	37	84	88	103	24	620	16,700
3750	84	85	108	47	38	85	88	112	24	660	19,300
5000	84	96	108	48	48	96	100	112	24	930	25,000
7500	94	102	122	54	48	102	100	126	24	1,580	41,900

1 Weights, gallons of fluid, and dimensions are for reference only and not for construction. Please contact Eaton for exact dimensions.

* Add 9" for Bay-O-Net fusing.

Table 8. Fluid-Filled—Copper Windings 55/65 °C Rise[1]

65° Rise	DEAD-FRONT—LOOP OR RADIAL FEED—BAY-O-NET FUSING OIL FILLED—COPPER WINDINGS										
	OUTLINE DIMENSIONS (in.)									Gallons of Fluid	Approx. Total Weight (lbs.)
kVA Rating	A*	B	C	D	E	F	G	H	I		
45	50	64	39	34	30	64	69	43	20	110	2,100
75	50	64	39	34	30	64	69	43	20	115	2,350
112.5	50	64	49	34	30	64	69	53	20	115	2,500
150	50	64	49	34	30	64	69	53	20	120	2,700
225	50	64	51	34	30	64	73	55	20	140	3,250
300	50	64	51	34	30	64	75	55	20	160	3,800
500	50	81	53	34	30	64	85	57	20	200	4,800
750	64	89	57	42	30	72	93	61	20	255	6,500
1000	64	89	59	42	30	72	93	63	20	300	7,800
1500	73	89	86	42	30	72	93	90	24	410	10,300
2000	73	72	87	42	30	72	76	91	24	420	11,600
2500	73	72	99	42	30	72	76	103	24	500	14,000
3000	73	84	99	46	37	84	88	103	24	720	18,700
3750	84	85	108	47	38	85	88	112	24	800	20,500
5000	84	96	108	48	48	96	100	112	24	850	25,000
7500	94	102	122	54	48	102	100	126	24	1,620	46,900

[1] Weights, gallons of fluid, and dimensions are for reference only and not for construction. Please contact Eaton for exact dimensions.

* Add 9" for Bay-O-Net fusing.

Standard features

Connections and neutral configurations

- Delta - Wye: Low voltage neutral shall be a fully insulated X0 bushing with removable ground strap.
- Grounded Wye-Wye: High voltage neutral shall be internally tied to the low voltage neutral and brought out as the H0X0 bushing in the secondary compartment with a removable ground strap.
- Delta-Delta: Transformer shall be provided without a neutral bushing.
- Wye-Wye: High voltage neutral shall be brought out as the H0 bushing in the primary compartment and the low voltage neutral shall be brought as the X0- bushing in the secondary compartment.
- Wye-Delta: High voltage neutral shall be brought out as the H0 bushing in the primary compartment. No ground strap shall be provided (line to line rated fusing is required).

High and low voltage bushings

- 200 A bushing wells (15, 25, and 35 kV)
- 200 A, 35 kV Large Interface
- 600 A (15, 25, and 35 kV) Integral bushings (dead-front)
- Electrical-grade wet-process porcelain bushings (live-front)

Tank/cabinet features

- Bolted cover for tank access (45-2500 kVA)
- Welded cover with hand hole (>2500 kVA)
- Three-point latching door for security
- Removable sill for easy installation
- Lifting lugs (4)
- Stainless steel cabinet hinges and mounting studs
- Steel divider between HV and LV compartment
- 20" Deep cabinet (45-1000 kVA)
- 24" Deep cabinet (1500-7500 kVA)
- 30" Deep cabinet (34.5/19.92 kV)
- Pentahead captive bolt
- Stainless steel 1-hole ground pads (45-500 kVA)
- Stainless steel 2-hole ground pads (750-10,000 kVA)
- Parking Stands (dead-front)

Valves/plugs

- One-inch upper filling plug
- One-inch drain plug (45-500 kVA)
- One-inch combination drain valve with sampling device in low voltage compartment (750-10,000 kVA)
- Automatic pressure relief valve

Nameplate

- Laser-scribed anodized aluminum nameplate

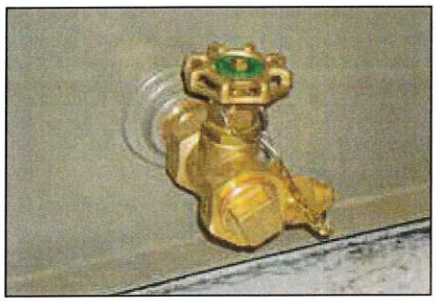


Figure 3. Drain valve with sampler.

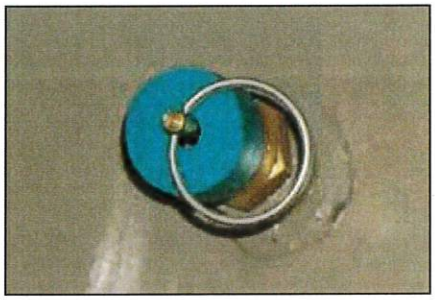


Figure 4. Automatic Pressure relief valve.

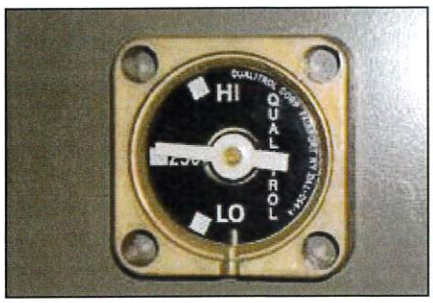


Figure 5. Liquid level gauge.

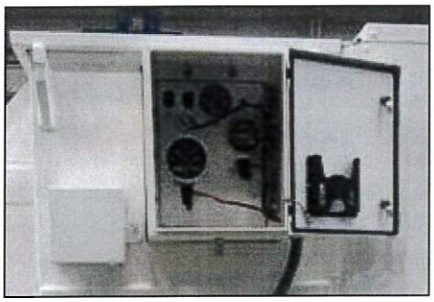


Figure 6. External Gauges.

Figure 7. External visible break with gauges.

Optional features

High and low voltage bushings

- 200 A (15, 25 kV) bushing inserts
- 200 A (15, 25 kV) feed thru inserts
- 200 A (15, 25 kV) (HTN) bushing wells with removable studs
- High-voltage 600 A (15, 25, 35 kV) deadbreak one-piece bushings
- Low voltage 6-, 8-holes spade
- Low voltage 12-, 16-, 20-holes spade (750-2500 kVA)
- Low voltage bushing supports

Tank/cabinet features

- Stainless steel tank base and cabinet
- Stainless steel tank base, cabinet sides and sill
- 100% stainless steel unit
- Service entrance (2 inch) in sill or cabinet side
- Touch-up paint (domestic)
- Copper ground bus bar
- Kirk-Key provisions
- Nitrogen blanket
- Bus duct cutout

Special designs

- Factory Mutual (FM)
- UL® Classified
- Triplex
- High altitude
- K-Factors
- Step-up
- Critical application
- Modulation transformers
- Seismic applications (including OSHPD)

Switches

- One, two, or three On/Off loadbreak switches
- 4-position loadbreak V-blade switch or T-blade switch
- Delta-wye switch
- 3-position V-Blade selector switch
- 100 A, 150 A, 300 A tap changers
- Dual voltage switch
- Visible break with VFI interrupter interlock
- External visible break (15, 25, and 35 kV, up to 3 MVA)
- External visible break with gauges (15, 25, and 35 kV, up to 3 MVA)

Gauges and devices

- Liquid level gauge (optional contacts)
- Pressure vacuum gauge (optional contacts and bleeder)
- Dial-type thermometer (optional alarm contacts)
- Cover mounted pressure relief device (optional alarm contacts)
- Ground connectors
- Hexhead captive bolt
- Molded case circuit breaker mounting provisions
- External gauges in padlockable box

Overcurrent protection

- Bay-O-Net fusing (Current sensing, dual sensing, dual element, high amperage overload)
- Bay-O-Net expulsion fuse in series with a partial range under-oil ELSP current limiting fuse (below 23 kV)
- Cartridge fusing in series with a partial range under-oil ELSP current limiting fuse (above 23 kV)
- MagneX™ interrupter with ELSP current-limiting fuse
- Vacuum Fault Interrupter (VFI)
- Visible break window
- Fuse/switch interlock

Valves/plugs

- Drain/sampling valve in high-voltage compartment
- Globe type upper fill valve

Overvoltage protection

- Distribution-, intermediate-, or station-class surge arresters
- Elbow arresters (for dead-front connections)

Metering/fan/control

- Full metering package
- Current Transformers (CTs)
- Metering Socket
- NEMA® 4 control box (optional stainless steel)
- NEMA® 7 control box (explosion proof)
- Fan Packages

Testing

- Customer test witness
- Customer final inspection
- Zero Sequence Impedance Test
- Heat Run Test
- ANSI® Impulse Test
- Audible Sound Level Test
- RIV (Corona) Test
- Dissolved Gas Analysis (DGA) Test
- 8- or 24-Hour Leak Test

Coatings (paint)

- ANSI® Bell Green
- ANSI® #61 Light Gray
- ANSI® #70 Sky Gray
- Special paint available per request

Nameplate

- Stainless steel nameplate

Decals and labels

- High voltage warning signs
- Mr. Ouch
- Bi-lingual warning
- DOE compliant
- Customer stock code
- Customer stenciling
- Shock and arc flash warning decal
- Non-PCB decal

Construction

Core

The three-legged, step-lap mitered core construction is manufactured using a high-quality cutting machine. For maximum efficiency, cores are precisely stacked, virtually eliminating gaps in the corner joints.

Five-legged wound core or shell-type triplex designs are used for wye-wye connected transformers, and other special transformer designs.

Cores are manufactured with precision cut, burr-free, grain-oriented silicon steel or amorphous metal, depending on customer preference or optimal material based upon performance requirements. Many grades of core steel are available for optimizing core loss efficiency.

Coils

Pad-mounted transformers feature a rectangular coil configuration with wire-wound, high-voltage primaries and sheet-wound secondaries. The design minimizes axial stress developed by short circuits and provides for magnetic balancing of tap connections.

Coils are wound using the highest quality winding machines providing exacting tension control and conductor placement for superior short-circuit strength and maximum efficiency.

Extra mechanical strength is provided by diamond pattern, epoxy-coated paper insulation, used throughout the coil, with additional epoxy at heavy stress points. The diamond pattern distribution of the epoxy and carefully arranged ducts, provide a network of passages through which cooling fluid can freely circulate.

Coil assemblies are heat-cured under calculated hydraulic pressure to ensure performance against short-circuit forces.

Core and coil assemblies

Pad-mounted transformer core and coil assemblies are braced with heavy steel ends to prevent the rectangular coil from distorting under short-circuit conditions. Plates are clamped in place using presses, and welded or bolted to form a solid core and coil assembly. Core and coil assemblies exceed ANSI® and IEEE® requirements for short-circuit performance. Due to the rigidity of the design, impedance shift after short-circuit is comparable to that of circular wound assemblies.

Tanks

Transformer tanks are designed for high strength and ease of handling, installation, and maintenance. Tanks are welded using precision-cut, hot rolled, pickled and oiled steel. They are sealed to protect the insulating fluid and other internal components.

Transformer tanks are pressure-tested to withstand 7 psig without permanent distortion and 15 psig without rupture.

Tank finish

An advanced multi-stage finishing process exceeds IEEE Std C57.12.28™-2014 standards. The eight-stage pre-treatment process assures coating adhesion and retards corrosion. It converts tank surfaces to a nonmetallic, water insoluble iron phosphate coating.

The paint method consists of two distinct layers of paint. The first is an epoxy primer (E-coat) layer which provides a barrier against moisture, salt and corrosives. The two-component urethane final coat seals and adds ultraviolet protection.

Vacuum processing

Transformers are dried and filled with filtered insulating fluid under vacuum, while secondary windings are energized. Coils are heated to drive out moisture, ensuring maximum penetration of fluid into the coil insulation system.

Insulating fluid

Eaton's Cooper Power series transformers are available with electrical-grade mineral insulating oil or Envirotemp™ FR3™ fluid. The highly refined fluids are tested and degassed to assure a chemically inert product with minimal acid ions. Special additives minimize oxygen absorption and inhibit oxidation. To ensure high dielectric strength, the fluid is re-tested for dryness and dielectric strength, refiltered, heated, dried, and stored under vacuum before being added to the completed transformer.

Eaton's Cooper Power series transformers filled with Envirotemp™ FR3™ fluid enjoy unique fire safety, environmental, electrical, and chemical advantages, including insulation life extending properties.

A bio-based, sustainable, natural ester dielectric coolant, Envirotemp™ FR3™ fluid quickly and thoroughly biodegrades in the environment and is non-toxic per acute aquatic and oral toxicity tests.

Building for Environmental and Economic Sustainability (BEES) total life cycle assessment software, utilized by the US Dept. of Commerce, reports its overall environmental performance impact score at 1/4th that reported for mineral oil. Envirotemp™ FR3™ fluid has also earned the EPA Environmental Technology Verification of transformer materials.

With a fire point of 360 °C, Envirotemp™ FR3™ fluid is FM Approved® and Underwriters Laboratories (UL®) Classified "Less-Flammable" per NEC® Article 450-23, fitting the definition of a Listed Product per NEC®.

Figure 8. VFI transformer with visible break.

Pad-mounted VFI transformer

Eaton's Cooper Power series VFI transformer combines a conventional distribution transformer with the proven Vacuum Fault Interrupter (VFI). This combination provides both voltage transformation and transformer over current protection in one space saving and money saving package. The pad-mounted VFI transformer protects the transformer and provides proper coordination with upstream protective devices. When a transformer fault or overload condition occurs, the VFI breaker trips and isolates the transformer.

The three-phase VFI breaker has independent single-phase initiation, but is three-phase mechanically gang-tripped. A trip signal on any phase will open all three phases. This feature eliminates single-phasing of three phase loads. It also enables the VFI breaker to be used as a three-phase load break switch.

Due to the resettable characteristics of the VFI breaker, restoring three-phase service is faster and easier.

The sealed visible break window and switch is an option that can be installed to provide visible break contact. This feature provides enhanced safety and allows an operator to see if the loadbreak switch contacts are in an open or closed position before performing

maintenance.

Envirotran™ FM Approved special protection transformer

Eaton's Cooper Power series Envirotran™ transformer is FM Approved and suitable for indoor locations. Factory Mutual Research Corporation's (FMRC) approval of the Envirotran transformer line makes it easy to comply with and verify compliance with Section 450.23, 2008 NEC, Less-Flammable Liquid-Filled Transformer Requirements for both indoor and outdoor locations.

Envirotran FM Approved transformers offer the user the benefit of a transformer that can be easily specified to comply with NEC, and makes FM Safety Data Sheet compliance simpler, while also providing maximum safety and flexibility for both indoor and outdoor installations.

Because the "FM Approved" logo is readily visible on the transformer and its nameplate, NEC compliance is now easily verifiable by the inspector.

Envirotran FM Approved transformers are manufactured under strict compliance with FMRC Standard 3990 and are filled with

FM APPROVED

FM Approved Envirotemp™ FR3™ fluid, a fire-resistant dielectric coolant.

Special application transformers

Data Center transformer

With focus rapidly shifting from simply maximizing uptime and supporting demand to improving energy utilization, the data center industry is continually looking for methods to increase its energy efficiency and reliability. Utilizing cutting edge technology, Eaton's Cooper Power series Hardened Data Center (HDC) transformers are the solution. Designed with special attention given to surge protection, HDC liquid-filled transformers provide superior performance under the harshest electrical environments. Contrary to traditional dry-type units, HDC transformers provide unsurpassed reliability, overloadability, operational life, efficiency, thermal loading and installed footprint. These units have reliably served more than 100 MW of critical data center capacity for a total of more than 6,000,000 hours without any reported downtime caused by a thermal or short-circuit coil failure.

The top priority in data center operations is uninterrupted service. Envirotran HDC transformers from Eaton, having substantially higher levels of insulation, are less susceptible to voltage surges. Eaton has experienced zero failures due to switching transients. The ANSI® and IEEE® standard impulse withstand ratings are higher for liquid-filled transformers, making them less susceptible to insulation failure. The Envirotran HDC transformer provides ultimate protection by increasing the BIL rating one level higher than standard liquid-filled transformer ratings. The cooling system of liquid-filled transformers provides better protection from severe overloads—overloads that can lead to significant loss of life or failure.

Data center design typically includes multiple layers of redundancy, ensuring maximum uptime for the critical IT load. When best in class transformer manufacturing lead times are typically weeks, not days, an unexpected transformer failure will adversely affect the facility's reliability and profitability. Therefore, the ability to determine the electrical and mechanical health of a transformer can reduce the probability of costly, unplanned downtime. Routine diagnostic tests, including key fluid properties and dissolved gas analysis (DGA), can help determine the health of a liquid-filled transformer. Although sampling is not required for safe operation, it will provide the user with valuable information, leading to scheduled repair or replacement, and minimizing the duration and expense of an outage. With a dry-type transformer, there is no reliable way to measure the health or likelihood of an impending failure.

Solar transformer

As a result of the increasing number of states that are adopting aggressive Renewable & Alternative Energy Portfolio Standards, the solar energy market is growing—nearly doubling year over year. Eaton, a key innovator and supplier in this expanding market, is proud to offer its Cooper Power series Envirotran transformers specifically designed for Solar Photovoltaic medium-voltage applications. Eaton is working with top solar photovoltaic developers, integrators and inverter manufacturers to evolve the industry and change the way we distribute power.

In accordance with this progressive stance, every Envirotran Solar transformer is filled with non-toxic, biodegradable Envirotemp™ FR3™ dielectric fluid, made from renewable seed oils. On top of its biodegradability, Envirotemp™ FR3™ fluid substantially extends the life of the transformer insulation, saving valuable resources. What better way to distribute green power than to use a green transformer. In fact, delaying conversion to Envirotran transformers places the burden of today's environmental issues onto tomorrow's generations. Eaton can help you create a customized transformer, based on site specific characteristics including: temperature profile, site altitude, solar profile and required system life. Some of the benefits gained from this custom rating include:

- Reduction in core losses
- Improved payback on investment
- Reduction in footprint
- Improved fire safety
- Reduced environmental impact

For the solar photovoltaic industry, Eaton is offering standard step up transformers and dual secondary designs, including 4-winding, 3-winding (Low-High-Low) and 3-winding (Low-Low-High) designs.

Wind transformer

Eaton is offering custom designs for renewable energy power generation. Eaton manufactures its Cooper Power series Generator Step-Up (GSU) transformers for installation at the base of every wind turbine. Additionally, grounding transformers are available for wind power generation.

DOE efficiency

The United States Department of Energy (DOE) has mandated efficiency values for most liquid type, medium voltage transformers. As a result, all applicable Eaton's Cooper Power series transformers 2500 kVA and below conform to efficiency levels as specified in the DOE ruling "10 CFR Part 431 Energy Conservation Program".

Underwriters Laboratories® (UL®) Listed and Labeled/ Classified

The Envirotran transformer from Eaton can be specified as UL® Listed & Labeled, and/or UL® Classified. Underwriters Laboratories (UL®) listing is a verification of the design and construction of the transformer to the ANSI® and IEEE® standards. UL® listing generally is the most efficient, cost-effective solution for complying with relevant state and local electrical codes. UL® Combination Classification/Listing is another way in which to comply with Section 450.23, 2008 NEC® requirements. This combines the UL® listed transformer with a UL® Classified Less-Flammable Liquid and complies with the use restrictions found within the liquid Classification.

c UL US LISTED

K-Factor transformer

With a drastic increase in the use of ferromagnetic devices, arcing devices, and electric power converters, higher frequency loads have increased significantly. This harmonic loading has the potential to generate higher heat levels within a transformer's windings and leads by as much as 300%. Harmonic loading has the potential to induce premature failure in standard-design distribution transformers.

In addition to standard UL® "K-Factor" ratings, transformers can be designed to customer-provided specifications detailing precise loading scenarios. Onsite measurements of magnitude and frequency, alongside harmonic analysis of the connected load can be performed by Eaton engineers or a third party consultant. These field measurements are used to determine exact customer needs and outline the transformer specifications.

Eaton will design harmonic-resistant transformers that will be subjected to the unique harmonic loads. These units are designed to maintain normal temperature rise under harmonic, full-load conditions. Standard UL® "K-Factor" designs can result in unnecessary costs when the "next-highest" K-Factor must be selected for a calculated design factor. To save the customer these unnecessary costs, Eaton can design the transformer to the specific harmonic spectrum used in the application. Eaton's Cooper Power series K-factor transformers are filled with mineral oil or Envirotemp™ FR3™ fluid and enjoy the added benefits of dielectric cooling such as higher efficiencies than dry-type transformers.

Modulation transformer

Bundled with an Outboard Modulation Unit (OMU) and a Control and Receiving Unit (CRU), a Modulation Transformer Unit (MTU) is designed to remotely achieve two way communication.

The use of an MTU reduces travel time and expense versus traditional meter reading performed by high voltage electricians. Additionally, with MTU it is possible to manage and evaluate energy consumption data, providing reduced metering costs and fewer tenant complaints.

An MTU utilizes existing utility infrastructure, therefore eliminating the need to engineer and construct a dedicated communication network.

Figure 9. Modular transformer.

Inverter/rectifier bridge

Eaton complements its range of applications for transformers by offering dual winding designs. These designs are intended for connection to 12-pulse rectifier bridges.

Product attributes

To set us apart from other transformer manufactures, Eaton includes the following guarantees with every three-phase pad-mounted transformer.

Engineered to order (ETO)

Providing the customer with a well developed, cost-effective solution is the number one priority at Eaton. Using customer specifications, Eaton will work with the customer from the beginning to the end to develop a solution to fit their needs. Whether it is application specific, site specific, or a uniquely specified unit, Eaton will provide transformers with the best in class value and performance, saving the customer time and money.

Made in the U.S.A.

Eaton's three-phase pad-mounted transformers are produced right here in the United States of America. Our manufacturing facilities are positioned strategically for rapid shipment of products. Furthermore, should the need arise, Eaton has a broad network of authorized service repair shops throughout the United States.

Superior paint performance

Protecting transformers from nature's elements worldwide, Eaton's E-coat system provides unrivaled transformer paint life, and exceeds IEEE Std C57.12.28™-2014 and IEEE Std C57.12.29™-2005 standards. In addition to the outside of the unit, each transformer receives a gray E-coat covering in the interior of the tank and cabinet, providing superior rust resistance and greater visibility during service.

If the wide range of standard paint selections does not suit the customer's needs, Eaton will customize the paint color to meet their requirements.

Rectangular coil design

Eaton utilizes a rectangular coil design. This winding technique results in a smaller overall unit footprint as well as reducing the transformer weight. The smaller unit size does not hinder the transformer performance in the least. Units have proven short circuit withstand capabilities up to 10 MVA.

Testing

Eaton performs routing testing on each transformer manufactured including the following tests:

- Insulation Power Factor: This test verifies that vacuum processing has thoroughly dried the insulation system to required limits.
- Ratio, Polarity, and Phase Relation: Assures correct winding ratios and tap voltages; checks insulation of HV and LV circuits. Checks entire insulation system to verify all live-to-ground clearances.
- Resistance: This test verifies the integrity of internal high-voltage and low-voltage connections; provides data for loss upgrade calculations.
- Routine Impulse Tests: The most severe test, simulating a lightning surge. Applies one reduced wave and one full wave to verify the BIL rating.
- Applied Potential: Applied to both high-voltage and low-voltage windings, this test stresses the entire insulation system to verify all live-to-ground clearances.
- Induced Potential: 3.46 times normal plus 1000 volts for reduced neutral designs.
- Loss Test: These design verification tests are conducted to assure that guaranteed loss values are met and that test values are

within design tolerances. Tests include no-load loss and excitation current along with impedance voltage and load loss.

- Leak Test: Pressurizing the tank to 7 psig assures a complete seal, with no weld or gasket leaks, to eliminate the possibility of moisture infiltration or fluid oxidation.

Design performance tests

The design performance tests include the following:

- Temperature Rise: Our automated heat run facility ensures that any design changes meet ANSI® and IEEE® temperature rise criteria.
- Audible Sound Level: Ensures compliance with NEMA® requirements.
- Lightning Impulse: To assure superior dielectric performance, this test consists of one reduced wave, two chopped waves and one full wave in sequence, precisely simulating the harshest conditions.

Thomas A Edison Research and Test Facility

We are constantly striving to introduce new innovations to the transformer industry, bringing you the highest quality transformer for the lowest cost. Eaton's Cooper Power series Transformer Products are ISO 9001 compliant, emphasizing process improvement in all phases of design, manufacture, and testing. We have invested millions of dollars in the Thomas A. Edison Technical Center, our premier research facility in Franksville, Wisconsin affirming our dedication to introducing new innovations and technologies to the transformer industry. This research facility is fully available for use by our customers to utilize our advanced electrical and chemical testing labs.

Three-phase pad-mounted compartmental type transformer

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Cooper Power Systems Division
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Printed in USA
Publication No. CA202003EN

For Eaton's Cooper Power series three-phase transformer product information call 1-877-277-4636 or visit: www.eaton.com/cooperpowerseries.

Powering Business Worldwide

TECHNICAL CHARACTERISTICS

HEMK 600V

		FRAME 1	FRAME 2
REFERENCE		**FS2125K**	**FS3190K**
OUTPUT	AC Output Power(kVA/kW) @50°C [1]	2125	3190
	AC Output Power(kVA/kW) @40°C [1]	2200	3300
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) [2]	600V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDI)	< 3% per IEEE519	
	Power Factor (cosine phi) [3]	0.5 leading .. 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPt @full power (VDC)	849V-1310V	
	Maximum DC voltage	1500V	
	Number of PV inputs [2]	Up to 36	
	Number of Freemaq DC/DC inputs [4]	Up to 6	
	Max. DC continuous current (A) [4]	2645	3970
	Max. DC short circuit current (A) [4]	4000	6000
EFFICIENCY & AUXILIARY SUPPLY	Efficiency (Max) (η)	98.78%	98.84%
	Euroeta (η)	98.39%	98.56%
	Max. Power Consumption (KVA)	8	10
CABINET	Dimensions [WxDxH] (ft)	12 x 7 x 7	
	Dimensions [WxDxH] (m)	3.7 x 2.2 x 2.2	
	Weight (lb)	12125	12677
	Weight (kg)	5500	5750
	Type of ventilation	Forced air cooling	
ENVIRONMENT	Degree of protection	NEMA 3R - IP54	
	Permissible Ambient Temperature	-35°C to +60°C / >50°C Active Power derating	
	Relative Humidity	4% to 100% non condensing	
	Max. Altitude (above sea level)	2000m; >2000m power derating (Max. 4000m)	
	Noise level [5]	< 79 dBA	
CONTROL INTERFACE	Communication protocol	Modbus TCP	
	Plant Controller Communication	Optional	
	Keyed ON/OFF switch	Standard	
PROTECTIONS	Ground Fault Protection	GFDI and isolation monitoring device	
	General AC Protection	Circuit Breaker	
	General DC Protection	Fuses	
	Overvoltage Protection	AC, DC Inverter and auxiliary supply type 2	
CERTIFICATIONS	Safety	UL1741, CSA 22.2 No.107.1-16, UL62109-1, IEC62109-1, IEC62109-2	
	Compliance	NEC 2017 / IEC	
	Utility Interconnect	EEE 1547.1-2005 / UL1741SA-Feb. 2018 / IEC62116:2014	

[1] Values at 1.00·Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Consult Power Electronics for Freemaq DC/DC connection configurations.
[5] Readings taken 1 meter from the back of the unit.

NEMA Standards Publication No. TR 1-1993 (R2000)

Transformers, Regulators and Reactors

Published by:

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209

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FOREWORD

The standards appearing in this publication have been developed by the Transformer Section and have been approved for publication by the National Electrical Manufacturers Association. They are used by the electrical industry to promote production economies and to assist users in the proper selection of transformers.

The Transformer Section is working actively with the American National Standards Committee, C57, on Transformers, Regulators and Reactors, in the development, correlation and maintenance of national standards for transformers. This Committee operates under the procedures of the American National Standards Institute (ANSI).

It is the policy of the NEMA Transformer Section to remove material from the NEMA Standards Publication as it is adopted and published in the American National Standard C57 series. The NEMA Standards Publication for Transformers, Regulators and Reactors references these and other American National Standards applying to transformers, and is intended to supplement, without duplication, the American National Standards.

The NEMA Standards Publication for Transformers, Regulators and Reactors contains provision for the following:

a. American National Standards adopted by reference and applicable exceptions approved by NEMA, if any.
b. NEMA Official Standards Proposals. These are official drafts of proposed standards developed within NEMA or in cooperation with other interested organizations, for consideration by ANSI. They have a maximum life of five years, during which time they may be approved as American National Standards or adopted as NEMA Standards, or rescinded.
c. Manufacturing Standards. These are NEMA Standards which are primarily of interest to the manufacturers of transformers and which are not yet included in an American National Standard.
d. Standards Which Are Controversial. These are NEMA Standards, on which there is a difference of opinion within Committee C57. The NEMA version will be included in the NEMA Standards Publication until such time as the differences between ANSI and NEMA are resolved.

NEMA Standards Publications are subject to periodic review and take into consideration user input. They are being revised constantly to meet changing economic conditions and technical progress. Users should secure latest editions. Proposed or recommended revisions should be submitted to:

Vice President, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037-1526

SCOPE

This publication provides a list of all ANSI C57 Standards that have been approved by NEMA. In addition it includes certain NEMA Standard test methods, test codes, properties, etc., of liquid-immersed transformers, regulators, and reactors that are not American National Standards.

PART 0
GENERAL

The following American National Standards have been approved as NEMA Standards and should be inserted in this Part 0:

ANSI/IEEE C57.12.00-1988	*General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers*
ANSI/IEEE C57.12.01-1989	*General Requirements for Dry Type Power and Distribution Transformers*
ANSI C57.12.10-1988	*Requirements for Transformers 230,000 volts and below, 833/958-8333/10,417 kVA single-phase 750/862-60,000/80,000/100,000 kVA three phase, including supplements*
ANSI C57.12.70-1993	*Terminal Markings and Connections for Distribution and Power Transformers*
ANSI/IEEE C57.12.90-1993	*Test Code for Liquid-immersed Distribution, Power & Regulating Transformers and Guide for Short-Circuit Testing of Distribution & Power Transformers*
ANSI/IEEE C57.19.00-1992	*General Requirements and Test Procedure for Outdoor Apparatus Bushings*
ANSI/IEEE C57.19.01-1992	*Standard Performance Characteristics & Dimensions for Outdoor Apparatus Bushings*
ANSI/IEEE C57.92-1992	*Guide for Loading Mineral-oil-immersed Power Transformers up to and including 100 MVA with 55C or 65C Average Winding Rise*

The NEMA Standards TR 1-0.01 through TR 1-0.09 on the following pages (see Part 0 Pages 1–9) also apply generally to transformers.

0.01 PREFERRED VOLTAGE RATINGS

Preferred system voltages and corresponding transformer voltage ratings are given in the American National Standard for Electric Power Systems and Equipment--Voltage Ratings (60 Hz), C84.1-1989. It is recommended that these ratings be used as a guide in the purchase and operation of transformers.

0.02 FORCED-AIR (FA) AND FORCED-OIL (FOA) RATINGS

Under the conditions of par. 5.11 of American National Standard ANSI/IEEE C57.12.00-1988, the relationship between self-cooled ratings and forced-air-cooled or forced-oil-cooled ratings shall be in accordance with Table 0-1.

Table 0-1
FORCED-AIR AND FORCED-OIL RATINGS RELATIONSHIPS

	Self-cooled Ratings* (kVA)		Percent of Self-Cooled Ratings With Auxiliary Cooling	
Class	Single Phase	Three Phase	First Stage	Second Stage
OA/FA	501-2499	501-2499	115	--
OA/FA	2500-9999	2500-11999	125	--
OA/FA	10000 and above	12000 and above	133-1/3	--
OA/FA/FA	10000 and above	12000 and above	133-1/3	166-2/3
OA/FA/FOA	10000 and above	12000 and above	133-1/3	166-2/3
OA/FOA/FOA	10000 and above	12000 and above	133-1/3	166-2/3

*In the case of multi-winding transformers or autotransformers, the ratings given are the equivalent two-winding ratings.

PERFORMANCE

0.03 RADIO INFLUENCE VOLTAGE LEVELS

The following values apply to liquid-filled transformers. They do not apply to load tap changing during switching or to operation of auxiliary relays and control switches.

0.03.1 Distribution Transformers

Radio influence voltage levels for distribution transformers, for systems rated 69 kV and less, shall not exceed 100 microvolts when measured in accordance with Section 7.01. The test voltage shall be the line-to-neutral voltage corresponding to 110 percent excitation of the transformer. This will be the coil voltage for wye connections and 1/3 times the coil voltage for delta connections.

0.04 POWER FACTOR OF INSULATION OF OIL-IMMERSED TRANSFORMERS

While the real significance which can be attached to the power factor of oil-immersed transformers is still a matter of opinion, experience has shown that power factor is helpful in assessing the probable conditions of the insulation when good judgement is used.

The proper interpretation of power factor of oil-immersed transformers is being given careful attention by manufacturers in connection with the problems of (1) selecting insulating materials, (2) sealing, and (3) processing the transformers. However, it is the comparative values which are guides for the successful solution for these problems rather than an absolute value of power factor.

The generally accepted factory tests for proving the insulation level are the prescribed low-frequency tests and impulse tests given in the American National Standard C57.12.90-1993.

When required, a factory power-factor test can be made, and this measurement will be of value for comparison with field power-factor measurements to assess the probable condition of the insulation. It is not feasible to establish standard power-factor values for oil-immersed transformers because:

a. Experience has definitely proved that little or no relation exists between power factor and the ability of the transformer to withstand the prescribed dielectric tests.
b. Experience has definitely proved that the variation in power factor with temperature is substantial and erratic so that no single correction curve will fit all cases.

When a factory power-factor measurement of a transformer is required, the measurement should be made with the insulation at room temperature, preferably at or close to 20°C.

0.05 AUDIBLE SOUND LEVELS

Transformers shall be so designed that the average sound level will not exceed the values given in Tables 0-2 through 0-4 when measured at the factory in accordance with the conditions outlined in ANSI/IEEE C57.12.90-1993.

The guaranteed sound levels should continue to be per Tables 0-2 through 0-4 until such time as enough data on measured noise power levels becomes available.

Sound pressure levels are established and published in this document. Sound power may be calculated from sound pressure, using the method described in C57.12.90-1993.

Rectifier, railway, furnace, grounding, mobile and mobile unit substation transformers are not covered by the tables. The tables do not apply during the time that power switches are operating in load-tap-changing transformers and in transformers with integral power switches.

ble 0-2
AUDIBLE SOUND LEVELS F(-IMMERSED POWER TRANSFORMERS

mn 1 - Class "OA, Oa and FOW Ratings
mn 2 - Class " FA and FOA First stage Auxiliary Cooling"†
mn 3 - Straight FOA" Ratings, FA" FOA" Second-stage Auxiliary Cooling"†

erage Sound wel 11, cibels	Equivalent Two-winding Rating‡																	
	350 kV BIL and Below			450, 550, 650 kV BIL			750 and 825 kV BIL			900 and 1050 kV BIL			1175 kV BIL			1300 kV BIL and Above		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	700	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	1000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	700	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	1500	--	--	1000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2000		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2500	--	--	1500	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3000	--	--	2000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	4000	--	--	2500	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5000	--	--	3000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	6000	--	--	4000	--	--	3000	--	--	--	--	--	--	--	--	--	--	--
	7500	6250▲▲	--	5000	3750▲▲	--	4000	3125▲▲	--	--	--	--	--	--	--	--	--	--
	10000	7500		6000	5000	--	5000	3750	--	--	--	--	--	--	--	--	--	--
	12500	9375	--	7500	6250	--	6000	5000	--	--	--	--	--	--	--	--	--	--
	15000	12500	--	10000	7500	--	7500	6250	--	--	--	--	--	--	--	--	--	--
	20000	16667		12500	9375		10000	7500	--	--	--	--	--	--	--	--	--	--
	25000	20000	20800	15000	12500	--	12500	9375	--	--	--	--	--	--	--	--	--	--
	30000	26667	25000	20000	16667	--	15000	12500	--	12500	--	--	--	--	--	--	--	--
	40000	33333	33333	25000	20000	20800	20000	16667	--	15000	--	--	12500	--	--	--	--	--
	50000	40000	41667	30000	26667	25000	25000	20000	20800	20000	16667	--	15000	--	--	12500	--	--
	60000	53333	50000	40000	33333	33333	30000	26667	25000	25000	20000	20800	20000	16667	--	15000	--	--
	80000	66667	66667	50000	40000	41667	40000	33333	33333	30000	26667	25000	25000	20000	20800	20000	16667	--
	100000	80000	83333	60000	53333	50000	50000	40000	41667	40000	33333	33333	30000	26667	25000	25000	20000	20800
	--	106667	100000	80000	66667	66667	60000	53333	50000	50000	40000	41667	40000	33333	33333	30000	26667	25000
	--	133333	133333	100000	80000	83333	80000	66667	66667	60000	53333	50000	50000	40000	41667	40000	33333	33333
	--	--	166667	--	106667	100000	100000	80000	83333	80000	66667	66667	60000	53333	50000	50000	40000	41667
	--	--	200000	--	133333	133333	--	106667	100000	100000	80000	83333	80000	66667	66667	60000	53333	50000
	--	--	250000	--	--	166667	--	133333	133333	--	106667	100000	100000	80000	83333	80000	66667	66667
	--	--	300000	--	--	200000	--	--	166667	--	133333	133333	--	106667	100000	100000	80000	83333
	--	--	400000	--	--	250000	--	--	200000	--	--	166667	--	133333	133333	--	106667	100000
	--	--	--	--	--	300000	--	--	250000	--	--	200000	--	--	166667	--	133333	133333
	--	--	--	--	--	400000	--	--	300000	--	--	250000	--	--	200000	--	--	166667
	--	--	--	--	--	--	--	--	400000	--	--	300000	--	--	250000	--	--	200000
	--	--	--	--	--	--	--	--	--	--	--	400000	--	--	300000	--	--	250000
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	400000	--	--	300000
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	400000
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Classes of cooling (see 2.6.1 of American National Standard C57.12.00-1968.
First- and second-stage auxiliary cooling (see TR 1.0.02).
For columns 2 and 3 ratings, the sound levels are with the auxiliary cooling equipment in operation.
‡For intermediate kVA ratings, use the average sound level of the next larger kVA rating.
The equivalent two-winding 55°C or 65°C rating is defined as one-half the sum of the kVA rating of all windings.
▲▲Sixty-seven decibels for all kVA ratings equal to this or smaller.

Table 0-3
AUDIBLE SOUND LEVELS FOR LIQUID-IMMERSED DISTRIBUTION TRANSFORMERS AND NETWORK TRANSFORMERS

Equivalent Two-winding kVA	Average Sound Level, Decibels
0–50	48
51–100	51
101–300	55
301–500	56
750	57
1000	58
1500	60
2000	61
2500	62

Small Transformer

Table 0-4
AUDIBLE SOUND LEVELS FOR DRY-TYPE TRANSFORMERS 15000-VOLT NOMINAL SYSTEM VOLTAGE AND BELOW

Equivalent Two-Winding kVA	Average Sound Level, Decibels		Equivalent Two-winding kVA	Average Sound Level, Decibels Ventilated Forced Air Cooled **,†
	Self-cooled Ventilated*	Self-cooled Sealed*		
0–50	50	50	...	...
51–150	55	55	...	...
151–300	58	57	3–300	67
301–500	60	59	301–500	67
501–700	62	61	501–833	67
701–1000	64	63	834–1167	67
1001–1500	65	64	1168–1667	68
1501–2000	66	65	1668–2000	69
2001–3000	68	66	2001–3333	71
3001–4000	70	68	3334–5000	73
4001–5000	71	69	5001–6667	74
5001–6000	72	70	6668–8333	75
6001–7500	73	71	8334–10000	76

Large Transformer

* Class AA rating

**Does not apply to sealed-type transformers

†Class FA and AFA ratings

Part 1
POWER TRANSFORMERS

The American National Standard C57.12.10-1988 has been approved as a NEMA Standard for power transformers and should be inserted in this Part 1.

The ANSI/IEEE Standard C57.92-1992, has been approved by NEMA and should be inserted in this Part 1.

The following other parts of this NEMA Publication No. TR 1 shall also apply:

a. Part 1 General
b. Part 6 Terminology
c. Part 7 Test Code
d. Part 12 Underground-Type Three-Phase Distribution Transformer

Noise Increases with Vehicle Speed

When Congress allowed states to raise speed limits, and many states did raise speed limits from 55 mph to 65 mph and higher, highways in these states got noisier. The table below lists the change in the noise made by auotmobiles, medium trucks, and heavy trucks as they increase in speed from 30 mph to 70 mph. Raising the speed of an automobile 10 mph (from 55 to 65 mph) increases the noise made by that vehicle 3 dB, from 72 dB to 75 dB. Similarly, noise made by trucks increases from 86 to 88 dB with the same 10 mph increase in speed. In these examples, gas mileage also decreases by 15%.

The result is a substantial increase in noise for those living and working near highways. Soundwalls are capable of reducing noise levels by 10 dB, so increased speed limits have also significantly reduced the effectiveness of highway noise barriers.

Reducing speed limits on roadways and increasing enforcement of speed limits is often the most effective and cost efficient means of reducing noise. For example, reducing vehicle speeds from 40 to 30 mph is as effective as removing one half the vehicles from the roadway.

Speed (mph)	Noise at 50 ft (dB)		
	Auto	Medium Truck	Heavy Truck
30	62	73	80
31	62	74	80
32	63	74	81
33	63	75	81
34	64	75	81
35	64	76	82
36	65	76	82
37	65	77	82
38	66	77	82
39	66	77	83
40	67	78	83
41	67	78	83
42	67	78	84
43	68	79	84
44	68	79	84
45	68	79	84
46	69	80	85
47	69	80	85
48	70	80	85
49	70	81	85
50	70	81	85
51	71	81	86
52	71	82	86
53	71	82	86
54	72	82	86

55	72	82	86
56	72	83	87
57	72	83	87
58	73	83	87
59	73	83	87
60	73	84	87
61	74	84	88
62	74	84	88
63	74	84	88
64	74	85	88
65	75	85	88
66	75	85	88
67	75	85	89
68	75	86	89
69	76	86	89
70	76	86	89
Source: Cowan, Environmental Acoustics, 150			

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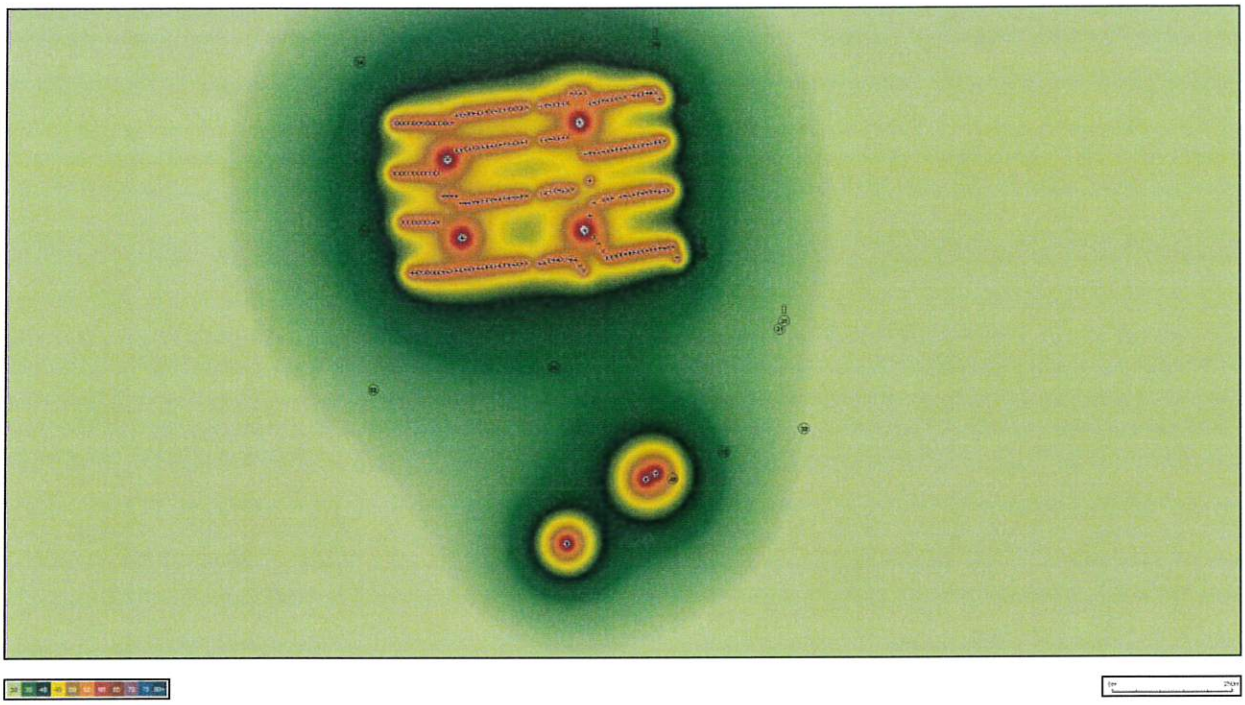
dBmap.net - Noise Mapping Results

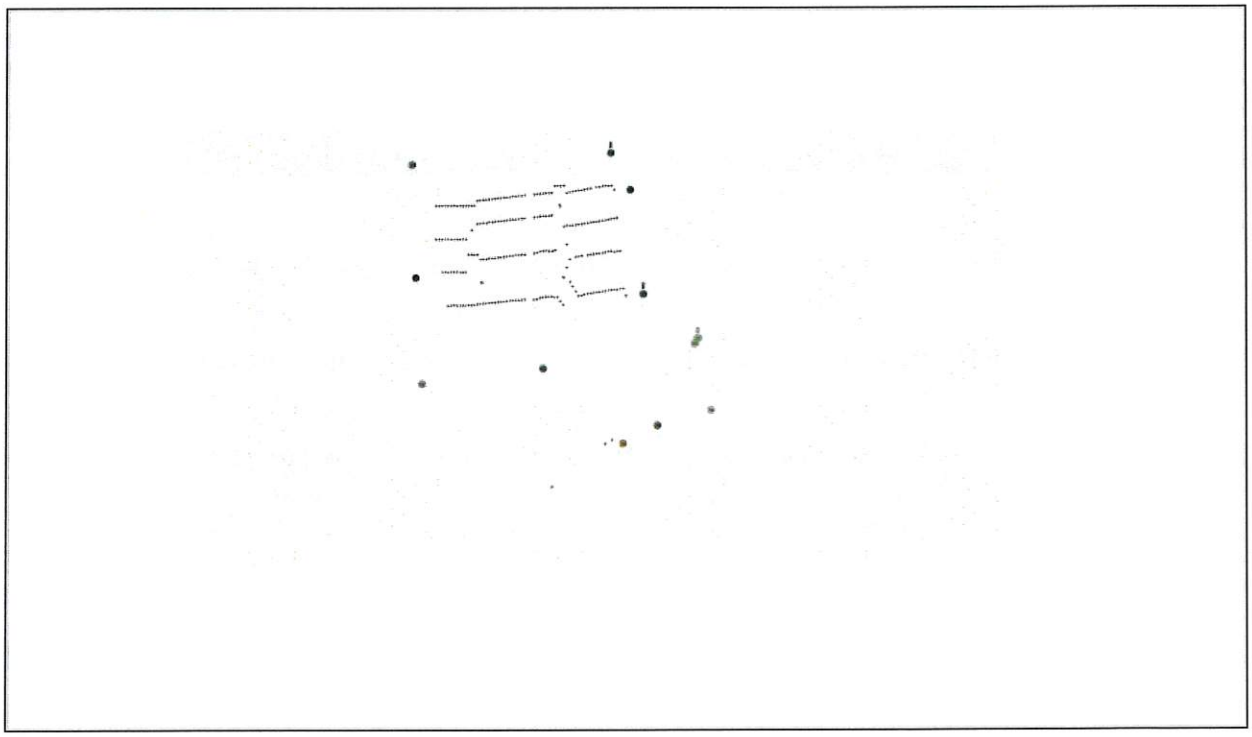
Report

2/7/2022

Noise Map - Grid height 1m (A-weighted)



Model Overview



Receiver Results - Summary

Receiver Name	Height (m)	Overall Level dB(A)	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
At Property Line	1	35					35				
Building	1	31					31				
Home	1	49					49				
Home 2	1	30					30				
Home 3	1	31					31				
Property Line	1	37					37				
Property Line-2	1	38					38				
Property Line-3	1	36					36				
Property Line-4	1	34					34				
Property Line-5	1	37					37				
Property Line-6	1	32					32				
Property Line-7	1	35					35				

Sources

Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
AC-1	1.5	94					94				
AC-2	1.5	94					94				
AC-3	1.5	94					94				
AC-4	1.5	94					94				
BESS-1	1.5	100					100				
BESS-2	1.5	100					100				
BESS-3	1.5	100					100				
BESS-4	1.5	100					100				
DC-DC2	1.5	85					85				
DC-DC3	1.5	85					85				
DC-DC 1	1.5	85					85				
DC-DC 4	1.5	85					85				
ET-3	1.5	77					77				
ET-4	1.5	77					77				
INV-1	1.5	100					100				
INV-2	1.5	100					100				
INV-3	1.5	100					100				
INV-4	1.5	100					100				

Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Point-248	1.5	100					100				
SWTCHGR-1	1.5	100					100				
SWTCHGR-2	1.5	100					100				
T1	1.5	85					85				
T2	1.5	85					85				
T3	1.5	85					85				
T4	1.5	85					85				
T5	1.5	85					85				
T6	1.5	85					85				
T7	1.5	85					85				
T8	1.5	85					85				
T9	1.5	85					85				
T10	1.5	85					85				
T11	1.5	85					85				
T12	1.5	85					85				
T13	1.5	85					85				
T14	1.5	85					85				
T15	1.5	85					85				
T16	1.5	85					85				
T17	1.5	85					85				
T18	1.5	85					85				
T19	1.5	85					85				
T20	1.5	85					85				
T21	1.5	85					85				
T22	1.5	85					85				
T23	1.5	85					85				
T24	1.5	85					85				
T25	1.5	85					85				
T26	1.5	85					85				
T27	1.5	85					85				
T28	1.5	85					85				
T29	1.5	85					85				
T30	1.5	85					85				
T31	1.5	85					85				
T32	1.5	85					85				
T33	1.5	85					85				

Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
T34	1.5	85					85				
T35	1.5	85					85				
T36	1.5	85					85				
T37	1.5	85					85				
T38	1.5	85					85				
T39	1.5	85					85				
T40	1.5	85					85				
T41	1.5	85					85				
T42	1.5	85					85				
T43	1.5	85					85				
T44	1.5	85					85				
T45	1.5	85					85				
T46	1.5	85					85				
T47	1.5	85					85				
T48	1.5	85					85				
T49	1.5	85					85				
T50	1.5	85					85				
T51	1.5	85					85				
T52	1.5	85					85				
T53	1.5	85					85				
T54	1.5	85					85				
T55	1.5	85					85				
T56	1.5	85					85				
T57	1.5	85					85				
T58	1.5	85					85				
T59	1.5	85					85				
T60	1.5	85					85				
T61	1.5	85					85				
T62	1.5	85					85				
T63	1.5	85					85				
T64	1.5	85					85				
T65	1.5	85					85				
T66	1.5	85					85				
T67	1.5	85					85				
T68	1.5	85					85				
T69	1.5	85					85				

Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
T70	1.5	85					85				
T71	1.5	85					85				
T72	1.5	85					85				
T73	1.5	85					85				
T74	1.5	85					85				
T75	1.5	85					85				
T76	1.5	85					85				
T77	1.5	85					85				
T78	1.5	85					85				
T79	1.5	85					85				
T80	1.5	85					85				
T81	1.5	85					85				
T82	1.5	85					85				
T83	1.5	85					85				
T84	1.5	85					85				
T85	1.5	85					85				
T86	1.5	85					85				
T87	1.5	85					85				
T88	1.5	85					85				
T89	1.5	85					85				
T90	1.5	85					85				
T91	1.5	85					85				
T92	1.5	85					85				
T93	1.5	85					85				
T94	1.5	85					85				
T95	1.5	85					85				
T96	1.5	85					85				
T97	1.5	85					85				
T98	1.5	85					85				
T99	1.5	85					85				
T100	1.5	85					85				
T101	1.5	85					85				
T102	1.5	85					85				
T103	1.5	85					85				
T104	1.5	85					85				
T105	1.5	85					85				

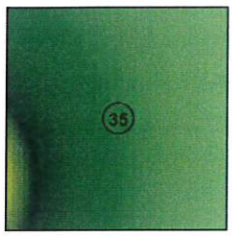
Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
T106	1.5	85					85				
T107	1.5	85					85				
T108	1.5	85					85				
T109	1.5	85					85				
T110	1.5	85					85				
T111	1.5	85					85				
T112	1.5	85					85				
T113	1.5	85					85				
T114	1.5	85					85				
T115	1.5	85					85				
T116	1.5	85					85				
T117	1.5	85					85				
T118	1.5	85					85				
T119	1.5	85					85				
T120	1.5	85					85				
T121	1.5	85					85				
T122	1.5	85					85				
T123	1.5	85					85				
T124	1.5	85					85				
T125	1.5	85					85				
T126	1.5	85					85				
T127	1.5	85					85				
T128	1.5	85					85				
T129	1.5	85					85				
T130	1.5	85					85				
T131	1.5	85					85				
T132	1.5	85					85				
T133	1.5	85					85				
T134	1.5	85					85				
T135	1.5	85					85				
T136	1.5	85					85				
T137	1.5	85					85				
T138	1.5	85					85				
T139	1.5	85					85				
T140	1.5	85					85				
T141	1.5	85					85				

Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
T142	1.5	85					85				
T143	1.5	85					85				
T144	1.5	85					85				
T145	1.5	85					85				
T146	1.5	85					85				
T147	1.5	85					85				
T148	1.5	85					85				
T149	1.5	85					85				
T150	1.5	85					85				
T151	1.5	85					85				
T152	1.5	85					85				
T153	1.5	85					85				
T154	1.5	85					85				
T155	1.5	85					85				
T156	1.5	85					85				
T157	1.5	85					85				
T158	1.5	85					85				
T159	1.5	85					85				
T160	1.5	85					85				
T161	1.5	85					85				
T162	1.5	85					85				
T163	1.5	85					85				
T164	1.5	85					85				
T165	1.5	85					85				
T166	1.5	85					85				
T167	1.5	85					85				
T168	1.5	85					85				
T169	1.5	85					85				
T170	1.5	85					85				
T171	1.5	85					85				
T172	1.5	85					85				
T173	1.5	85					85				
T174	1.5	85					85				
T175	1.5	85					85				
T176	1.5	85					85				
T177	1.5	85					85				

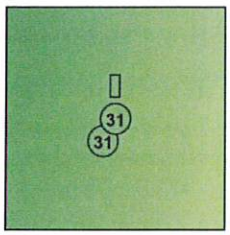
Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
T178	1.5	85					85				
T179	1.5	85					85				
T180	1.5	85					85				
T181	1.5	85					85				
T182	1.5	85					85				
T183	1.5	85					85				
T184	1.5	85					85				
T185	1.5	85					85				
T186	1.5	85					85				
T187	1.5	85					85				
T188	1.5	85					85				
T189	1.5	85					85				
T190	1.5	85					85				
T191	1.5	85					85				
T192	1.5	85					85				
T193	1.5	85					85				
T194	1.5	85					85				
T195	1.5	85					85				
T196	1.5	85					85				
T197	1.5	85					85				
T198	1.5	85					85				
T199	1.5	85					85				
T200	1.5	85					85				
T201	1.5	85					85				
T202	1.5	85					85				
T203	1.5	85					85				
T204	1.5	85					85				
T205	1.5	85					85				
T206	1.5	85					85				
T207	1.5	85					85				
T208	1.5	85					85				
T209	1.5	85					85				
T210	1.5	85					85				
T211	1.5	85					85				
T212	1.5	85					85				
T213	1.5	85					85				

Source Name	Height (m)	Overall Level dB	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
T214	1.5	85					85				
T215	1.5	85					85				
T216	1.5	85					85				
T217	1.5	85					85				
T218	1.5	85					85				
T219	1.5	85					85				
T220	1.5	85					85				
T221	1.5	85					85				
T222	1.5	85					85				
T223	1.5	85					85				
T224	1.5	85					85				
T225	1.5	85					85				
T-1	1.5	77					77				
T-2	1.5	77					77				

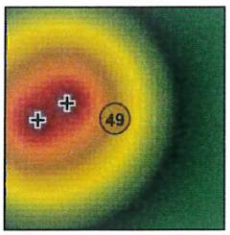
Receiver Locations



At Property Line

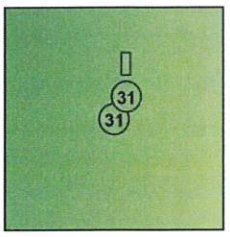


Building

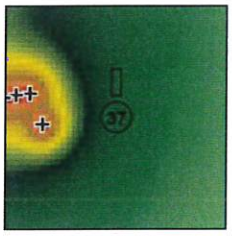


Home

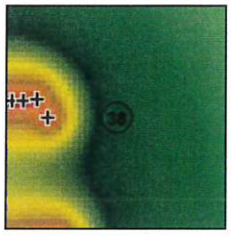
Home 2



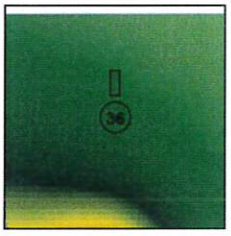
Home 3



Property Line

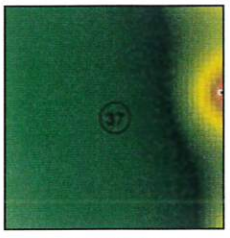


Property Line-2



Property Line-3

Property Line-4

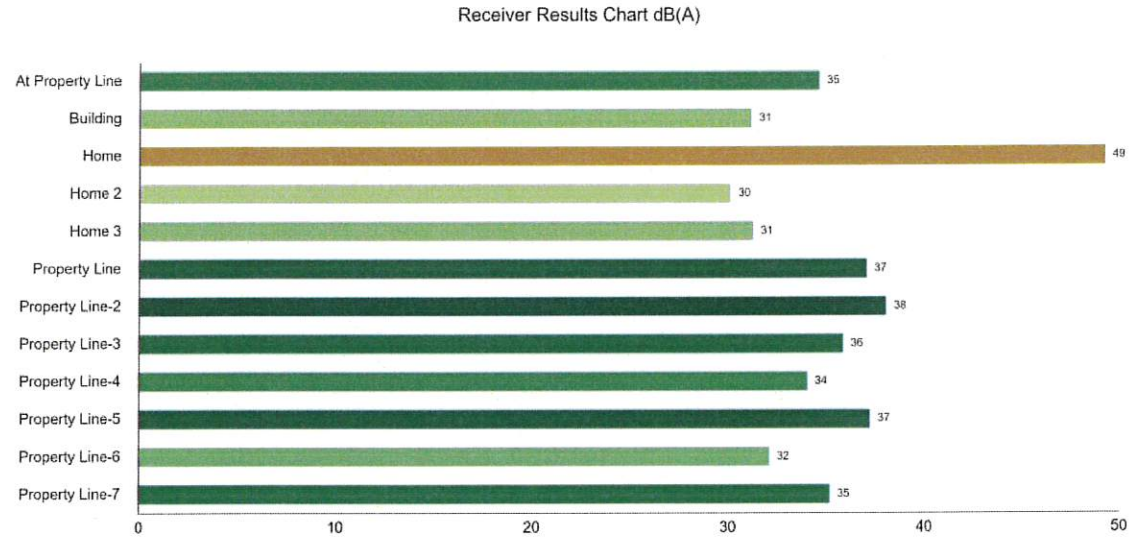


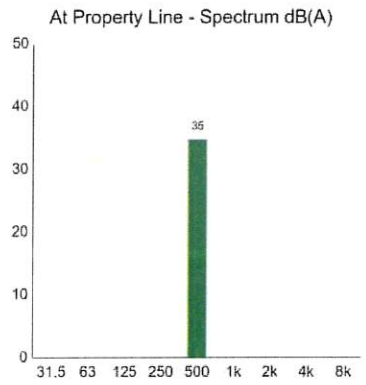
Property Line-5

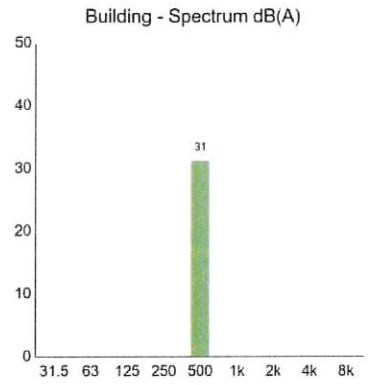
Property Line-6

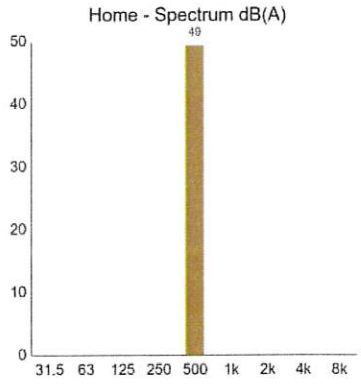
Property Line-7

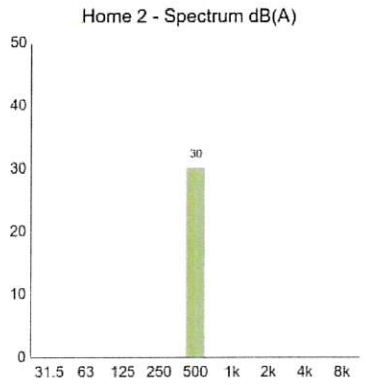
Receiver Charts

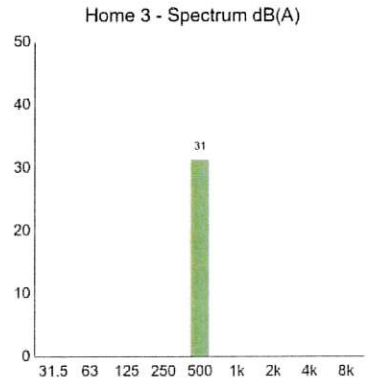


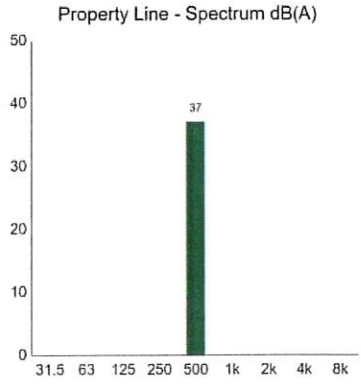


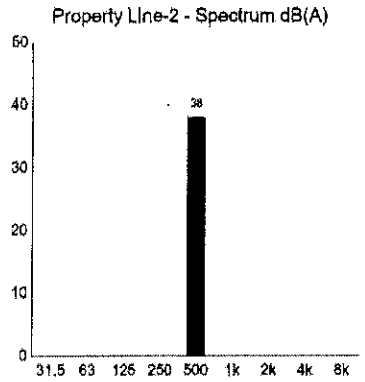


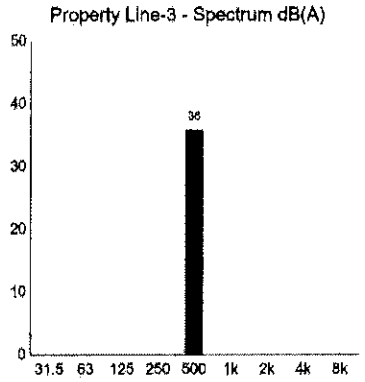


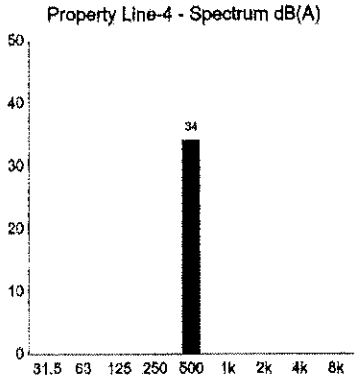


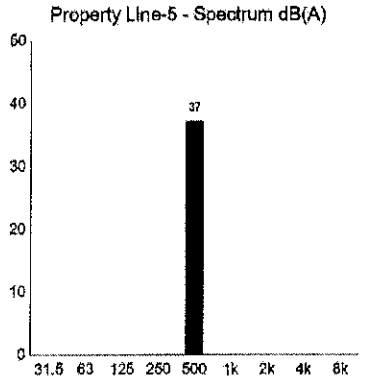


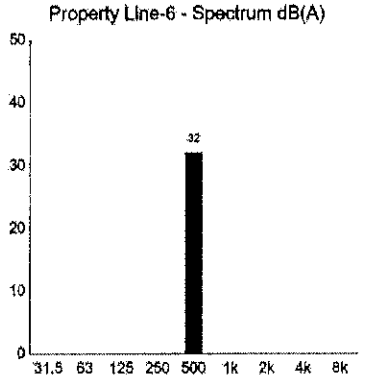


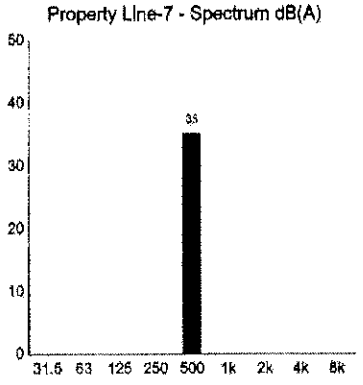

Property Line-2 - Spectrum dB(A)
50
40
30
20
10
0
38
31.5 63 125 250 500 1k 2k 4k 8k


Property Line-3 - Spectrum dB(A)
50
40
30
20
10
0
36
31.5 63 125 250 500 1k 2k 4k 8k


Property Line-4 - Spectrum dB(A)
50
40
30
20
10
0
34
31.5 63 125 250 500 1k 2k 4k 8k


Property Line-5 - Spectrum dB(A)
50
40
30
20
10
0
37
31.5 63 125 250 500 1k 2k 4k 8k


Property Line-6 - Spectrum dB(A)
50
40
30
20
10
0
32
31.5 63 125 250 500 1k 2k 4k 8k


Property Line-7 - Spectrum dB(A)
50
40
30
20
10
0
35
31.5 63 125 250 500 1k 2k 4k 8k

Configuration

0.9G Ground Factor

0°C Temperature

70% Humidity

Results are A-weighted

Results are rounded to 0 decimal places

Second order reflections are included

Reflections are only considered at a distance of 1m or greater from a reflector (facade level)

ISO9613-2 barrier attenuation limit (20/25dB) is enabled

Vertical edges (lateral paths) are included using convex paths only (following ISO17534-3 recommendation 5.2)

Ground reflections are not screened (as recommended in ISO17534-3 5.3)

References

ISO 9613-1:1993 — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere

ISO 9613-2:1996 — Attenuation of sound during propagation outdoors — Part 2: General method of calculation

ISO/TR 17534-3:2015 — Acoustics — Software for the calculation of sound outdoors — Part 3: Recommendations for quality assured implementation of ISO 9613-2 in software according to ISO 17534-1. Quality Assurance and Test Cases: https://dbmap.net/Iso17534results

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Duanesburg, NY 12056

February 4, 2022

Re: Oak Hill Solar 1, LLC and Oak Hill Solar 2, LLC

Dear Chairman Schmitt and the Planning Board,

Please provide this letter and attached color image in the Planning Board member's binders for review at the next Planning Board meeting. Please include this letter and attachments with the official meeting minutes as posted on the the town website.

We are immensely concerned about Oak Hill Solar's design and storm water pollution prevention plan's impact on the abutting parcels, surrounding neighborhood and the greater Town of Esperance-Schoharie Creek watershed. Our Comprehensive Plan's vision statement was agreed to by the taxpayers and should be a guiding force on the town's development and land use planning. It says:

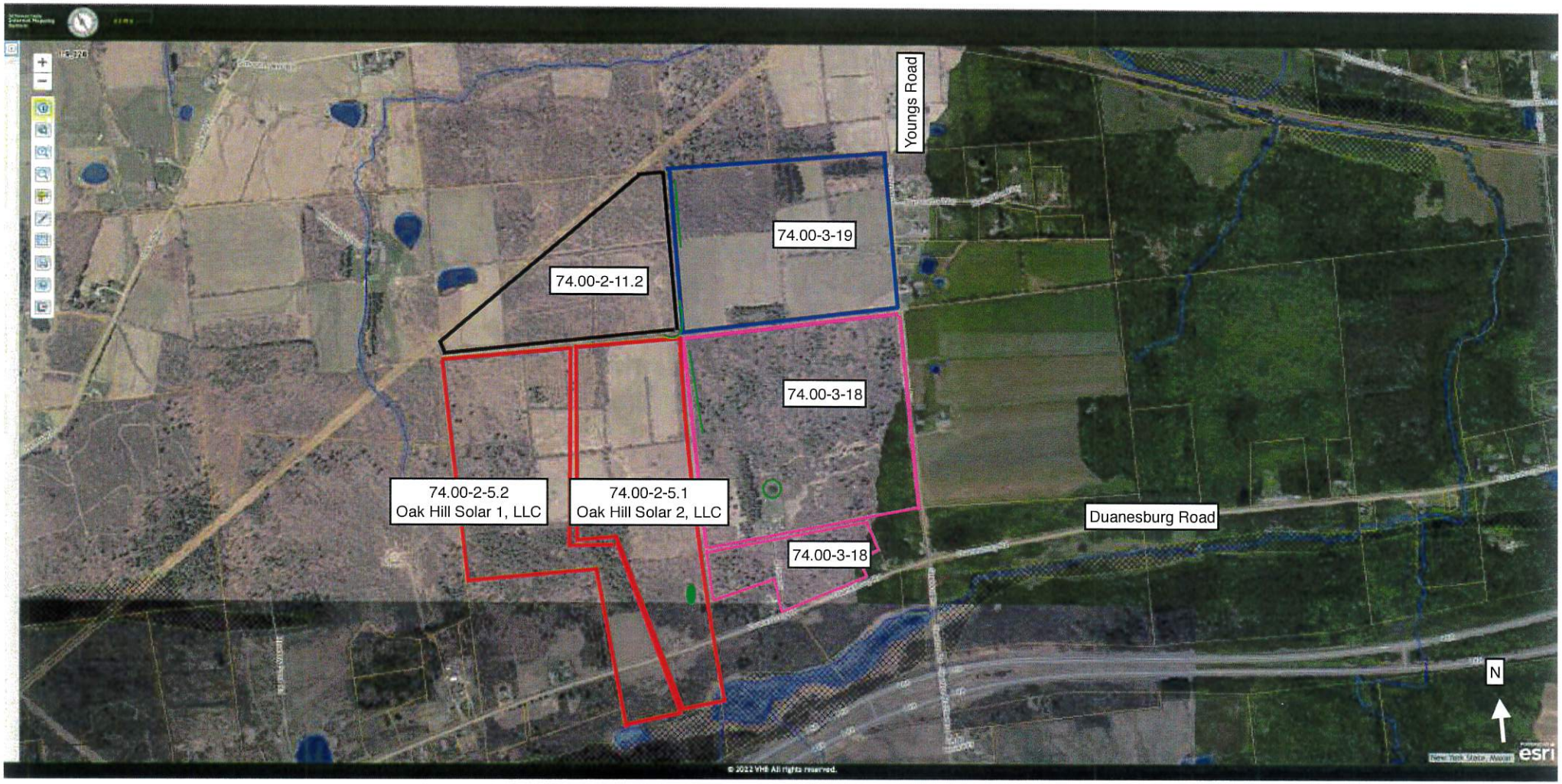
> "The Town of Duanesburg is a proud community of strong heritage and rural character. We encourage the preservation of our attractive and cultural landscape. We provide economically vibrant commercial and retail zones, and a variety of quality housing, cultural and recreational options. We are committed to sustaining our valuable economic and natural resources, particularly agricultural land use, open spaces, natural habitats, and fresh watersheds. We support thoughtful growth and development that enable affordable taxes, enhances the character of commercial and residential zones, improves our schools, and provides local business and employment opportunities."

We urge the Board to protect and preserve our natural resources and rural community character.

Attached are three appendix that detail some of our concerns:

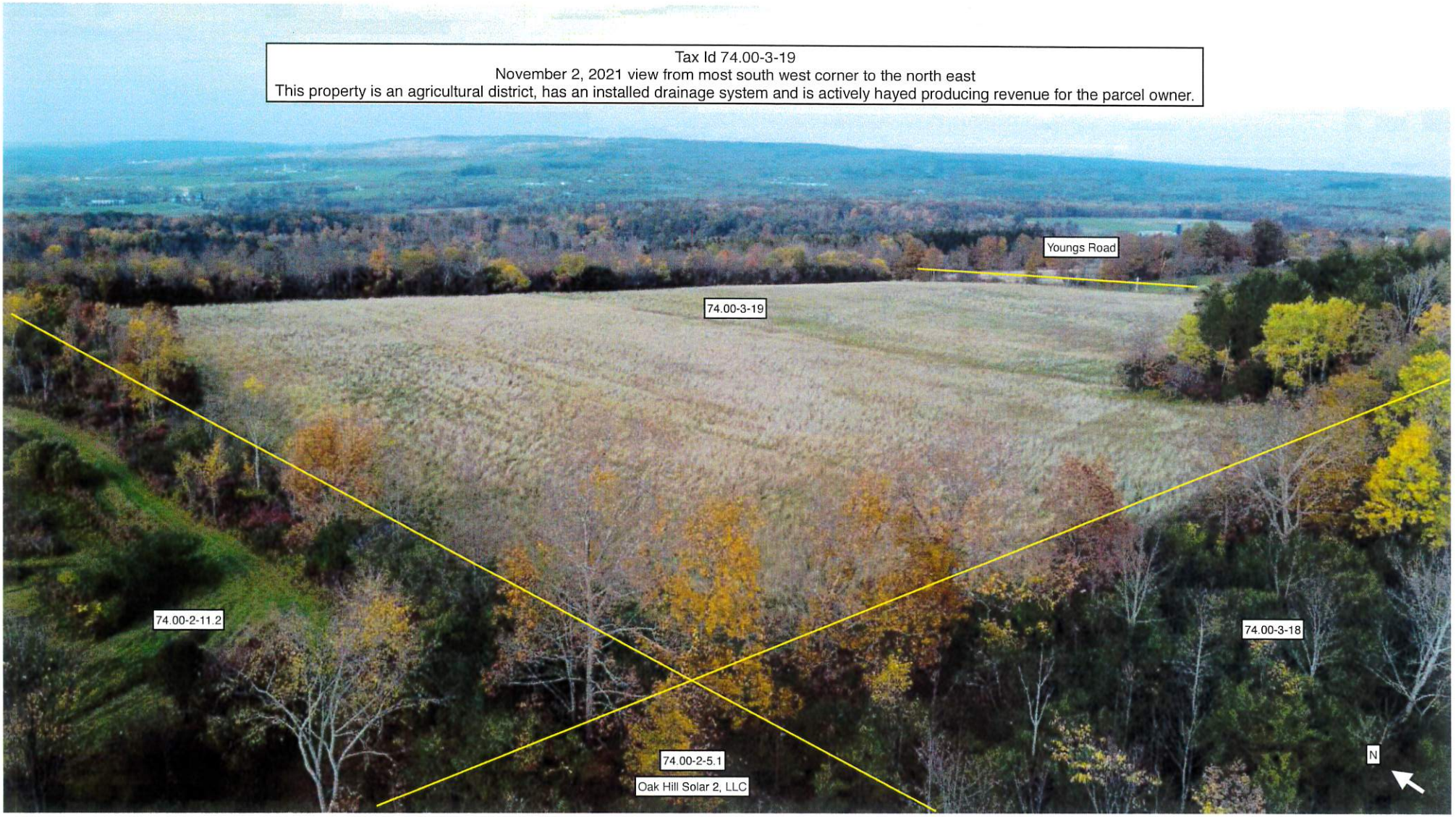
Appendix A provides information for parcels 74.00-3-18 and 74.00-3-19. These lands already experience erosion from rain and snow melt stormwater run off from tax id parcel 74.00-2-5.1, the proposed Oak Hill Solar site. Constructing hundreds of 13.3 feet wide rows of tracking solar panels along a north -south axis may increase sheet flow down the steep 10-15% grade slope. The images clearly document that the highest point of the site is in the south and the lowest point

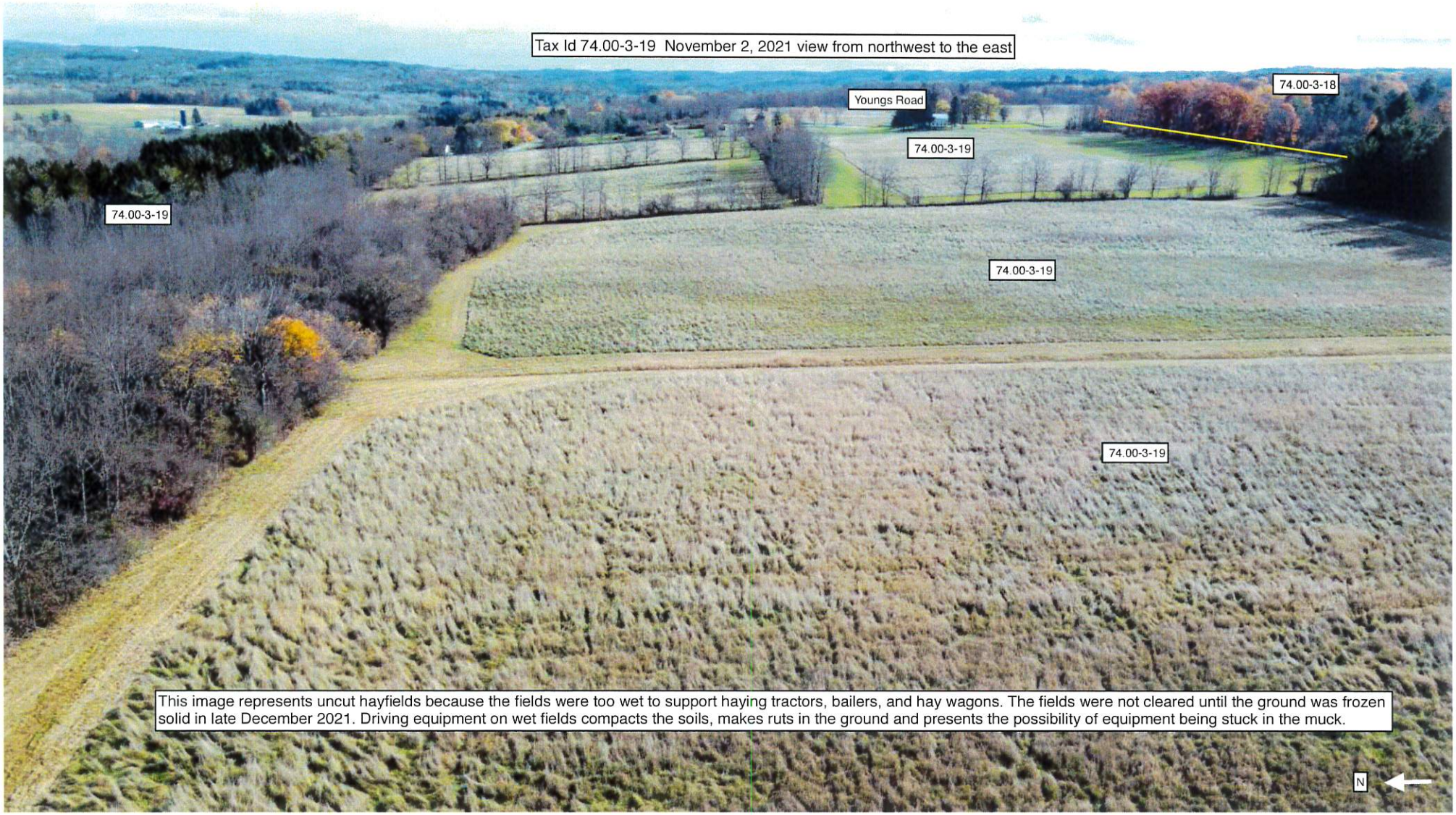
Appendix A

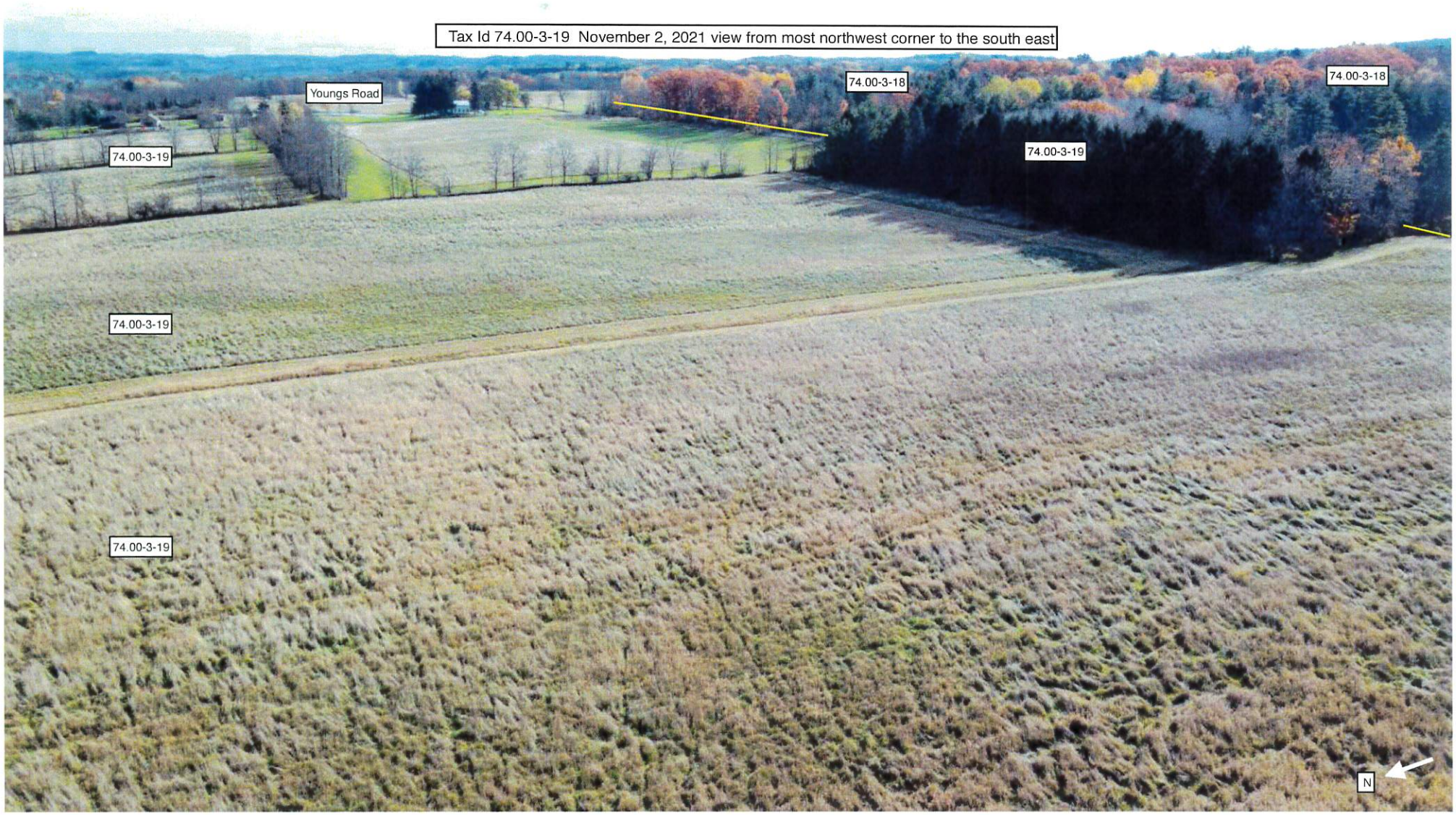


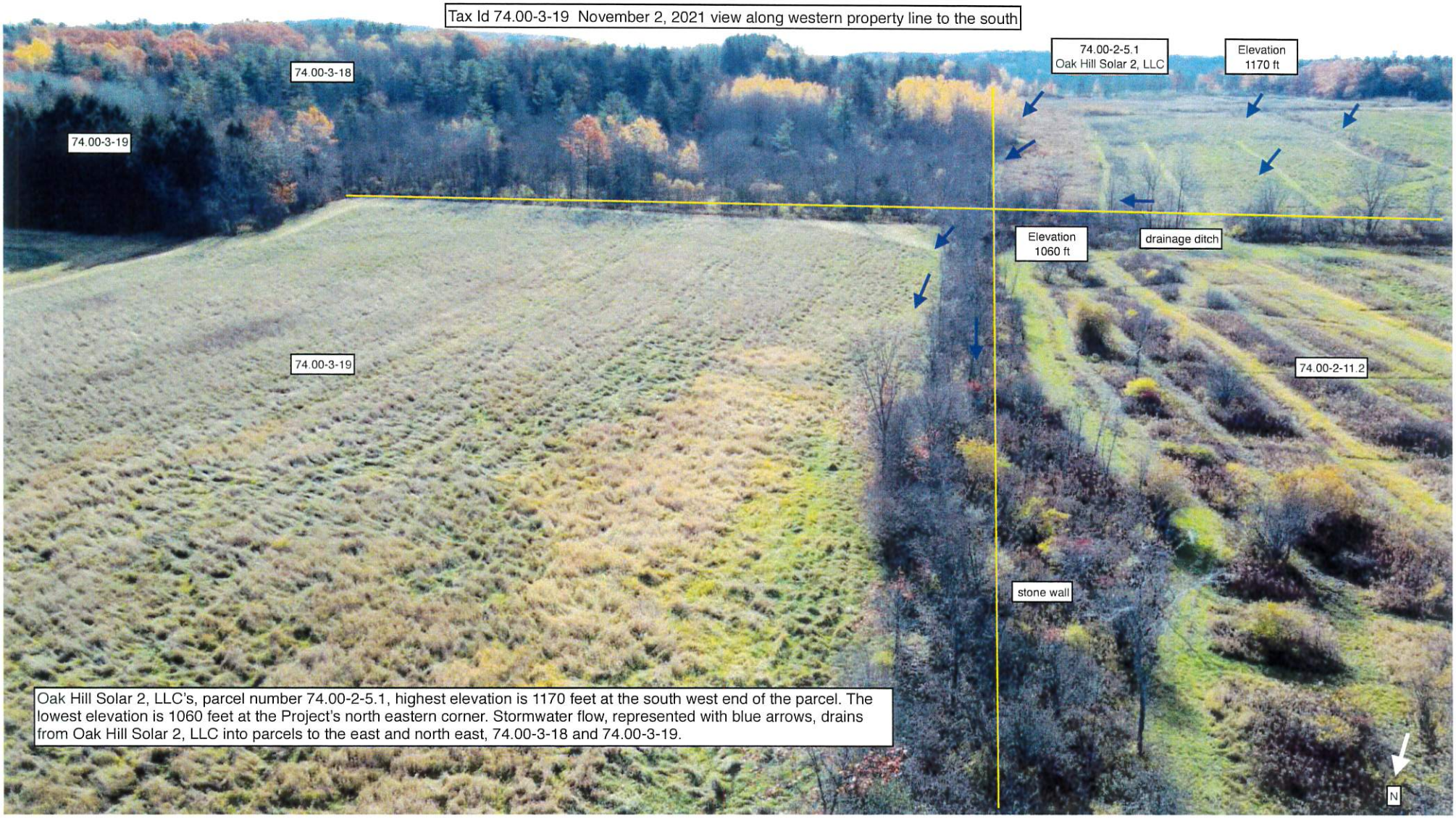
Oak Hill Solar 1, LLC, proposed for parcel 74.00-2-5.2, and Oak Hill Solar 2, LLC, proposed for parcel 74.00-2-5.1, are located at 13590 Duanesburg Road, Delanson in the Town of Duanesburg in Schenectady County, New York 12053. The Project site is divided by Duanesburg Road, New York State Route 7. The site's highest elevation is 1170 feet and is found on the site's south fence line. The lowest elevation is 1060 feet which is found at the north east corner of the project . The Project site abuts unrelated parcels 74.00-2-11.2 to the north, 74.00-3-19 to the north east and parcel 74.00-3-18 to the east. The site is steeply sloped 100% poorly drained clay soils. The site drains into parcels 74.00-3-18 and 74.00-3-19. Abutting landowners are strongly opposed to the project due to existing storm water run off and damage to parcel 74.00-3-18 and parcel 74.00-3-19. The abutters are very concerned that the January 6, 2022 Stormwater Pollution Prevention Plan is inadequate and incomplete. The Applicant's proposal for wet swales and level spreaders may slow the stormwater, but due to 100% poorly drained clay soils it is unlikely to prevent stormwater drainage and erosion damage to abutting properties 74.00-3-18 and 74.00-3-19. The increased and excessive stormwater run off may negatively impact the use, enjoyment and development of the abutting parcels. This may decrease the landowners property values.

Tax Id 74.00-3-19
November 2, 2021 view from most south west corner to the north east
This property is an agricultural district, has an installed drainage system and is actively hayed producing revenue for the parcel owner.

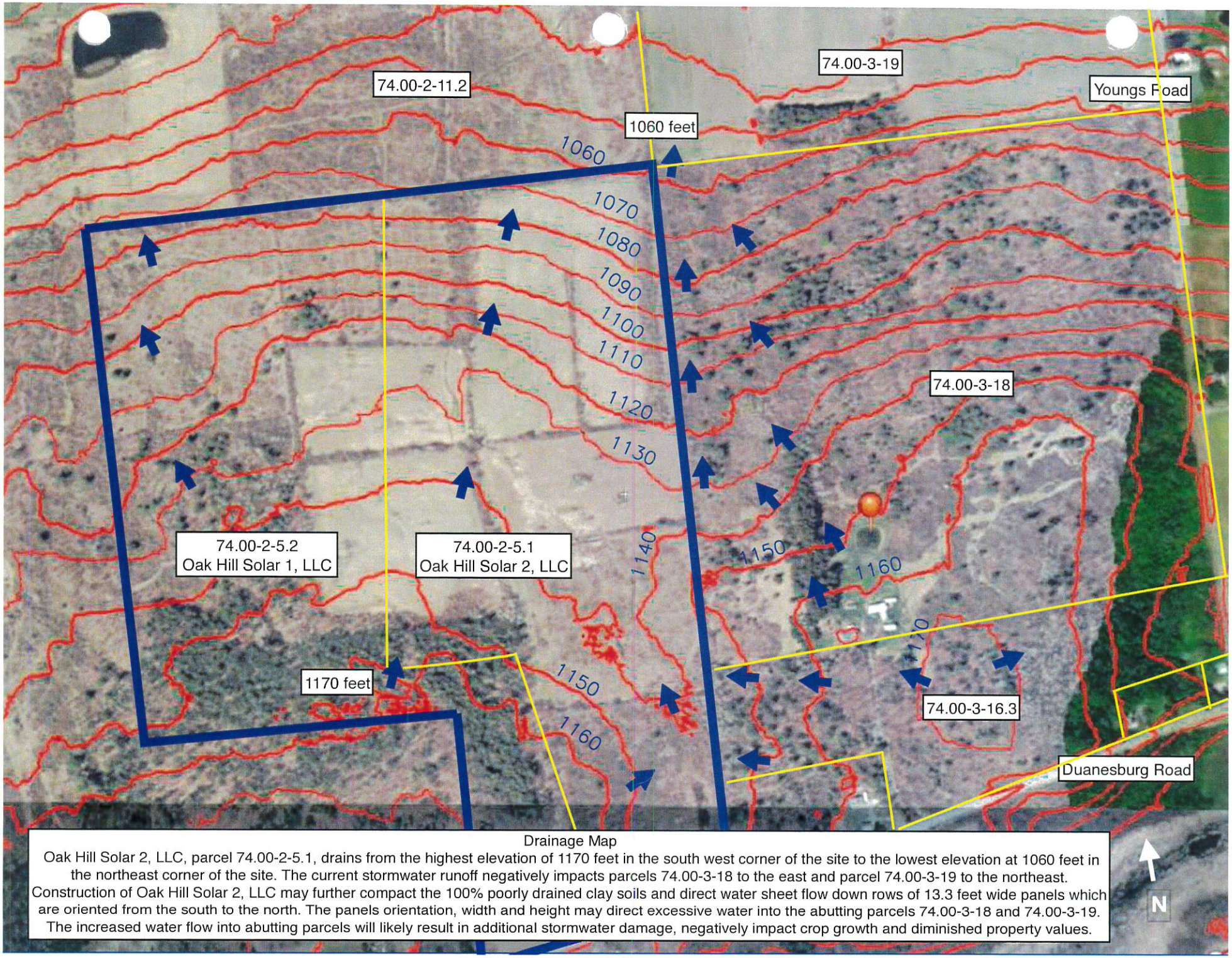



Tax Id 74.00-3-19 November 2, 2021 view from northwest to the east
Youngs Road
74.00-3-18
74.00-3-19
74.00-3-19
74.00-3-19
74.00-3-19
This image represents uncut hayfields because the fields were too wet to support haying tractors, bailers, and hay wagons. The fields were not cleared until the ground was frozen solid in late December 2021. Driving equipment on wet fields compacts the soils, makes ruts in the ground and presents the possibility of equipment being stuck in the muck.
N


Tax Id 74.00-3-19 November 2, 2021 view from most northwest corner to the south east
Youngs Road
74.00-3-18
74.00-3-18
74.00-3-19
74.00-3-19
74.00-3-19
74.00-3-19
N


Tax Id 74.00-3-19 November 2, 2021 view along western property line to the south
74.00-3-18
74.00-3-19
74.00-2-5.1
Oak Hill Solar 2, LLC
Elevation
1170 ft
Elevation
1060 ft
drainage ditch
74.00-3-19
74.00-2-11.2
stone wall
N
Oak Hill Solar 2, LLC's, parcel number 74.00-2-5.1, highest elevation is 1170 feet at the south west end of the parcel. The lowest elevation is 1060 feet at the Project's north eastern corner. Stormwater flow, represented with blue arrows, drains from Oak Hill Solar 2, LLC into parcels to the east and north east, 74.00-3-18 and 74.00-3-19.

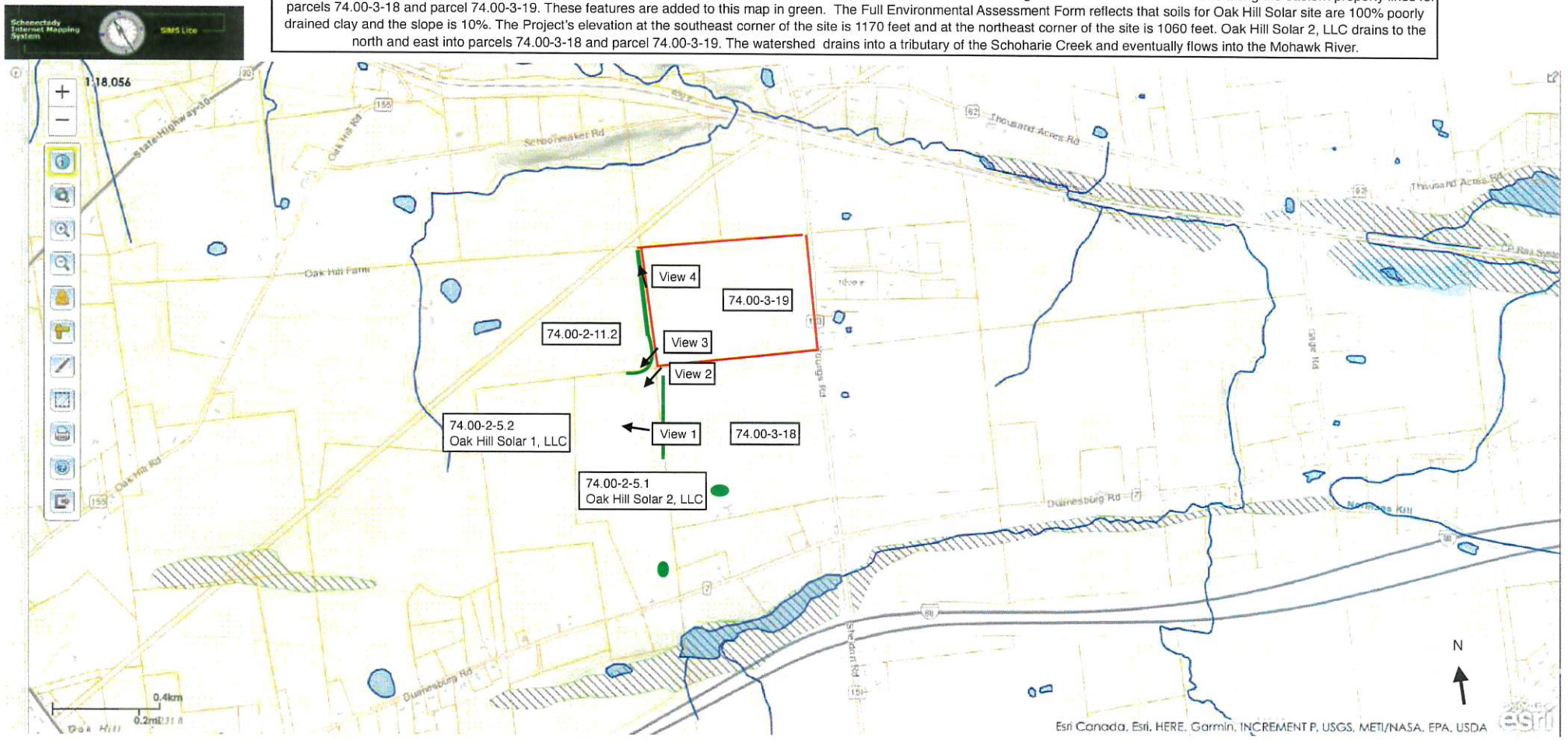
Appendix B



Drainage Map

Oak Hill Solar 2, LLC, parcel 74.00-2-5.1, drains from the highest elevation of 1170 feet in the south west corner of the site to the lowest elevation at 1060 feet in the northeast corner of the site. The current stormwater runoff negatively impacts parcels 74.00-3-18 to the east and parcel 74.00-3-19 to the northeast. Construction of Oak Hill Solar 2, LLC may further compact the 100% poorly drained clay soils and direct water sheet flow down rows of 13.3 feet wide panels which are oriented from the south to the north. The panels orientation, width and height may direct excessive water into the abutting parcels 74.00-3-18 and 74.00-3-19. The increased water flow into abutting parcels will likely result in additional stormwater damage, negatively impact crop growth and diminished property values.

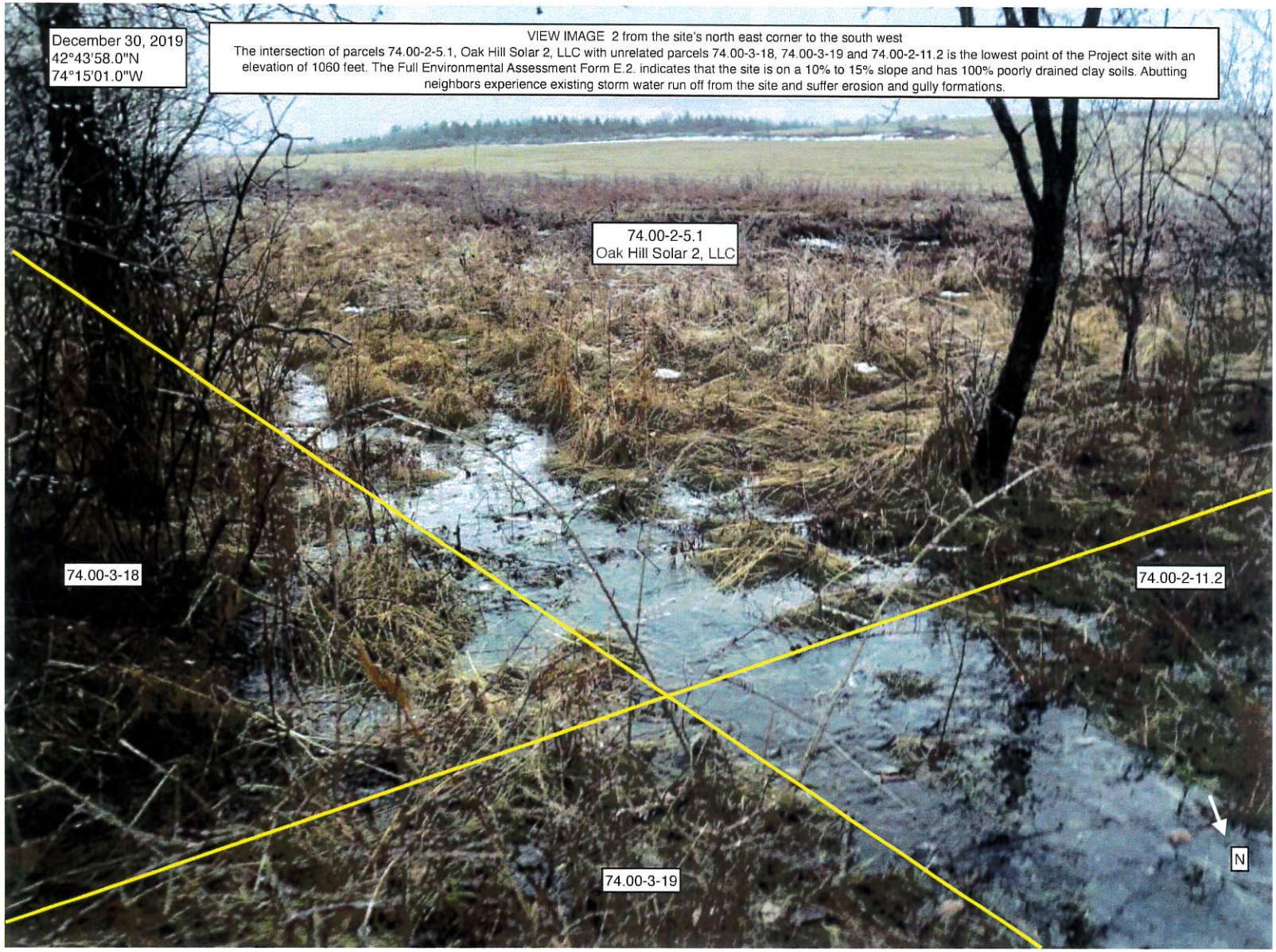
Schenectady County Internet Mapping System omits a marsh on parcel 74.00-2-5.1, a pond on parcel 74.00-3-18 and drainage ditches and seasonal streams along the eastern property lines for parcels 74.00-3-18 and parcel 74.00-3-19. These features are added to this map in green. The Full Environmental Assessment Form reflects that soils for Oak Hill Solar site are 100% poorly drained clay and the slope is 10%. The Project's elevation at the southeast corner of the site is 1170 feet and at the northeast corner of the site is 1060 feet. Oak Hill Solar 2, LLC drains to the north and east into parcels 74.00-3-18 and parcel 74.00-3-19. The watershed drains into a tributary of the Schoharie Creek and eventually flows into the Mohawk River.

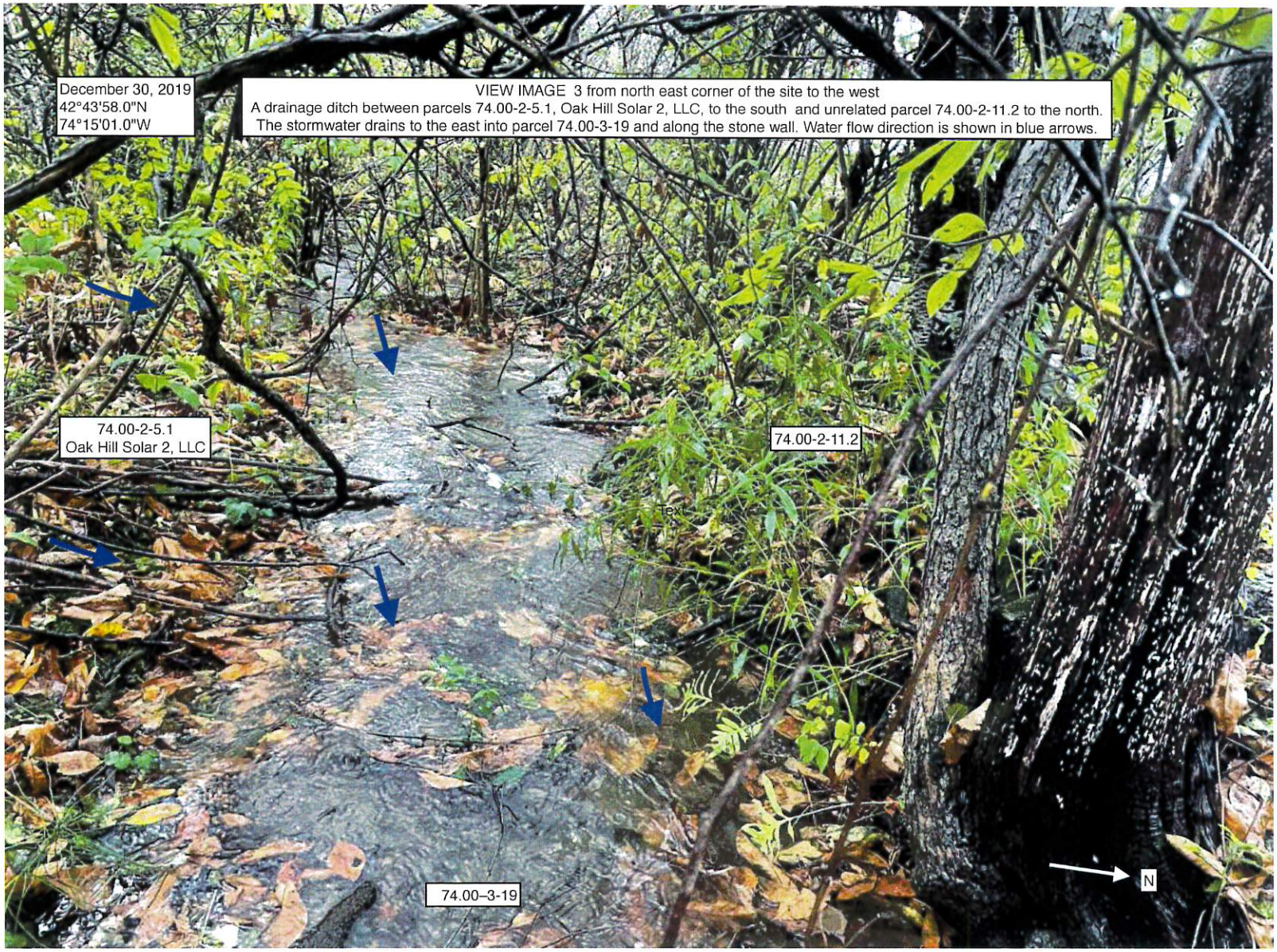


Schenectady County Internet Mapping System
January 22, 2022
Map includes: parcel lines, streams, bodies of water, DEC wetlands
streams and bodies of water omitted from the map are shown in aqua color

Location Key - View Images Attached
1. December 30, 2019 GPS 42°43'48.1"N 74°15'00.2"W view to west for Oak Hill Solar shows standing water at property line
2. December 30, 2019 GPS 42°43'58.0"N 74°15'01.0"W view to south west towards Oak Hill Solar projects shows standing water
3. October 17, 2021 GPS 42°43'58.0"N 74°15'01.0"W view to north shows flowing stream along property line
4. October 17, 2021 GPS 42°44"'7.4N 74°15'03.0"W view to north shows rapidly flowing turbulent stream along property line


74.00-2-5.1
Oak Hill Solar 2, LLC
VIEW IMAGE 1 from parcel 74.00-3-18 property line to the north west
The Full Environmental Assessment Form Part 1.E. indicates that Parcel 74.00-2-5.1, Oak Hill Solar 2, LLC, site is on a 10% to 15% slope and that the clay soils are 100% poorly drained. Stormwater flows off the Project site to the north and to the east. There is existing stormwater damage on parcel 74.00-3-18 and 74.00-3-19 where erosion gully's have formed. Abutting property owners request that the Board perform a site visit to Oak Hill Solar 1, LLC, Oak Hill Solar 2, LLC and the abutting parcels to fully understand the Project's impact on the surrounding lands. Additionally, the Project is an industrial use and may be in violation of the town's Comprehensive Plan to preserve the town's rural character, natural resources and fresh watersheds.
Standing Water
N
December 30, 2019
42°43'48.1"N
74°15'00.2"W
74.00-3-18


December 30, 2019
42°43'58.0"N
74°15'01.0"W
VIEW IMAGE 2 from the site's north east corner to the south west
The intersection of parcels 74.00-2-5.1, Oak Hill Solar 2, LLC with unrelated parcels 74.00-3-18, 74.00-3-19 and 74.00-2-11.2 is the lowest point of the Project site with an elevation of 1060 feet. The Full Environmental Assessment Form E.2. indicates that the site is on a 10% to 15% slope and has 100% poorly drained clay soils. Abutting neighbors experience existing storm water run off from the site and suffer erosion and gully formations.
74.00-2-5.1
Oak Hill Solar 2, LLC
74.00-3-18
74.00-2-11.2
74.00-3-19
N


December 30, 2019
42°43'58.0"N
74°15'01.0"W
VIEW IMAGE 3 from north east corner of the site to the west
A drainage ditch between parcels 74.00-2-5.1, Oak Hill Solar 2, LLC, to the south and unrelated parcel 74.00-2-11.2 to the north.
The stormwater drains to the east into parcel 74.00-3-19 and along the stone wall. Water flow direction is shown in blue arrows.
74.00-2-5.1
Oak Hill Solar 2, LLC
74.00-2-11.2
74.00–3-19
N


October 17, 2021
42°44' 7.4"N
74°15' 3.0"W
VIEW IMAGE 4 from parcel 74.00-3-19 eastern property line to the north
Storm water drains from 74.00-2-5.1, Oak Hill Solar 2, LLC, to the north and east into parcel 74.00-3-19. The excess water results in the formation of a gully between parcels 74.00-2-11.2 to the west and parcel 74.00-3-19 to the east.
74.00-2-11.2
74.00-3-19
N