North Seneca Solar Project

ORES Permit Application No. 23-00036

1100-2.11 Exhibit 10

Geology, Seismology, and Soils

REVISION 1

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EXHIBIT 10 GEOLOGY, SEISMOLOGY, AND SOILS

(a) Study of the Geology, Seismology, and Soils Impacts

North Seneca Solar Project, LLC (the Applicant) proposes to construct and operate the North Seneca Solar Project (the Facility), an up to 90-megawatt commercial photovoltaic (PV) energy system located in the Towns of Waterloo and Junius, Seneca County, New York. Section 10(a) includes a study of geologic, seismologic, and soil impacts of the Facility including mapped or otherwise identified existing conditions, an impact analysis, and proposed impact avoidance and mitigation measures.

(1) Existing Slopes Map

Land within the Facility Site is relatively flat with the majority of the Facility Site between 0 and 3% slopes. There are limited areas within the Facility Site where slopes increase, ranging between 3% and 15%, and are generally associated with localized high or low points. Figure 10-1 delineates existing slopes (0–3%, 3–8%, and 8–15%) within the area of the Facility Site, as well as the associated drainage areas. This figure was prepared using 1-meter digital elevation model (DEM) data provided by the U.S. Geological Survey (USGS) and the New York State GIS Program Office. The data were processed using ESRI ArcGIS® software.

(2) Proposed Site Plan

Civil Design Drawings indicating existing and proposed contours at two-foot intervals are included in Exhibit 5 of this application.

(3) Excavation Techniques to be Employed

Excavation activities, such as vegetation clearing, grubbing, topsoil stripping and grading, will be associated with the construction of the collection substation, point of interconnection (POI) substation, storage trailer, inverters, underground collection lines, and photovoltaic (PV) arrays. Additionally, laydown areas, used only during construction, will be similarly cleared, grubbed, topsoil stripped, and graded. Ground disturbance within existing agricultural lands, including excavation and topsoil removal, will be conducted in accordance with New York State Department of Agriculture and Markets *Guidelines for Solar Energy Projects – Construction Mitigation for Agricultural Lands* (Revision 10/18/2019) as further discussed in Appendix 15-A pursuant to the requirements of Title 16 New York Codes, Rules and Regulations (16 NYCRR) Section 1100-6.4(s)(1)(i). Most trenching excavation required at the Facility Site may be completed as open cuts using conventional hydraulic backhoe and/or excavating equipment. Excavations at the site will be completed using industry standard equipment (e.g., bulldozers, and track hoes). Temporary excavations will be shored, sloped, or braced, as required by the Occupational Safety and Health Administration (OSHA). Erosion control stabilization measures such as straw bales and silt fences may also be utilized where determined necessary. Native soils deemed suitable may be re-used as fill or backfill on site. General backfill material, comprised of imported granular material with less than 15% fine grains, may be used at all other fill locations throughout the Facility Site.

Although the exposed soil subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Should unstable subgrade conditions develop, stabilization measures, such as the addition of replacement fill, would be employed.

Foundation excavations will be completed using industry standard equipment (e.g., bulldozers and trackhoes). Excavations for foundations and utilities may encounter very dense soil (likely with cobbles and/or boulders) and shallow bedrock in some locations. All excavations will comply with applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards. Concrete foundations for major equipment and structural supports will be placed, followed by the installation of various conduits, cable trenches, and grounding grid conductors.

The majority of the electrical collection system will be installed using direct burial methods. Industry standard equipment (e.g., trackhoe) will be used. Direct burial will involve the installation of bundled cable directly into a narrow cut or "rip" in the ground. The rip would disturb an area approximately 24 inches wide. Bundled cable would be installed to a minimum depth of 48 inches in agricultural land or, in non-agricultural areas where the depth of bedrock is less than 48 inches, at least 36 inches.[1]

Topsoil and subsoil will be segregated and stockpiled adjacent to the trench in upland areas for use in site restoration. As utility trenches can provide a conduit for groundwater flow, trenches will be backfilled with material that approximately matches the permeability characteristics of the surrounding soil. If higher permeability fill is used in trenches, consideration will be given to installing seepage collars and check dams to reduce the likelihood of migration of water through the trenches.

Trenchless technologies (e.g., Horizontal Directional Drilling [HDD] or jack and bore) are planned for installation of the collection cables under streams, wetlands, roadways, pipelines, and other environmentally sensitive areas. Trenchless installations involve installing the cable under a wetland, stream, or roadway using boring/drilling equipment set up on either side of the crossing outside of sensitive resource areas. No surface disturbance is required between the bore pits, and all existing vegetation along the streams and within the wetlands (including mature trees) can remain in place and disturbance to these sensitive resources can be avoided. Refer to Figure 10-2 (Trenchless Installation Locations) and the Design Drawings in Exhibit 5 for additional information on the location, length, and details of these proposed trenchless crossings. The only potential impact associated with HDD is a surface release of drilling mud (i.e., inadvertent return). Such inadvertent returns would be avoided or minimized to the maximum extent practicable. An Inadvertent Return Plan will be submitted as a compliance filing pursuant to 16 NYCRR Section 1100-10.2(f)(5).

Any stormwater Facility construction activities using similar earth moving equipment discussed in this section is addressed in the Stormwater Pollution Prevention Plan (Appendix 13-C) prepared in

[1] During the final design of the Facility, the Applicant may propose a reduced collection line burial depth, where collection lines are sited within the security fence of the Facility. If a reduced burial depth is proposed, the Applicant will update applicable supporting drawings and plans (e.g., typical details in the design drawings, the Site Restoration and Decommissioning Plan, etc.) as needed, to support this design change.

accordance with the New York State Standards and Specifications for Erosion and Sediment Control Standards (NYS Standards) and the New York State Stormwater Management Design Manual. Typical excavation techniques may include limited ditches for the conveyance of surface runoff into stormwater detention basins and other infiltration systems. Construction of the Facility's stormwater facilities is expected to require standard equipment such as excavators, loaders, and/or backhoes.

(4) Suitability for Construction

On behalf of the Applicant, TerraCon conducted a preliminary geotechnical investigation to obtain and review subsurface soil and groundwater conditions and provide geotechnical recommendations for the proposed structures within the Facility Site. The results of the investigation are summarized in the *Geotechnical Engineering Report* (Appendix 10-A). As part of this evaluation, TerraCon performed the following activities:

- Investigated subsurface soil and bedrock conditions through sampling and limited geotechnical laboratory testing at 18 boring sites, eight test pits, eight field electrical resistivity test sites, and eight pile load test sites the distributed throughout the proposed PV arrays, collection substation, and POI substation locations which are anticipated to be representative of mapped soil and bedrock formations within the Facility Site.
- Collected and reviewed publicly available data regarding surface and subsurface soil, bedrock, and groundwater conditions.
- Analyzed the available data to determine the suitability of the Facility Site for construction.
- Developed a *Geotechnical Engineering Report*, that discusses:
  - Regional geology, tectonic setting, and seismology;
  - Geotechnical characterization of the Facility Site (e.g., groundwater conditions, bedrock, soil types);
  - An assessment of soil corrosivity, soils with high frost risk, and soils with high shrink/swell potential and recommended mitigation measures;
  - Preliminary earthwork recommendations for pile driving and foundations; and
  - Suitability for construction.

Based on TerraCon's findings, the Facility Site is suitable for the proposed development. According to the *Geotechnical Engineering Report*, the surficial soils encountered at the Facility Site were generally found to be loose to very dense (or soft to hard) consisting of silty, clayey, and sandy soils underlain by Onondaga Limestone of the Middle Devonian geological age. Surficial geology within the Facility Site is mapped as kame moraine, lacustrine sand, and till moraine deposits. Excavated soils are considered suitable for re-use as general site fill. Depending on the soil moisture content during construction, additional management of the soil is recommended and will be addressed during final geotechnical testing prior to the start of construction. In the event that construction is performed during the wet season, it may be possible that the moisture content of the excavated soils is more than the optimum moisture content to achieve proper compaction, and proper compaction of on-site soils may be difficult to achieve; if such a situation occurs, imported structural fill may then be required.

The corrosivity potential of soils in the Facility Site was measured at eight boring locations. Samples were tested for pH, water soluble sulfate, water soluble chloride, sulfide content, oxygen reduction potential, and electrical resistivity (Appendix 10-A). Results were compared to the guidelines presented in the American Concrete Institute (ACI) 318 Manual of Concrete Practice, and the American Association of State Highway and Transportation Officials (AASHTO) Manual and indicated high corrosion potential for structural concrete materials.

The *Geotechnical Engineering Report* did not observe any shallow bedrock throughout the Facility Site and results of the borings indicate the depth to bedrock appears to be over 20 feet below ground surface (bgs) across the Facility Site. Based on the depth of bedrock, blasting is not expected to be necessary for construction of proposed foundations and associated equipment.

Test boring results indicate that the depth of the water table varies across the Facility Site, which is generally consistent with the United States Department of Agriculture (USDA) National Resource Conservation Service (NRCS) Web Soil Survey (WSS) and Soil Survey Geographic (SSURGO) database (Soil Survey Staff, NRCS, & USDA, 2023). Thirteen of the borings were dry and the observed groundwater depth at the remaining five boring locations ranged from depths of 6 to 18 feet bgs. Groundwater levels observed during borings may not be representative of long-term levels. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors. Water may also become temporarily perched over low permeability layers, or bedrock, especially after rainfall. Therefore, groundwater levels during construction or operation may be higher or lower than the levels indicated on the boring logs. Figure 10-4 shows depth to bedrock and depth to the high-water table across the Facility Site relative to Facility components.

Where groundwater or perched water conditions are encountered, instability of the soils during excavations may be expected in the form of caving, sloughing, and raveling. Dewatering and additional grading may be required for Facility construction to allow for adequate compaction of soils (e.g., in buried collection line trenches) and prevent ponding on the Facility Site. Any dewatering necessary for construction will be conducted in accordance with the Facility's SWPPP (Appendix 13-C) and 16 NYCRR Section 1100-6.4(q). Dewatering methods will involve pumping the water to a predetermined vegetated discharge point, away from wetlands, waterbodies, and other sensitive resources. The use of sumps and pumps is a common and economical method of dewatering and will be adequate given the conditions within the Facility Site. As detailed in the *Geotechnical Engineering Report*, additional geotechnical investigations will be conducted by the contractor prior to construction to inform whether long-term dewatering will be necessary. It is not anticipated that the Facility will include any components located below grade that will require continuous dewatering. The Contractor will be made aware that excavations could require bracing, sloping, and/or other means to create safe and stable working conditions. All excavations and fills will comply with OSHA, local, state, and federal safety regulations. All dewatering activities will comply with New York State Department of Environmental Conservation (NYSDEC) storm water discharge requirements and federal regulations for construction and will comply with the Facility's SWPPP. See Exhibit 13 (Water Resources and Aquatic Ecology) for an additional discussion of groundwater on the Facility Site and how water will be managed during construction.

Based on the fine soils present within the Facility Site (e.g., silt and clay) and the potential for shallow seasonally high water or perched water conditions on the Facility Site, the soils on site are considered to have the potential for shrink and swell and may be susceptible to frost action. The effects of frost heave are possible if shallow foundations are built in the frost zone. To mitigate the high frost risk, foundations will be constructed below the depth of frost penetration in accordance with the 2020 Building Code of New York State and specific construction procedures associated with potential expansive clays may be required for the Facility.

According to the *Geotechnical Engineering Report*, adfreeze on pile foundations may be significant. If the anchorage of the foundations and the deadweight of the pile are not sufficient to resist these upward forces, adfreeze load can cause uplift to structures. It is recommended that an adfreeze stress of 1,500 per square foot (psf) be considered when determining frost heave load on a pile. Therefore, while direct driven piles may be used for this Facility, the Applicant will carefully consider these design and construction implications throughout the design and construction process.

Collection lines will be installed through trenchless technology (e.g., HDD or jack and bore) in several locations to avoid sensitive resources such as wetlands and streams, cultural resources, public roads or pipelines. Soil types in the areas where trenchless installation is proposed are generally consistent with the conditions within Facility Site as a whole and primarily include loamy or fine sands and silt loams, with some areas of mucky soil textures. According to the publicly available USDA SSURGO data, soil drainage classifications range from well drained to very poorly drained. Throughout much of the area proposed for trenchless installation (approximately 56%) the anticipated depth to water table ranges from 6 to 36 inches bgs while the water table is reported to be greater than 80 inches bgs in approximately 29% of the area. Shallow water tables at ground surface are anticipated within the remaining 15% of the area proposed for trenchless installation. Bedrock is anticipated to be deeper than 80 inches bgs (Soil Survey Staff, 2023). Section 10(a)(11) and Table 10-1 provide more information on the soil types within the areas proposed for trenchless installation and the Facility Site.

Publicly available data representing mapped bedrock and high-water table depths may differ from site-specific conditions identified during the geotechnical investigation due to a lack of field verification in some areas of the public datasets. As such, prior to construction, additional geotechnical investigations will be conducted throughout the Facility Site to confirm suitability. In addition, the subcontractor undertaking the trenchless installations will use drilling equipment suitable for the soil conditions on the Facility Site. If rock conditions encountered vary from what was predicted, the appropriate drill bit will be used to drill effectively within the specific conditions encountered.

(5) Blasting Plan

As detailed in the *Geotechnical Engineering Report* (Appendix 10-A), bedrock was not encountered during borings and refusal occurred at only one boring location at a depth of 14.5 feet bgs. Therefore, blasting is not anticipated to be needed during the construction of the Facility.

If any future investigations conducted by the Applicant alter the conclusion that blasting is not needed to construct the Facility, the Applicant will complete a permit modification request and provide a full analysis of the potential blasting impacts in future filings.

(6) Potential Blasting Impacts

As detailed in Section 10(a)(5), blasting is not anticipated to be necessary during the construction of the Facility, therefore, there will be no impacts associated with blasting and mitigation is not required.

(7) Mitigation Measures for Blasting Impacts

As detailed in Section 10(a)(5), blasting is not anticipated to be necessary during the construction of the Facility, therefore, there will be no impacts associated with blasting and mitigation is not required.

(8) Regional Geology, Tectonic Setting, and Seismology

The Facility is located in the Finger Lakes Region of New York State in the Tows of Junius and Waterloo, Seneca County, New York. Seneca County contains two major physiographic providences, the Ontario Lowland located north of Seneca River, and the Allegheny Plateau located south of Seneca River. The Facility Site falls entirely within the Ontario Lowland physiographic providence. Most of Seneca County is underlain by sedimentary bedrock. The underlying bedrock at the Facility Site is mapped as dolostone (dolomite) and shale from the Upper Silurian geologic period and limestone and chert from the Middle Devonian geologic period (Wells, 2004; NYSM/NYSGS, 1970). According to the USGS, the entirety of the Facility Site is mapped as underlain by carbonate bedrock forming a regional karst terrain (USGS, 2014; USGS, 2020). As identified above, limestone is the dominant bedrock type throughout the Facility Site and is often associated with karst geology.

According to New York State tectonic spatial data, there are no recorded fault lines in the vicinity of the Facility. The nearest fault line is greater than 10 miles east of the Facility Site. The New York State Seismic Hazard Map indicates that the Facility is situated in a location with moderately low risk of significant seismic activity (USGS, 2014). The USGS Earthquake Hazards Program does not list any young faults or faults that have had displacement in the Holocene epoch within the vicinity of the Facility Site (USGS, 2018). There are no topographic linear features identified as brittle structures by the New York State Museum (NYSM) within the Facility Site. The nearest brittle structure is a drillhole approximately 3.2 miles to the southeast of the Facility Site (NYSM, 1977). Likewise, according to the *Geotechnical Engineering Report* (Appendix 10-A), seismicity within the Facility Site is low; therefore, there are no anticipated risks from seismic activity on the Facility Site.

(9) Facility Impacts on Regional Geology

Based on subsurface inspections and analyses, the Facility Site is considered suitable for the construction and operation of the Facility and is not anticipated to result in any significant impacts to the regional geology. To the extent practical, Facility components will be designed, sited, and constructed in a manner that avoids or minimizes temporary and permanent impacts to physiography, geology, and soils. Before construction commences, a site survey will be performed to stake out the exact location of proposed Facility components. Prior to construction, the Applicant will carry out targeted subsurface investigation activities to inform final design.

Although the underlying carbonate bedrock in the area is documented as providing potential for karst feature formation, Seneca County does not contain any documented karst features (e.g., sinkholes and areas of soil subsidence, cave entrances, closed depressions, and the appearance of sinking or disappearing streams) (Kappel et al., 2020). According to the *Karst Survey and Assessment Report* developed in support of this project (Appendix 10-B), six suspect karst features were identified during preliminary desktop evaluation, none of which were identified as karst during the field verification survey, but rather were associated with tractor ruts and surface drainage. However, the absence of identified karst features does not remove the risk of potential karst feature formation given the underlying geology of the Facility Site. Karst features may be present below the ground surface that were not identified by either the karst or preliminary geotechnical studies conducted at the Facility Site. Additional geotechnical investigations will be conducted prior to construction, to verify no new karst features have developed. Please refer to Appendix 10-B for more information regarding karst geology within the Facility Site.

Overall, Facility components will be designed, sited, and constructed in a manner that avoids and minimizes temporary or permanent impacts to physiography, geology, and soils, to the extent practicable. Accordingly, when operational, Facility impacts to regional geology will be negligible.

(10) Impacts of Seismic Activity on Facility Operation

As stated in Section 10(a)(8), the New York State Seismic Hazard Map indicates that the Facility is situated in a location with moderately low risk of significant seismic activity (USGS, 2014) and the USGS Earthquake Hazards Program does not list any young faults or faults that have had displacement in the Holocene epoch within the vicinity of the Facility Site (USGS, 2018). Therefore, Facility operations are considered low risk for impacts from seismic activity. However, to further minimize potential impacts from seismic activity, the Facility will be designed to resist the effects of earthquake motions in accordance with Section 1613 of the 2020 Building Code of New York State or ASCE 7. Additionally, Facility components are designed with emergency electrical shut offs in case of emergency, such as a large seismic event. Furthermore, the Applicant has developed a Safety Response Plan (Appendix 6-B) to outline procedures to follow during construction or operation activities in the event of an emergency. See Section 10(a)(8) of the Plan for a discussion of the risk factors related to the anticipated impacts of seismic activity on the Facility.

(11) Soil Types Map

Soil types at the Facility Site were mapped using data from the USDA NRCS SS. See Figure 10-3 for a map delineating soil types within the Facility Site.

(12) Characteristics of Each Soil Type and Suitability for Construction

According to the USDA NRCS SSURGO database, 22 soil series comprise the Facility Site. The general characteristics of these soil series present within the Facility Site are provided in Table 10-1.

It is important to note that the USDA NRCS SSURGO is the most comprehensive set of information published by the National Cooperative Soil Survey, but not all areas have been field-verified. Therefore, this Exhibit supplements the federal soils data with site-specific soils information gathered during the geotechnical investigations.

Table 10-1. Soil series identified within the Facility Site and their characteristics.

Soil Series	Main Characteristics
Alden Series	• 0 to 2% slopes • Not prime farmland • Alden mucky silt loam, Depressions • Mucky silt loam texture • Organic material is approximately 15% • Very poorly drained • Depth to restrictive layer greater than 80 inches • Depth to water table about 0 inches
Arkport Series *	• 1 to 6% slopes, 6 to 12% slopes • All areas are prime farmland, farmland of statewide importance • Deltas on lake plains • Loamy fine sand texture • Organic material is approximately 15% • Well drained • Depth to restrictive layer greater than 80 inches • Depth to water table more than 80 inches
Cazenovia Series	• 3 to 8% slopes • All areas are prime farmland • Cazenovia silt loam, Reworked lake plains, till plains • Silt loam texture • Organic material is approximately 15% • Moderately well drained • Depth to restrictive layer greater than 80 inches • Depth to water table about 24 to 48 inches
Claverack Series *	• 0 to 2% slopes, 2 to 6% slopes • All areas are prime farmland • Lake plains • Loamy fine sand texture

Soil Series	Main Characteristics
	• Organic material is approximately 10% • Moderately well drained • Depth to restrictive layer greater than 80 inches • Depth to water table about 18 to 24 inches
Collamer Series	• 0 to 2% slopes, 2 to 6% slopes • All areas are prime farmland • Lake plains • Silt loam texture • Organic material is approximately 1% • Moderately well drained • Depth to a restrictive layer greater than 80 inches • Dept to water table about 18 to 24 inches
Collamer Series (variant) *	• 2 to 6% slopes • All areas are prime farmland • Moderately shallow variant, Lake plains • Silt loam texture • Organic material is approximately 1 percent • Moderately well drained • Depth to a restrictive layer 40 to 60 inches to lithic bedrock • Depth to water table 18 to 24 inches
Cosad Series	• 0 to 2% slopes • Prime farmland if drained • Lake plains • Loamy fine sand texture, silty clay • Organic material is approximately 15% • Somewhat poorly drained • Depth to restrictive layer greater than 80 inches • Depth to water table 6 to 18 inches
Dunkirk Series	• 1 to 6% slopes • All areas are prime farmland • Lake plains • Silt loam texture • Organic material is unknown • Well drained • Depth to restrictive layer greater than 80 inches • Depth to water table greater than 80 inches
Elnora Series *	• 2 to 6% slope • All areas are prime farmland • Deltas • Loamy fine sand textures • Organic material is unknown • Moderately well drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 18 to 24 inches
Fonda Series *	• 0 to 1% slope • Not prime farmland

Soil Series	Main Characteristics
	• Depressions • Mucky, silty, clay loam • Organic material is approximately 15% • Very poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 0 inches
Lakemont Series	• 0 to 3% slope • Farmland of statewide importance • Depressions • Silty clam loam texture • Organic material is approximately 25% • Poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 0 inches
Lamson Series *	• 0 to 2% slope • Not prime farmland • Depressions • Fine sandy loam and mucky fine sandy loam texture • Organic material is unknown • Very poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 0 inches
Muck *	• 0 to 2% slopes • Not prime farmland • Swamps and marshes • Muck or clay loam texture • Organic material is approximately 20% • Very poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 0 inches
Odessa Series *	• 0 to 3% slopes, 3 to 8% slopes • Prime farmland if drained • Lake terraces • Silty clay loam texture • Organic material is approximately 25% • Somewhat poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 6 to 18 inches
Ontario Series (fine sandy loam)	• 3 to 8% slopes, 8 to 15% slopes • All areas are prime farmland, farmland of statewide importance • Till plains, ridges, drumlins • Fine sandy loam texture • Organic material is approximately 40% • Well drained • Depth to restrictive feature greater 80 inches • Depth to water table greater than 80 inches

Soil Series	Main Characteristics
Ontario Series (loam)	• 3 to 8% slopes, 8 to 15% slopes • All areas are prime farmland, farmland of statewide importance • Till plains, ridges, drumlins • Loam texture • Organic material is approximately 40% • Well drained • Depth to restrictive feature greater than 80 inches • Depth to water table greater than 80 inches
Ovid Series *	• 3 to 8% slopes • Prime farmland if drained • Reworked lake plains, till plains • Silt loam texture • Organic material is approximately 15% • Somewhat poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 6 to 24 inches
Schoharie Series (silt loam) *	• 2 to 6% slope • All areas are prime farmland • Lake terraces • Silt loam texture • Organic material is approximately 25% • Moderately well drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 18 to 36 inches
Schoharie Series (silty clay loam)	• 2 to 6% slope, 6 to 12% slope • All areas are prime farmland, farmland of statewide importance • Lake terraces • Silty clay loam texture • Organic material is approximately 25% • Moderately well drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 18 to 36 inches
Sloan Series	• 0 to 2% slope • Farmland of statewide importance • Flood plains • Silt loam texture • Organic material is approximately 15% • Very poorly drained • Depth to restrictive feature greater than 80 inches • Depth to water table about 0 to 12 inches
Stafford Series *	• 0 to 2% slope • Farmland of statewide importance • Deltas, beach ridges • Loamy fine sand texture • Organic material is unknown • Somewhat poorly drained

Soil Series	Main Characteristics
	• Depth to restrictive feature greater than 80 inches • Depth to water table about 6 to 18 inches
Varick Series	• 0 to 2% slope • Farmland of statewide importance • Depressions • Silty clay loam texture • Organic material is unknown • Poorly drained • Depth to restrictive feature 20 to 40 feet to lithic bedrock • Depth to water table about 0 to 12 inches

Source: SSURGO Database (Soil Survey Staff, 2023).
* Soil series mapped within collection line areas proposed for trenchless installation.

Section 10(a)(4) and the *Geotechnical Engineering Report* (Appendix 10-A) includes additional information on the suitability and limitations of existing soils, depth to bedrock, and depth to groundwater with respect to construction of the Facility. According to the Report, the Facility Site is generally suitable for the proposed development.

(13) Bedrock Analyses and Maps

Figure 10-4 shows depth to bedrock and depth to the water table across the Facility Site relative to Facility components. Representations of bedrock and water table depth are derived from both public data (i.e., USDA NRCS SSURGO) and the Applicant's site-specific data (i.e., data from individual borings completed during the preliminary geotechnical investigation). It is important to note that the public data may represent mapped bedrock and water table depth different than the site-specific bedrock depth and water table depth measured during geotechnical investigations. This is primarily due to a general lack of comprehensive field verification of the public datasets. The *Geotechnical Engineering Report* (Appendix 10-A) includes maps, figures, and a more detailed discussion of subsurface conditions across the Facility Site. The Site Plan Drawings (Exhibit 5, Appendix 5-A) depict the typical foundation depths of the various Facility components.

The typical stratigraphy, as determined from field data, consists of approximately 6 inches of topsoil and organic materials underlain by a heterogeneous mixture of silty, clayey, and sandy soils underlain by Onondaga limestone. Bedrock was not encountered in any of the borings. Eight pile load test locations were also selected to further evaluate the bedrock and/or cobbles/boulder depths across the Facility Site. Across these eight locations, rock probe refusal depths ranged from approximately 4.5 to 10.8 feet. In areas of pile refusal, it may be necessary to predrill an undersized hole to a depth of about 6 inches below the pile embedment depth before backfilling the hole and driving the pile to the design embedment depth.

During trenching and excavation, proper methods for segregating stockpiled and spoil material will be implemented. Topsoil and subsoil spoils will be separated and placed in upland locations best suited to their storage, adjacent to the sites where they are excavated. Specific locations where cut and fill materials will be temporarily stockpiled have not yet been developed and are anticipated to be determined during final design. Final cut and fill storage areas will be available as part of the Construction Operations Plan and will be included in the pre-construction compliance filing plans, profiles, drawings, and SWPPP consistent with the requirements of 16 NYCRR Section 1100-10.2 (e)(2).

(b) Foundation Suitability Evaluation

Based on the *Geotechnical Engineering Report* (Appendix 10-A), the subsurface conditions encountered at the Facility Site are structurally suitable for support of foundations for the collection substation, POI substation, storage trailer, inverters, and PV arrays. Foundation construction occurs in several stages, which typically include installation of driven piles for the PV panels or excavation, pouring of concrete, removal of the forms for associated structures, followed by backfilling and compacting, and site restoration. Excavation and foundation construction will be conducted in a manner that will minimize the size and duration of excavated areas required to install foundations. In addition, foundations will be constructed and inspected in accordance with relevant portions of the New York State Building Code and in conformance with all pre-construction site-specific studies.

(1) Preliminary Engineering Assessment

Pile foundation construction will support the PV array mounts. PV Arrays will be installed with W-section steel beams (e.g., W6x9 or similar). Based on field explorations documented in the *Geotechnical Engineering Report*, pre-drilling is not anticipated to be required except at limited locations. Where driven piles encounter refusal above the required embedment depth, it may be appropriate to predrill an undersized hole at the pile location and then backfill the predrilled hole with cuttings, provided cobbles and boulders culled from the material, and then pile drive to the design embedment depth.

Soils within the Facility Site are considered to be susceptible to uplift due to frost; therefore, frozen soils may exert heaving force on the supports. If the anchorage of the piles and the deadweight of the structures are not enough to resist these forces, they can cause uplift. Therefore, piles will be structurally designed to resist the compression, uplift, and bending forces anticipated within the Facility Site. Driven piles will be designed to be long enough to counteract potential heave forces in the seasonal frost zone. Thawing soils typically have significantly less strength than frozen or fully thawed soils. Strong frost heaving is likely to be associated with expandable soils. Fine-grained soils were observed in multiple test borings; accordingly, as mentioned previously, soils found on-site should have moderate shrink/swell potential. As a result, specific construction procedures associated with potential expansive clays will be required for the Facility.

Pile depths typically range from 4.5 to 12 feet below the ground surface. However, the final design length of driven supports is not known at this time and will be primarily dependent on the embedment/lateral capacity required to resist live loading (e.g., the combination of wind and ice loads). Technical specifications will be prepared that require material and installation detail submittals, and proof of experience in driven support installation. See the *Geotechnical Engineering Report* (Appendix 10-A) for a full discussion of pile construction considerations.

Concrete footing and/or pad foundations will be constructed at the collection substation, POI substation, storage trailer, and inverter pads. Based on the *Geotechnical Engineering Report*, several foundation types can be utilized, the exact type to be determined by additional, site-specific subsurface evaluations. Based on the anticipated types of structures and the expected magnitude of loading, surface compaction using a moderate to heavy vibratory roller should provide adequate improvement for shallow foundation support of these structures.

As applicable, shallow mat foundations will include strip or spread footings that will be approximately 3 to 6 feet wide and buried at least 18 inches below the finish ground surface. Further, it is anticipated that there will be pole-mounted equipment inside the collection substation and POI substation, and large diameter drilled shafts for dead-end transmission line structures within the POI substation. These foundations will be constructed in several stages, and will include, as applicable, ground excavation, rebar and bolt cage assembly, outer form setting, casting, and finishing of the concrete, removal of the forms, backfilling, compacting, and site restoration.

Excavation and foundation construction will be conducted in a manner to minimize the size of the excavation area and duration of time required to install foundations. These foundations will be constructed and inspected in accordance with relevant portions of the New York State Building Code and in conformance with the *Geotechnical Engineering Report* (Appendix 10-A), and pre-construction site-specific studies.

(2) Pile Driving Assessment

Pile foundation types anticipated for the Facility are similar to foundations used for highway signs or guide rails and are insignificant compared to those used in typical sheet pile foundations. Accordingly, any potential impacts associated with installation are anticipated to be commensurately smaller.

An assessment of driven pile foundation alternatives is included in Appendix 10-A. Driven piles are considered feasible in all portions of the Facility Site; however, pre-drilling may be required in locations where dense glacial till, shallow refusal on bedrock, or cobble/boulders is encountered above the design pile embedment depth. Due to the electrical resistivity, pH, and sulfate concentration of the samples tested within the Facility Site, along with the potential for shallow or perched groundwater, corrosion potential of steel piles may be considered in the design of the solar array foundation system. Methods such as protective coatings, concrete encasement, cathodic protection, use of special steel alloys, and/or increased steel area may be considered to reduce the corrosion potential of steel piles.

Considering the number and type of PV arrays included in the current design, it is anticipated that approximately 30,000-50,000 piles will need to be driven during the construction of the Facility. These piles are anticipated to be approximately 15 to 20 feet in length. Assuming an 8-hour workday, driving these piles would take approximately 70-90 days. Pile driving may be performed using high-speed impact hammers, vibratory driver extractor, down-the-hole hammers, or auger drives, all of which have the potential to emit vibrations. The American Association of State Highway and Transportation Officials has set maximum recommended vibration limits, in units of inches per second for peak particle velocity

(PPV), to prevent damage to existing structures in the vicinity of pile driving or vibrational operations. The recommended limits near a residential structure are between 0.2 and 0.5 PPV (inches/second), and 0.1 PPV (inches/second) near historic sites or other critical locations.

According to an evaluation of vibration amplitude by pile impact drivers conducted in support of the *Geotechnical Engineering Report*, vibrational impacts due to pile driving during construction of the Facility are expected to be negligible.

No residential or historic structures exist within 200 feet of PV arrays or fence lines where pile driving operations could occur, and therefore the need for vibrational monitoring is not anticipated. The pile driving process will be performed under the direction of a geotechnical engineer. The load carrying capacity of the piles will vary when installed by different methods (e.g., driving vs pre-drilled, grout filled holes). Production pile testing will be performed on piles installed using each installation method to confirm their capability to carry the foundation loads. Actual pile lengths will be determined by full-scale pile load testing at the time of construction. The geotechnical engineer will document the pile installation process, including soil, rock, and groundwater conditions encountered; consistency with expected conditions; and details of the installed pile. The contractor will submit a pile driving plan and a pile hammer-cushion combination to the engineer for evaluation prior to pile installation. Each pile will be observed and checked for buckling, crimping and alignment and penetration resistance, depth of embedment, and general pile driving operations will be recorded by the geotechnical engineer.

(3) Mitigation Measures for Pile Driving Impacts

As discussed above, vibrations generated from high-speed impact hammers are relatively low and coupled with the limited timeframe of pile driving activities and implementation of Facility setbacks from neighboring properties, allowing for greater attenuation, there are no anticipated impacts to surrounding properties from vibrations associated with pile driving for the construction of the Facility. Therefore, no mitigation as a result of pile driving vibration impacts is anticipated.

The Applicant will develop a Complaint Management Plan as part of pre-construction compliance fillings to establish a process and procedures for the public to notify the Applicant if any issues arise during the construction, operation, or decommissioning of the proposed Facility. This plan includes methods to register vibration or noise complaints and the Applicant's commitment to responding to and resolving complaints. While not anticipated, should structural damages occur due to pile driving during Facility construction, the Applicant will work with the property owner to identify such damages and, if confirmed, negotiate compensation to address the damages.

(4) Vulnerability to Earthquake and Tsunami Events

As stated in Section 10(a)(8), the Facility is considered to have minimal vulnerability associated with seismic events based on a review of publicly available data. The USGS Earthquake Hazards Program does not list any young faults, or faults that have had displacement in the Holocene epoch within the vicinity of the Facility Site (USGS, 2018) and based on the 2014 New York State Hazard Map (USGS, 2014), the Facility Site is located in an area of relatively low seismic hazard.

The components of this Facility will be evaluated, designed, and constructed to resist the effects of earthquake motions in accordance with the American Society of Civil Engineers (ASCE) and section 1613 of the Building Code 2015 of New York State. The *Geotechnical Engineering Report* indicates that the Facility Site can be classified under the Seismic Site Classification of D, based on the soil properties observed at the Facility Site and as described on the exploration logs and results. The soils encountered during the subsurface explorations are not susceptible to liquefaction. The *Geotechnical Engineering Report* lists the applicable parameters for design based on the seismic site classification and in accordance with ASCE 7-10.

The Facility is located at an elevation of over 400 feet above mean sea level and is located over 200 miles from the nearest ocean; therefore, the Facility is not vulnerable to tsunami events.

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