

June 7, 2017  
Revised June 9, 2017

Project No. 1668031-1000-L01

North Kent Wind 1 LP  
c/o Samsung Renewable Energy Inc.  
2050 Derry Road West, 2nd floor  
Mississauga, ON L5N 0B9

**PHASE 2: PRODUCTION PILE VIBRATION MONITORING PROGRAM  
NORTH KENT WIND 1 PROJECT  
CHATHAM-KENT, ONTARIO**

Dear Mr. Law:

Following completion of Phase 1 of the vibration monitoring program for test pile installation at the T5 and T42 turbine sites, this letter provides the Phase 2 work plan to carry out independent vibration monitoring during construction of the North Kent Wind 1 facility (Project) as part of Section H1 of the Renewable Energy Approval (REA) 5272-A9FHRL issued by the Ontario Ministry of the Environment and Climate Change (MOECC). This work plan is based on experience gained during the Phase 1 vibration monitoring program and discussions with representatives from North Kent Wind 1 LP, RES (engineering, procurement and construction) and Golder Associates Ltd. (Golder). The Project will follow the conditions of the REA with regards to addressing any potential complaints received during the construction phase of the Project, as described within Section G5 and G6 of the REA.

## **Background**

Closed-end pipe piles will be driven into the ground to support each turbine tower. These piles will be stopped on or above bedrock. Once in position the piles will be anchored to the bedrock by drilling a hole into the bedrock through the pile, inserting a steel reinforcing bar, fully grouting the hole and filling the pile with concrete. The anchor drilling equipment and methods and size of the drilled holes are similar to those of residential water well installation except that the final hole is grouted with cement. Driving foundation piles is anticipated to take about 2 to 3 days per turbine location. Other construction activities will take place as part of the Project including building a substation, meteorological station and other support infrastructure. Foundations systems for other infrastructure may include use of helical piles<sup>1</sup> or drilled piles, neither of which induce vibrations of concern. If other infrastructure will be supported by driven piles, these will be monitored as planned for the turbine sites.

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<sup>1</sup> For examples of helical construction, see <http://www.ebsgeo.com/helical-piles/videos>, <http://geosolv.ca/helical-piles/>. These companies may or may not be the subcontractor chosen for the NK1 project work but helical pile systems are similar and are constructed by a variety of different contractors.



## Phase 2 Work Plan: Production Pile Vibration Monitoring Program

The Phase 2 vibration monitoring work program is summarized below:

- 1) Turbine sites have been grouped into seven clusters, the first of which is illustrated on the attached map. The turbine clusters are being developed based on geographic proximity, as the primary consideration, and construction sequence.

The subsurface conditions are similar within and among all of the clusters, where the ground consists of surficial sand, silt and clay soils, of varying consistency/density, overlying a relatively thick deposit of soft clay. The soft clay is typically underlain by a layer of glacial till or sand and gravel immediately overlying bedrock. All clusters are characterised by approximately 15 to 22 m of these soils overlying bedrock, consistent with the T5 and T42 test pile sites, except one turbine site at the far western limit of the project where the bedrock is somewhat deeper (about 28 m below the surface). Vibration propagation and attenuation characteristics at any given turbine site are not expected to be substantively different as compared to the test pile sites (T5 and T42) when driving the piles at depths near or on the bedrock.

- 2) Monitoring of vibrations at the turbine construction sites will be conducted full-time during pile driving activity at each turbine site. Vibrations will also be monitored at two domestic water wells in proximity to a turbine site within each of the turbine clusters. The two domestic water wells will be monitored full-time while pile driving occurs at each turbine within the cluster. The two monitored well locations within each of the identified turbine clusters will not change for the duration of pile driving within the cluster.
- 3) Pile foundation construction is planned to occur between mid-June, 2017 and mid-October, 2017.

The two domestic water well locations that will be monitored in each cluster will be identified as permission to enter is obtained by North Kent Wind 1 LP. Selection of domestic water wells for monitoring will be governed by proximity to the turbine, the nature of the well casing as it relates to attaching accelerometers, and permission to access the well from the owner. If North Kent Wind 1 LP cannot secure at least two water wells in the proximity of each turbine cluster, North Kent Wind 1 LP will provide the Ministry with rationale and a record that identifies the following information about contacting water well owners:

- a. Name of the water well owner
  - b. Location of water well and distance to the closest turbine
  - c. Date and time of contact
  - d. Name of Project representative or their consultant that attempted contact
  - e. Reason why water well owner rejected participating in the monitoring
- 4) For each of the turbine sites within each cluster, the monitoring program will consist of:
    - a. having one conventional ground surface construction vibration seismograph (Instantel Minimate geophone as previously used during the test pile monitoring program) that will be located close to the first individual pile to be driven on each of the monitored turbine sites (e.g., within 3 to 5 m);
    - b. at each monitored turbine site, the monitoring device will remain stationary as the piles that make up the foundation are driven (i.e., the monitoring device location will remain unchanged as the piles are driven around the circumference of the foundation); and

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- c. the Minimate will be set to capture waveforms following exceedance of a set trigger levels of 1 mm per second (to avoid exceeding internal memory capacity) and will be set to capture peak particle velocity and time history data values below this trigger level (within the sensitivity of the instrument) using the continuous mode of operation throughout the pile driving operation.
  - 5) Each of the two selected domestic water well casings for each turbine cluster will be monitored according to the following program:
    - a. Seismic accelerometers matching those used during the test pile monitoring program (PCB 393A03) will be mounted to the portion of the well casings accessible from the surface so as to capture vibrations in vertical and longitudinal (in-line with the shortest distance line from the well to turbine site under construction) if the well casing and its physical environment permit one or more directions to be monitored; otherwise, vibrations in at least one direction will be monitored.
    - b. The well casings will not be altered or entered (e.g., opening of well cover) for any reason.
    - c. As pile driving moves among the turbine sites, the longitudinal monitoring direction will be changed to match as closely as practicable, pending the physical feasibility of doing so for each of the wells (e.g., pumps, casing attachments or other obstructions may prohibit some orientations of the accelerometers) and the orientation of accelerometers will be documented for each day of monitoring.
    - d. The domestic water well monitoring instruments will be set to record all vibrations in a continuous mode when pile driving is occurring and during periods of time prior to and/or after pile driving so as to capture background readings. Vibration monitoring will not be conducted overnight.
    - e. Monitoring of the domestic water wells will include either an individual attendant (from Golder or the Project team) or an automated video recording system (if permissible) to document activities at the well site in the event that such on-site activities generate vibrations during the monitoring period.
  - 6) During pile driving, a Golder staff member will frequently read the output from the instruments at the turbine site making sure ground coupling is maintained and the Minimate system is operating properly. While on the turbine site, the Golder staff member will also monitor the times at which the pile driving starts and completes for each pile, any indications of changes in driving behavior, hammer blows per metre of pile penetration, final depth and coordinate monitoring with driving activities. It is expected that the pile driving crew or other staff will provide records for each pile driven, noting the times and conditions during pile driving as described above.
  - 7) The Golder staff member charged with operating the monitoring instruments will also travel between the turbine site and well monitoring locations throughout the monitoring durations to document conditions at the well sites and check on the status of the monitoring systems.
  - 8) A map illustrating the first of the turbine clusters is attached to this work plan. A second map, illustrating the locations of the two wells that will be monitored in this cluster, for which monitoring permission has been obtained, is also attached. This second map illustrates the distance between the two wells and the first of the turbine sites at which pile driving will commence for this cluster (T35).
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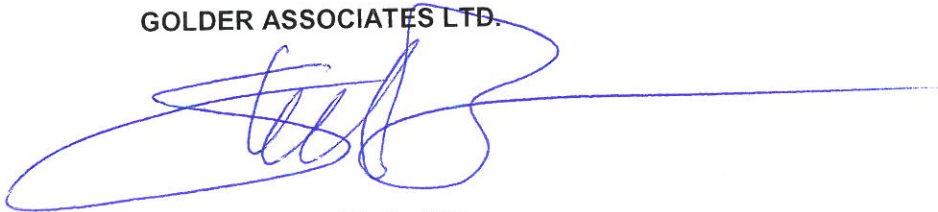
- 9) Identification of the remaining turbine site clusters and the two domestic water wells that will be monitored within each cluster will be provided by June 26, 2017. If the Project identifies that additional time is required to secure well locations Project representatives will notify the MOECC three (3) days prior to June 26, 2017 so a new submission date can be agreed upon,
- 10) Following conclusion of pile driving for the project, the results of the monitoring will be provided in a brief report summarizing:
  - a) conditions observed on site during installation of the instruments;
  - b) conditions observed during pile driving and times at which these conditions were observed;
  - c) conditions observed during periods when pile driving was not occurring and times at which these conditions were observed;
  - d) summaries of data for each of the monitored turbine sites and each monitored well; and
  - e) interpretation of data.

## Closure

We thank you for the opportunity to submit this work plan. Upon review and approval to proceed, the work plan will be stamped and signed by a licenced professional engineer in Ontario. North Kent 1 will not commence the Operations Phase of the Project until a ground-borne vibration monitoring program for Project operations is submitted to and approved in writing by the Director. If you have any other questions regarding the proposed work plan or require further clarification, please contact this office.

Yours truly,

**GOLDER ASSOCIATES LTD.**

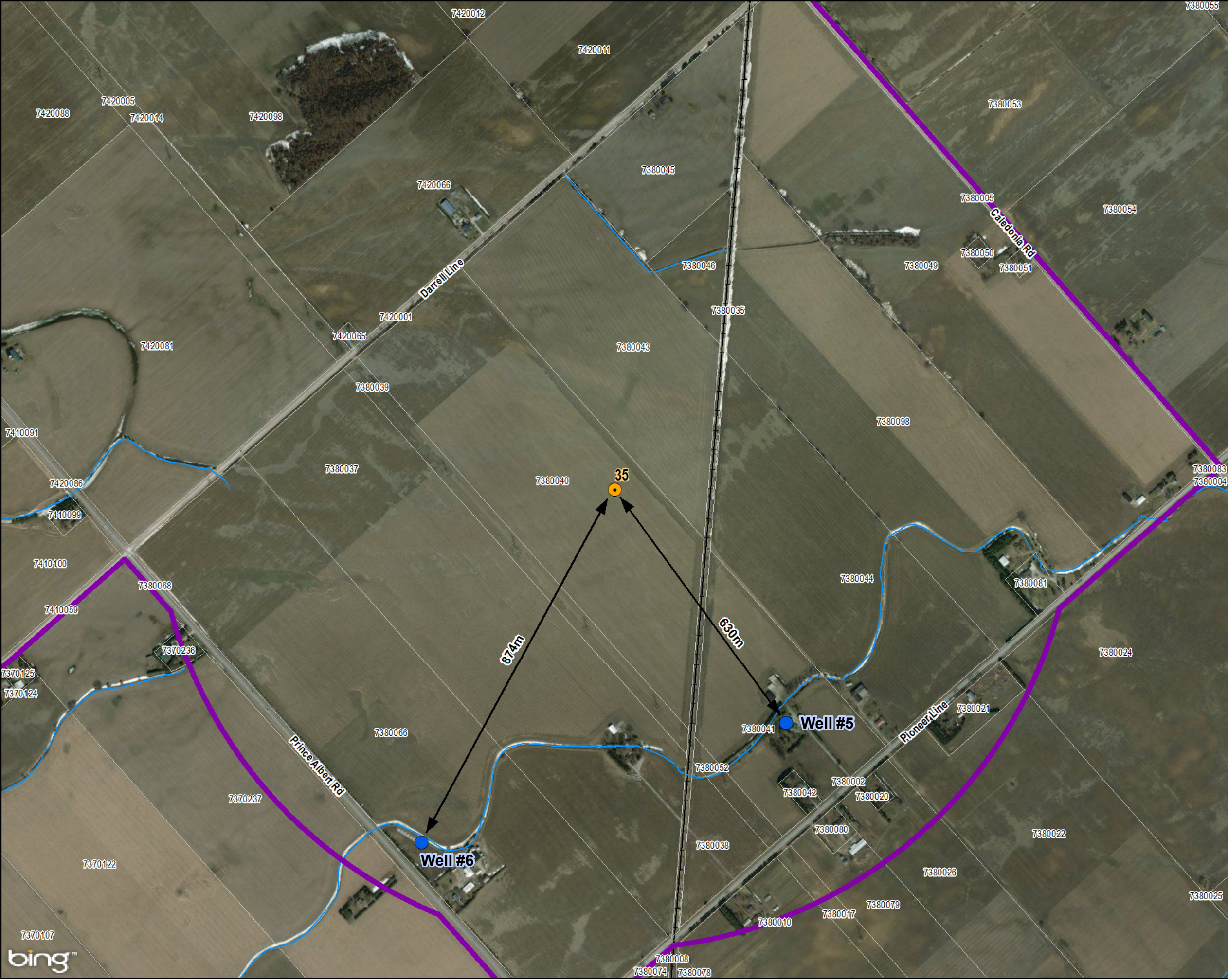


Storer J. Boone, Ph.D., P.Eng.  
Principal

SJB/MEB/cr

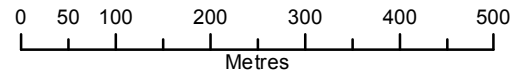
Attachments: Map of Wells  
Map of First Turbine Cluster






Legend

- Turbine
- Participating Private Wells
- Highway
- Road
- Railway
- Watercourse
- Property
- Project Study Area



North Kent Wind Project

Well Water Quality Pile-Driving  
Impact Assessment

Jun 2017	1:8,000	Datum: NAD83, Zone 17 Source: LIO, First Base 2015, NRSI 2015
P#: 60343599	V#: Final	
Figure 2		

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Map location: \\C:\AECOM\PF001\Projects\60343599\3000\Works\2016\GIS\Graphics\Design\WaterWells\_201603\WQI\_Wells\_Monitoring\_135.mxd  
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