1001.21 Exhibit 21: Geology, Seismology, and Soils

Deer River Wind Farm

Article 10 Certificate Application

Case No. 16-F-0267

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Acronyms and Abbreviations

ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
DRWF	Deer River Wind Farm
ERT	Electrical Resistivity Tomography
Facility	Consists of all generating facility components; ancillary features located within the Facility Site, including but not limited to an Operations & Maintenance building, meteorological towers, substation(s), and access roads; and interconnections.
Facility Area	The general area of interest identified by the Applicant and depicted on Figure 2-2 of the Application.
Facility Site	The parcels proposed to host the Facility components, which are identified in the Application.
HDD	Horizontal Directional Drilling
HDPE	high-density polyethylene
MASW	Multichannel Analyses of Surface Waves
NRCS	Natural Resource Conservation Service
NYSDAM	New York State Department of Agriculture and Markets
NYSDAM Guidelines	Guidelines for Agricultural Mitigation for Wind Power Projects
NYSDEC	New York State Department of Environmental Conservation
O&M	Operations and Maintenance
POI	Point of Interconnection

psf	pounds per square foot
RQD	Rock Quality Designation
SSURGO	NRCS Soil Survey Geographic digital data
STATSGO	NRCS State Soil Geographic digital data
SWPPP	Stormwater Pollution Prevention Plan
USDA	US Department of Agriculture
USGS	US Geological Survey

EXHIBIT 21 GEOLOGY, SEISMOLOGY, AND SOILS

(a) Existing Slopes Map

Figure 21-1 depicts the existing slopes (0-3%, 3-8%, 8-15%, 15-25%, 25-35%, and 35% and over) within the drainage area potentially influenced by the Facility including the interconnections. Information on existing slopes was derived using the US Geological Survey (USGS) digital elevation model. Based upon this data, slopes within the Facility Site range from 0% to over 135% with the steepest slopes associated with the electrical interconnection crossings of topographic ravines such as the ravine containing the Deer River. Slopes associated with other Facility components are less steep, ranging from 0% to 20%.

(b) Proposed Site Plan

Preliminary design drawing at 1" to 100' scale showing existing and proposed contours at 2-foot intervals for the Facility Site, including interconnection, are provided as part of Exhibit 11. Contours were created using aerial survey data collected for the Deer River Wind Farm (DRWF).

(c) Cut and Fill

Based on 2-foot contours derived using aerial surveyed data collected by the Applicant and the preliminary geotechnical investigations, an estimated 440,000 cubic yards of material will be excavated to construct the Facility. The total estimated volume of excavated material will include approximately 170,000 cubic yards of topsoil, 264,000 cubic yards of sub-soil, and 6,000 cubic yards of rock. Cut calculations were calculated using AutoCAD Civil 3D.

Approximately 305,000 cubic yards of fill is estimated to be needed to construct the Facility. Fill material will include approximately 57,000 cubic yards of aggregate base and 248,000 cubic yards of sub-soil. It is anticipated material excavated to construct the Facility will be used as fill, although aggregate material will need to be imported to the site. Cut and fill activities will be required to construct access roads to meet turbine supplier grade requirements and to allow safe movement of the assembly crane between turbine sites. In addition, several Facility turbine sites will require cut and fill to create an adequate work area for the assembly and erection of the turbines.

Exhibit 22 provides a description of how fill material, either site excavated (i.e., spoil) material or imported fill, will be assessed for the presence of invasive species to reduce the likelihood of spreading or introducing invasive species. To the extent practicable, excavated soil will be reused at the location where it is excavated to limit the potential spread of invasive species.

(d) Fill, Gravel, Asphalt, and Surface Treatment Material

As previously noted, approximately 305,000 cubic yards of fill is estimated to be needed to construct the Facility. Fill material will include approximately 57,000 cubic yards of aggregate base, which will be imported, and 248,000 cubic yards of sub-soil, which will come from the excavation needed to construct the Facility. It is anticipated material excavated to construct the Facility will be used as fill, although it is estimated that 38,471 cubic yards of aggregate material will need to be imported to the site. The imported aggregate base will be used principally to construct crane pads and access roads. Estimated amounts of aggregate material are based upon a 65 foot x 100 foot x 12 inch crane pad plus the length of 16 foot wide access road with a 12-inch depth required to reach each turbine.

(e) Type and Amount of Cut Materials or Spoil to be Removed from the Facility and Interconnection Sites

Cut materials and spoils excavated to construct the Facility will be used as fill material or in site restoration and will not be removed from the Facility Site.

(f) Excavation Techniques to be Employed

Prior to the start of construction activities, known locations of sensitive resources such as wetlands, streams, or archaeological sites will be marked in the field. In addition, the location of clearing limits, drainage features (e.g., culverts, ditches), wetland and stream crossings, and underground utilities will be marked in the field. Sediment and erosion controls will be installed in accordance with the preliminary stormwater pollution prevention plan (SWPPP) provided in Appendix 23-C.

Standard heavy construction equipment (e.g., excavators, loaders, scrapers, trucks, dozers) will be used during site preparation and excavation as deemed appropriate by the contractor. Generally, site preparation will begin with the clearing of woody vegetation. Woody vegetation will be chipped on site, offered to landowners, or properly disposed of offsite. No woody vegetation or other debris will be disposed of within wetlands, streams, or floodways. In addition, to reduce the potential spread of invasive insect pests and plant disease, offsite disposal of woody vegetation will be limited to a 50-mile radius of the Facility Site. Following removal of woody vegetation, the site will be grubbed, and stumps will be removed as needed. Stumps will be disposed of in the same manner as woody debris. Topsoil will be stripped, stockpiled, and segregated from subsoil. Topsoil will be used for site restoration.

Depending upon the Facility component being constructed, the site may be graded, and the subsoil compacted and then covered with gravel and/or geotextile fabric such as for the construction laydown area and access roads. To construct turbine foundations, after the topsoil is removed, excavators will be used to excavate the foundation hole. As appropriate, subsoil and rock will be segregated and reused as backfill.

To construct the underground electrical collection system, it is anticipated that direct burial methods using standard industry equipment such as a cable plow, rock saw, rock wheel and/or trencher will be used whenever possible. With direct burial, the bundled cable is installed directly into a narrow cut or “rip” in the ground. This narrow cut will be approximately 24 inches wide and a minimum depth of 48 inches deep in active agriculture and pasture lands and 42 inches deep elsewhere. Where direct burial is not possible, an open trench will be excavated. With an open trench, topsoil and subsoil will be excavated, segregated, and stockpiled adjacent to the trench. Following cable installation, the trench will be backfilled with the excavated material and returned to pre-construction grades. Surplus excavated material will be spread out or properly disposed of. To help minimize and/or mitigate impacts to active agricultural land and farming operation, the Applicant generally will comply with the New York State Department of Agriculture and Markets (NYSDAM) Guidelines for Agricultural Mitigation for Wind Power Projects (NYSDAM Guidelines; NYSDAM 2018), as set forth in Exhibit 4(b) of this Application.

Road crossings at paved roads will be accomplished by directional boring (e.g., jack and bore; auger bore) and then a high-density polyethylene (HDPE) bore casing will be installed through the bore pit and cables will run through the bore casing. At unpaved roads, the cables may be direct buried using trenching or excavating. In areas where the medium voltage cable is to pass under roads or areas subject to heavy vehicle loads, the cable will be placed in steel casing or a larger diameter HDPE casing will be used. Directional boring may be employed to minimize the impact in certain sensitive areas like wetlands or under existing utilities, road and railroad crossings, congested areas, areas subject to heavy loads or when trenching and excavating are not practical.

(g) Temporary Cut and Fill Storage Areas

As described above in Section (f), excavated material will be properly segregated, and to the extent practicable, will be reused as backfill or for site restoration. Stockpiles will not be placed in sensitive areas such as wetlands and will be properly stabilized according to the preliminary SWPPP provided in Appendix 23-C. The location of cut and fill storage areas will be determined following Certification and will be included in the final construction drawings.

(h) Suitability for Construction – Preliminary Geotechnical Investigation

Mott MacDonald conducted the preliminary geotechnical investigation for the Facility, and the preliminary geotechnical investigation report is provided in Appendix 21-A. The preliminary geotechnical investigation included a desktop review of publicly available information and site investigations with associated laboratory analyses. The site investigations included geophysical investigations (Electrical Resistivity Tomography [ERT] testing and Multichannel Analyses of Surface Waves [MASW]), soil borings, and rock corings. ERT testing was conducted at the proposed substation and select turbine locations to determine the natural ground formation's conductivity. Electrical resistivity and conductance are important for design of grounding systems at substations, as well as evaluation of cabling requirements. ERT also was conducted at turbine locations to determine consistency across the Facility Site; to identify if limiting strata, such as shallow rock, existed; and to provide an in-situ moisture content of site soils at each test location. MASW testing was conducted to determine shear wave velocity to estimate rock rippability and seismic site class. Soil boring and rock corings were conducted to characterize subsurface conditions. In general, Mott MacDonald selected well-spaced boring locations to generate a generalized profile of the underlying area. Boring locations were selected based upon accessibility and proximity to the Facility extents. Soil samples were shipped to Geotherm USA of Livermore, California, and tested for thermal properties. In addition, representative soil samples were submitted to Craig Testing Laboratories, Inc. for testing of material index properties in accordance with applicable American Society for Testing and Materials (ASTM) standards. Results of test borings are provided as part of the preliminary geotechnical investigation report in Appendix 21-A.

Nine geophysical tests were conducted: 5 ERT tests and 4 MASW tests. ERT testing sites included the Point of Interconnection (POI) switchyard, collector substation (proposed and alternate locations), and 2 turbine locations. MASW test sites included 4 turbine locations. Soil borings were conducted at the POI switchyard, collector substation, Operation and Maintenance (O&M) building, and 4 turbine locations. The rock corings were conducted at all but one of the soil boring sites. The analysis also included a literature review and a review of publicly available data regarding surface and subsurface soil, bedrock and groundwater conditions at the Facility Site.

Based upon the results of the preliminary geotechnical investigation, Mott MacDonald concluded in its professional opinion that the subsurface conditions are suitable for the planned construction of the DRWF. According to Mott MacDonald, the stiff soils observed will provide adequate support for the proposed structures with minimal concern of undergoing excessive or differential deflection (both laterally and axially). Areas investigated indicated that shallow bedrock, where present, is likely rippable and will not require blasting. Prior to construction, a more detailed geotechnical investigation will be performed to confirm subsurface conditions at each turbine location and, as necessary, at other Facility component locations. These additional investigations will refine the design concepts but do not affect the suitability of the site to support the Facility.

(i) Preliminary Blasting Plan

Based upon the preliminary geotechnical investigation, where shallow bedrock was encountered, shear wave velocity measurements indicate that the rock is generally rippable using conventional rock removal techniques such as pneumatic hammer or line drill-and-rip methods. Therefore, blasting for construction of turbine foundations or other Facility components is not expected to be needed and a Preliminary Blasting Plan is not included as part of this Article 10 Application.

(j) Potential Blasting Impacts and Proximity to Natural Gas Wells

Blasting for construction of turbine foundations or other Facility components is not expected to be needed. Therefore, potential blasting impacts will not be discussed as part of this Article 10 Application.

(k) Mitigation Measures for Blasting Impacts

Blasting for construction of turbine foundations or other Facility components is not expected to be needed. Therefore, mitigation measures for blasting impacts will not be discussed as part of this Article 10 Application.

(I) Regional Geology, Tectonic Setting, and Seismology, including Karst Features

The Facility Site is located in the Northeastern Highlands ecoregion (Bryce et al. 2010). This ecoregion covers most of the mountainous portions of New England and New York. It is characterized by hills and mountains, extensive forest cover, and nutrient-poor frigid and cryic soils (mostly Spodosols). The Facility Site occurs in the sub-ecoregion referred to as the Tug Hill Plateau (Bryce et al. 2010). The parent materials that formed most of the soils in Lewis County were deposited by glaciers except for the area at the base of the Tug Hill Plateau, which includes more recent alluvial deposits (riverine deposits) (US Department of Agriculture [USDA] 1960). In the portion of Lewis County west of the Black River, including the Facility Site, the bedrock consists of Ordovician sediments. These sediments are made up of a series of limestone, black shale, gray shale and sandstone beds. The landscape surrounding the Facility Site is underlain by Lorraine, sandstones and shales. Bedrock of the Lorraine group is hundreds of feet thick. The Pulaski formation represents the upper portion of the Lorraine group (USDA 1960). This formation consists of gray, acid shale and thick-bedded, slightly calcareous sandstone. The lower portion of the Lorraine group is the Whetstone Gulf formation, which is gray, acid shale and thin-bedded sandstone (USDA 1960).

Surficial geology underlying the Facility Site is mapped primarily as till with smaller areas of exposed bedrock, ablation moraine, swamp deposits, recent alluvium, and till moraine (Cadwell and Pair 1991) Based upon subsurface investigations completed as part of the preliminary geotechnical investigation, the generalized subsurface profile of the Facility Site, in order of increasing depth below grade, consists of: approximately 6 inches of topsoil; an average of 6.5 feet of stiff to hard silt; an average of 3.5 feet of clay containing significant amounts of silt; an average of 1 foot of silty sand; and an average of 5.5 feet of silty gravel over slightly weathered shale bedrock (Appendix 21-A).

Based on information presented in the Lewis County Multi-Jurisdictional Natural Hazard Mitigation Plan (URS 2010), between 1737 and 2005 there were three earthquakes near Lewis County characterized as “significant seismic events”. The first earthquake, which was recorded in 1853, had an Intensity of VI and damage was described as “machinery knocked over”. The other two earthquakes were of magnitude 4.7 and magnitude 5.1. The 5.1 magnitude earthquake resulted in some minor structural damage to buildings. In addition to these three events, there have been several other minor earthquakes recorded in the Lewis County area (URS 2010).

Soil type can influence the severity of an earthquake. In general, soft soils like fill and sand are more likely to amplify ground motion during an earthquake. The soil types in much of Pinckney and Harrisburg are characterized as rock (i.e., Soil Type B) with smaller areas of softer soil types such as very dense soil/soft rock (URS 2010). Earthquake spectral acceleration takes into account soil type and is a better indicator of potential building damage. In Pinckney, only about 3% of the total area has a spectral acceleration with a 2% probability of exceedance over 50 years. Similarly, only 4% of the total area in Harrisburg has a spectral acceleration with a 2% probability of exceedance over 50 years. This characterization was confirmed during the preliminary geotechnical investigation conducted for the DRWF. Based upon field-obtained shear wave velocity measures, the average recorded shear wave velocity was 3,900 feet per second, which is within the criteria for rock (i.e., Site Class B) (Appendix 21-A). According to information presented in the Lewis County Multi-Jurisdictional Natural Hazard Mitigation Plan, there is a 10% chance over 50 years that Lewis County would be the epicenter of an earthquake with a magnitude of 4.0-4.9 (URS 2010). This magnitude earthquake would produce light to moderate perceptible shaking (Peak Ground Acceleration 3% to 5%) and potential damage would range from none to very light. Earthquakes causing greater damage have a less than 10% chance of occurring in Lewis County over a 50-year period (URS 2010). The New York State 2014 Seismic Hazard Map (USGS 2014) shows a similar likelihood for an earthquake of this intensity near the Facility. According to this map, the 2% probability of exceedance in 50 years of Peak Ground Acceleration for this area is 8–10% of standard gravity.

The potential presence of karst topography can be a concern with ground disturbance because these systems are very vulnerable to groundwater pollution. Karst is a distinctive topography that develops in rock capable of being dissolved by surface water or groundwater. This landform is often associated with carbonate rocks (limestone and dolomite) although it can occur in the presence of other highly soluble rocks such as evaporates (gypsum and rock salt) (USGS 2017). Karst systems have relatively rapid rates of water flow and lack a natural filtration system, which makes them particularly susceptible to groundwater pollution. As discussed in the preliminary geotechnical investigation report (Appendix 21-A), ground subsidence (i.e., sinkholes) is a potential geologic hazard associated with karst terrain or where underground mining has occurred. In their review of available data, Mott MacDonald found no evidence of karst formations in the Facility Area. In addition, geophysical surveys conducted as part of the preliminary geotechnical investigation found no indication of sinkholes, ground subsidence, or related karst features.

(m) Facility Impacts on Regional Geology

Construction of the Facility is expected to have limited impacts to local geology related to cut and fill activities. However, it is not expected that the Facility will impact regional geology.

As noted in (l) above, directional boring (e.g., jack and bore; auger bore), trenching, or excavating will be used to install underground electrical cable where it passes under roads or in areas subject to heavy vehicle loads. Directional boring (e.g., jack and bore; auger bore) may be employed to minimize the impact in certain sensitive areas like wetlands or under existing utilities, road and railroad crossings, congested areas, areas subject to heavy loads or when trenching and excavating are not practical.

The Applicant does not currently plan to use horizontal directional drilling (HDD) as a construction technique due to limited land control, practicality, and physical land constraints, unless other construction techniques are proven ineffective. Therefore, no Inadvertent Return (Frac-out) Plan or scaled drawings showing typical HDD equipment staging layout and design are included in this Application.

(n) Impacts of Seismic Activity on Facility Operation

The St. Lawrence Rift System runs parallel to the St. Lawrence River for approximately 620 miles. These faults were most active during the Late Proterozoic-Early Paleozoic periods. Earthquakes that have occurred in the Lewis County area between 1627 and 2003 were clustered around this rift zone (URS 2010. As noted in Section (l) above, damage from earthquakes in the area of Lewis County has been limited with minor or less structural damage. The USGS Earthquakes Hazards Program has not identified young faults in the vicinity of the Facility Site. It is not expected that seismic activity will impact operation of the Facility.

(o) Soil Types Map

Figure 21-2 depicts the soil types near the Facility Site based upon the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) and State Soil Geographic (STATSGO) digital soil survey data. This includes the location of Prime Farmland, Prime Farmland if Drained, and Farmland of Statewide Importance. On October 23, 2018, the Applicant's consultant sent an email to the local USDA Service Center requesting information on Unique Farmland or Farmland of Local Importance associated with the Facility Site but received no response. Table 21-1 provides a list of NRCS soil map units underlying the Facility Site. The dominant soil types are Camroden silt loams, Pinckney silt loams, Marcy silt loams, and Alden silt loam. Table 21-2 provides a summary of anticipated impact to each soil map unit, addressing both temporary and permanent impacts.

No publicly available information on the presence of drainage tiles within the Facility Site was identified. Based upon observable ground conditions, the Applicant's consultant noted no apparent evidence of drainage tiles on the Facility Site.

Table 21-1. Soil map units within the Facility.

Soil Unit	Percent Slope	Drainage Class	Area within Facility (acres)	Percent of Area within Facility
Camroden silt loam	3 to 8 percent slopes	Somewhat poorly drained	132	33
Pinckney silt loam	3 to 8 percent slopes	Well drained	72	18
Marcy silt loam	0 to 3 percent slopes	Poorly drained	35	9
Pinckney silt loam	8 to 15 percent slopes	Well drained	28	7
Marcy silt loam	3 to 8 percent slopes	Poorly drained	22	5
Alden silt loam	0 to 3 percent slopes	Very poorly drained	20	5
Darien silt loam	3 to 8 percent slopes	Somewhat poorly drained	15	4

Soil Unit	Percent Slope	Drainage Class	Area within Facility (acres)	Percent of Area within Facility
Camroden silt loam	8 to 15 percent slopes	Somewhat poorly drained	13	3
Pinckney silt loam	15 to 35 percent slopes	Well drained	11	3
Plainfield fine sandy loam	8 to 15 percent slopes	Excessively drained	8	2
Fluvaquents-Udifluvents complex, frequently flooded	—	Poorly drained	6	1
Camroden silt loam	0 to 3 percent slopes	Somewhat poorly drained	5	1
Bice-Pinckney complex	—	—	4	1
Angola silt loam	0 to 3 percent slopes	Somewhat poorly drained	3	1
Darien silt loam	8 to 15 percent slopes	Somewhat poorly drained	3	1
Rock outcrop	45 to 70 percent slopes	—	3	1
Pinckney silt loam	15 to 25 percent slopes	Well drained	3	1
Ilion silt loam	3 to 8 percent slopes	Poorly drained	2	1
Teel silt loam	—	—	2	1
Danley silt loam	8 to 15 percent slopes	—	2	1
Fonda silt loam	0 to 3 percent slopes	Very poorly drained	2	1
Danley silt loam	3 to 8 percent slopes	—	2	1
Herkimer silt loam	8 to 15 percent slopes	Well drained	2	<1
Raynham silt loam	0 to 6 percent slopes	Poorly drained	1	<1
Manlius channery silt loam	8 to 15 percent slopes	—	1	<1
Kars gravelly loam	8 to 15 percent slopes	Somewhat excessively drained	1	<1
Blasdell channery silt loam	8 to 15 percent slopes	Well drained	1	<1
Lansing silt loam	3 to 8 percent slopes	Well drained	1	<1

Soil Unit	Percent Slope	Drainage Class	Area within Facility (acres)	Percent of Area within Facility
Lansing silt loam	8 to 15 percent slopes	Well drained	1	<1
Bice fine sandy loam	8 to 15 percent slopes	Well drained	1	<1
Water	—	—	<1	<1
Colton cobbly loamy fine sand	8 to 15 percent slopes	Excessively drained	<1	<1
Ilion silt loam	0 to 3 percent slopes	Poorly drained	<1	<1
Peat and Muck, deep	—	Very poorly drained	<1	<1
Allis silt loam	0 to 3 percent slopes	Poorly drained	<1	<1

Table 21-2. Anticipated impacts to soils.

Soil Unit	Temporary (acres)	Permanent (acres)	Total (acres)
Camroden silt loam, 3 to 8 percent slopes	83	49	132
Pinckney silt loam, 3 to 8 percent slopes	43	29	72
Marcy silt loam, 0 to 3 percent slopes	22	13	35
Pinckney silt loam, 8 to 15 percent slopes	18	9	28
Alden silt loam, 0 to 3 percent slopes	16	4	20
Marcy silt loam, 3 to 8 percent slopes	15	7	22
Darien silt loam, 3 to 8 percent slopes	9	6	15
Camroden silt loam, 8 to 15 percent slopes	8	5	13
Fluvaquents-Udifluvents complex, frequently flooded	5	1	6
Pinckney silt loam, 15 to 35 percent slopes, eroded	5	6	11
Camroden silt loam, 0 to 3 percent slopes	5	0	5
Bice-Pinckney complex, rolling	4	0	4
Plainfield fine sandy loam, 8 to 15 percent slopes	4	4	8
Angola silt loam, 0 to 3 percent slopes	3	0	3
Darien silt loam, 8 to 15 percent slopes	3	0	3
Rock outcrop, 45 to 70 percent slopes	3	0	3
Pinckney silt loam, 15 to 25 percent slopes	3	0	3
Danley silt loam, 8 to 15 percent slopes	2	0	2
Danley silt loam, 3 to 8 percent slopes	2	0	2
Ilion silt loam, 3 to 8 percent slopes	2	0	2

Soil Unit	Temporary (acres)	Permanent (acres)	Total (acres)
Fonda silt loam, 0 to 3 percent slopes	2	0	2
Raynham silt loam, 0 to 6 percent slopes	1	0	1
Manlius channery silt loam, 8 to 15 percent slopes	1	0	1
Kars gravelly loam, 8 to 15 percent slopes	1	0	1
Blasdell channery silt loam, 8 to 15 percent slopes	1	0	1
Herkimer silt loam, 8 to 15 percent slopes	1	1	2
Lansing silt loam, 3 to 8 percent slopes	1	0	1
Lansing silt loam, 8 to 15 percent slopes	1	0	1
Water	0	0	0
Colton cobbly loamy fine sand, 8 to 15 percent slopes	0	0	0
Ilion silt loam, 0 to 3 percent slopes	0	0	0
Total	265	136	402

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

The preliminary geotechnical investigation report provides a general discussion of the suitability and limitations of existing soils for the proposed site development including excavation stability, erosion hazard, corrosion potential, percentage of organic matter, and foundation integrity (Appendix 21-A). The preliminary geotechnical investigation report also provides some recommended Best Management Practices (BMPs) to help minimize potential risks/hazards.

As noted in the preliminary geotechnical investigation report, NRCS soil data was developed to be used for agricultural planning. Therefore, this data was reviewed primarily in the context of soil erosion, reuse, and chemical characteristics. The dominant soil types mapped within the Facility Site (Camroden, Pinckney, Marcy, and Alden silt loams) are characterized as poorly drained channery silt loams, which are have erodibility ratings that range from slight to moderate. Based on observations made during the preliminary geotechnical investigation, many of the proposed turbine locations and other Facility component locations are well-vegetated and flat to mildly-sloped, minimizing the concern for appreciable erosion. In addition, the stiff or hard nature of the soils will limit the erodibility of the native materials with proper housekeeping and erosion and sediment controls.

As noted in the preliminary geotechnical investigation report, soils within the Facility Site are generally products of past glacial deposition including till and alluvium. Therefore, it is expected that the organic content of natural soils will be negligible. It is expected that a thin layer of topsoil with some organics will exist near the surface in vegetated areas. However, this layer was less than 6 inches at investigated locations. During construction, this surficial top soil will be stripped and appropriately staged on-site for likely reuse in areas to be revegetated.

Some native soil units within the Facility Site are mapped by NRCS as having a moderate to high risk rating for the corrosion of steel or concrete. Soil corrosivity potential can be easily managed during design by the selection of appropriate construction materials. For example, turbine, substation, and site locations with concrete construction in direct contact with corrosive soils would be designed with standard, Type II or Type V concrete type or admixture suitable to withstand such soil conditions. Similarly, locations including steel construction in direct contact with corrosive soils should be designed to include protective coatings, casings, or slightly increased thickness of sacrificial steel, as necessary. As typical with wind farm developments, additional detailed design geotechnical investigations will be conducted at each turbine location. At that time, soil sampling can be conducted to determine plot-specific considerations.

It is not expected that significant dewatering activities will be required to construct the Facility. Following precipitation events, it is anticipated that the contractor will use small portable pumps (e.g. trash pumps) to remove stormwater during foundation excavation and construction. These small pumps also will be used if a seasonal highwater table is encountered during construction of turbine foundations. To reduce sediment in the pump discharge water, a sediment removal system (i.e., dirtbag), will be used in conjunction with the portable pumps. Water from these pumps will not be discharged directly to a wetland or stream but will be managed consistent with the SWPPP (Appendix 23-C). It is not anticipated that dewatering wells will be need during Facility construction. Dewatering is further discussed in Exhibit 23(c).

(q) Bedrock Analyses and Maps

In the portion of Lewis County west of the Black River, including the Facility Site, the bedrock consists of Ordovician sediments. These sediments are made up of a series of limestone, black shale, gray shale and sandstone beds. The landscape surrounding the Facility Site is underlain by Lorraine, sandstones and shales. Bedrock of the Lorraine group is hundreds of feet thick. The Pulaski formation represents the upper portion of the Lorraine group (USDA 1960). This formation consists of gray, acid shale and thick-bedded, slightly calcareous sandstone. The lower portion of the Lorraine group is the Whetstone Gulf formation, which is gray, acid shale and thin-bedded sandstone (USDA 1960). Figure 21-3 provides a map of bedrock types underlying the Facility based upon data available from the New York State Museum (2018).

From the preliminary geotechnical investigation, shale was encountered in all rock core runs and was identified as the primary bedrock material throughout the Facility Site. The shale rock obtained was generally classified as slightly weathered, medium strong to strong material with average recovery and Rock Quality Designation (RQD) values around 80 and 20 percent, respectively, which is indicative of “very poor” rock. Calcareous siltstone was observed at one of the rock coring locations. During these subsurface investigations, bedrock was encountered between 6 and 24 feet below grade. The preliminary geotechnical investigation report is provided in Appendix 21-A.

Based upon a review of the New York State Department of Environmental Conservation (NYSDEC) Interactive Water Well database for wells within 2 miles of the Facility, groundwater depths range from 5 to 28 feet below grade (NYSDEC 2018). Based upon data available through the NRCS SSURGO, groundwater depth around the Facility Site ranges from 0 to 11 feet below ground surface.

(r) Foundation Evaluation

(1) Preliminary Engineering Assessment

Based upon the preliminary geotechnical investigation, it is anticipated that octagonal shallow mat foundations will be used for turbines, although some foundations may require anchoring into bedrock where bedrock is shallow. Continuous strip footings or spot footings are anticipated for ancillary support buildings and structures. Bottom of foundations should extend to at least below frost depth (approximately 4.5 feet below proposed final grades). Based upon the preliminary investigations, foundations placed on native, undisturbed overburden soils will have an allowable bearing capacity of 2,000 pounds per square foot (psf) in accordance with Table 1804.2 of the Building Code of New York State (2010 edition). Native silt or clay overburden are typically moisture-sensitive and can soften if exposed to run-off or precipitation. Therefore, proper housekeeping and erosion control measures will be implemented to minimize the potential for disturbance of native soils if foundations are placed on native silt or clay. Foundations placed on intact shale rock (RQD > 50%) will have an allowable bearing capacity of up to 4,000 psf based on Building Code of New York State (2010 edition) Table 1804.2.

(2) Pile Driving Assessment

Based upon the preliminary geotechnical investigation, it is not anticipated that pile driving will be required to construct the Facility.

(3) Mitigation Measures for Pile Driving Impacts

Based upon the preliminary geotechnical investigation, it is not anticipated that pile driving will be required to construct the Facility.

(s) Vulnerability to Earthquake and Tsunami Events

Based upon a review of publicly available data and results from the DRWF preliminary geotechnical investigation, the Facility appears to have minimal vulnerability associated with seismic events. However, components of this Facility will be evaluated and designed to resist the effects of earthquake motions in accordance with the American Society of Civil Engineers (ASCE) 7, Minimum Design Loads for Buildings and Other Structures. The seismic design category for Facility structures will be determined in accordance with Section 1613 of the New York State Building Code (Earthquake Loads) or ASCE 7. In addition, because the nearest large body of water, Lake Ontario, is located approximately 14 miles from the Facility Site, there is no vulnerability associated with tsunami events.

REFERENCES

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