December 21st, 2018

Nation Rise Wind Farm Limited Partnership – REA Condition R1 - Geotechnical Scope of Work

As per condition R1 of Renewable Energy Approval 0871-AV3TFM, Nation Rise Wind Farm Limited Partnership (the proponent) is hereby submitting the proposed scope of work for a supplemmentary detailed geotechnical investigation report. The proponent has contracted Tulloch Engineering to complete a geotechnical program to assist in the development and design of the Nation Rise Wind Farm (the project). As part of the development of the final geotechnical report, Tulloch Engineering is required to complete the onsite reports and investigations as outlined below. The final value of all testing locations are constantly updated throughout the life of the geotechnical program. If certain areas of the project are removed and/or added to the scope of work then the number of test locations may decrease and/or increase accordingly.

The report will address the terrain in association with the construction and structural loading of the soil for the proposed wind farm development. Based on laboratory analysis outlined in this scope and engineering judgment, specific recommendations for construction activities and isolated excavations for turbine foundations, access roads, trenching for underground collection cables, and any other grading / earthwork activities associated with the development ("the work") will consider the impacts to the surrounding ground stability. Specific engineered recommendations will be provided to fully mitigate impacts associated with the work.

1) Pre-Construction Road Condition Investigation which includes:
    a. 110 Boring Investigations
        i. Note that the borings were removed at the request of the municipalities and replaced with ground penetrating radar. The total number of test locations was modified from the original scope with the final transporation plan.
    b. 110 Falling Weight Deflectometer Investigations
        i. Note the total number of test locations was modified from the original scope with the final transporation plan.
    c. Pre-Construction Road Condition Investigation Report

2) Geothermal Testing and Reporting for underground collection lines and grounding.

3) Proposed Turbine Locations - Geotechnical Investigations
    a. 33 Soil Boring Investigations
    b. 2 Seismic Refraction Tests
        i. Note that 5 more tests were added at the previous request of the Ministry.

4) Private Access Roads – Geotechnical Investigations
    a. 16 Additional Trial Pits
    b. 16 Additional Soil Borings

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5) Substation Location – Geotechnical Investigations
    a. 4 Soil Boring Investigations
    b. 4 Electrical Resitivity Tests
    c. 1 Thermal Resistivity Test

6) Interconnection Switchyward (Gantry)
    a. 4 Soil Boring Investigations
        i. Note that the final number of borings was reduced to 2 borings to comply with Hydro One standards.
    b. 4 Electrical Resistivity Tests
    c. 1 Thermal Resistivity Test

7) Laydown Yard – Geotechnical Investigations
    a. 3 Soil Boring Investigations

8) Met Tower Locations – Geotechnical Investigations
    a. 4 Soil Boring Investigations
        i. Note that the number of tests is for each possible Met Tower location and not multiple borings per tower.

9) Underground Transmission Line Locations – Geotechnical Investigations
    a. 10 Electrical Resistivity Tests
    b. 10 Thermal Resistivity Tests

As a general rule, the following information will be necessary for Tulloch to prepare recommendations for the project:

- Existing topsoil thickness at proposed turbine sites.
- Subgrade support parameter for foundations, crane pads and proposed private roads.
- Complete soil boring logs at proposed turbine sites.
- Determination whether there is a presence of high moisture content, moderate strengthsilty clays or silt deposits.
- Determination whether there are other possible risks shall also be included, such as collapsible soils, expansive soils, landslides, glbal stabilty in steep areas, karst geology or potnential voids, etc.

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Wind Turbine Locations

Tulloch Engineering will complete the following investigations at each turbine location:

- Borings
  - 33 borings shall be drilled to 75 feet below ground surface (BGS).
  - Continuous split-spoon samples and/or Shelby tube samples of the overburden soils will be obtained to a depth of 12 feet, and at maximum intervals of 5 feet, thereafter to 75 feet or to the top of bedrock as determined by refusal of the soil sampler. Split-spoon sampling will be in accordance with American Society of Testing Materials (ASTM) Method D-1586. If auger refusal is encountered at a depth less than 30 feet BGS, a 10-foot core of the bedrock shall be obtained using a NX-sized core barrel (approximately 2-inch diameter core) in accordance with ASTM Method D-2113. At those locations where the bedrock is determined to be of poor quality, the boring may be progressed further into the rock to determine the vertical extent of the poor rock quality.
  - Observe for groundwater seepage during drilling, immediately after drilling, and 24 hours following the completion of drilling operations and record levels.
  - Consultant shall also install piezometers at each boring locations at an estimated depth of 25 feet BGS and provide monitoring once a month for six (6) months.
- Seismic refraction testing:
  - The specific locations for the testing shall be selected after discussions with and in concert with the proponent's instructions along with an evaluation of the test boring data.
  - Testing and analysis should include two methodologies, a seismic refraction analysis to establish a two dimensional (2D) model of compressional velocities of the earth below the seismic spread and a multichannel analysis of surface wave analysis (MASW) survey to develop a one-dimensional (1D) model of shear velocities at the center of a seismic spread.
- If special geological conditions are found in the project area (i.e bedrock – weathered rock, bedrock – soil), all of them shall be analyzed and included in the report.
- Tulloch will prepare a written log of each boring describing the subsurface soils or bedrock encountered as well as the depth to water table. Tulloch will also be responsible for making modifications to the boring program, if warranted.

Crane Pads

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- Tulloch shall utilize the subsurface information obtained from the turbine borings for evaluation of the ground characteristics in order to provide recommendations for aggregate section and crane mat use.

Met Mast Locations

- Met mast locations will require test borings drilled to 40 feet BGS.

Private/Site Access Roads

- Additional road trial pits (preferred) or borings to the tests performed in turbine locations close to private roads, will be performed in areas where the proposed roads are at a distance to turbine locations agreed between Tulloch and the proponent typically higher than 1500 meters. These investigations will include measurement of the existing topsoil thicknesses. The trial pits and borings will be drilled 2.3 meters below ground surface and the distance between soil investigations shall be 100-1500 meters depending on project specifics**.**

Substation and Interconnection Switchyard Locations

- A total of 4 borings will be performed at the substation location. If auger refusal is encountered at a depth less than 40 feet BGS, a 10-foot core of the bedrock shall be obtained.
- Electrical resistivity test: Testing to provide electrical resistivity parameters and recommendations in the geotechnical report and coordination with the proponents electrical engineering consultant to aid in determining grounding requirements at the project:
    - Testing is to be conducted at 4 traverses locations within the substation locations. It is anticipated that two arays will be oriented at a 90-degree arrangement.
    - Each traverse shall be performed with probe spacing of 2, 3, 5, 7, 10, 30, 50, 70, 125, 200 and 300 feet.
    - Probe depths of 4” shall be used for 2, 3, 5 feet specing and a probe depth of 12” thereafter. The four propbes shall be equally spaced in a straight line with the current probes on the outside and the potnential probes on the inside.

Laydown Yard

- A total of 3 boring investigations to be completed at a depth of 30 ft BGS.

Underground Collection

- Electrical Resistivity Test: Testing is to be conducted at proposed electric line locations, consisting of Top Soil Resistivity and Deep Soil Resistivity. The following summarizes the number of tests proposed per site:

- Top Soil Resistivity: At each location, one set of readings will be conducted, consisting of 2 traverses each, with a 90-degree arrangement to each other. Maximum probe depths of 3 inches, with probe spacing of 5, 10 and 20 feet.
- Deep Soil resitivity: At each location, one set of readings will be conducted, consisting of 2 traverses each with a 90-degree arrangement to each other. Probe depth of abour 1 foot, with probe spacing of 25, 50, 75, 125, 175, 200, 250 and 300 feet.
- The four probes shall be equally spaced in a striahgt line with the current probes on the outside and the potential probes on the inside.

- Soil Thermal Condictivity Testing and Report (Underground Lines):
  - All testing necessary to determine the thermal conductivity/resistivity of the soil at representative locations throughout thesite. This includes preparation of a report detailing findings and coordination with the proponent's electrical engineering consultant to aid in determing the required backfill and cable sizing for underground collection cabling.

Laboratory Testing

- Perform the following testing on the samples obtained in the split-barrel sampled and/or shelby tube samples from the Public roads and private access roads:
  - Visial Soils Classification
  - Moisture Content
  - Unconfined compressive strength (QP). Undrained Shear Strength, and/or friction angle.
- Perform as-compacted and saturated CBR tests on selected samples of subgrade soils representative of the major soil types. These tests will be perfomred on samples taken from the existing county roadways and proposed private access roads.
- Perform grain size analysis on representative samples of soil.
- Perform Atterberg Limits Testing to define plasticity characteristics on representative samples of subgrade soils.
- Perform soil and groundwater analysis for pH, chloride and sulfate content to determine potential for corrosivity.

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