Exhibit E
Noise Report

October 3, 2018

Hecate Energy Highland LLC
621 Randolph Street
Chicago, Illinois 60661

Attn: Ms. Patti Shorr
P: 614-205-3798
E: PShorr@HecateEnergy.com

Re: Ohio Power Siting Board Application Process – Highlands Site
Highland Solar
Highland County, Ohio 45110
Terracon Project No. 49187638

Dear Ms. Patti Shorr:

Terracon has investigated the potential noise impacts from the construction and operation of the proposed Highland solar farm in accordance to Ohio Power Siting Board Requirement 4906-4-08(A)(3). Terracon reviewed noise evaluations from similar projects and other information relating to the construction activities and operation of the proposed solar farm to assess the potential noise impacts from the project.

After reviewing the construction and operation activities associated with the proposed solar farm that may have noise impacts, Terracon expects that the offsite noise impacts from the construction and operation of the proposed solar farm will be minimal.

Construction of the solar farm is expected to start in July 2020 and finish in June 2021. It is expected that the weekly construction schedule will occur Monday through Friday between 7:00AM and 7:00PM, however some construction activities could also occur on weekends if necessary. The solar farm will be constructed in several phases as it is expanded from one area to another. The beginning of construction in each phase will generate the most noise as this is when the heavy machinery will be operated.

Noise level is measured in decibels (dB) and indicates the amount of raw pressure, in Pascals, that a sound source generates. Noise level is dependent on several factors including distance and number of sources. In an open field, noise level dissipates at a rate of 6 dBs every time the distance from the source doubles. If a source generates 100 dB 3 feet from the source, then the

source generates 94 dB at 6 feet away and 88 dB at 12 feet away and so on. Equation 1 can be used to calculate the difference in sound pressure level[1].

$$\text{Equation 1:} \quad dL = 10 * \log(R_2 / R_1)^2$$

Where;

dL: change in sound pressure level (dB)
R_1: distance from source to location 1 (ft, m)
R_2: distance from source to location 2 (ft, m)

In order to calculate the increase in the sound level from multiple sources the pressure from each sound source at the point of interest is summed and converted to decibels. Equation 2 is used to calculate the total raw pressure at a location from multiple sources using the raw pressure from each sound source[2].

$$\text{Equation 2:} \quad P_T = (P_A^2 + P_B^2 + \ldots + P_F^2)^{0.5}$$

Where;

P_T: Total combined pressure at location 1 (µPa)
P_A: Pressure from source A at location 1 (µPa)
P_B: Pressure from source B at location 1 (µPa)
P_F: Pressure from the last source at location 1 (µPa)

The construction activities that will generate the most noise will take place during the construction phase are due to pile driving, potential rock drilling, and dozier grading work. The U.S. Department of Transportation Federal Highway Administration has measured noised impacts from construction activities and the expected noise associated with the potential equipment to be used during construction can be seen in Table 1.

Table 1: Common Construction Equipment[3]

Equipment Description	Actual Measured L_{max} @ 50 feet (dBA, slow) (Samples Averaged)	Number of Actual Data Samples
Dozer	82	55
Excavator	81	170
Front End Loader	79	96
Impact Pile Driver	101	11
Man Lift	75	23
Pickup Truck	75	1
Vibratory Pile Driver	101	44

[1] Equation 1 from *Estimating Sound Levels with the Inverse Square Law* on *HyperPhysics,* an online reference book for physics by Georgia State University
[2] Equation 2 from *Adding Decibels* on *Engineering Toolbox,* an online reference book for engineering equations.
[3] Knauer, H., & Pederson, S. U.S. Dept. of Transportation, Federal Highway Administration, *Highway Construction Noise Handbook*. Jan. 2006.

Neighbors in close proximity to the construction activities likely will be able to notice the noises associated with the machinery required for construction. However, according to the study Farm Noise Emissions During Common Agricultural Activities done by Depczynski, Franklin, Challinor, Williams, and Fragar, the machinery required for construction has similar noise levels as farm equipment that are currently used in the area. Dozers, combines, tractors, irrigation pumps, semi-trucks, and chainsaws used by farmers can all generate noise levels between 80 and 110 dB. The specific farm related sources and noise levels as predicted in the study can be seen in Table 2.

Table 2: Common Farm Sound Levels[4]

Machinery	Average Noise Level at Operators ear (dB)	Noise Level Range at Operators ear (dB)
Air Compressor	86	72-95
All Terrain Vehicle	86	84-87
Angle Grinder	98	96-100
Auger	93	89-96
Bulldozer	99	97-100
Chainsaw	106	104-107
Farm Truck	85	83-88
Fork Lift	84	81-88
Harvester	83	75-91
Irrigation Pump	100	96-104
Tractor	92	90-93

Any noise generated by the transport of equipment in and out of the Site will be comparable to the sound levels generated by the hauling of crops each season. Although construction noise levels will vary from day to day during construction depending on the activity being performed, the overall generated noise levels during construction are expected to be similar to noise levels generated from typical farm activities.

The operation of solar farms primarily generate noise from two main sources; invertors and transformers. The project will have around 2400 inverters and several transformers. Inverters are used on solar farms to turn the direct current (DC) power generated by the solar panels into alternating current (AC). Transformers are used on solar farms to increase the alternating voltages generated by the invertors and help facilitate the transmission, distribution, and utilization of AC for electrical energy. The solar farm also uses a motorized tracking system in order to keep the panels facing the sun and optimize output during different times of the day and year. The

[4] Depczynski, J., Franklin, R. C., Challinor, K., Williams, W., & Fragar, L. J.. *Farm Noise Emissions During Common Agricultural Activities* (Tech.). National Center for Biotechnology Information. 2005.

motors used to move the panels are small and are hard to hear on a calm day when just standing a couple feet away.

The preliminary inverters chosen for the project are 125kW, 1500Vdc String Inverters produced by Chint Power. The inverters register 65 dB at one meter away from the inverter. The Project is projected to use 2400 inverters. Each individual noise source adds to the total measurable noise level, however as stated above, the doubling of the distance from the previous reference measuring point decreases the number of decibels registered by 6dB. The inverters will be spread out and will not be generating noise when the sun goes down. A field study done is 2012 by the Massachusetts Clean Energy Center[5], found that the noise level from general solar farm inverters become unnoticeable from background noise at 50 meters. Based on the planned spacing of the inverters, the combined impact from the inverters will result in minimal noise impacts due to the diminishing sound impacts and the distance between sources inverters.

For one inverter, the sound level 8 meters from the inverter would be 47dB. To put that in perspective, the average sound level generated for a household refrigerator is 50dB. So, at 8 meters from an inverter, the expected sound level is lower than that of an average house hold refrigerator. Based on the spacing of the inverters, the additive impacts from other inverters and transformers are unlikely to increase the overall sound level at 8 meters from an inverter to much over 47 dB.

The other main source of noise will be from transformers. Each anticipated transformer produces a sound level of 85 dB at one meter away from the transformer. For a scenario where two transformers are located 200 meters apart, the predicted sound level at the midpoint between the two transformers would be 51 dB after considering the diminishing sound impacts as the distance from the source increases and the combined impacts from two transformers. The transformers are planned to be positioned inside the arrays. The anticipated location of the transformers will reduce the total cumulative sound pressure onsite and thus reduce the measurable decibels generated on Site.

Anticipated maintenance operations will include grass mowing and general solar panel maintenance. The upkeep and small fixes are not anticipated to generate any loud or distinguishable noise from off the Site. The site will have the grass mowed three to four times a year, this will be done during the day. According to the Environment, Health and Safety, riding lawn mowers operate around 90 dB. Due to the large area being mowed, the distance from the mower to anywhere offsite would create an environment where the sound generated from mowing would largely go unnoticed. Secondly, the mowing of grass already takes place at each resident's household and is generally accepted as a common noise. Finally, the last potential for increasing the ambient noise level of the Site would be an increase in traffic into and around the site. The estimated number of vehicles needed to service the solar farm amounts to 10 vehicles on days

[5] Guldberg, P. Tech Environmental, *Study of Acoustic and EMF Levels from Solar Photovoltaic Projects*, Prepared for the Massachusetts Clean Energy Center, Boston, Dec. 2012.

when the panels are serviced and the grass needs mowing which is not expected to have any significant noise impacts.

The noise impacts from constructing a solar farm on existing farm land and the operation of the solar farm are expected to be minimal. The construction process will last 12 months and will primarily occur during daylight hours during week days. The noise impacts from construction equipment is expected to be similar to the operation of typical farm equipment. Due to the spacing of the inverters and transformers, the noise levels from the operation of the solar farm are expected to be lower than those created by general farm equipment operation. Considering the location of the inverters and transformers and the distance from this equipment to any offsite locations, it is unlikely that any offsite location will be able to notice any significant noise impacts.

Services provided by Terracon were performed in a manner consistent with generally accepted practices of the profession undertaken in similar projects in the same geographical area during the same time period. Terracon makes no warranties, either express or implied, regarding findings, conclusions or recommendations. The data, interpretations, findings, and our recommendations are based solely upon data obtained at the time and within the scope of these services. This report has been prepared for the exclusive use of Hecate Energy Highland LLC, and any authorization for use or reliance by any other party (except a governmental entity having jurisdiction over the site) is prohibited without the express written authorization of Hecate Energy Highland LLC and Terracon.

Sincerely,
Terracon Consultants, Inc.

Matt B. Gregoire
Field Engineer

David C. Reynolds, PE
Senior Engineer

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Summary: Application Exhibit E electronically filed by Ms. Karen A. Winters on behalf of Hecate Energy Highland LLC