GEOTECHNICAL PRELIMINARY STUDY

FOR

ALABAMA WIND FARM, GENESEE COUNTY, NEW YORK

Prepared for:

ALABAMA LEDGE WIND FARM, LLC

DECEMBER 2006
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1.0 EXECUTIVE SUMMARY

There are a number of different geotechnical conditions present within the project site that will affect the design and construction of the proposed access roads, interconnects, and wind turbine generators. The depth of soil varies on either side of an escarpment which crosses the project from east to west. Rock is generally shallow (0-15 feet) to the south of the escarpment and deeper (20-50 feet) to the north of the escarpment. The rock consists of limestone and dolomite which should provide good foundation bearing, but may pose some difficulty for excavations where it is shallow.

While the soils are all predominantly of glacial origin, they vary from dense glacial tills to soft lacustrine clays. In most areas, the soils should be suitable for support of conventional spread footing foundations for the proposed wind turbines. In some areas, lacustrine clays comprised of soft or compressible soils may be present and it will be necessary to evaluate these in greater detail at specific sites to assess the impacts to the foundations and roadways. The mapping indicates that 6 of the proposed wind turbines may be in these lacustrine clay areas (numbers 40, 41, 42, 48, 49 and 50). Some of the till moraine soils may be less dense and will require evaluation of potential settlement.

Most of the soils have a fine grained component that may be less than ideal for roadway subgrades and might require stabilization or reinforcement of roadways for proper performance. Boulders are common in the glacial till and should be expected to cause obstructions to trenching and other confined excavations.

Mineral extraction also is a factor; including a surface limestone quarry and subsurface gypsum mine. U.S. Gypsum's Oakfield Mine is an underground mine that crosses the site from east to west paralleling the Onondaga Escarpment. The mine is no longer active, but U.S. Gypsum continues to pump water from the mine. The limits of the deep mining have been mapped, but the mapping was based on tracings and not actual survey of the mine workings. The extent of mining may vary from the limits depicted on the maps. There has been a history of sinkholes forming over the mine at isolated locations and along the northern perimeter of the mine. It is recommended that wind turbines be setback at least 100 feet from the mapped limits and that deep borings be conducted into the bedrock to verify sound rock and the absence of mining for any site within 250 feet of the mapped mine limits.

Buffalo Crushed Stone operates a quarry in the southern area of the project site. The quarry is actively mining limestone to make crushed stone. The quarry is expected to expand to the north, west, and south of its present limits and to be deepened to mine rock below the existing floor level. Perimeter rock walls are roughly 30 feet high at present. The overburden soils at the quarry perimeter slope into the quarry at their angle of repose. Wind turbines sited in the vicinity of the quarry may be subjected to blast vibrations and potential stability issues as quarry operations continue. It is recommended that the proposed wind turbine numbers 35 and 41 be set back at least 100 feet and that site specific stability evaluations be performed to asses the long term impacts of existing and proposed future mining on the wind turbine foundations.

The detailed findings of this study are included in the body of the report. The report also contains recommendations for the detailed geotechnical investigations.

2.0 INTRODUCTION

- Alabama Ledge Wind Farm, LLC (the "Applicant") contracted Tetra Tech EC, Inc. (TtEC) to prepare a Geotech desktop analysis of the Alabama Wind Farm Project (the "Project"), which is proposed for development in Genesee County, New York.

The proposed Project is located in western New York between the cities of Buffalo and Rochester in Genesee County. The extent of the Project will reside in the Town of Alabama approximately seven miles northwest of the city of Batavia. All of the turbines are proposed to be constructed in the town of Alabama.

The Applicant is proposing to develop a wind-powered electric generating facility of up to 52 turbines each generating a capacity of 1.65 – 2.0 megawatts (MW), interconnected by underground transmission lines, with permeable surface service roads approximately 40 feet wide constructed to provide access to the wind turbines during Project operation. To allow crane access during Project construction, roads will be built with a maximum soil disturbance width of 48 feet.

3.0 DATA SOURCE

To prepare this report TtEC, contacted the following offices:

- New York State Department of Environment and Conservation (NYSDEC)
274 E. Avon-Lima Rd., Avon, NY 14414
Phone: (585) 226-2466.

- Buffalo Crushed Stone Inc.
Mr. Joe Lorezo (Vice President), Buffalo Crushed Stone, Inc. Subsidiary of New Enterprise Stone & lime Co., Inc. 2544 Clinton Street, P.O. Box 710, Buffalo, NY-14224.
Phone: (716) 826-7310 Fax: (716) 826-1342.

- United States Gypsum Co.Mr. Ray Tamblin, (Plant Engineer),
United States Gypsum Company,
P.O. Box 139, 2844 Judge Road, Oakfield, NY -14125.
Phone: (716) 948-5221 Fax (716) 948-5018.

The following Documents were obtained from the above mentioned offices:

- Oakfield Mine Closure Plan, Golder Associates Inc. 1998.

1. Section 1.0 to 5.0
2. Appendix B, Figure B-2 to 15, 19, 20 and 21.
3. Appendix D, Figure D-2 to 11, 19 and 20.
4. Figure E-3

- Buffalo Crushed Stone, Inc. Alabama Quarry. Original Static Module for New York State Department of transportation, March 4, 2002.

- Buffalo Crushed Stone, Inc. Alabama, NY. Quarry. Mined Land –Use Plan, June 30, 2006.

- Lancaster Stone Products Corporation. Alabama Quarry, Mined Land –Use Plan, For New York State Department of Environmental Conservation, Dec 28, 1978.

This Geotech Desktop Study is prepared based on the literature sited in the above-mentioned references along with the other references mentioned at the end of this report.

4.0 SOILS

The ***Soil Survey of Genesee County***, New York (Wulforst, 1969) indicates that the proposed area consists of ten predominant soil series. An illustration of soils identified within the project area is presented in Figure 1. The soil series designations listed in the legend of Figure 1 include a two-letter code, which designates the soils series followed by a third letter indicating the degree of slope and occasionally by a number indicating erosion.

The primary soil types described in (Wulforst, 1969) are summarized as follows:

Arkport Series
Soils of the Arkport series consist of very deep, well drained soils formed in glacio-fluvial deposits having a high content of fine and very fine sand. These soils have thin horizontal bands of loamy material in the subsoil. Bedrock is at a depth of 4 to 80 ft. Permeability is moderately rapid through the soil. Slope ranges from 0 to 60 percent. The potential for surface runoff is low to high. The primary soils mapped within the areas of the proposed wind turbines include ArB and ArC (see Figure 1) and have slopes of 1% to 6% and 6% to 12%, respectively.

Benson Series
The Benson series consists of shallow to limestone or calcareous shale, somewhat excessively and excessively drained soils on glaciated uplands. These are formed in loamy till. Bedrock is at a depth of 1 to 1.5 ft. Permeability is moderate throughout the soil. Slope ranges from 0 to 70 percent. Most areas are wooded. Common trees are sugar maple, beech, yellow birch, basswood, red oak, hickory, white ash, white pine, northern white cedar, red cedar, and hemlock. The primary soils mapped within the areas of the proposed wind turbines include BeB and BeD (see Figure 1) and have slopes of 0% to 8% and 8% to 25%, respectively.

Canandaigua Series

The Canandaigua series consists of very deep, poorly and very poorly drained soils formed in silty glacio-lacustrine sediments. Canandaigua soils are nearly level soils mainly on glacial lake plains, but are also in depressional areas of glaciated uplands where water-sorted sediments have accumulated to a depth of more than 40 inches. Bedrock is at a depth of 8 to 30 ft. Slope is mainly less than 1 percent, but ranges up to 3 percent. The primary soils mapped within the areas of the proposed wind turbines include CaA, and CdA (see Figure 1) and have slopes of 0% to 2%, 0% to 2%and 0% to 3%, respectively.

Cazenovia Series
Cazenovia soils are very deep and deep, moderately well drained soils formed in loamy till (variable texture, usually poorly sorted sand rich diamict, deposition beneath glacier ice). They are nearly level to very steep soils on till plains. Saturated hydraulic conductivity is moderately high-to-high in the surface layer and subsoil and moderately low to moderately high in the substratum. The till contains limestone with an admixture of reddish lake-laid clays or reddish clay shale. Bedrock is at a depth of 3.5 to 25 ft. The potential for surface runoff is low to very high. Most areas have been cleared and are used for hay, pasture, corn and small grains. The primary soils mapped within the areas of the proposed wind turbines include CeB, CeC, CeA and CgC3 (see Figure 1) and have slopes of 3% to 8%, 8% to 15%and 8% to 15% respectively.

Collamer Series
The Collamer series consists of very deep, moderately well drained soils formed in silty glacio-lacustrine sediments. They are on lake plains and till plains that have a thick mantle of lake sediments. Bedrock is at a depth of 5 to 40 ft. The potential for surface runoff is low to very high. Saturated hydraulic conductivity is moderately high or high in the mineral surface layer and upper part of the subsoil, and moderately slow to high in the lower part of the subsoil and substratum (any layer lying beneath the true soil or Solum). The primary soils mapped within the areas of the proposed wind turbines include ClB (see Figure 1) and have slopes of 2% to 6% respectively.

Hilton Series
The Hilton series consists of very deep, moderately well drained soils formed in till of Wisconsin age, derived from sandstone and limestone. They are nearly level to sloping soils on till plains and glaciated dissected plateaus. Bedrock is at a depth of 4 to 25 ft. Permeability is moderate in the solum (the upper part of the soil profile, above the parent material) and slow or very slow in the substratum. Nearly level to undulating area of till plains. Slope gradients are mainly 1 to 8 percent, but range from 0 to 15 percent. The regolith (a layer of loose, heterogeneous material covering solid rock) is fine sandy loam to loam calcareous till of Wisconsin age, derived principally from sandstone and limestone. The potential for surface runoff is low to high. Permeability is moderate in the solum and slow or very slow in the substratum. The primary soils mapped within the areas of the proposed wind turbines include HlA and HlB (see Figure 1) and have slopes of 0% to 3% and 3% to 15% respectively.

Lima Series
The Lima series consists of very deep, moderately well drained soils on till plains. They are nearly level to moderately steep soils formed in till that is strongly influenced by limestone and calcareous shale. The till may be dense. Bedrock is at a depth of 3 to 10 ft. Permeability is

moderate within the solum, but is slow or very slow in the underlying substratum. Dominantly nearly level to moderately steep parts of till plains. Calcium carbonate equivalent is mainly between 15 and 45 percent of the fine earth fraction in the substratum. The potential for surface runoff is medium. Permeability is moderate within the solum, but is slow or very slow in the underlying substratum. The primary soils mapped within the areas of the proposed wind turbines include LmA and LmB (see Figure 1) and have slopes of 0% to 3% and 3% to 8% respectively.

Odessa Series

The Odessa series consists of very deep, somewhat poorly drained soils formed in clayey lacustrine deposits. These soils are in moderately low areas on lake plains. Odessa soils formed in fine textured lacustrine deposits of pro-glacial and post-glacial lakes. Bedrock is at a depth of 15 to 50 ft. The potential for runoff ranges from medium to very high. Permeability is moderately slow in the surface layer and slow or very slow in the subsoil and substratum. The primary soils mapped within the areas of the proposed wind turbines include OdA and OdB (see Figure 1) and have slopes of 0% to 2% and 2% to 6% respectively.

Ontario Series

The Ontario series consists of deep or very deep, well-drained soils formed in till which is strongly influenced by limestone and sandstone. They are nearly level to very steep soils on convex upland till plains and drumlins (An elongated, oval hill or ridge that is composed of glacial drift). Bedrock is at a depth of 4 to 50 ft. Permeability is moderate in the solum and slow or very slow in the substratum. Dominantly undulating to rolling till plains and drumlins. The regolith is calcareous basal till of Wisconsin age high in limestone and sandstone. A high proportion of the series has been cleared and farmed. The primary soils mapped within the areas of the proposed wind turbines include OnA, OnB, OnC and OnD (see Figure 1) and have slopes of 0% to 3%, 3% to 8%, 8% to 15% and 15% to 25% respectively.

Ovid Series

The Ovid series consists of very deep, somewhat poorly drained soils formed in moderately fine textured, reddish colored till. These soils formed in moderately fine textured, reddish till containing a major component of reddish shale or reddish lacustrine clays mixed with limestone and some sandstone. Bedrock is at a depth of 6 to 40 ft. The potential for surface runoff is high to low. Permeability is moderate in the surface and subsurface layers; moderately slow in the subsoil; and slow in the substratum.

The primary soils mapped within the areas of the proposed wind turbines include OvA and OvB (see Figure 1) and have slopes of 0% to 3% and 3% to 8% respectively.

A summary of soil properties for the various soil series presented in Wulforst (1969.) and a summary of properties listed for the soils mapped within the project area is included in Table 1.

5.0 TOPOGRAPHY AND SLOPES

The project is mapped as a part of ***United States Geological Survey*** (USGS) 7.5min topographic map entitled Oakfield-Akron quadrangle (USGS 1971, 1981).

Review of the ***USGS*** mapping indicates the following:

The topography within the Alabama region is comparatively flat to slightly rolling. The ground surface elevation over the Project site varies from about 670 feet to 890 feet. The topography generally declines northwards. The project is divided into two by the northward facing Onondaga Escarpment, along this divide the elevation rises immediately to 850 to 900 feet. South of the Escarpment, Galloway swamp lies at an elevation of approximately 870 to 880 feet and it drains southward to Tonawanda creek. North of the Escarpment lies in the Oak Orchard Creek watershed except the western end this lies in the Whitney Creek drainage of the Tonawanda Creek.

6.0 SURFICIAL GEOLOGY

Based on literature from the ***Oakfield Mine Closure Plan***, (Golder, 1998), and ***New York Geological Survey***, (Cadwell, 1988) indicates the following;

The surficial geology in the project area is dominated by gently undulating and drumlinized till plain largely comprised of silty to clayey till deposits (see Figure 2). The drumlins have a distinct northeast to southwest alignment reflecting the southwesterly glacial advance. Directly North of the Escarpment, the till deposit thins over limestone outcrops that form the caprock of the northward facing Onondaga Escarpment. The Escarpment locally rises up to 80 feet above the till plain. The face of the Escarpment is usually buried beneath the surficial deposits while locally; portions of the escarpment bedrock are exposed.

South of the Escarpment, the surficial deposits form a prominent series of east west tending moraine ridges. These ridges are variously comprised of fine grained till deposits and ice contact granular materials. The moraines located south of the Escarpment form a comparatively narrow ridge that rises 20-50 ft above the surrounding terrain along the northern edge of the Galloway Swamp. This moraine ridge forms the watershed divide between Oak Orchard Creek and Tonawanda Creek to the south. Similar moraine ridges north of the Escarpment also form the northern watershed divide of the Oak Orchard Swamp. Organic peat deposits and Glaciolacustrine silts and clays underlie the intervening area of the flat lowland area associated with the Oak Orchard Swamp.

7.0 BEDROCK GEOLOGY

The Generalized Bedrock Geology mapping by the ***New York Geological Survey***, New York State Museum, 1986 indicates that this project is mainly located within the Silurian Age gypsiferous Dolomite, Onondaga limestone and Camillius shale (see Figure 3).

The literature referenced from the ***Oakfield Mine Closure Plan***, Golder Associates, 1998, indicates the following:

"The Area lying north of the Onondaga escarpment is comprised of Camillius, Syracuse and Vermont Formations. Whereas the area south of the escarpment is overlain by the dolomite and cherty limestone of the Bertie, Arkon and Onondaga Formations with a combined thickness of 60-80 feet. These resistant rock formations form the caprock of the Onondaga Escarpment. The Escarpment base is formed out of the Camillus Formation from the Salina Group. The surface of the caprock is commonly fractured and contains penetrative karst holes associated with localized areas of internally drained depressions near the Escarpment edge. These depressions are likely related to the solutioning of gypsum within the top of the underlying Salina Group (Golder Associates, 1998).

The Camillus Formation is comprised of approximately 70 ft of gypsiferous shaly dolomite and shale. It directly underlies the caprock sequence and tends to form the buried lower half of the Onondaga Escarpment due to its lower errosional resistance and susceptibility to weathering, much of which is associated with the gypsum dissolutioning. Karstic voids of up to several feet were commonly encountered in the upper portion of this sequence during the exploratory drilling conducted by Golder Associates.

The Camillus Formation underlies the Syracuse Formation, a 130 to 140 ft sequence of gypsiferous dolomite with lesser amounts of shale. The USG Oakfield seam, a 3.5 ft thick gypsum bed, lies within the lower portion of the Syracuse Formation. Other much thinner seams also occur interbedded with in the Syracuse Formation. The roof rock that overlies the mine seam is largely comprised of the harder dolomitic strata of the Syracuse Formation, while the shaly Camillius Formation has been largely removed back to near the base of the Onondaga Escarpment by erosion over geologic time.

The Vernon Formation forms the lower half of the Salina Group and has a combined thickness of approximately 260 to 280 ft. The Vernon Formation contains a comparatively high percentage of shale and shaly dolomite. The top of the Vernon Formation hosts the Lower seam gypsum bed that is situated approximately 45 to 50 ft below the Oakfield Seam. The Host shaft of the USG mine is founded at the base of the lower seam, limited extraction took place due to its lower gypsum purity. The 4th Seam gypsum bed, which has not been mined, occurs in the lower portion of the Vernon Formation, approximately 160 to 170 ft below the Lower seam.

Onondaga Formation is composed of the limestones, cherts and cherty limestone's of the Clarance and Edgecliff Members and is middle Devonian in geologic age. The Onondaga ledge averages approximately 31 ft thick over the premises. The Arkon-Bertie Dolomite sequence of the upper Silurian geologic age lies beneath the Onondaga limestone. The irregularly fracturing, thinner bedded to banded Arkon, if it is present, lies over the darker, conchoidally fracturing more massive Bertie."

8.0 MINERAL RESOURCES

The mineral resources potentially located in the project area include Gypsum, Natural gas, Crushed Stone, Construction sand and gravel (***NYSDEC, Division of Mineral Resources***). The two companies identified by the ***NYSDEC*** with the extraction of these mineral resources in the project area are United States Gypsum Co (USG) and Buffalo Crushed Stone Inc.

Gypsum

Literature referenced in the ***Oakfield Mine Closure Plan***, Golder Associates, 1998, indicates the following, USG Oakfield Plant, which is located in the town of Oakfield, owns one continuous interconnected complex extending over the 11-mile length of the mine and two surface facilities (Paper Mill and Gypsum Board Mill). The underground mine is not operational. The mine workings cross Highway 77 at the western most end of Oak Orchard Road at the eastern most end. The northern most mine workings cross Judge Road and approach Lewiston Road at the approximate center of the mine. The south extent of the mine workings cross Marble Road at the west end of the mine and the eastern end of the mine is located between Drake and Towline Roads.

Literature referenced from the ***Oakfield Mine Closure Plan*** (Golder Associates, 1998) indicates that the three available seams in the areas are the Oakfield seam (gypsum bed), Lower seam gypsum bed and the 4th seam gypsum/anhydrite bed. The mined gypsum seam (the Oakfield seam) is thin, approximately 3.5 ft on average, and relatively flat lying with a southward dip of approximately 1.0 percent. The closure plan indicates that the top of the mine occurs at depths of approximately 40 ft to 110 ft below surface, largely reflecting variations in the surface and the southward dip of the seam. The northern, up-dip extent of the mining with in the Oakfield seam is limited by thinning roof cover or areas of ground water inflow. In older areas of the mine, such as north of Judge road, the seam was locally mined to the bedrock surface or to the point where is was no longer present due to it's removal near the bedrock surface over geologic time through dissolution in circulating ground water. The southern extent is limited by rock purity, associated with the transition from gypsum to anhydrite.

Natural Gas

Along with the Gypsum mines, USG also owns and operates several active gas wells located south of the proposed project. The ***DEC's Environmental Navigator*** website database indicates that in the southern portion of the Town of Alabama there are about 24 active wells. Piping layout for these gas wells are not know at this time.

Limestone

Literature referenced from the Buffalo Crushed Stone, Inc. Original Static Module for NYSDOT, March 4, 2002, indicates that Buffalo Crushed Stone, Inc., which is a subsidiary of New Enterprise Stone, & Lime Co., Inc., acquired this quarry from Lancaster Stone Co in 2002. The mining site is a quarry operation within the Onondaga Limestone and is located approximately 2.25 miles east of the junction of Ledge road and NYS Route 77, north of Indian Falls. The quarry ledge is composed of the limestone of the Nedrow, Clarance and Edgecliff members of the Onondaga Formation. The quarry is surface mine. It is presently worked in a single level with faces averaging approximately 25 to 30 ft high. Future stone reserves lie to the north, west, south and east of the existing faces and in the quarry's floor. The water table lies approximately 15 to 20 ft below the land surface; occasionally the mine is pumped so that the ledge can be quarried. The quarry will be progressively worked in these directions, as the floor is lowered (***Mining Map, 2006-1***). In the future, the stone reserves beneath the present quarry floor will be worked in two or three levels. Records indicate that additional 20 acres north of Ledge Road is permitted for quarrying. Approximately 230 acres are estimated to be affected by mining since April 1975. Approximately 5 acres is expected to be excavated from the quarry each year of the five-year permit, for a term total of approximately 20 acres, more or less as outlined on the Mining Plan Map, dated June 21, 2006.

9.0 HISTORICAL MINE COMPANIES

Literature referenced from the ***Oakfield Mine Closure Plan***, Golder Associates, 1998, indicates the following:

> *"Gypsum was mined in Genesee County since 1825 and in the Oakfield area since at least 1845. Early gypsum manufactures in the Oakfield area included the English Plaster Company, with a mill formerly located at the Oakfield railroad station and the mines situated northwest of the town. The Oakfield plaster Manufacturing Company, with mines 2.5 miles west of the Oakfield along the former West shore Railroad; and, the Genesee Plaster Company, formerly located west and south of Oakfield. USG acquired the English and Genessee properties in 1903. Soon after this acquisition, USG dismantled the Genessee Plaster Company and the Oakfield Plaster Company plants and erected a central plant. Other plants in the area included the Niagara Gypsum Company, which started operations in 1908. This was located north of the railroad about one-half mile west of the USG plant on Macomber Road. The Oakfield Gypsum Product Corporation (OGP), which began in 1922 and was located south of the railroad opposite the Niagara Gypsum Company; and the Phoenix Gypsum Company, which started operations in 1920 and was located about one half mile south of South Alabama, two miles west of the USG plant."*

> *"All of these various mining operations were consolidated into the United States Gypsum Co. Oakfield Mine operation. They are all part of the one continuous interconnected underground complex extending over the 11-mile length of the mine."*

10.0 FLOODWAY DESIGNATIONS

The ***Federal Emergency Management Agency*** maps (FEMA, 1984) were reviewed to evaluate the presence of floodplains within the project area. None of the proposed Wind Turbine locations are within mapped floodplain. The 100-year floodplain zone of the Tonawanda Creek is the closest floodplain to the project site. The project area is located in FEMA (Federal Emergency Management Agency) designated Zone C (identified as an area outside the 500-year floodplain).

11.0 GEOLOGICAL HAZARDS

Landslide Hazard

Review of Geology hazards of New York mapped by ***United States Geological Survey*** (USGS) identifies that the project area is located in a zone of low (less than 1.5 % area involved) landslide incidence. However if the quarry floor is lowered this would change the quarry wall slopes, which could induce instability to the adjoining area.

Seismic Hazard

No faults are identified within or near the footprint of the proposed project. The peak ground acceleration (pga) at the site resulting from the seismic event was estimated using information developed by the USGS in the ***National Seismic Hazard Mapping Facility***. This information includes estimated pga on rock for different probabilities of occurrences (or return periods). The de-aggregation information defines the mean magnitude and mean epicentral distance associated with the return period for a given location. For a 500-year recurrence interval, the ***USGS*** de-aggregation information indicates that the mean moment magnitude is magnitude 6.70 at a mean distance of 216.79 miles with an associated pga of 0.02 g. The USGS estimates a moment magnitude of 6.78 at a distance of 179.00 miles will produce a pgs of 0.03 g for the 2,500-year return period event. The moment magnitude and pga for the 5,000-year return period earthquake are estimated by the USGS to be 6.79 and 0.04g respectively. The mean distance for the 5,000-year return period event is 147.69 miles. The figures 4, 5 and 6 show the de-aggregation data for the 500-, 2,500-, and 5,000-year return periods.

Table 2 provides the date of occurrence, location, and reported magnitude and intensity at the epicenter of earthquake causing Modified Mercalli (MM) III shaking intensity or greater at the project site. For reference, an intensity of MM III is associated with shaking that is “noticeable indoors, but may not be recognized as an earthquake.” An intensity of MM VII is “noticed by people driving cars, everyone runs outdoors and slight to moderate damage is caused to well-built, ordinary buildings.” The largest recorded earthquake to shake the project area was at 1929, which caused shaking intensity of MM VII at its epicenter.

Information in Table 2 was developed by screening information from earthquake databases given by the ***USGS National Earthquake Information Center***.

Table 2
Large Earthquakes Less than 100 miles from the Site

Date	Latitude N	Longitude W	Magnitude	Maximum Mercalli Intensity
Aug. 12, 1929	42.87	78.35	-	VII
Jan. 1, 1966	42.80	78.29	4.7	IV
June. 13, 1967	42.90	78.20	3.9	V
Sept. 15, 1972	41.59	89.42	3.7	IV
Jul. 27,1980	38.17	83.91	5.1	IV
Oct. 7,1983	43.94	74.26	5.3	III

Mine Subsidence

The project area is located near the USG Oakfield mine due to which surface subsidence and sinkhole formations will be noticeable (Golder Associates, 1998). The Oakfield mine includes properties previously mined by other mining companies and those workings mined by USG. Golder Associates completed documentation of mined geometries for USG; however, records of mined geometries by previous owners often lack detail. Golder Associates has carried out continuous monitoring of the roof convergence at some locations with in the Oakfield seam for over 25 years. Monitoring carried out from 1969 to 1997 at 88 monitoring stations provide results leading to average convergence between 0.011in/yr to 0.128in/yr. Stability assessments made by Golder Associates indicates that the documented pillars within the Oakfield mine currently exhibit factors of safety in excess of 3.0. Golder indicates that the confined dolomite rock unit overlying the mined horizon is of good quality and forms a self-supporting beam above the mine roof. Assessment of long-term stability due to solution of the pillars within the water-filled areas of the mine indicates very low rates of reduction in the pillar mass at the anticipated water inflow rates and water qualities (Golder, 1998).

Golder Associates reports that several sinkholes have been experienced above the Oakfield mine workings. One area of underground instability due to over extraction and deteriorating pillars had been identified in an area to the east of the present mine office buildings and within the mine surface property boundaries. This instability apparently resulted in small surface depression of less than 20 ft diameter, which was subsequently backfilled (Golder, 1998). On December 21, 2003, USG notified the DEC that a surface subsidence feature had been found near Marble road (***New York State Oil, Gas and Mineral Resources, 2003 report***).

Reported surface expressions of ground instabilities have been fairly limited including the above mentioned subsidence near the office buildings and some sink holes, typically located at the edge of the mine workings near thin ground cover. The sinkholes were reportedly backfilled to existing ground surface. Golder Associates anticipates that the potential for sinkhole formation will be greatly reduced or eliminated once the mine has been allowed to be filled with water. In the filled mine workings the downward gradient will be reduced or eliminated. In the areas that are partially, or not filled, the potential for sinkhole development will still exist. The unfilled areas that correspond to minimum competent roof cover or water inflows will have the greatest potential for sinkhole development.

The current plan is to allow the mine to fill to elevation 730. Any additional water is being removed by pumping. This leaves only a small portion of the mine north of Judge Road that will not be submerged.

12.0 THERMAL RESISTIVITY AND GROUNDING

Electricity flowing in a conductor generates heat. A resistance to heat flow between the cable and the ambient environment causes the cable temperature to rise. Moderate increases in temperature are within the range for which the cable was designed, but temperatures above the design temperature shorten cable life. Catastrophic failure occurs when cable temperatures become too high. Since the soil is in the heat flow path between the cable and the ambient environment, and therefore forms part of the thermal resistance, soil thermal properties are an important part of the overall design.

Thermal Resistivity of Soil

Five constituents are important in determining the thermal resistivity of soil. These are quartz, other soil minerals, water, organic matter, and air, in order of increasing resistivity. The actual values for these materials are 0.1, 0.4, 1.7, 4.0, and 40 mK/W (meter Kelvin per watt). Without knowing anything about the weighting factors for these in an actual soil or fill material, four things are clear:

1) Air is bad. Fill must be tightly compacted to minimize air space, in order to achieve acceptably low thermal resistances.
2) Replacing air with water helps a lot, but water is still not a very good conductor.
3) Organic matter, no matter how wet, will still have a very high resistivity.
4) <u>Fill materials high in quartz will have the lowest resistivity, other things being equal.</u>

Considering that natural soils, which support plant growth, will always have much higher resistivities than engineered materials because of their lower density and variable water content. Top soil containing organic matter, will have a lower thermal conductivity, engineered backfill materials should be considered to assure adequate thermal performance under all conditions. Lower dry resistivities can be achieved using specially designed backfill materials. Measurement of thermal conductivity, both in the field and in the laboratory, is relatively straightforward, and should be part of the cable design and installation.

Site-specific issues such as depth of cable placement, vegetation and soil water management, and avoidance of excessive drying and soil cracking that could lead to air gaps, need to be taken into account when designing and implementing underground power cable installations.

Overall the project site is dominated by the following the soil series Odessa, Ontario, Ovid, Lima, Cazenovia and Canandaigua. All the above-mentioned soils are categorized as Loam or Silt Loam. Estimated Thermal Conductivity of Silt loam is expected to be on the order of 3.21 W/mK(Resistivity = 0.3 mK/W) (Ochsner.T.E). Site specific conditions will affect this value and testing is recommended

13.0 GEOTECHNICAL INDICATIONS

Foundations and Roadways

In most areas, conventional spread footing foundations should be suitable for support of the proposed wind turbines. In some areas, soft or compressible soils may be present and it will be necessary to evaluate these in greater detail at specific sites to assess the impacts to the foundations and roadways. Most of the soils have a fine grained component that may be less than ideal for roadway subgrades and might require stabilization or reinforcement of roadways for proper performance. Shallow bedrock and boulders may be present at various locations at the site and will pose difficulty for confined excavations.

In order to simplify the discussion of the geotechnical issues, we have grouped wind turbine generator locations together that would be expected to have similar conditions. The different settings that relate to the proposed wind turbine locations have been subdivide into regions and zones. The regions relate to the locations relative to the Onondaga Escarpment that divides the site in distinctly different conditions. **Region 1** designates the area south of the north facing

Onondaga Escarpment where rock is shallow. **Region 2** designates the area north of the north facing Onondaga Escarpment where rock is generally deep.

Each region is subdivided into zones that relate to the types of soils present or to mining features that would affect the proposed construction. **Region 1** is subdivided into four zones:

a) Zone 1: Project area overlain by Glacial Till
b) Zone 2: Project area over Till Moraines
c) Zone 3: Project area over Lacustrine Silt and Clay
d) Zone 4: Project area in close proximity to a Surface Quarry(Buffalo Crushed Stone)

Region	**Zone**	**Wind Turbine Number (10-26-06 layout)**
1	1	13,14,16,17,18,20,21,22,23,25,27,28,30,31,33,34,35,37, 38,39,46,47,55
	2	24,29,43,44,45
	3	40,41,42,48,49,50
	4	35,41

Region 2 is subdivided into two zones:

a) Zone 1: Project area overlain by Glacial Till
b) Zone 2: Project area over Till Moraines
c) Zone 3: Project area over abandoned underground mine(US Gypsum)

Region	**Zone**	**Wind Turbine Number (10-26-06 layout)**
2	1	2,8,9,10,11,19,51,54
	2	1,3,4,5,7,15
	3	9

Both Zone 1 of Region 1 and Region 2 is overlain by Till, which is generally good for all types of construction. Some portions of Region 1 and Region 2 are overlain by Till Moraines (Zone 2) which are generally less dense and variable in texture. The sub glacial tills are generally good for construction, however may contain boulders, which would affect trenching or any other form of excavations activities. These types of soils are classified with high site class in the New York State Building Code.

Region 1 is comprised of a small portion of Lacustrine Clay and Silts (Zone 3), soils of this type tend to be weak in the horizontal plane and tend to be varved. These soils may undergo settlement, consolidation under loading and can be problematic for slope stability related issues. The lacustrine clays and silts also make a poor sub grade for roads. Sites with these type soils may have unfavorable site classes in the New York State Building Code. These soils do not have good thermal and electrical conductivities, which may pose as an issue related to thermal heat dissipation for the underground cables, and would increase grounding depth of electrical grounding.

Zone 3 of Region 2 is associated with proposed facilities on or in near proximity with the mapped underground mine working boundaries. One of the major issues related to these locations are issues related to subsidence and sinkholes. Based on the Oakfield Mine Closure Study, Golder reports that the probability for subsidence to occur is low. However, there have been several occasions where subsidence or sinkholes were reported to occur in and around the mine. It is possible that the mapped boundaries may be different from the actual boundaries. This could be a problematic issue to turbines located close to known mapped mine boundaries (8,9,11, 21 and 51) The second issue related to this location relates to the ground water pumping activity carried out by US Gypsum to maintain the ground water levels within the mine. In the event that the pumping is increased, decreased, or stopped, for any reason, the ground water level changes could enhance raveling, subsurface erosion, or collapse of underground openings. An extended lack of pumping could induce a water table rise that might result in surface springs that could destabilize foundations and possibly induce subsidence. If the abandoned mine is left as it is, infiltration into the mine may result in local subsidence and enhanced solutioning. This could cause sinkholes or collapse of the mine roof. Due to the angle of draw, this may influence areas beyond the mine limits and is of particular concern where the roof rock is thin.

Future stability of this Zone 3, Region 2 will also depend on the potential for future mining of the deeper seams. This likelihood of future mining would be driven by economic considerations and ownership of mineral rights. All these above-mentioned issues would directly affect the stability of the roads and the wind turbine generators sited with in this zone.

Zone 4 of Region 1 is associated to proposed facilities in close proximity to the Quarry. Based on the proximity to the quarry and site-specific conditions of the turbines to this zone, blast vibrations could affect the stability and performance of foundations in these areas. Based on the current records, quarrying activity has not yet been carried below the ground water table, but occasional pumping has been carried out in order to quarry the ledge. In the future, if the quarry is deepened below the water table, then the associated dewatering will likely affect the regional hydrology of the area and may have a limited influence on the stability of sidewalls and overburden soils.

Grounding and Cabling

Soil electrical resistivity directly affects the design of a grounding system. When designing an extensive grounding system it is advisable to locate the area of lowest soil electrical resistivity in order to achieve the most economical grounding installation. Soil resistivity is the key factor that determines what the resistance of the grounding electrode will be, and to what depth it must be driven to obtain sound resistance. The resistivity of soils varies seasonally, which is determined largely by its contents of electrolytes, which consists of moisture, minerals and dissolved salts. A dry soil has high resistivity if it contains no soluble salts. Since soil resistivity directly relates to moisture content and temperature, it is reasonable to assume that the resistance of any grounding system will vary throughout the different seasons of the year. Since both temperature and moisture content become more stable at greater distances below the ground surface. It follows that a grounding system to be most effective at all times, should be constructed with the ground rod driven down a considerable distance below the ground surface. Best results are obtained if the ground rod reaches the water table. Ground rods should be installed where there is stable temperature i.e. below the frost line. Soil that is low in resistivity is often highly corrosive because of the presence of water and salts, and this soil can eat away the ground rods and their connectors.

Deep grounding rods will be difficult to install in the area designated as Region 1, south of the escarpment, where rock will be shallow. Rock drilling may be required to install grounding rods in this area.

The predominant soil series represented at the site are Odessa, Ontario, Ovid, Lima, Cazenovia and Canandaigua consisting of loam or silt loam. Loams fall under the category of low electrical resistivity and are expected to fall in the range between 3,000-10,000 ohm-cm (George.A.S, et.al, 1994). This indicates that the salt content of the soil will likely be is high and the tendency for corrosion is high. However, Ph values reported in the Soil survey of Genesee County Indicate that this value range from 5.5-7.7, thus the corrosion product on reaction will be ferric hydroxide, which leads to form a protective coating. This retards the diffusion of oxygen, and hence reducing the rate of corrosion.

14.0 RECOMMENDED INVESTIGATIONS

Based on the conditions revealed by this evaluation, a geotechnical investigation is recommended to assess conditions at locations where construction is proposed to determine soil properties for design, specific groundwater depths, and to verify suitability for the proposed roadways and wind turbine foundations. These investigations should also explore groundwater and bedrock conditions where they would the proposed underground construction for buried electric lines and foundations. A limited number of deep borings are necessary to evaluate the geotechnical conditions; particularly in the areas of deep mining and in the areas of deep soils. Borings must be drilled at each proposed turbine location and several borings within the substation area and proposed roads. Bedrock should be cored if encountered within 30 feet of the ground surface, or for structures located within 250 feet of subsurface mining activities. Where rock is not encountered, borings will extend to depths equal to 1 to 2 times the foundation width below the foundation elevation, depending on the quality of the subsoils encountered. If compressible strata are encountered, the borings must extend through the compressible soil into a competent bearing stratum or to bedrock. Geotechnical investigations should also include classification tests, soil and rock strength determination and consolidation properties. At locations over suspected mined areas, at least 20 feet of sound rock must be cored.

A seismic survey must be performed to determine shear wave velocity of the various strata. Shear and/or compression wave velocities can measured at various depths from the field data. The Seismic refraction test is also recommended to be conducted at areas where shallow bedrock occurs(South of the Escarpment) to assess the depth to rock along proposed buried cable routes. Where deep soft soils are encountered, the seismic down hole test may be needed to determine the site class; however, based on the mapped conditions, refraction testing should be sufficient. Deep borings will need to be carried out south of the Escarpment to determine the Seismic classification. At locations where Till Moraine exists more than two borings are recommended for each Wind turbine Generator due to potentially variable conditions and the presence of boulders.

Where roads, interconnect lines, or other structures are located near steep slopes, additional borings will need to be taken to evaluate the subsurface profile of the slope for stability analyses. Testing to assess the strength characteristics of the subsoil and rock should be performed for stability evaluation. Analyses should be conducted to evaluate the stability of slopes and the impact, if any of slope stability issues on the proposed structures. Additional testing to assess thermal resistivity and electrical conductivity will also be required for each soil type encountered in the investigation.

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TABLE 1

GENERAL DESCRIPTION OF SOIL SERIES

TABLE 1

GENERAL DESCRIPTION OF SOIL SERIES

(Taken from Soil Survey of Genesee County, New York. Wulforst, 1969)

Soil Name	Hydrologic Group[1]	Water Table Depth (ft)	Bedrock Depth (ft)	Permeability (in/ hr)	pH	Risk of Corrosion		Erosion Factors K	Unified Soil Classification[2]	Plasticity Index
						Uncoated Steel	Concrete			
Arkport	NA	10+	4-80	2.0-6.3	5.5-65	NA	NA	NA	ML,SM	NA
Benson	NA	1.0-1.5	1-1.5	0.63-6.3	6.0-7.7	NA	NA	NA	ML	NA
Canandaigua	NA	0-1	8-30	0.63-2.0	7.0-7.5	NA	NA	NA	ML,CL	NA
Cazenovia	NA	1.5-2.5	3.5-25	0.63-2.0	6.5-7.5	NA	NA	NA	ML,CL	NA
Collamer	NA	1.5-2.0	5-40	0.2-2.0	6.0-7.0	NA	NA	NA	ML-CL	NA
Hilton	NA	1.5-2.5	4-25	0.63-2.0	5.5-6.8	NA	NA	NA	ML	NA
Lima	NA	1.5-2.5	3-10	0.63-2.0	6.0-7.4	NA	NA	NA	ML-CL	NA
Odessa	NA	0.5-1.0	15-50	0.63-2.0	6.5-7.5	NA	NA	NA	CL,CH	NA
Ontario	NA	3+	4-50	0.63-2.0	5.5-6.5	NA	NA	NA	ML,SM	NA
Ovid	NA	0.5-1.5	6-40	0.63-2.0	6.0-7.2	NA	NA	NA	ML	NA

NOTES:

[1]a) Definition

Hydrologic group is a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonally high water table, intake rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The influence of ground cover is treated independently.

(b) Classes

The soils in the United States are placed into four groups, A, B, C, and D, and three dual classes, A/D, B/D, and C/D. In the definitions of the classes, infiltration rate is the rate at which water enters the soil at the surface and is controlled by the surface conditions. Transmission rate is the rate at which water moves in the soil and is controlled by soil properties. Definitions of the classes are as follows:

A. (Low runoff potential). The soils have a high infiltration rate even when thoroughly wetted. They chiefly consist of deep, well drained to excessively drained sands or gravels. They have a high rate of water transmission.

B. The soils have a moderate infiltration rate when thoroughly wetted. They chiefly are moderately deep to deep, moderately well drained to well drained soils that have moderately fine to moderately coarse textures. They have a moderate rate of water transmission.

C. The soils have a slow infiltration rate when thoroughly wetted. They chiefly have a layer that impedes downward movement of water or have moderately fine to fine texture. They have a slow rate of water transmission.

D. (High runoff potential). The soils have a very slow infiltration rate when thoroughly wetted. They chiefly consist of clay soils that have a high swelling potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. They have a very slow rate of water transmission.

(1) Dual hydrologic groups, A/D, B/D, and C/D, are given for certain wet soils that can be adequately drained. The first letter applies to the drained condition, the second to the undrained. Only soils that are rated D in their natural condition are assigned to dual classes. Soils may be assigned to dual groups if drainage is feasible and practical.

[2] Unified Soil Classification, see ASTM D2487.

NA -not available

FIGURES