3.0 ENVIRONMENTAL SETTING, IMPACT ANALYSIS AND MITIGATION MEASURES

3.1 Soils, Topography and Geological Resources

3.1.1 Existing Conditions

3.1.1.1 Surficial Geology

The surficial geology of the Project area was mapped by the New York State Geological Survey (Cadwell *et al*., 1991). Based upon an evaluation of the maps (including Figure 3-1), the surficial geology of the Project area consists primarily of glaciolacustrine lake, silts, and clays. As glaciers from the last Ice Age melted from south to north, they filled low-lying areas with water, which became inundated with silts and clays. A small portion of the Project area consists of peat muck (swamp deposits) which are poorly drained areas and consist of organic silts and sands. The proposed wind turbine locations within the peat muck areas would include Nos. 14, 15, 18 and 85. Local areas may also consist of mixed glacial and residual soils weathered from the underlying limestone bedrock. The thickness of glacial soils is expected to vary widely across the site from very shallow to very deep (McDowell, 1989).

3.1.1.2 Bedrock Geology

The proposed Project area is located in the Ontario Lowlands Physiographic Province which includes sedimentary rocks (Cambrian and Ordovician) of the Lower Paleozoic age. The underlying bedrock (Figure 3-2) is comprised of rocks of the Trenton group (Trenton Limestone) and Black River Group (Lowville Limestone and Watertown Limestone) (Ruedemann, 1908).

The New York State Geological Survey indicates the primary mineral resources of Jefferson County include crushed stone, construction gravel, and topsoil. The New York State Department of Environmental Conservation (NYSDEC) Mined Land Database (NYSDEC, 2006b) indicates records of commercial mining around the proposed Project area. The mineral resource mined in the vicinity of the Project area is carbonate rock (limestone), which can be used in the construction industry for concrete or highway paving materials. The Project is not anticipated to impact these resources.

A review of United States Geological Survey and New York State Geological publications did not identify any specific geological hazards within the Project area. Since the Project area is located mainly on lowlands and consists predominantly of glacial till there is no possibility of landslides. Review of topographic maps (Figure 2-1) and aerial photographs of the site (Figure 3-3) revealed no evidence of landslides. While no limestone (karst) hazards are mapped, the Trenton and Black River Groups are comprised of carbonate rocks that are susceptible to dissolution and sinkhole formation. Caverns have been mapped in the Project area and mapping has indicated numerous closed depressions. Due to its particular characteristics, including an irregular bedrock surface, the presence of large voids and rapid underground drainage, karst limestone presents special problems for civil engineering projects such as roads, bridges, tunnels, sewerage pipelines, and mining. Careful preparatory investigations are therefore required with special design measures and provisions for unforeseen problems. As a result, bedrock in the Project area should be investigated for karst and other dissolution features as part of the geotechnical investigation(s) prior to construction.

The proposed Project area lies in a zone of relatively low seismic risk. The maximum earthquake ground motion is expected to be 0.20 times the acceleration due to gravity (0.20g) for 0.20 second response acceleration and 0.08g to 0.11g for one second response acceleration (Building Code of New York State, 2002).

Based upon the soils information and geologic setting, it appears that the Project area conditions could vary considerably from shallow hard rock to deeper organic soils; as a result the Project area may include site classes A through F. Based on the prevalence of shallow rock across the site it appears likely that most of the Project area would include Site Classes A, B or C. Nonetheless, detailed geotechnical investigations would be required to assess the specific site class for each proposed wind turbine location.

3.1.1.3 Soils and Floodplain Designations

The Soil Survey of Jefferson County, New York (McDowell, 1989) indicated that the proposed Project area is underlain by nine soil series, comprised of several soil types of similar developmental origin. These soil series consist predominantly of silt loams and loams of glacial origin. The soil survey indicates that the soils in and around the Project area vary from shallow to very deep and have been formed from glacial till derived from the underlying limestone. The soils identified within the Project area are presented in Figure 3-4. The soil series listed in the legend of Figure 3-4 are designated by a two letter code, followed by a third letter indicating the degree of slope, and, when data are available, by a number that indicates the degree of erosion. The primary soil types underlying the Project area include the following:

Benson (Bg)

The Benson series consist of nearly level to gently sloping, shallow and very shallow, somewhat excessively drained soils. These soils are mainly in broad, undulating areas interspersed with rock outcrops on ridges. Typically, the surface layer is dark brown channery silt loam about 3 inches thick. The subsoil is reddish brown and dark reddish brown, very channery silt loam about 9 inches thick. Bedrock is commonly at a depth of 10 to 20 inches. Most of these soils are used as permanent pasture or cedar woodland, or are reverting to brush. This soil is generally not suited for cultivated crops. The rate of runoff on the Benson soils is medium, and the capacity of these soils to store water available for plant growth is very low. The primary soils mapped within the areas of the proposed Project are BgB (see Figure 3-4) and have slopes of 0% to 8% in the vicinity of proposed turbine Nos. 20, 38, and 39.

Chaumont (Cl)

The Chaumont series consist of level to gently sloping, moderately deep and somewhat poorly drained soils in concave, sloping areas of lowland plains. Typically, the surface layer is dark grayish brown silty clay about 5 inches thick. The subsoil is mottled and about 22 inches thick. It is grayish brown to dark grayish brown clay in the upper part and dark grayish brown silty clay in the lower part. Bedrock is commonly at a depth of 20 to 40 inches. Most areas of this soil type have been cleared and are used for cultivated crops. Some areas are used as pasture and woodland; as a result drainage is needed in extensively cropped areas. The rate of water movement through the soil is slow or very slow, and runoff is slow. The capacity of the soil to store water available for plant growth is moderate to high. The surface layer is moderately acidic to neutral. The soils mapped within the Project area include ClA and ClB (see Figure 3-4) and have slopes of 0% to 3% and 3% to 8%, respectively.

Covington (Cp)

The Covington series consist of nearly level, very deep, poorly drained soils in smooth, broad, mostly level areas and depressions of the lowland plains. Slopes range from 0 to 3 percent, but are predominantly less than 1 percent. Typically, the surface layer is very dark silty clay about 6 inches thick. The subsoil is mottled, about 26 inches thick, and consists of dark gray to grayish brown clay. The substratum is mottled, gray firm, sticky and plastic silty clay to a depth of 60 inches or more. Most areas of this soil type have been cleared and are used for cultivated crops. The rate of water movement through the soil is slow or very slow in the surface layer and very slow in the subsoil and the substratum; in addition runoff is slow. The capacity of the soil to store water available for plant growth is moderate to high. The surface layer is moderately acidic to neutral. Bedrock is commonly at a depth of 20 to 40 inches. The prolonged seasonal high water table, the clayey texture, slow rate of water movement through the soil, poor stability, and potential frost action are limitations of this soil for urban uses.

Galoo (Gb)

The Galoo series consist of very shallow excessively drained and somewhat excessively drained soils. The areas are mainly on undulating ridges and knolls. The Galoo soil is 2 to 10 inches deep over limestone of calcareous sandstone bedrock. Typically, the surface layer consists of dark brown silt loam about 4 inches thick. The subsoil is reddish brown channery silt loam to a depth of 7 inches. Most of the areas used as pasture are reverting to brush, or are poor quality woodlands. This soil is not suited to cultivated crops because of the very shallow depth to bedrock, droughtness and rock outcroppings. The rate of water movement through the soil is moderate, and the runoff rate is slow or medium. The capacity of the soil to store water available for plant growth is very low. The surface layer is moderately acidic to mildly alkaline. Soils mapped within the Project area include GbB, and GcB (see Figure 3 4) and have slopes of 0% to 8%.

Hudson (Hu)

The Hudson series consist of gently sloping to steep, very deep, moderately well drained soils mainly in smooth, irregularly shaped areas and on convex slopes. Typically, the surface layer consists of brown silt loam about 8 inches thick. The subsurface is mottled brown silt loam about 4 inches thick, and the subsoil is mottled and approximately 47 inches thick. It is brown to dark brown silty clay in the middle part and yellowish brown silt loam in the lower part. Most areas of this soil have been cleared and used for cultivated crops for dairy farming. The rate of water movement through the soil is moderately slow or moderate in the surface layer, and slow or very slow in the subsoil and the substratum; in addition the runoff is medium. The capacity of the soil to store water available for plant growth is moderate to high. The surface layer is moderately acidic to neutral. Erosion is a serious hazard if the slopes are bare of vegetation. Mapped soils in the Project area include HuB, HuC and HyE3, (see Figure 3-4) and have slopes of 3% to 8%, 8% to 15% and 15% to 35%, respectively.

Kingsbury (Kg)

The Kingsbury series consist of nearly level, very deep, somewhat poorly drained soils mainly in smooth, broad, irregularly shaped areas on plains. Typically, the surface layer consists of dark grayish brown silty clay about 7 inches thick. The subsurface is mottled, grayish brown silty clay about 5 inches thick, and the subsoil is mottled and about 16 inches thick. It is firm, grayish brown clay in the upper part and olive gray clay in the lower part. Most areas of this soil have been cleared and used for cultivated crops and dairy farming. If properly drained this soil is moderately suited for cultivated crops. The rate of water movement through the soil is moderately slow in the surface layer and very slow in the subsoil and the substratum. The clayey subsoil somewhat restricts rooting depth, and runoff is slow. The capacity of the soil to store water available for plant growth is high. The surface layer is moderately acidic to mildly alkaline. Soils mapped within the Project area include KgA and KgB (see Figure 3-4) and have slopes in the range of 0% to 3%.

Livingston (Lc)

The Livingston series consist of nearly level, very deep and poorly drained soils mainly in smooth, broad, flat or depressional areas on plains. Typically, the surface layer is black mucky silty clay about 6 inches thick. The subsoil is mottled and about 24 inches thick. It is dark greenish gray to dark gray, very firm, very plastic and very sticky clay. Most areas of this soil are used as pasture or woodland. The rate of water movement through the soil is slow or very slow in the subsoil and the substratum. The runoff is very slow or ponded. The capacity of the soil to store water available for plant growth is high. The surface layer is moderately acidic to neutral. Soils mapped within the Project area include Lc and Ld (see Figure 3-4) and have slopes in the range of 0% to 3%.

Reinbeck (Rh)

The Reinbeck series is barely level to gently sloping very deep, somewhat poorly drained soil mainly in smooth, broad, irregularly shaped areas on lake plains and at the margins of uplands. Typically the surface layer is dark grayish brown silty loam about 8 inches thick. The subsurface layer is mottled, grayish brown silt loam about 4 inches thick. The subsoil is mottled and about 14 inches thick. Most areas of this soil have been cleared and are used for cultivated crops in dairy farming. The rate of water movement through the soil is moderately slow in the surface layer and slow in the subsoil and the substratum; in addition the runoff is very slow. The capacity of the soil to store water available for plant growth is high. The surface layer is moderately acidic to neutral. Soils mapped within the Project area include RhA and RhB (see Figure 3-4) and have slopes in the range of 0% to 3% and 3% to 8%, respectively.

Wilpoint (Wn)

The Wilpoint series consist of gently sloping, moderately deep, moderately well drained soil mainly on convex slopes. Typically, the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is mottled and about 16 inches thick. It is dark brown silty clay in the upper part and dark brown to dark grayish brown clay in the lower part. Bedrock is at a depth of 20 to 40 inches. Most areas of this soil have been cleared and are used for cultivated crops. The rate of water movement through the soil is slow or very slow, and the runoff is medium. The capacity of the soil to store water available for plant growth is moderate. The surface layer is moderately acidic to neutral. Soils mapped within the Project area include WnB and WnC (see Figure 3-4) and have slopes in the range of 3% to 8% and 8% to 15%, respectively.

The Soil Survey of Jefferson County indicates that ground water is seasonally perched within the upper 0.0 to 6.0 feet during the months of December to May and/or March to May depending on the underlying soils (McDowell, 1989). The soils mapped within the proposed Project area are described as poorly drained, and groundwater is expected to be shallow in most areas.

A summary of soil properties for the various soil series are presented in McDowell (1989), and a summary of the properties listed for the soils mapped within the Project area is included as Table 3-1.

3.1.1.4 Unusual Landforms or Geologic Formations

The Project area contains landforms that are unique to the local geologic environment. The landforms are typical of a glacial lacustrine plain and include relatively flat terrain with small lakes and wetland areas. The area also includes surficial peat deposits. Other landforms include a cave near the northern limit of the Project area, just south of Millen Bay, and numerous closed depressions. The closed depressions are likely remnant glacial features, but may also reflect karst (sinkhole) activity in the underlying limestone.

The Project area is mapped as part of four United States Geological Survey (USGS) 7.5 Minute Topographic maps: Cape Vincent North, Cape Vincent South, Chaumont and St Lawrence Quadrangles. Based upon the USGS Topographic maps (USGS, 1958a, b, c, d), the proposed Project area is located in the St. Lawrence River Valley (or the Thousand Island Region). The St. Lawrence Valley and the Erie-Ontario plain together are referred to as the "lowlands." The elevations across the Project area vary from about 249 feet above mean sea level (msl) to about 370 feet above msl. The proposed Project area is encompassed by rivers and lakes, which include the St Lawrence River, the Black River, and Lake Ontario. A majority of the Project area consists of nearly level agricultural land (row crops). Approximately 80% of the Project area has slopes within the range of 0 to 10%, approximately 16% of the area is between 10 to 15% and approximately 4% of the Project area includes slopes greater than 15%. A majority of the area is level and the drainage pattern is generally in the direction of small streams and creeks (e.g., Kents Creek, Fox Creek, Shower Creek, Super Creek, Three Mile Creek), which discharge directly into the St Lawrence River.

3.1.2 Potential Impacts

3.1.2.1 Potential Short-Term Impacts

Based on the information reviewed and described above, the soils and geologic conditions should be properly evaluated prior to construction of the proposed wind energy project. The subsoils are expected to consist predominantly of silt loams and loams of glacial origin. The soil survey indicates that the soils in and around the Project area vary from shallow to very deep and have

Table 3-1

General Description of Soil Series

(Taken from Soil Survey of Jefferson County, New York [McDowell, 1989])

Soil Name	Hydrologic Group[1]	Water Table Depth (ft)	Bedrock Depth (in)	Permeability (in/ hr)	pH	Risk of Corrosion		Erosion Factors K	Unified Soil Classification[2]	Plasticity Index
						Uncoated Steel	Concrete			
Benson	C/D	>6	10-20	0.6-2.0	5.6-7.3	Low	Low	0.02	SM/GM	NP-10
Chaumont	D	1.5-1.5	20-40	<0.2	5.6-7.3	High	Low	0.49	MH,CH	15-50
Covington	D	0.5-1.0	>60	<0.2	5.6-7.3	High	Moderate	0.49	CH,MH	10-40
Galoo	C/D	>6	2-10	0.6-2.0	5.6-7.8	Low	Low	0.32	CL,ML	3-15
Hudson	C	1.5-2.0	>60	0.2-2.0	5.1-7.3	High	Low	0.49	ML,CL-ML	5-19
Kingsbury	D	0.5-1.5	>60	0.06-0.2	5.1-7.8	High	Moderate	0.49	ML,MH	11-20
Livingston	D	0-1.0	>60	0.2-0.6	5.1-7.3	High	Low	0.49	CH,MH	10-40
Reinbeck	D	0.5-1.5	>60	0.2-0.6	5.1-7.3	High	Low	0.49	ML,MH	10-25
Wilpoint	D	1.5-2.0	20-40	<0.2	5.6-7.3	High	Low	0.49	MH,CH	15-50

[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 clay pan 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.

been formed from glacial till derived from the underlying limestone. The water table is expected to be shallow in the Project area. In addition, bedrock depths across the area would vary greatly in areas underlain by karst limestone. The finer grained soils may have a tendency to soften on exposure to weather and would likely require protection from weather and vehicle traffic to prevent rutting. Slopes are generally slight to moderate in the area of the proposed wind turbines and slope stability is not expected to be an issue for design. The seismic risk is low.

Based upon the topographic features (see Figure 2-1) and drainage characteristics of the proposed Project area, grading and other construction activities could cause the disruption of soils and the increased potential for erosion during construction without appropriate erosion and sediment controls. In addition, the short-term removal of vegetation, including the root system from portions of the site, would expose soils to erosive factors such as wind, rain and surface runoff. Without appropriate erosion controls, soil transported by surface runoff could potentially migrate to nearby surface waters where it may settle out as sediment. The Project is required to obtain a soil Stormwater Pollution Discharge Elimination System (SPDES) permit, which entails creation of a SWPPP for construction. Construction traffic could also create airborne dust. Dust control measures are addressed in Section 3.9.

3.1.2.2 Potential Long-Term Impacts

The proposed Project, once built, could potentially cause a minor alteration to existing drainage patterns. A SWPPP would be created to address any potential sediment and erosion impacts associated with Project operation.

3.1.3 Proposed Mitigation

3.1.3.1 Soil Erosion and Siltation

To avoid and mitigate the short-term potential impacts associated with soil erosion and siltation, and ensure that downstream waterways are not adversely impacted, a sediment and erosion control plan would be developed as part of the Project Stormwater Pollution Prevention Plan, which is required by the SPDES permit for construction and the SPDES permit for operation.

3.1.3.2 Soils in Agricultural Areas

In order to prevent the loss or compaction of topsoil, SLW commits to following the NYS agricultural protection measures during construction, as set forth in Appendix A of the NYS Department of Agriculture and Markets Guidelines for Agricultural Mitigation for Wind Power Projects.

Soils impacted during construction would also be minimized by inclusion of applicable soil protection erosion control and soil restoration measures in the final construction documentation and plans for the contractor(s) and subcontractor(s). One or more pre-construction meetings would be held between the construction contractor(s) and a representative of the New York State Department of Agriculture and Markets. During construction the environmental inspector would monitor compliance with the soil protection measures (including potential access restrictions) described above and included in Appendix A.

3.1.3.3 Shallow Bedrock, Blasting and Geotechnical Investigation

A geotechnical investigation would be conducted to assess conditions (including potential karst features) at locations where construction is proposed to determine soil properties for design, specific groundwater depths, and to verify suitability of the native materials for support of the proposed roadways and wind turbine foundations. The investigation would also assess areas where shallow groundwater or bedrock might impact proposed underground construction for buried electric lines and foundations. A limited number of deep borings are necessary to evaluate the geotechnical considerations discussed above.

The investigation would include at least one boring at each proposed wind turbine location. Additional borings may be added where karst features are identified or suspected. The borings would be drilled to bedrock. Bedrock would be cored if encountered within 20 feet of the ground surface. Where rock is not encountered, borings would 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 would extend through the compressible soil into a competent bearing stratum. Cone Penetration Testing (CPT) would be considered as a low cost method to evaluate subgrade conditions for proposed roadways. Additional borings would be made at the proposed substation location and where directional borings might be needed. Borings would obtain undisturbed samples of cohesive materials. Geotechnical borings and slope stability analyses may also be necessary.

Geophysical investigation, coupled with a limited number of geotechnical borings, would be provided to determine the depth to rock along proposed underground interconnect lines. The geotechnical data would be presented in a geotechnical report that includes boring logs, laboratory test results, recommended foundation types, depths and allowable pressures, seismic site classification, and recommended soil and rock parameters to be used for the design of foundations and roadways. This report would be prepared prior to the final engineering design.

3.1.3.4 Management of Oil and Hazardous Materials

Wind turbines, and their associated equipment, use lubricating and insulating oils in a closed system. A SPCC Plan would be developed as part of the SWPPP for the construction and operation of the Project as required by the SPDES permits.

3.2 Water Resources

3.2.1 Groundwater and Groundwater Quality

3.2.1.1 Affected Environment

Glaciolacustrine lake silts and clays overlie consolidated rocks of sedimentary origin in the area of the Project (Cadwell *et al.*, 1991). Small portions of the Project consist of peat muck (swamp deposits) which are poorly drained areas and include of organic silts and sands. The glacial till deposits form surficial aquifers, while bedrock consisting of carbonate rocks (primarily limestone) form deep aquifers. These consolidated rocks yield water primarily from bedding planes, fractures, joints, and faults, rather than from intergranular pores. Carbonate rocks generally yield more water than other types of consolidated rocks because carbonate rocks are subject to dissolution by slightly acidic groundwater. Dissolution along bedding planes, fractures, and joints enlarges these openings and increases the permeability of these carbonate rocks (Isachsen *et al.*, 2000).

No known sole-source aquifers occur within the Project area or its vicinity (United States Environmental Protection Agency [EPA], 2006a). In 2000, total freshwater use was 17.21 million gallons per day (Mgal/d), of which 13.25 Mgal/d (27 percent) was from surface-water sources and 3.96 Mgal/d (73 percent) was from groundwater (USGS, 2006). However, domestic users acquired 100 percent of their water supply from groundwater sources (USGS, 2006). Table 3-2 lists an excerpt from the USGS report of water usage statistics in Jefferson County, New York. Current data (October 2006) from the EPA indicates that drinking water is obtained from groundwater, surface water and purchased groundwater/surface water resources in Jefferson County (EPA, 2006b).

Table 3-2
Year 2000 Water Usage Statistics in Jefferson County [1]

Type of Usages	Water Withdrawals[2]		
	Groundwater	Surface	Unit
Public supply[3]	2.17	8.20	Mgal/d
Domestic, self-supplied withdrawals	0.45	0.00	Mgal/d

[1] Source: http://water.usgs.gov/watuse/data/2000/index.html
[2] 6.39 Mgal/d was industrial use
[3] Population (Year 2000) in Jefferson County was approximately 111,740