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# Technical Memorandum

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| To | North Kent 1 LP | Page | 1 |
| CC | Mark Van der Woerd (AECOM), Jody Law (Pattern), Joshua Vaidhyan (Samsung) | | |
| Subject | **North Kent Wind 1 (Chatham-Kent, ON)**<br>**Well Water Impact Complaint Investigation - UPDATED**<br>**[redacted] - PIN 007530004, [redacted]** | | |
| From | Jason Murchison, P.Geo. | | |
| Date | November 30th, 2017 | Project No. | 60343599 |

## 1. Introduction and Background

AECOM Canada Ltd. (AECOM) has been retained by North Kent Wind 1 LP (NKW1) to provide hydrogeological services pursuant to *Condition G* of Renewable Energy Approval (REA) No. 5272-A9FHRL.

The purpose of this Technical Memorandum (TM) is to present a response to email correspondence received by NKW1 from Ms. Deb Jacobs, Environmental Officer, with the Ministry of the Environment and Climate Change (MOECC), Windsor Area Office, dated 13-September-2017. In this correspondence, Ms. Jacobs provides a summary narrative of a well interference complaint that was received by MOECC on 13-September (exact time unspecified) from [redacted], the property owner of [redacted] (Dresden, ON).

In brief, Ms. Jacobs describes the well interference complaint as follows:

> *The Ministry has received a new complaint from [redacted], of [redacted]. Who indicated that that his well pump is "deadheading" as of this morning due to sediment buildup and he cannot get water to his residence or his machine shop, both of which are at [redacted]. [redacted] can be reached at [redacted]. He is quite concerned as he is scheduled to be away starting Friday Morning, yet he has 12 employees that need to be able to work in the shop and require water in his absence.*

A copy of the MOECC correspondence described above is provided herein as **Attachment A**.

## 2. REA Condition Response

**Table 1** provides a summary of action(s) taken pursuant to REA Condition G5 in response to the current well interference complaint.

**TABLE 1:** REA CONDITIONS AND RESPONSE SUMMARY

| REA CONDITIONS | ACTION(S) TAKEN |
|---|---|
| **G5.** Should the Company receive a complaint about wells or well water from an owner of an active water well (i) within the Project Study Area; or (ii) outside of the Project | Steps undertaken to satisfy the requirements of Condition G5 are summarized, as follows:<br>(1) AECOM was retained by NKW1 to investigate a |

| REA CONDITIONS | ACTION(S) TAKEN |
|---|---|
| Study area and located within 1 km from each individual Equipment and meteorological tower, the microwave tower, and the operations & maintenance building, the Company shall retain a qualified expert (P.Eng or P.Geo) to immediately undertake the following:<br>(1) collect a water well sample at the complainant's water well, prior to any treatment systems ("raw"), after allowing the distribution system to flow for approximately 5 minutes and submit the water sample to a qualified laboratory for an analysis of the general chemistry suite of water quality parameters identified in Condition G3;<br>(2) compare the results of the analysis of the water sample noted in Condition G5(1) to the pre-construction water sampling analysis results noted in Condition G3 for the subject well (if a pre-construction water sample at the subject well was taken); and<br>(3) provide a detailed written opinion as to whether the water sampling analysis results demonstrate that the construction, operation or decommissioning of the Facility caused or may have caused an adverse effect to the well's water supply. | Well Interference Complaint received from MOECC at 3:01pm on 13-September-2017.<br>(2) AECOM arranged directly with the property owners an appointment to visit the property at 2:30pm on 14-September-2017 (based on property owner availability).<br>(3) Tasks completed by AECOM during the well interference complaint site visit included:<br>i) interview with the property owner regarding their reported well interference issue(s);<br>ii) collection of a raw (untreated) groundwater sample for analytical laboratory testing; and,<br>iii) collection of digital photographs of pertinent site features (eg. water well, water treatment equipment, etc.).<br>(4) Information obtained during the site visit has been compiled and is summarized within this technical memorandum. An opinion regarding potential association of the well interference complaint with local construction activities as part of the NKW1 Project is provided and potential remedial options are presented, as appropriate. |

## 2.1 Property Owner Statements Regarding Well Interference Complaint

During AECOM's 14-September-2017 site visit to the subject property, a series of seven (7) standard questions were raised with the property owner ([redacted]) for the purposes of obtaining further details regarding their reported well water supply issue(s). The questions raised with the property owner were as detailed on *Form B: Well Complaint Procedure for Site Investigation*, included as part of MOECC's approved *Well Interference Protocol* (AECOM, 2017) for the NKW1 project.

**TABLE 2:** PROPERTY OWNER QUESTIONNAIRE RESPONSE SUMMARY

| QUESTION | PROPERTY OWNER RESPONSE |
|---|---|
| "Please explain the type of problem you are having" | • Approximately two (2) days ago (12-September-2017), filters plugged.<br>• Filter system has been in place for about two (2) months.<br>• Outdoor fountain has increased rust colouring on rock surface over last month.<br>• Running business and supplying home, need water. |
| "What do you think is the cause?" | • Windmill construction – nearby pile driving. |
| "When did you first notice the problem (Date/Time)?" | • Approximately two (2) days prior to AECOM site visit (ie. 12-September-2017). |
| "Is the problem still occurring?" | • Yes. |
| "Do you have an alternate source of potable water (i.e. municipal water)?" | • No. |
| "Were you provided a temporary supply of potable water?" | • Yes.<br>• Bottled water arrived during AECOM site visit. |

| | |
|---|---|
| "Did you participate in the Detailed Well Assessment program prior to construction?" | • Yes |

Upon completion of the questionnaire, both the property owner ([redacted]) and his representative of Water Wells First (Mr. Kevin Jakubec) were provided an opportunity to review the responses detailed in **Table 2** and were in agreement that the information provided was accurate to the best of their knowledge.

At the time of our site visit, the property owner and his representative of Water Wells First provided copies of various water quality analysis results and jars of water that reportedly were obtained from the site well. Unfortunately, with the exception of a baseline sample collected on 16-January-2017, AECOM did not undertake or witness the collection of any of these samples, nor are we able to independently verify the sampling, preservation and/or analytical methods used in the collection and testing of these samples. As a result, this information was not considered as part of the current complaint investigation.

## 3. Construction Activities and Vibration Monitoring

Within a two (2) week timeframe preceding the [redacted] reported outset of well impact (12 September-2017), pile driving for foundation construction as part of the NKW1 project was completed at the following six (6) turbine locations:

- T14 – September 11th @ 2,400 m Southeast
- T33 – September 5th & 6th @ 2,450 m North-Northwest
- T45 – August 30th & September 12th @ 5,650 m Northeast
- T20 – August 30th @ 6,100 m Northeast
- T46 – August 28th & 29th @ 6,230 m Northeast
- T21 – August 28th & 29th @ 6,650 m Northeast

Approximate directions and distances away from the subject property are provided above for reference purposes. Based on their distances of greater than 5 km from the [redacted] property, vibration monitoring relating to the installation of pile foundations at Turbines T45, T20, T46 and T21 has not been considered as part of this assessment.

The following turbines sites represent the nearest three (3) locations to the subject property.

- T44 – 1,275 m East-Northeast
- T5 – 1,400 m North-Northwest
- T52 – 1,600 m North

Up to and including the reported date of impact by the property owner, pile driving work at each of the locations above had not yet commenced.

Pile driving activities for foundation construction at Turbine T14 commenced in the area of Pile #18 at 8:39am on 11-September-2017. Following the initial pile installation, an additional seventeen (17) piles at the T14 site were driven on that same day, with work concluding at the location of Pile #2 at approximately 4:32pm. As noted above, the pile driving work at T14 was undertaken at a distance of approximately 2,400 m (southeast) from the property owner's water well.

Pile driving activities for foundation construction at Turbine T33 commenced in the area of Pile #1 at 1:10pm on 5-September-2017. Following the initial pile installation, an additional eight (8) piles at the

T33 site were driven on that same day, with work concluding at the location of Pile #9 at approximately 6:28pm. Nine (9) additional piles were installed and two (2) restrikes were completed at the T33 site on the subsequent day, with the final restrike at Pile #6 having been completed at 6:23pm. As noted above, the pile driving work at T33 was undertaken at a distance of about 2,450 m (north-northwest) from the property owner's water well.

Monitoring of vibration effects during pile driving and restrikes at T14 and T33 was completed by Golder Associates Ltd. (GAL) on behalf of NKW1 in accordance with *Condition H* of the REA. The monitoring program developed and implemented by GAL (and as approved by MOECC) comprised the measurement of particle velocities at locations in close proximity to the piles, as well as at two (2) local private water well supplies in the vicinity of each turbine. The local groundwater well supplies monitored during pile driving at T14 included Well 13 ([redacted]) and Well 14 ([redacted]), reportedly being located at radial distances of 841 m and 580 m from T14, respectively. Monitored wells during pile driving at T33 included Well 3 ([redacted]) and Well 4 ([redacted]), reportedly being located at radial distances of 1,778 m and 2,080 m from T33, respectively. Vibration monitoring results obtained by GAL are summarized in a technical letter, dated 20-September-2017.

In addition to the foregoing, a site-specific vibration assessment pertaining to the subject property was completed by GAL, the results of which are presented in a letter, dated 24-November-2017.

A copy of each GAL letter is included herein as **Attachment B**.

Based on the vibration monitoring completed by GAL, the following interpretation and conclusions are presented within their 20-September-2017 technical letter:

> *In summary, vibration measurements obtained with the geophone system (Instantel Minimate) on all sites reported herein were within expectations as compared to those measured at the T5 and T42 test pile sites and general project expectations. On sites where piles penetrated through the near-surface soils under their own weight or a low number of hammer blows (e.g., less than 5) the ground surface vibrations during this phase of pile driving for each pile were nominal. Ground surface vibrations measured when driving the piles on the glacial till or rock were also either comparable to or less than those at the test pile sites and, in all cases, were within expectations. Vibration measurements made using the accelerometers mounted on the well casings were also within expectations based on the T5 and T42 test pile sites and turbine to well distances.*
>
> *Well monitoring to-date has identified several wells for which the vibrations induced by the pumps dominated the instrument readings when the pumps were active or other activities dominated the measured vibrations. Relevant notes regarding various pumps, their operation and other influences on vibration measurements are described below:*
>
> - ***Well 3:*** *Activities at the Well 3 property included crop harvesting, movement of farm vehicles and loading of haul trucks in relatively close proximity to Well 3.*
> - ***Well 4:*** *Maximum well casing vibration velocities for Well 4 of about 4.8 mm/s were recorded on September 6, 2017 when a well pump was connected, operated and adjusted and the owner made frequent return visits to the well shed. Crop harvesting was also carried out as close as about 25 m from the well casing.*
> - ***Well 13:*** *Well 13 is located approximately 87 m from the centreline of Union Line which is subjected to local truck traffic. Review of the data indicates that well pumping and non-pile driving transient sources influenced the results at this location. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.*

- ***Well 14:*** *Well 14 is located approximately 13 m from the centreline of Union Line which is subjected to local truck traffic. A limited evaluation of transient traffic vibrations indicated well casing velocities of at least 0.079 mm/s associated with this cause, though inspection of the data indicates higher values occurred outside of pile driving times. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.*

*In summary, measured vibrations have been evaluated and reported as associated with driving 329 piles and replacement piles on the glacial till/rock along with restrike events and pile dynamic testing events. These measurements have been obtained at the turbine sites and at wells located at distances ranging from 580 to 4,359 m from the turbine sites. It is our opinion, based on these measurements, that the vibration magnitudes at all wells during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at these well sites, less than the observed and measured influence of well pumps and inconsequential for the wells.*

The interpretation and conclusions above are reconfirmed by GAL within their site-specific assessment letter, dated 24-November-2017, which reads:

*Based on the data available to-date from the test pile and construction monitoring programs, the distance between pile driving and the [redacted] residence, the proximity of the residence to both Greenvalley Line and St. Clair Road, pile-induced vibrations at the well would be expected to be one or more orders of magnitude less than vibrations induced by typical pumping systems in the area, less than vibrations associated with vehicles operating near the wells and less than the International Standards Organization (ISO) threshold for human perception of vibrations at frequencies greater than 8 Hz (0.1 mm/s). At distances between pile driving and wells ranging from about 580 m to 911 m, directly relevant to this water well complaint, maximum vibration velocities related to pile driving ranged from 0.030 to 0.003 mm/s, respectively. The distance to [redacted] is such that any vibration velocities associated with pile driving would have been well below this range. It is our opinion, based on vibration measurements, that the vibration magnitudes during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at these well sites, less than the observed and measured influences of typical well pumps in the area and inconsequential for the well at [redacted].*

## 3.1 Discussion

GAL reports that local background PPV values generally fall within the range of <0.01 to 0.07 mm/s, based on data previously collected at T5 and T42. As a basis of comparison, the particle velocity threshold for human perception is stated by GAL to be approximately 0.1 mm/s at between about 8 and 100 Hz (ISO 2631-2).

The interpretation presented by GAL within their technical letter is confirmed through a review of the vibration monitoring data summary appended thereto.

Reported daily Peak Particle Velocity (PPV) measurements obtained at Well 13 during pile driving at T14 ranged between 0.005 and 0.543 mm/s, whereas at Well 14 PPV values ranged between 0.014 and 0.675 mm/s. At Well 13, when the vibration effects of well pump operation are excluded by GAL, reported PPV values decrease significantly to between 0.007 and 0.011 mm/sec. These PPV values are interpreted to be within local background levels. Considering that the subject property is located at a distance of approximately 1.5 km farther away than the nearest monitored well (Well 13), it is interpreted that any vibration generated during pile driving at T14 would be fully attenuated prior to reaching the area local to the site well.

Reported daily Peak Particle Velocity (PPV) measurements obtained at Well 3 during pile driving at T33 ranged between 0.003 and 0.056 mm/s, whereas at Well 4 PPV values ranged between 0.072 and 4.987 mm/s. At Well 4, the vibration data presented is reported to have been "significantly influenced by near-well activities" unrelated to pile driving activities at T33. Excluding PPV values influenced by outside sources, the monitoring results presented by GAL are interpreted to generally be within local background levels. Considering that the subject property is located at a distance of approximately 400 m farther away than the nearest monitored well (Well 4), it is interpreted that any vibration generated during pile driving at T33 would be fully attenuated prior to reaching the area local to the site well.

## 4. Well Construction Details

**Table 3** provides a summary of available construction details for the water well located at [redacted], based on details provided to AECOM by [redacted] during our 14-September-2017 well interference complaint site visit, as well as information provided by the property owners on their completed baseline water well survey (WWS) form and during our baseline site visit on 16-January-2017.

A review of the MOECC on-line database did not reveal a water well record for the subject property.

Visual inspection and measurement of well details (ie. including well type, total depth, water level, etc.) was unable to be completed by AECOM during our 14-September-2017 site visit due to the wellhead being buried. Similarly, a photograph of the well was unable to be obtained.

**TABLE 3:** REPORTED PRIVATE WELL CONSTRUCTION DETAILS

| DETAILS | [redacted] (PIN 007530004) |
|---|---|
| Well Tag # | *Unknown* |
| Well ID | *Unknown* |
| Installation Date | Assumed Prior to 1990 (as on WWS states that [redacted] have owned property for 26.5 years) |
| Well Location | Immediate Rear of Residence (as on WWS) |
| Contractor | *Unknown* |
| Contractor No. | *Unknown* |
| Construction Method | Drilled (as on WWS) |
| Total Depth | 21.9 mBGS (72') (as on WWS) |
| Target Formation | Possible Shale Bedrock (based on Well Depth Reported on WWS) |
| Casing Length | *Unknown* |
| Casing Diameter | 102 mm (4') (as on WWS) |
| Casing Material | *Unknown* |
| Casing Stick-Up | Below Grade (exact depth unknown as wellhead buried) |
| Annular Seal | *Unknown* |

| DETAILS | [redacted] (PIN 007530004) |
|---|---|
| Sealant Type | *Unknown* |
| Well Screen Installed? | *Unknown* |
| Well Screen Details | *Unknown* |
| Well Screen Interval | *Unknown* |
| Well Cover Type | *Unknown* (wellhead buried) |
| Pump Intake Depth | 21.9 mBGS (72') (as on WWS) |
| Pumping Rate | 24 L/min / 6.3 USgpm (as measured by AECOM – treated water stream, average of 5 separate flow rate measurements) |
| Well Pump Type | Piston Pump (as observed by AECOM) (reported on WWS to be ~27 years old) |
| Well Pump Size | ½ hp (as on WWS) |
| Static Level | *Unknown* |
| Pumping Level | *Unknown* |

**NOTE:** mBGS - meters below ground surface; L/min – litres per minute; USgpm – US gallons per minute.

## 4.1 Limited Well Flow Rate Testing and Pumping System Assessment

During AECOM's well complaint site visit on 14-September-2017, a limited flow rate test was completed to assess the current pumping capacity of the well pump (piston type – ½ hp). This testing was completed using a standard hose faucet installed on the pump discharge within the basement of the residence at a location upstream of a recently-installed particle filtration array (see **Photo 1** – blue handle faucet at lefthand side of upper filter bank). Prior to the test, a ball valve located downstream of the faucet was shut to prevent backflow of water through the pressure tank, piping, and particle filtration system.



**PHOTO 1: Particle Filter System (as observed by AECOM on 14-September-2017)**

For the test, the well pump was permitted to operate continuously for a period of approximately ten (10) minutes using a 12 mm (1/2") hose assembly (provided by [redacted]) attached to the faucet orifice. Discharge from the hose was directed into a nearby sump hole. During pumping, the discharge rate from the hose was assessed by AECOM on three (3) occasions. Flow rate measurement was completed by timing the discharge of 10 L of water into a calibrated pail. Based on this monitoring, a constant flow rate of approximately 7 L/min (1.8 USgpm) was determined. No variation in flow rate (including increasing or decreasing trends) was observed during the test. Similarly, no detectable changes in the quality of the water discharge stream (eg. colour, odour, dissolved gas, sediment, etc.) were identified either during flow rate testing or subsequent water quality sample collection activities.

Following completion of sample collection, the property owner operated the water system with the filtration system on-line. Within a period of approximately 1.5 minutes, the pressure at the inlet side of the filtration system increased significantly (observed via pressure gauge) and the pump began to labour to continue to provide water. After approximately two (2) minutes, the pump ceased operation as it could not overcome the backpressure generated by the water treatment system.

The location of recently-installed filtration system represents a concern based on observations made during our 14-September-2017 site visit. As can be observed in **Photo 1**, the filtration system is installed intermediate to the well (piston) pump and pressure tank / pressure switch. This configuration is not recommended, as the presence of the filter array would result in the generation of additional backpressure on the discharge side of the pump (as observed during our site visit). The amount of backpressure generated is cumulative based on the number and pore diameter of filters that are installed and will progressively increase over time as the capacity of the filters becomes used. With the pressure tank and pressure switch being located on the opposing side of the filtration array, the water system (via the pressure tank and switch) may be calling for water for prolonged periods of time, resulting in significant additional effort for the pump. This can lead to possible pump damage or failure due to prolonged operation under a significant backpressure condition and/or repetitive cycling. Labouring and/or repetitive cycling of a well pump can also result in the generation of turbulence within the well which can suspend sediment existing at its base and draw it into the water system. This effect may be exacerbated should the pump inlet within the well be located in close proximity to the well bottom. To alleviate these issues, water filtration systems for a well supply typically are installed downstream of the primary pumping and pressure systems (ie. on the distribution side of the water system), inclusive of such components as the well pump, pressure switch and pressure tank.

The pump labouring and lack of water observed during pump and water treatment system in operation on 14-September-2017 is interpreted to likely be a result of one or both of the potential mechanisms below.

- Age / condition of the well pump and/or downhole components (including the well itself);
- Presence of the filtration system (as noted above) resulting in a restriction and/or damage to the pumping system.

In either case above, it is recommended that the property owner contact an MOECC-licenced well pump contractor (Class 1 / Class 4) to assess the system components and to make any necessary replacement, repairs or re-arrangements, as necessary. The information detailed herein appears to be related to the property's pumping / filtration systems and not associated with changes in groundwater flow / quality.

# 5. Water Quality Data

**Table 4** provides a summary of available groundwater quality data for the site well. Laboratory Certificates of Analysis are included as **Attachment C**.

**TABLE 4:** PRIVATE WELL SAMPLING SUMMARY

| LOCATION | SAMPLED BY | DATE | TYPE | PURPOSE |
|---|---|---|---|---|
| [redacted] | AECOM | 16-January-2017 | Raw (Untreated) | Baseline |
| | AECOM | 14-September-2017 | Raw (Untreated) | Complaint Investigation |

## 5.1 Discussion

Available raw (untreated) groundwater sampling data for the well indicates the presence of a poor baseline raw (untreated) groundwater quality, with elevated levels of total dissolved solids, chloride, colour and sodium, in addition to a low level of hardness, as shown in **Table 5**. Groundwater quality data reported for the raw groundwater sample collected by AECOM during our 14-September-2017 site visit also is included in the table for comparative purposes.

**TABLE 5:** RAW (UNTREATED) GROUNDWATER SAMPLING RESULTS

| PARAMETER | ODWQS CRITERIA | ODWQS TYPE | BASELINE (16-January-2017) | COMPLAINT INVESTIGATION (14-September-2017) |
|---|---|---|---|---|
| Escherichia coli | 0 CFU/100mL | MAC | Non detection | Non detection |
| Total Coliforms | 0 CFU/100mL | MAC | Non detection | Non detection |
| Electrical Conductivity | -- | -- | 1,410 µS/cm | 1,420 µS/cm |
| pH | 6.5 – 8.5 | OG | 8.15 | 8.49 |
| Total Hardness (as $CaCO_3$) | 80 – 100 mg/L | OG | **59.5 mg/L** | **61.0 mg/L** |
| Total Dissolved Solids | 500 mg/L | AO | **724 mg/L** | **690 mg/L** |
| Total Suspended Solids | -- | -- | <10 mg/L | <10 mg/L |
| Alkalinity (as $CaCO_3$) | 30 – 500 mg/L | OG | 262 mg/L | 267 mg/L |
| Fluoride | 1.5 | MAC | 1.04 mg/L | 1.25 mg/L |
| Chloride | 250 | AO | **294 mg/L** | **309 mg/L** |
| Nitrate as N | 10 | MAC | <0.05 mg/L | <0.25 mg/L |
| Nitrite as N | 1 | MAC | <0.05 mg/L | 0.07 mg/L |
| Bromide | -- | -- | 0.71 mg/L | <0.05 mg/L |
| Sulphate | 500 mg/L | AO | <0.10 mg/L | <0.50 mg/L |
| Ammonia as N | -- | -- | 0.23 mg/L | 0.27 mg/L |
| Dissolved Organic Carbon | 5 mg/L | AO | 1.3 mg/L | 4.4 mg/L |
| Colour | 5 TCU | AO | **8 TCU** | **27 TCU** |
| Turbidity | 5 NTU | AO | 2.9 NTU | 2.1 NTU |
| Calcium | -- | -- | 14.5 mg/L | 14.4 mg/L |
| Magnesium | -- | -- | 5.66 mg/L | 6.08 mg/L |
| Sodium | 200 mg/L | AO | **253 mg/L** | **267 mg/L** |
| Potassium | -- | -- | 2.05 mg/L | 1.98 mg/L |

| | | | | |
|---|---|---|---|---|
| Iron | 0.300 mg/L | AO | 0.123 mg/L | 0.278 mg/L |
| Manganese | 0.050 mg/L | AO | 0.008 mg/L | 0.010 mg/L |

**NOTE:** MAC – maximum acceptable concentration (health-related); AO – Aesthetic Objective (non health-related); Operational Guideline (non health-related)

At the time of AECOM's baseline site visit on 16-January-2017, no water treatment devices reportedly were installed, as per the property owner's completed WWS form and as confirmed verbally by [redacted] to AECOM staff at that time. During AECOM's 14-September-2017 site visit however, a multi-stage particle filtration system was observed to have been installed within the basement of the property owner's residence, as shown in **Photo 1**.

According to [redacted], the filter housings contain progressively decreasing pore sizes (packaging not available to confirm), including 140 (104 µm), 250 (61 µm), 500 (30 µm) and 1,000 (15 µm) mesh sediment filters (in-line T-Standard filter housings, upper bank in photo), as well as two (2) 5µm cartridge filters and two (2) 1µm cartridge filters (clear styrene-acrylonitrile bowls, lower bank in photo). The particle filtration system present at the time of our 14-September-2017 site visit reportedly was installed approximately two (2) months prior at the recommendation of Water Wells First (WWF) as part of an ongoing particle/sediment quality study.

Sample collection during our 14-September-2017 site visit was completed using a valve installed immediately downstream of the well pump and upstream of the water treatment system in the basement of the [redacted] residence (blue handle faucet at lefthand side of upper filter bank in **Photo 1**). Prior to sampling, the faucet was permitted to flush for a period of approximately ten (10) minutes with the pumped water being directed into a calibrated pail. As noted previously, no detectable changes in the water discharge stream (eg. colour, odour, dissolved gas, sediment, etc.) were identified either during flow rate testing or water quality sample collection activities.

No exceedances of health-related parameters analyzed, including Escherichia coli and Total Coliform bacteria, Nitrate (as N), Nitrite (as N), and Fluoride, were detected either in the baseline or complaint investigation raw (untreated) groundwater samples collected from the existing on-site well supply.

Turbidity is an Aesthetic Objective (AO) of the ODWQS. In this regard, a value of 5 Nephelometric Turbidity Units (NTU) has been established by MOECC. The MOECC's *Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines* (June 2003; revised June 2006) makes a clear distinction between turbidity related to organic constituents and inorganic constituents stating: "Raw water supply which is ground water with very low organic content may contain inorganic-based turbidity, which may not seriously hinder disinfection. For such waters, an Operational Guideline for turbidity is not established". Further guidance is provided by MOECC regarding the relationship between turbidity and its organic and inorganic components, the disinfection processes, and as a measure of the water supply filtration and treatment efficiency. The technical explanations also note that while organic turbidity is an important measure as related to health concerns, the AO value is an aesthetic component which is set for all waters at the point of consumption (i.e., not at the source). At the site well, turbidity levels were 2.9 NTU in the baseline sample and 2.1 NTU during the recent well interference complaint site visit. Both values are within ODWQS limits.

Total suspended solids (TSS) levels within both the baseline and complaint investigation raw groundwater samples were below laboratory method detection limits indicating a relative absence of detectable sediment load in the raw (untreated) groundwater pumped from the well. An ODWQS criteria limit has not been established for this parameter.

Both the baseline and complaint investigation sampling results indicate hardness levels that are relatively low (soft) in the raw (untreated) groundwater and below the Ontario Drinking Water Quality Standard (ODWQS) Operational Guideline (OG) range of 80-100 mg/L. This owes to the relatively low carbonate content of the local shale bedrock and correspondingly low concentrations of calcium and magnesium within the groundwater source. Low hardness levels within water can result in the accelerated corrosion of water pipes, appliances, and other metallic fixtures and components.

The potential for groundwater quality impacts associated with pile driving is both time-dependent and related to the intensity and propagation of ground-borne vibration. In the case of piling associated with T14 and T33 within two (2) weeks prior to the reported outset of well impacts (12-September-2017), no significant vibrations attributed to pile driving were detected at either in close proximity to the turbine locations, nor at any of the monitored wells, as discussed previously in **Section 3**. Based on GAL's monitoring data and considering the separation distance which exists between T14 / T33 and the site well (ie. >2.4 km), the suspension of particles within or in its immediate vicinity is not considered plausible.

As an alternate consideration, to have the potential to impact the quality of groundwater at the subject well, vibration impacts in the immediate vicinity of pile driving at T14 and/or T33 would have needed to result in: i) the suspension of settled particles within the groundwater system; ii) the particles remaining in suspension for a prolonged period of time; and, iii) the water well being situated in a position hydraulically downgradient of and/or within the radius of pumping influence relative to the location of T14 / T33. Factors (ii) and (iii) above are not considered plausible in the context of the local hydrogeological setting (ie. potential hydraulic gradient and groundwater travel times), vibration monitoring data collected by GAL, and reported timeline of outset of impact at the site well.

# 6. Conclusions

Based on a review and interpretation of information gathered during AECOM's well interference complaint investigation, as presented herein, it is our opinion that the groundwater quality / supply issue reported by the property owners at [redacted] (PIN 007530004) is *not* as a result of NKW1 turbine foundation construction or pile-driving activities. No indication of water quality impact at the site well was apparent based on our recent sampling works relative to baseline data collected prior to the outset of construction. The water quantity issues reported by [redacted] appear to be more related to local water system issues versus an area-wide impact to the local groundwater system. As noted within this report, assessment by a qualified professional of the current condition of the on-site well supply, pumping system, and current installed location of the particle filtration system is recommended.

No pile driving work was being completed as part of the NKW1 construction activities within a radial distance of 2.4 km from the subject property within a period of two (2) weeks prior to the reported outset of water quality concerns that could have represented a potential mechanism of impact. With respect to the pile driving works completed at T14 and T33, monitoring data provided by GAL and presented in this report indicates that full attenuation of residual ground vibration likely would have occurred prior to reaching the site well.

This interpretation and opinions presented in this technical memorandum are based on information available as of the date the document was prepared. Should additional information become available at a future date, AECOM reserves the right to review and potentially reconsider the findings of our current assessment through the issuance of addenda to this technical memorandum.

*-- End of Memorandum --*

# Attachments

# Attachment A

## Correspondence

**From:** Jacobs, Deb (MOECC) [mailto:deb.jacobs@ontario.ca]
**Sent:** Wednesday, September 13, 2017 3:01 PM
**To:** Josh Vaidhyan (j.vaidhyan@samsung.com); Jody Law (jody.law@patternenergy.com); mark.vanderwoerd@aecom.com
**Cc:** Gilbert, Teri (MOECC); Smith, Mark (MOECC); Moroney, Michael (MOECC); Harman, Bruce (MOECC); Lehouillier, Jason (MOECC); McDonald, Dan (MOECC); Colella, Nick (MOECC); Keyvani, Mohsen (MOECC)
**Subject:** New complaint - [redacted] and follow up on old complaint (XXXXXXX)
**Importance:** High

1. The Ministry has received a new complaint from [redacted], of [redacted]. Who indicated that that his well pump is "deadheading" as of this morning due to sediment buildup and he cannot get water to his residence or his machine shop, both of which are at [redacted]. [redacted] can be reached at [redacted]. He is quite concerned as he is scheduled to be away starting Friday Morning, yet he has 12 employees that need to be able to work in the shop and require water in his absence.

It is the Ministry's expectation that Samsung / Pattern will initiate the complaint response procedure forthwith, as per Condition G5 in your REA. Please keep us (including Michael Moroney) apprised of all developments re this complaint.

2. I received a call from <<Property Owner Information Redacted >>.

*Deb Jacobs*
*Environmental Officer / Agente de l'environnement*
*Ministry of the Environment and Climate Change*
*Ministère de l'Environnement et de l'Action en matière de changement climatique*
*Windsor Area Office / Bureau du Secteur de Windsor*
*4510 Rhodes Drive, Unit(è) 620*
*Windsor, Ontario*
*N8W 5K5*
*Telephone: 519-948-4148*
*Fax / Télécopieur: 519-948-2396*
*E-Mail /Courriel: deb.jacobs@ontario.ca*

# Attachment B

## Vibration Monitoring Data (Golder Associates Ltd.)

November 24, 2017 Project No. 1668031-2000-L19R

Mr. Jody Law
c/o North Kent Wind 1 LP
355 Adelaide Street West, Suite 1000
Toronto, ON M5V 1S2

**WATER WELL COMPLAINT 9**
**NORTH KENT WIND 1 PROJECT**
**CHATHAM-KENT, ONTARIO**

Dear Mr. Law:

This letter is provided to summarize vibration monitoring data associated with Well Complaint 9 dated September 17, 2017 related to the well located at [redacted] in Dresden, Ontario. For the purposes of this letter, vibration data is summarized for the period starting one day prior to prior to the first reported well issues, September 12, 2017 through to one day after.

Table 1 is attached summarizing the following data:

1) date of pile driving;

2) turbine site at which pile driving was undertaken and the number of piles driven on the identified date;

3) maximum measured particle velocities at three locations:

    a. at the turbine site; and

    b. at the two wells within the turbine cluster specified for monitoring where the distance from the turbine site to the monitored well is also shown;

    where these tabulated measurements specifically exclude vibrations directly associated with the well pumps (described below) but include vibrations attributable to other general sources such as nearby road and utility construction, nearby car and truck traffic and movements of farm equipment as examples, and the distances from the pile driving to the well monitoring locations;

4) notes specific to the monitoring data; and

5) the distance from the pile driving to the well for which the complaint was submitted.

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Pile driving of the closed-end pipe piles was completed in accordance with the Project foundation design using equipment with a driving hammer with a rated energy no greater than the hammer used during the test pile vibration monitoring. During pile driving, the times during which the pile was being actively struck by the hammer were recorded from the start of hammering to conclusion of hammering. Further, the times during which the pile was driven on glacial till/rock were recorded based on observations of the pile driving conditions. It should be noted that very little energy was required during initial pile penetration since piles penetrated significant depths into the soft clay soil under their own weight or with very few hammer blows. Table 1 summarizes the numbers of individual piles driven at each turbine location on the noted dates, the distances from the turbine locations and monitored wells, and distances of pile driving to the well for which the complaint was reported.

Vibrations at the turbine sites were monitored using portable construction vibration monitoring geophone devices common to construction monitoring and in accordance with the approved monitoring work plan. Vibrations at the well locations were monitored using three accelerometers mounted to the steel well casings and a portable data collection system in accordance with the approved monitoring plan. Monitoring of the well casings and pile driving sites was completed continuously during driving of all piles relevant to this letter. All monitoring instruments were calibrated at the manufacturer or manufacturer-approved facility prior to use by Golder. All such calibrations were conducted on a schedule as required according to the manufacturer or instrument supplier. Field verification of accelerometer calibration was completed with a portable controlled vibration source before and after each time the accelerometers were installed on well casings. Accelerometer responses during field verification remained within required tolerances.

Following pile driving, data was downloaded from all devices, stored electronically, vibration magnitudes were assessed, compared to pile driving records and observations at the well sites and summarized. Assessment of vibrations included examination of time histories of data with a specific focus on comparing observation of vibration energy sources such as pile driving, well pumps and nearby farm and roadway vehicle traffic. Analysis of accelerometer data was completed using the methods defined in the test pile vibration monitoring program (June, 2017). Evaluation of data was completed in Golder's London, Ontario office.

When reviewing Table 1, attached, it should be noted that during well monitoring of multiple wells in the area, well casing vibrations directly attributable to the well pumps were measured and these were as much as 2.4 millimetres per second (mm/s) at Well 12 with one well in the area (Well 4) experiencing vibrations of almost 5 mm/s during installation, initial operation and adjustments. One of the monitored wells, Well 13, also experienced pump-induced vibrations similar to other wells in the area. Well 14, the second of the two monitored wells relevant to this letter, was located within 13 m of the [redacted] centre line and experienced vibration magnitudes of as much as 0.675 mm/s resulting from passing road traffic.

Details of the well at [redacted] were not available. It was reported by AECOM (October 11, 2017) that the well casing was buried and inaccessible for viewing. Based on AECOM's observations, a piston pump and filtration system were attached to the water line.

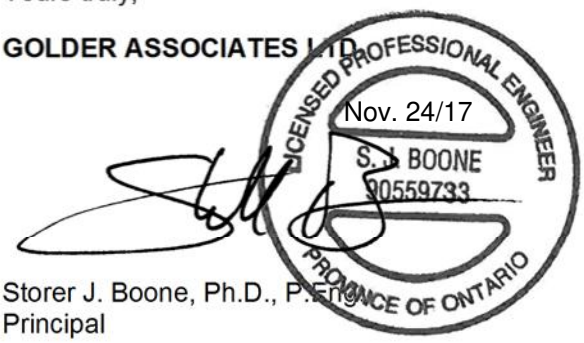
Based on the data available to-date from the test pile and construction monitoring programs, the distance between pile driving and the [redacted] residence, the proximity of the residence to both Greenvalley Line and St. Clair Road, pile-induced vibrations at the well would be expected to be one or more orders of magnitude less than vibrations induced by typical pumping systems in the area, less than vibrations associated with vehicles operating near the wells and less than the International Standards Organization (ISO) threshold for human perception of vibrations at frequencies greater than 8 Hz (0.1 mm/s). At distances between pile driving and wells ranging from about 580 m to 911 m, directly relevant to this water well complaint, maximum vibration velocities related to pile driving ranged from 0.030 to 0.003 mm/s, respectively. The distance to [redacted] is such that any vibration velocities associated with pile driving would have been well below this range. It is our

opinion, based on vibration measurements, that the vibration magnitudes during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at these well sites, less than the observed and measured influences of typical well pumps in the area and inconsequential for the well at [redacted].

We trust that this letter is adequate for your present requirements. If any point requires further clarification, please contact this office.

Yours truly,

**GOLDER ASSOCIATES LTD.**




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

SJB/MEB/cr

CC: J. Vaidyan, Samsung

Attachments: Table 1 - Summary of Vibration Monitoring Data, Well Complaint 9

n:\active\2016\3 proj\1668031 pattern_north kent vib monit_chatham-kent\ph 2000-vib monit field work\2-correspondence\3-ltrs\l19\1668031-2000-l19r nov 24 17 water well complaint 9.docx

**Table 1: Summary of Vibration Monitoring Data, Well Complaint 9[1]**

| Date | Turbine and Piles[4] | Measured Maximum Particle Velocities During Pile Driving, Inclusive of Traffic and Other Activities, Exclusive of Pump-Induced Vibrations (mm/s)[2] | | | | Distance from Well Complaint Residence (m) |
|---|---|---|---|---|---|---|
| | | Turbine Site | Monitored Well (Well No., distance) | Monitored Well (Well No., distance) | Notes[3] | |
| ***Complaint 9 September 12, 2017*** | | | | | | |
| 9/11/2017 | T14 (18) | 4.95 | 0.114 (W13, 841 m) | 0.675 (W14, 580 m) | Maximum values associated with traffic passing Well 14. See text. | 2,363 |
| 9/12/2017 | *No Pile Driving* | | | | | |
| 9/13/2017 | *No Pile Driving* | | | | | |

NOTES: 1) Table shall be read in conjunction with accompanying letter.
2) Other activities included nearby car and truck traffic on adjacent road, vehicles entering and leaving the property, farm equipment travel near the well, etc.
3) See letter text for discussion of pump and other influences.

September 20, 2017 Project No. 1668031-2000-L06

Mr. Jody Law
c/o North Kent Wind 1 LP
355 Adelaide Street West, Suite 1000
Toronto, ON M5V 1S2

**SUMMARY OF VIBRATION MONITORING**
**FOUNDATION PILE DRIVING – MULTIPLE TURBINES**
**NORTH KENT WIND 1 PROJECT**
**CHATHAM-KENT, ONTARIO**

Dear Mr. Law:

Please find attached a summary of the vibration monitoring that has been undertaken during driving of foundation piles for turbines being constructed as part of the North Kent Wind 1 project (NK1) at the locations listed in Table 1 (following the text of this letter) through to September 12, 2017, exclusive of data for Turbines T26 and T27 as these are still being processed and analyzed. Vibration monitoring was carried out to meet Section H1 of the Renewable Energy Approval (REA) document issued by the Ontario Ministry of the Environment and Climate Change (MOECC). The work was carried out in accordance with a vibration monitoring program prepared by Golder Associates Ltd. (Golder) dated June 2, 2017 and subsequently approved by MOECC and issued June 9, 2017.

This report addresses vibration monitoring data obtained during pile foundation driving at the turbine sites and domestic water well pairs listed in Table 1, attached, as defined by the times and dates for pile driving within the seven geographic turbine clusters. The locations of the turbines and associated wells are illustrated on the attached figures. The attached pages of summary data and notes include particle velocity measurements made at the referenced sites that were taken in close proximity to the pile driving together with measurements obtained at domestic water well casings associated with the relevant turbine clusters. Previously issued summary pages have been updated to reflect changes, if and as applicable, related to:

- detailed review of Instantel Minimate data histogram files for the turbine sites;
- well and turbine site vibration monitoring data associated with pile dynamic analyser testing, subsequent pile restrikes or replacements;
- monitoring of vibrations during well pump operating periods in the absence of pile driving;

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- examination of vibration data associated with background conditions, other transient vibration sources (e.g., road traffic, movement of farm equipment, pump maintenance) and/or time durations during which pile driving was not actively in progress;
- clarifications or additions to pile driving monitoring notes; and
- typographical/clerical corrections, if and as needed.

The vibration measurements as reported on the attached pages are considered finalized for the analysis time periods, stated conditions and the context of this report. Golder reserves the right to update reports for the various turbine sites and wells as additional information becomes available and to address any of the items noted above. In particular, additional evaluation of turbine site geophone data is anticipated whereby actual off-set distances and vibration measurements at specific piles and times of day may be updated rather than the current listing of daily maximum measurements. A finalized report will be issued after the conclusion of all pile driving for this project.

## Monitoring Work Plan

Vibration monitoring was carried out in accordance with the June 2, 2017 work plan submitted to and approved by the MOECC and reissued on June 9, 2017. In summary, key elements of the work plan include:

- Pile driving at the turbine sites is visually monitored by a Golder staff member who keeps notes regarding start and stop times of active pile hammering, monitoring data logging and instrument status and other site conditions as relevant to the pile driving. Ground surface vibrations at each turbine site are being monitored with two Instantel Minimate Pro III or Pro IV systems. Two systems are being utilized to allow periodic downloading of data so that vibrations, if any, could then be captured by the other redundant system. The geophone systems captured vibration velocities in three mutually perpendicular directions. One direction was vertical and the longitudinal direction was oriented toward the closest pile with the third (transverse) direction being determined by the other two.
- Three accelerometers are being securely coupled to the monitored well casings for which permissions to enter and carry out monitoring have been obtained. The accelerometers are oriented in three mutually perpendicular directions. One direction is vertical and the longitudinal direction is oriented toward the closest pile driving operation, with the third (transverse) direction being determined by the other two. Golder personnel monitor the instrument status and any other relevant activities around the wells such as local road traffic, movements of farm equipment, traffic in and out of the well properties, other construction activities (if any) and well pump operations or maintenance.

## Overview of Pile Driving Conditions and Monitoring Notes

Pile driving at the turbine sites was conducted after constructing an access road, stripping topsoil, excavating to approximately 2.6 m below the ground surface and placing a concrete working pad. The concrete working pads have been fitted with pre-formed openings for the piles or constructed to a smaller diameter with the piles driven just beyond the outer perimeter of the concrete. Pile driving cranes were operated on timber mats placed on the concrete. Typically, piles were driven with the same hammer type as used for the pre-construction test pile and vibration monitoring program. In one case, a different hammer was used with a significantly lower driving energy. Subsequent use of this hammer has been rejected by the constructor.

On the attached monitoring reports, three times are reported for each driven pile. The column heading “Start” refers to the time of day when the pile hammering commenced on the indicated pile. Times of other site activities, such as crane movements, welding, equipment start-up and other work occurring prior to start of active pile hammering were not recorded except in specific instances where the turbine site geophones were inadvertently influenced by other equipment operating too closely. The column heading “Rock/Till” indicates the time at which hard driving started, as evidenced by the rate of pile depth change as compared to the numbers of hammer strikes on the pile. Commonly, the piles penetrated the first few metres of ground under their own weight, with nominal pile driving effort required until the underlying glacial till and/or rock was encountered. In many cases, the pile driving resistance in the upper soil layers was insufficient to engage the firing mechanism in the diesel hammer. Upon reaching the glacial till, the pile hammer fully engaged for the remainder of driving. The column heading “End” indicates the time of day at which active pile hammering ceased for the identified pile. While the total pile driving duration can be determined by the difference between the “Start” and “End” times, the duration of active pile hammering was frequently interrupted by pile splicing, welding, equipment repair, decision-making required for pile termination depths, pile testing and daily labour breaks. Many of these start and stop instances are identified on the attached summary pages.

## Summary of Results

In summary, vibration measurements obtained with the geophone system (Instantel Minimate) on all sites reported herein were within expectations as compared to those measured at the T5 and T42 test pile sites and general project expectations. On sites where piles penetrated through the near-surface soils under their own weight or a low number of hammer blows (e.g., less than 5) the ground surface vibrations during this phase of pile driving for each pile were nominal. Ground surface vibrations measured when driving the piles on the glacial till or rock were also either comparable to or less than those at the test pile sites and, in all cases, were within expectations. Vibration measurements made using the accelerometers mounted on the well casings were also within expectations based on the T5 and T42 test pile sites and turbine to well distances.

Well monitoring to-date has identified several wells for which the vibrations induced by the pumps dominated the instrument readings when the pumps were active or other activities dominated the measured vibrations. Relevant notes regarding various pumps, their operation and other influences on vibration measurements are described below:

- **Well 3:** Activities at the Well 3 property included crop harvesting, movement of farm vehicles and loading of haul trucks in relatively close proximity to Well 3.
- **Well 4:** Maximum well casing vibration velocities for Well 4 of about 4.8 mm/s were recorded on September 6, 2017 when a well pump was connected, operated and adjusted and the owner made frequent return visits to the well shed. Crop harvesting was also carried out as close as about 25 m from the well casing.
- **Well 6:** The pump for Well 6 is mounted in close proximity to the well casing (as illustrated on the attached Photograph 1). Maximum particle velocities of as much as 0.8 mm/s were obtained from monitoring data collected at Well 6 on July 13, 2017 when the well pump was operating during a time period without pile driving. The influences of the pump were readily discernable in the monitoring data. Approximately 1 minute after driving of Pile 1 for turbine T12 concluded, a loaded tractor-trailer dump truck drove by on the road near Well 6 and, at the same time, the resident was hammering in a nearby shed. Vibrations associated with the loaded dump truck were also perceptible by our well monitoring staff and registered at about 2.8 mm/s.

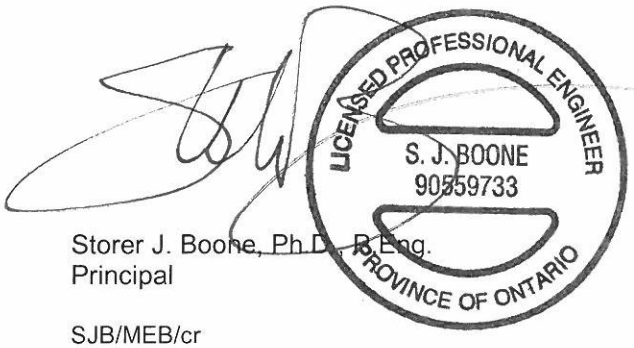
- **Well 9:** A piston pump for Well 9 is located within the barn adjacent to the Well 9 casing location, a total distance (inside and outside) of about 3 to 4 m. During pile driving for turbines T28 and T32, on August 11, 2017, other work was occurring near Well 9. This work included construction along the access road leading to the T32 site and included movement of heavy equipment, excavator operations, dump truck traffic, discharge of stone from delivery vehicles and other activities. This surface construction work was as close as 100 m to Well 9. Additionally, Well 9 is approximately 74 m from Countryview Line that experiences significant traffic. Traffic included loaded construction equipment, buses, fuel tanker trucks and other vehicles. Golder conducted a separate monitoring event at this well on September 8, 2017 to measure the influence of the pump on well casing vibrations in the absence of pile driving. Maximum measured casing vibrations during this test were about 1.2 mm/s. Measurements at Well 9 on dates other than August 11, 2017 are consistent with expectations based on local traffic volumes and the potential influence of the adjacent piston pump.
- **Well 10:** Well 10 exhibited maximum vibrations of about 1.25 mm/s during pump operation. The influence of pump operations were clearly discernable in the vibration monitoring data. The proximity of the pump and well casing are illustrated in the attached Photograph 2.
- **Well 11:** Vibrations of the casing at Well 11 were measured during water quality sampling on August 17, 2017 in the absence of pile driving at any location. When the pump was operating, a maximum vibration magnitude of 0.016 mm/s was measured at this well. The pump is located within the residence and approximately 40 m from the well.
- **Well 12:** During pile driving, Well 12 operated on a number of clearly definable occasions. Maximum vibration measurements of pump-induced well casing vibrations were as much as 2.4 mm/s. The pump for Well 12 is a piston pump mounted directly on top of the well casing as illustrated in the attached Photograph 3.
- **Well 13:** Well 13 is located approximately 87 m from the centreline of Union Line which is subjected to local truck traffic. Review of the data indicates that well pumping and non-pile driving transient sources influenced the results at this location. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.
- **Well 14:** Well 14 is located approximately 13 m from the centreline of Union Line which is subjected to local truck traffic. A limited evaluation of transient traffic vibrations indicated well casing velocities of at least 0.079 mm/s associated with this cause, though inspection of the data indicates higher values occurred outside of pile driving times. Additional evaluation of transient, non-pile driving data is on-going and a specific monitoring period for well pump operation is being planned for a time without pile driving.

In summary, measured vibrations have been evaluated and reported as associated with driving 329 piles and replacement piles on the glacial till/rock along with restrike events and pile dynamic testing events. These measurements have been obtained at the turbine sites and at wells located at distances ranging from 580 to 4,359 m from the turbine sites. It is our opinion, based on these measurements, that the vibration magnitudes at all wells during pile driving were within expectations, no greater than may be induced by other common day-to-day sources at these well sites, less than the observed and measured influence of well pumps and inconsequential for the wells.

We trust that this letter is adequate for your present requirements. If any point requires further clarification, please contact this office.

Yours truly,

**GOLDER ASSOCIATES LTD.**




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

SJB/MEB/cr

Attachments: Table 1 - Vibration Measurement Locations
Photographs of Wells 6, 10 and 12 Pump Configurations
Preliminary Vibration Monitoring Summaries and Figures, Turbines T3, T4, T6, T7, T12, T14, T20, T21, T28, T30, T31, T32, T33, T35, T36, T43, T45 and T46

n:\active\2016\3 proj\1668031 pattern_north kent vib monit_chatham-kent\ph 2000-vib monit field work\2-correspondence\3-ltrs\l06\1668031-2000-l06 sep 20 17 summary of vibration monitoring.docx

**TABLE 1 – VIBRATION MEASUREMENT LOCATIONS**

| Turbine Cluster 1 | | |
|---|---|---|
| **Turbine** | **Well** | **Well** |
| **Turbine Cluster 1** | | |
| T12 | 5 ([redacted]) | 6 ([redacted]) |
| T35 | | |
| T36 | | |
| **Turbine Cluster 2** | | |
| T6 | 7 ([redacted]) | 8 ([redacted]) |
| T7 | | |
| T31 | | |
| **Turbine Cluster 3** | | |
| T28 | 9 ([redacted]) | 10 ([redacted]) |
| T30 | | |
| T32 | | |
| **Turbine Cluster 4** | | |
| T3 | 11 ([redacted]) | 12 ([redacted]) |
| T4 | | |
| T20 | | |
| T21 | | |
| T43 | | |
| T45 | | |
| T46 | | |
| **Turbine Cluster 5** | | |
| T33 | 3 ([redacted]) | 4 ([redacted]) |
| **Turbine Cluster 6** | | |
| T14 | 13 ([redacted]) | 14 ([redacted]) |
| T26 | | |
| T27 | | |
| **Turbine Cluster 7** | | |
| No construction pile driving to date of this report | 1A ([redacted]) | 2 ([redacted]) |

Note: Table to be read in conjunction with accompanying text.

Prepared By: SJB

Checked By: DB

## SITE PHOTOGRAPHS



Photograph 1: Well 6 illustrating proximity of pump, hoses and tank to well casing.




Photograph 2: Well 10 illustrating proximity of pump, hoses and tank to well casing.



Photograph 3: Well 12 illustrating pump mounted directly on well casing.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T3

| | Pile Driving Times and Dates | | | Vibration Measurements at Turbine Site | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[e] |
| 1 | 8/23/2017 10:01 | 8/23/2017 10:10 | 8/23/2017 10:11 | 21.6 | 7.27 | NA[e] | 0.021 | |
| 2 | 8/23/2017 11:29 | 8/23/2017 11:35 | 8/23/2017 12:35 | 23.2 | 7.27 | 0.011 | 0.003 | |
| 3 | 8/23/2017 11:46 | 8/23/2017 11:56 | 8/23/2017 12:41 | 24.2 | 7.27 | 0.024 | 0.013 | |
| 4 | 8/23/2017 12:12 | 8/23/2017 12:19 | 8/23/2017 12:21 | 24.5 | 7.27 | 0.014 | 0.010 | |
| 5 | 8/23/2017 9:43 | 8/23/2017 9:49 | 8/23/2017 9:52 | 24.2 | 7.27 | NA[e] | 0.010 | |
| 6 | 8/23/2017 9:28 | 8/23/2017 9:35 | 8/23/2017 9:35 | 23.2 | 7.27 | NA[e] | 0.004 | |
| 7 | 8/22/2017 12:16 | 8/22/2017 12:22 | 8/22/2017 12:57 | 21.6 | 8.26 | 0.015 | 0.016 | |
| 8 | 8/22/2017 18:43 | 8/22/2017 18:49 | 8/22/2017 18:54 | 19.4 | 8.26 | 0.013 | 0.004 | |
| 9 | 8/22/2017 16:52 | 8/22/2017 16:58 | 8/22/2017 17:00 | 16.8 | 8.26 | 0.018 | 0.011 | |
| 10 | 8/22/2017 18:19 | 8/22/2017 18:27 | 8/22/2017 18:32 | 13.9 | 8.26 | 0.014 | 0.008 | |
| 11 | 8/22/2017 16:34 | 8/22/2017 16:40 | 8/22/2017 16:45 | 11.0 | 8.26 | 0.022 | 0.025 | |
| 12 | 8/22/2017 17:48 | 8/22/2017 17:57 | 8/22/2017 18:08 | 8.7 | 8.26 | 0.011 | 0.003 | |
| 13 | 8/22/2017 16:08 | 8/22/2017 16:16 | 8/22/2017 16:18 | 7.7 | 8.26 | 0.007 | 0.029 | |
| 14 | 8/22/2017 17:29 | 8/22/2017 17:38 | 8/22/2017 17:39 | 8.7 | 8.26 | 0.012 | 0.013 | |
| 15 | 8/22/2017 14:27 | 8/22/2017 14:33 | 8/22/2017 15:41 | 11.0 | 8.26 | 0.066 | 0.008 | |
| 16 | 8/22/2017 17:13 | 8/22/2017 17:20 | 8/22/2017 17:20 | 13.9 | 8.26 | 0.026 | 0.005 | |
| 17 | 8/22/2017 13:14 | 8/22/2017 13:22 | 8/22/2017 15:48 | 16.8 | 8.26 | 0.046 | 0.008 | |
| 18 | 8/23/2017 11:05 | 8/23/2017 11:12 | 8/23/2017 11:16 | 19.4 | 7.27 | 0.018 | 0.014 | |
| **Restrikes** | | | | | | | | |
| 7C | 8/23/2017 18:27 | 8/23/2017 18:27 | 8/23/2017 18:31 | 21.6 | 7.27 | 0.023 | 1.354 | 0.022 |
| 8C | 8/23/2017 8:14 | 8/23/2017 8:14 | 8/23/2017 8:14 | 19.4 | 7.27 | 0.010 | 0.004 | |
| 11C | 8/23/2017 8:18 | 8/23/2017 8:18 | 8/23/2017 8:18 | 11.0 | 7.27 | 0.009 | 2.405 | 0.006 |
| 12C | 8/23/2017 8:22 | 8/23/2017 8:22 | 8/23/2017 8:22 | 8.7 | 7.27 | 0.009 | 2.405 | 0.006 |
| 13C | 8/23/2017 8:25 | 8/23/2017 8:26 | 8/23/2017 8:26 | 7.7 | 7.27 | 0.009 | 0.007 | |
| 14C | 8/23/2017 8:28 | 8/23/2017 8:28 | 8/23/2017 8:28 | 8.7 | 7.27 | 0.007 | 0.007 | |
| 16C | 8/23/2017 8:31 | 8/23/2017 8:31 | 8/23/2017 8:32 | 13.9 | 7.27 | 0.007 | 0.007 | |
| 17C | 8/23/2017 8:34 | 8/23/2017 8:34 | 8/23/2017 8:34 | 16.8 | 7.27 | 0.007 | 0.007 | |
| 6 | 8/23/2017 12:14 | 8/23/2017 12:15 | 8/23/2017 12:15 | 23.2 | 7.27 | 0.025 | 0.023 | |
| **Replacement Piles** | | | | | | | | |
| 7A | 9/6/2017 12:05 | 9/6/2017 12:14 | 9/6/2017 12:19 | 20.6 | 1.99 | 0.033 | 0.005 | |

**Well Information**

**Well No.:** 11
Municipal Address: [redacted]
Distance from Turbine Centre: 1707 m

**Well No.:** 12
Municipal Address: [redacted]
Distance from Turbine Centre: 1264 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Continued pile driving on subsequent days are marked "C". Replacement piles are marked "A". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and this pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 5 and 6 at Well 11 on August 23, 2017 due to battery failure in monitoring equipment. Battery was subsequently replaced. Driving/restriking of some piles occured in relatively rapid succession and, therefore, in some cases the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Where total driving duration between till/rock start and end times noted above is not representative, actual driving duration is shown in parentheses in minutes and seconds: 2(6:42), 3(5:13), 7(8:45), 12(7:08), 15(1:20), 17(1:42). Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T4

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[c] |
| 1 | 8/25/2017 8:00 | 8/25/2017 8:08 | 8/25/2017 8:09 | 23.9 | 2.54 | 0.004 | 0.006 | |
| 2 | 8/25/2017 8:30 | 8/25/2017 9:15 | 8/25/2017 9:16 | 25.6 | 2.54 | 0.006 | 2.335 | 0.008 |
| 3 | 8/25/2017 9:03 | 8/25/2017 9:09 | 8/25/2017 9:10 | 26.6 | 2.54 | 0.007 | 2.335 | 0.008 |
| 4 | 8/25/2017 8:47 | 8/25/2017 8:56 | 8/25/2017 8:57 | 27.0 | 2.54 | 0.005 | 0.011 | |
| 5 | 8/25/2017 8:15 | 8/25/2017 8:22 | 8/25/2017 8:23 | 26.6 | 2.54 | 0.028 | 0.018 | |
| 6 | 8/24/2017 13:01 | 8/24/2017 13:10 | 8/24/2017 13:11 | 25.6 | 4.32 | 0.011 | 0.056 | |
| 7 | 8/24/2017 9:56 | 8/24/2017 10:04 | 8/24/2017 10:51 | 23.9 | 4.32 | 0.018 | 1.511 | 0.024 |
| 8 | 8/24/2017 13:19 | 8/24/2017 15:13 | 8/24/2017 15:14 | 21.6 | 4.32 | 0.024 | 1.777 | 0.014 |
| 9 | 8/24/2017 10:56 | 8/24/2017 11:04 | 8/24/2017 11:04 | 19.0 | 4.32 | 0.006 | 0.004 | |
| 10 | 8/24/2017 13:35 | 8/24/2017 13:45 | 8/24/2017 13:45 | 16.1 | 4.32 | 0.006 | 0.018 | |
| 11 | 8/24/2017 11:10 | 8/24/2017 11:18 | 8/24/2017 11:18 | 13.2 | 4.32 | 0.013 | 0.026 | |
| 12 | 8/24/2017 13:52 | 8/24/2017 15:09 | 8/24/2017 15:10 | 11.0 | 4.32 | 0.024 | 1.777 | 0.014 |
| 13 | 8/24/2017 11:23 | 8/24/2017 11:32 | 8/24/2017 11:33 | 10.1 | 4.32 | 0.009 | 0.009 | |
| 14 | 8/24/2017 14:07 | 8/24/2017 14:17 | 8/24/2017 14:17 | 11.0 | 4.32 | 0.007 | 0.006 | |
| 15 | 8/24/2017 11:38 | 8/24/2017 15:03 | 8/24/2017 15:04 | 13.2 | 4.32 | 0.009 | 1.374 | 0.028 |
| 16 | 8/24/2017 14:24 | 8/24/2017 14:33 | 8/24/2017 15:01 | 16.1 | 4.32 | 0.009 | 1.374 | 0.028 |
| 17 | 8/24/2017 12:46 | 8/24/2017 14:55 | 8/24/2017 14:56 | 19.0 | 4.32 | 0.030 | 1.374 | 0.028 |
| 18 | 8/24/2017 14:40 | 8/24/2017 14:52 | 8/24/2017 14:52 | 21.6 | 4.32 | 0.030 | 0.029 | |

**Well Information**

**Well No.:** 11
Municipal Address: [redacted]
Distance from Turbine Centre: 1424 m

**Well No.:** 12
*Municipal Address:* [redacted]
Distance from Turbine Centre: 1072 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and this pump was mounted on the well casing. During pile driving on August 24, 2017, the maximum vibration measurement of the Well 12 casing was 1.777 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Note that driving of some piles was paused while the tip was in the upper soil deposits and subsequently driven to the glacial till/rock later in the day. In these instances, the hard driving conditions for different piles occured in relatively rapid succession and, therefore, the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Where total driving duration between till/rock start and end times noted above is not representative, actual driving duration is shown in parentheses in minutes and seconds: 2(7:33), 7(1:32), 8(0:53), 12(1:10), 15(1:15), 16(1:02), 17(1:31). Total driving durations derived from start and end times noted above include labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T6**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | |
|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 7 | Well 8 |
| 1 | 7/31/2017 11:25 | 7/31/2017 11:28 | 7/31/2017 11:32 | 27.0 | 4.57 | 0.068 | 0.049 |
| 2 | 7/31/2017 12:20 | 7/31/2017 12:26 | 7/31/2017 12:28 | 26.6 | 4.57 | 0.044 | 0.032 |
| 3 | 7/31/2017 12:37 | 7/31/2017 12:41 | 7/31/2017 12:46 | 25.6 | 4.57 | 0.018 | 0.028 |
| 4 | 7/31/2017 13:35 | 7/31/2017 13:40 | 7/31/2017 13:46 | 23.9 | 4.57 | 0.066 | 0.011 |
| 5 | 7/31/2017 13:18 | 7/31/2017 13:23 | 7/31/2017 13:28 | 21.6 | 4.57 | 0.017 | 0.010 |
| 6 | 7/31/2017 12:59 | 7/31/2017 13:05 | 7/31/2017 13:07 | 19.0 | 4.57 | 0.012 | 0.033 |
| 7 | 7/31/2017 7:33 | 7/31/2017 7:37 | 7/31/2017 7:42 | 16.1 | 4.57 | 0.050 | 0.050 |
| 8 | 7/31/2017 7:53 | 7/31/2017 7:56 | 7/31/2017 8:03 | 13.2 | 4.57 | 0.127 | 0.070 |
| 9 | 7/31/2017 8:14 | 7/31/2017 8:18 | 7/31/2017 8:22 | 11.0 | 4.57 | 0.051 | 0.015 |
| 10 | 7/31/2017 8:31 | 7/31/2017 8:37 | 7/31/2017 8:41 | 10.1 | 4.57 | 0.025 | 0.058 |
| 11 | 7/31/2017 8:48 | 7/31/2017 8:51 | 7/31/2017 8:53 | 11.0 | 4.57 | 0.035 | 0.012 |
| 12 | 7/31/2017 9:02 | 7/31/2017 9:07 | 7/31/2017 9:12 | 13.2 | 4.57 | 0.058 | 0.023 |
| 13 | 7/31/2017 9:21 | 7/31/2017 9:25 | 7/31/2017 9:33 | 16.1 | 4.57 | 0.118 | 0.005 |
| 14 | 7/31/2017 9:42 | 7/31/2017 9:47 | 7/31/2017 9:50 | 19.0 | 4.57 | 0.082 | 0.007 |
| 15 | 7/31/2017 10:21 | 7/31/2017 10:24 | 7/31/2017 10:29 | 21.6 | 4.57 | 0.039 | 0.032 |
| 16 | 7/31/2017 10:36 | 7/31/2017 10:40 | 7/31/2017 10:43 | 23.9 | 4.57 | 0.010 | 0.014 |
| 17 | 7/31/2017 10:51 | 7/31/2017 10:54 | 7/31/2017 10:58 | 25.6 | 4.57 | 0.040 | 0.057 |
| 18 | 7/31/2017 11:09 | 7/31/2017 11:13 | 7/31/2017 11:17 | 26.6 | 4.57 | 0.024 | 0.071 |

**Well Information**

**Well No.:** 7
Municipal Address: [redacted]
Distance from Turbine Centre: 1049 m

**Well No.:** 8
Municipal Address: [redacted]
Distance from Turbine Centre: 872 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Well monitoring undertaken during periods of time on these same days when pile driving was not occuring measured maximum particle velocities of as much as 0.37 mm/s (Well 7). Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T7

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | |
|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 7 | Well 8 |
| 1 | 7/27/2017 17:57 | 7/27/2017 18:03 | 7/27/2017 18:04 | 27.0 | 5.97 | 0.030 | 0.011 |
| 2 | 7/27/2017 18:31 | 7/27/2017 18:36 | 7/27/2017 18:36 | 26.6 | 5.97 | 0.063 | 0.013 |
| 3 | 7/28/2017 8:11 | 7/28/2017 8:16 | 7/28/2017 8:16 | 25.6 | 2.16 | 0.019 | 0.022 |
| 4 | 7/28/2017 8:37 | 7/28/2017 8:43 | 7/28/2017 8:44 | 23.9 | 2.16 | 0.035 | 0.045 |
| 5 | 7/27/2017 18:11 | 7/27/2017 18:17 | 7/27/2017 18:18 | 21.6 | 5.97 | 0.017 | 0.012 |
| 6 | 7/27/2017 15:27 | 7/27/2017 15:32 | 7/27/2017 15:33 | 19.0 | 5.97 | 0.019 | 0.028 |
| 7 | 7/27/2017 15:10 | 7/27/2017 15:15 | 7/27/2017 15:16 | 16.1 | 5.97 | 0.026 | 0.028 |
| 8 | 7/27/2017 14:30 | 7/27/2017 14:36 | 7/27/2017 14:37 | 13.2 | 5.97 | 0.017 | 0.027 |
| 9 | 7/27/2017 14:10 | 7/27/2017 14:16 | 7/27/2017 14:18 | 11.0 | 5.97 | 0.011 | 0.031 |
| 10 | 7/27/2017 13:55 | 7/27/2017 14:00 | 7/27/2017 14:01 | 10.1 | 5.97 | 0.030 | 0.012 |
| 11 | 7/27/2017 13:42 | 7/27/2017 13:46 | 7/27/2017 13:47 | 11.0 | 5.97 | 0.025 | 0.042 |
| 12 | 7/27/2017 13:09 | 7/27/2017 13:13 | 7/27/2017 13:23 | 13.2 | 5.97 | 0.019 | 0.035 |
| 13 | 7/27/2017 12:21 | 7/27/2017 12:34 | 7/27/2017 12:53 | 16.1 | 5.97 | 0.030 | 0.049 |
| 14 | 7/27/2017 15:42 | 7/27/2017 15:51 | 7/27/2017 15:54 | 19.0 | 5.97 | 0.026 | 0.039 |
| 15 | 7/27/2017 16:06 | 7/27/2017 16:12 | 7/27/2017 16:13 | 21.6 | 5.97 | 0.032 | 0.021 |
| 16 | 7/27/2017 16:34 | 7/27/2017 16:44 | 7/27/2017 16:45 | 23.9 | 5.97 | 0.010 | 0.066 |
| 17 | 7/27/2017 16:55 | 7/27/2017 17:01 | 7/27/2017 17:02 | 25.6 | 5.97 | 0.069 | 0.030 |
| 18 | 7/27/2017 17:17 | 7/27/2017 17:25 | 7/27/2017 17:26 | 26.6 | 5.97 | 0.027 | 0.060 |

**Well Information**

**Well No.:** 7
Municipal Address: [redacted]
Distance from Turbine Centre: 1354 m

**Well No.:** 8
Municipal Address: [redacted]
Distance from Turbine Centre: 2883 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Well monitoring undertaken during periods of time on these same days when pile driving was not occuring measured maximum particle velocities of as much as 0.073 mm/s. Total driving duration between till/rock start and end times noted above for Pile 13 is not representative and actual driving duration was 00:1:45 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T12

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 5 | Well 6 | No Pump[e] |
| 1 | 7/5/2017 12:33 | 7/5/2017 12:46 | 7/5/2017 12:47 | 27.5 | 5.97 | 0.008 | 0.044 | See Notes |
| 2 | 7/5/2017 15:47 | 7/5/2017 16:01 | 7/5/2017 16:01 | 27.8 | 5.97 | 0.001 | 0.106 | |
| 3 | 7/6/2017 8:08 | 7/6/2017 8:19 | 7/6/2017 8:20 | 27.5 | 4.32 | 0.010 | 0.775 | |
| 4 | 7/6/2017 7:47 | 7/6/2017 7:58 | 7/6/2017 7:59 | 26.4 | 4.32 | 0.002 | 0.048 | |
| 5 | 7/5/2017 12:57 | 7/5/2017 13:26 | 7/5/2017 13:27 | 24.7 | 5.97 | 0.002 | 0.729 | |
| 6 | 7/5/2017 14:11 | 7/5/2017 14:22 | 7/5/2017 14:23 | 22.5 | 5.97 | 0.002 | 0.298 | |
| 7 | 7/4/2017 14:48 | 7/4/2017 14:57 | 7/4/2017 14:58 | 19.8 | 5.97 | 0.002 | 0.026 | |
| 8 | 7/5/2017 11:38 | 7/5/2017 11:49 | 7/5/2017 11:50 | 16.8 | 5.97 | 0.008 | 0.030 | |
| 9 | 7/4/2017 9:26 | 7/4/2017 9:58 | 7/4/2017 10:00 | 14.0 | 9.91 | 0.011 | 0.246 | 0.014 |
| 10 | 7/5/2017 11:11 | 7/5/2017 11:25 | 7/5/2017 11:26 | 11.8 | 5.97 | 0.002 | 0.047 | 0.014 |
| 11 | 6/30/2017 12:03 | 6/30/2017 13:47 | 6/30/2017 13:54 | 11.0 | 11.20 | 0.004 | 0.755 | |
| 12 | 7/4/2017 15:15 | 7/4/2017 15:25 | 7/4/2017 15:25 | 11.8 | 9.91 | 0.002 | 0.179 | |
| 13 | 7/4/2017 11:22 | 7/4/2017 11:33 | 7/4/2017 11:34 | 14.0 | 9.91 | 0.002 | 0.066 | |
| 14 | 7/4/2017 15:47 | 7/4/2017 15:58 | 7/4/2017 15:58 | 16.8 | 9.91 | 0.069 | 0.037 | |
| 15 | 7/4/2017 11:55 | 7/4/2017 12:06 | 7/4/2017 12:07 | 19.8 | 9.91 | 0.003 | 0.023 | |
| 16 | 7/4/2017 16:35 | 7/4/2017 16:47 | 7/4/2017 16:47 | 22.5 | 9.91 | 0.004 | 0.155 | |
| 17 | 7/4/2017 13:01 | 7/4/2017 13:14 | 7/4/2017 13:20 | 24.7 | 9.91 | 0.007 | 0.085 | |
| 18 | 7/4/2017 15:08 | 7/4/2017 15:27 | 7/4/2017 15:28 | 26.4 | 9.91 | 0.002 | 0.729 | |
| **Restrikes** | | | | | | | | |
| 7 | 7/5/2017 8:42 | 7/5/2017 8:42 | 7/5/2017 8:42 | 19.8 | 5.97 | 0.007 | 0.647 | 0.027 |
| 9 | 7/5/2017 8:47 | 7/5/2017 8:47 | 7/5/2017 8:48 | 14.0 | 5.97 | 0.007 | 0.634 | 0.027 |
| 11 | 7/5/2017 8:51 | 7/5/2017 8:51 | 7/5/2017 8:52 | 11.0 | 5.97 | 0.007 | 0.634 | 0.032 |
| 12 | 7/5/2017 8:57 | 7/5/2017 8:57 | 7/5/2017 8:58 | 11.8 | 5.97 | 0.003 | 0.624 | |
| 13 | 7/5/2017 9:02 | 7/5/2017 9:02 | 7/5/2017 9:03 | 14.0 | 5.97 | 0.008 | 0.662 | |
| 14 | 7/5/2017 9:09 | 7/5/2017 9:09 | 7/5/2017 9:10 | 16.8 | 5.97 | 0.008 | 0.624 | |
| 15 | 7/5/2017 9:13 | 7/5/2017 9:13 | 7/5/2017 9:14 | 19.8 | 5.97 | 0.003 | 0.546 | 0.057 |
| 16 | 7/5/2017 9:17 | 7/5/2017 9:17 | 7/5/2017 9:19 | 22.5 | 5.97 | 0.002 | 0.546 | 0.057 |
| 17 | 7/5/2017 9:22 | 7/5/2017 9:22 | 7/5/2017 9:23 | 26.4 | 5.97 | 0.002 | 0.546 | 0.057 |

**Well Information**

**Well No.:** 5
Municipal Address: [redacted]
Distance from Turbine Centre: 3346 m

**Well No.:** 6
Municipal Address: [redacted]
Distance from Turbine Centre: 3368 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". On July 5, 2017, approximately 1 minute after pile driving stopped for Pile 1, the well monitoring personnel at Well 6 observed a loaded tractor/trailer dump truck drive by the well at 54 m distance and ground vibrations were sensed. At this time, the resident was also hammering on equipment within a nearby (120 m) shed during which it sounded as though a heavy sledge was being used with multiple recoil/hammer falls after each main strike. Vibrations associated with these activities (not separable) registered as 2.8 mm/s, consistent with the perception of vibrations by the well monitoring personnel. Monitoring of deliberate pump operation at Well 6 on July 13, 2017, during a period when no pile driving was occuring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Driving/restriking of some piles occured in relatively rapid succession and, therefore, in some cases the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time. The driving duration for Pile 11 on June 30, 2017 were unusually long since a small driving hammer was used for this pile. The total duration of driving on till/rock was 7 minutes for this pile.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T14

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 13 | Well 14 | No Pump[e] |
| 1 | 9/11/2017 16:01 | 9/11/2017 16:06 | 9/11/2017 16:09 | 18.9 | 4.95 | 0.020 | 0.206 | |
| 2 | 9/11/2017 16:24 | 9/11/2017 16:29 | 9/11/2017 16:32 | 21.0 | 4.95 | 0.010 | 0.056 | |
| 3 | 9/11/2017 15:48 | 9/11/2017 15:54 | 9/11/2017 15:56 | 22.6 | 4.95 | 0.017 | 0.132 | |
| 4 | 9/11/2017 15:33 | 9/11/2017 15:39 | 9/11/2017 15:43 | 23.6 | 4.95 | 0.012 | 0.190 | |
| 5 | 9/11/2017 15:19 | 9/11/2017 15:24 | 9/11/2017 15:26 | 24.0 | 4.95 | 0.006 | 0.064 | |
| 6 | 9/11/2017 15:04 | 9/11/2017 15:10 | 9/11/2017 15:13 | 23.6 | 4.95 | 0.005 | 0.221 | |
| 7 | 9/11/2017 12:33 | 9/11/2017 12:39 | 9/11/2017 12:44 | 22.6 | 4.95 | 0.007 | 0.083 | |
| 8 | 9/11/2017 12:17 | 9/11/2017 12:25 | 9/11/2017 12:27 | 21.0 | 4.95 | 0.005 | 0.338 | |
| 9 | 9/11/2017 11:53 | 9/11/2017 11:59 | 9/11/2017 12:02 | 18.9 | 4.95 | 0.114 | 0.675 | |
| 10 | 9/11/2017 11:36 | 9/11/2017 11:43 | 9/11/2017 11:45 | 16.3 | 4.95 | 0.013 | 0.240 | |
| 11 | 9/11/2017 11:20 | 9/11/2017 11:25 | 9/11/2017 11:28 | 13.5 | 4.95 | 0.013 | 0.168 | |
| 12 | 9/11/2017 10:24 | 9/11/2017 10:30 | 9/11/2017 10:34 | 10.6 | 4.95 | 0.428 | 0.077 | 0.011 |
| 13 | 9/11/2017 10:07 | 9/11/2017 10:14 | 9/11/2017 10:16 | 8.1 | 4.95 | 0.543 | 0.141 | 0.008 |
| 14 | 9/11/2017 9:50 | 9/11/2017 9:56 | 9/11/2017 10:01 | 7.1 | 4.95 | 0.021 | 0.102 | |
| 15 | 9/11/2017 9:34 | 9/11/2017 9:39 | 9/11/2017 9:42 | 8.1 | 4.95 | 0.004 | 0.014 | |
| 16 | 9/11/2017 9:17 | 9/11/2017 9:24 | 9/11/2017 9:28 | 10.6 | 4.95 | 0.318 | 0.021 | 0.007 |
| 17 | 9/11/2017 8:57 | 9/11/2017 9:03 | 9/11/2017 9:05 | 13.5 | 4.95 | 0.026 | 0.070 | |
| 18 | 9/11/2017 8:39 | 9/11/2017 8:47 | 9/11/2017 8:49 | 16.3 | 4.95 | 0.007 | 0.018 | |

**Restrikes**

**Well Information**

**Well No.:** 13
Municipal Address: [redacted]
Distance from Turbine Centre: 841 m

**Well No.:** 14
Municipal Address: [redacted]
Distance from Turbine Centre: 580 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time. Well 13 pump vibrations dominated data for periods of 1 to 5 minutes. "No pump" data column indicates vibration velocities exclusive of pump operating times for Well 13. Wells 13 and 14 are located approximately 87 m and 13 m from the centre line of Union Line, respectively. Vibration velocities noted above for both wells reflect maximum values induced by transient sources other than pile driving. Evaluation of acceleration time histories concluded that other transient vibrations occurring before, during and after pile driving times dominated all measurements. Data for two 10-minute time periods during which no pile driving occurred were evaluated with start times of 10:47 and 14:27 for Well 13 and and 10:48 and 14:36 for Well 14 indicated a maximum velocity of 0.079 mm/s. Additional evaluation of pump operations and other transient sources for both wells is pending.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T20**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[e] |
| 1 | 8/30/2017 15:30 | 8/30/2017 15:33 | 8/30/2017 15:54 | 25.0 | 5.33 | 0.016 | NA[e] | |
| 2 | 8/30/2017 18:17 | 8/30/2017 18:21 | 8/30/2017 18:29 | 26.0 | 5.33 | 0.005 | 0.008 | |
| 3 | 8/30/2017 18:33 | 8/30/2017 18:38 | 8/30/2017 18:45 | 26.3 | 5.33 | 0.003 | 0.004 | |
| 4 | 8/30/2017 17:55 | 8/30/2017 17:59 | 8/30/2017 18:10 | 26.0 | 5.33 | 0.004 | 0.005 | |
| 5 | 8/30/2017 17:38 | 8/30/2017 17:37 | 8/30/2017 17:49 | 25.0 | 5.33 | 0.004 | 0.855 | 0.022 |
| 6 | 8/30/2017 17:14 | 8/30/2017 17:19 | 8/30/2017 17:31 | 23.3 | 5.33 | 0.004 | NA[e] | |
| 7 | 8/30/2017 16:54 | 8/30/2017 16:56 | 8/30/2017 17:09 | 21.0 | 5.33 | 0.003 | NA[e] | |
| 8 | 8/30/2017 16:19 | 8/30/2017 16:24 | 8/30/2017 16:53 | 18.3 | 5.33 | 0.046 | NA[e] | |
| 9 | 8/30/2017 16:01 | 8/30/2017 16:05 | 8/30/2017 16:12 | 15.4 | 5.33 | 0.005 | NA[e] | |
| 10 | 8/30/2017 11:34 | 8/30/2017 11:38 | 8/30/2017 11:50 | 12.5 | 5.33 | 0.005 | 0.016 | |
| 11 | 8/30/2017 10:26 | 8/30/2017 10:29 | 8/30/2017 10:40 | 9.1 | 5.33 | 0.018 | 0.013 | |
| 12 | 8/30/2017 9:58 | 8/30/2017 10:02 | 8/30/2017 10:16 | 10.1 | 5.33 | 0.011 | 0.014 | |
| 13 | 8/30/2017 9:49 | 8/30/2017 9:44 | 8/30/2017 9:50 | 12.5 | 5.33 | 0.010 | 0.014 | |
| 14 | 8/30/2017 12:02 | 8/30/2017 12:04 | 8/30/2017 12:22 | 15.4 | 5.33 | 0.028 | 0.008 | |
| 15 | 8/30/2017 12:36 | 8/30/2017 12:39 | 8/30/2017 12:54 | 18.3 | 5.33 | 0.023 | 0.006 | |
| 16 | 8/30/2017 13:01 | 8/30/2017 13:05 | 8/30/2017 13:20 | 21.0 | 5.33 | 0.004 | 0.004 | |
| 17 | 8/30/2017 14:26 | 8/30/2017 14:29 | 8/30/2017 14:41 | 23.3 | 5.33 | 0.004 | 0.006 | |
| 18 | 8/30/2017 14:52 | 8/30/2017 14:56 | 8/30/2017 15:24 | 25.0 | 5.33 | 0.003 | 0.025 | |
| **Restrikes** | | | | | | | | |
| 13 | 8/30/2017 13:23 | 8/30/2017 13:23 | 8/30/2017 13:35 | 12.5 | 5.33 | 0.008 | 0.008 | |

**Well Information**

**Well No.:** 11
Municipal Address: [redacted]
Distance from Turbine Centre: 3800 m

**Well No.:** 12
Municipal Address: [redacted]
Distance from Turbine Centre: 3962 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and the pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 6, 7, 8 and 9 at Well 12 on August 30, 2017 due to battery failure in monitoring equipment. Battery was subsequently replaced. Total driving duration between till/rock start and end times noted above for Pile 1 is not representative and actual driving duration was 00:7:40 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Preliminary Vibration Monitoring Report

## Turbine Location: T21

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[e] |
| 1 | 8/29/2017 12:01 | 8/29/2017 12:04 | 8/29/2017 12:14 | 23.7 | 2.79 | NA[e] | 0.008 | |
| 2 | 8/29/2017 1:27 | 8/29/2017 1:30 | 8/29/2017 1:39 | 25.4 | 2.79 | 0.003 | 0.006 | |
| 3 | 8/29/2017 1:44 | 8/29/2017 1:47 | 8/29/2017 1:54 | 26.4 | 2.79 | 0.009 | 0.006 | |
| 4 | 8/29/2017 11:20 | 8/29/2017 11:23 | 8/29/2017 11:32 | 26.8 | 2.79 | 0.003 | 0.013 | |
| 5 | 8/29/2017 11:05 | 8/29/2017 11:08 | 8/29/2017 11:13 | 26.4 | 2.79 | NA[e] | 0.013 | |
| 6 | 8/29/2017 8:48 | 8/29/2017 8:51 | 8/29/2017 8:59 | 25.4 | 2.79 | NA[e] | 0.026 | |
| 7 | 8/29/2017 8:28 | 8/29/2017 8:33 | 8/29/2017 8:40 | 23.7 | 2.79 | NA[e] | 0.005 | |
| 8 | 8/29/2017 8:07 | 8/29/2017 8:11 | 8/29/2017 8:19 | 21.5 | 2.79 | NA[e] | 0.003 | |
| 9 | 8/29/2017 7:51 | 8/29/2017 7:54 | 8/29/2017 7:59 | 18.8 | 2.79 | 0.004 | 0.004 | |
| 10 | 8/28/2017 16:40 | 8/28/2017 16:44 | 8/28/2017 16:53 | 15.9 | 3.30 | 0.015 | 0.071 | |
| 11 | 8/28/2017 16:11 | 8/28/2017 16:14 | 8/28/2017 16:27 | 13.0 | 3.30 | 0.007 | 1.551 | 0.039 |
| 12 | 8/28/2017 15:51 | 8/28/2017 15:58 | 8/28/2017 16:05 | 10.8 | 3.30 | 0.005 | 0.007 | |
| 13 | 8/28/2017 14:27 | 8/28/2017 14:30 | 8/28/2017 14:37 | 9.9 | 3.30 | 0.003 | 0.005 | |
| 14 | 8/28/2017 14:10 | 8/28/2017 14:13 | 8/28/2017 14:21 | 10.8 | 3.30 | 0.006 | 0.005 | |
| 15 | 8/28/2017 13:45 | 8/28/2017 13:48 | 8/28/2017 13:58 | 13.0 | 3.30 | 0.008 | 0.013 | |
| 16 | 8/28/2017 13:21 | 8/28/2017 13:24 | 8/28/2017 13:37 | 15.9 | 3.30 | 0.006 | 0.011 | |
| 17 | 8/28/2017 13:01 | 8/28/2017 13:05 | 8/28/2017 13:13 | 18.8 | 3.30 | 0.011 | 0.010 | |
| 18 | 8/29/2017 11:44 | 8/29/2017 11:47 | 8/29/2017 11:54 | 21.5 | 2.79 | NA[e] | 0.031 | |

**Restrikes**

**Well Information**

**Well No.:** 11
Municipal Address: [redacted]
Distance from Turbine Centre: 3960 m

**Well No.:** 12
Municipal Address: [redacted]
Distance from Turbine Centre: 4161 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurement for Well 11 was 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurement for Well 12 was 0.896 mm/s and the pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 5, 6, 7, 8 and 18 at Well 11 on August 29, 2017 due to battery failure in monitoring equipment. Battery was subsequently replaced. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Preliminary Vibration Monitoring Report

## Turbine Location: T28

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 9 | Well 10 | No Pump[e] |
| 1 | 8/15/2017 14:33 | 8/15/2017 14:41 | 8/15/2017 14:43 | 21.6 | 3.17 | 0.061 | 0.020 | |
| 2 | 8/15/2017 14:53 | 8/15/2017 15:04 | 8/15/2017 15:06 | 23.9 | 3.17 | 0.019 | 0.036 | |
| 3 | 8/15/2017 15:31 | 8/15/2017 15:42 | 8/15/2017 15:44 | 25.6 | 3.17 | 0.111 | 0.805 | 0.019 |
| 4 | 8/15/2017 13:23 | 8/15/2017 13:37 | 8/15/2017 13:39 | 26.6 | 3.17 | 0.022 | 0.804 | 0.100 |
| 5 | 8/15/2017 12:10 | 8/15/2017 12:22 | 8/15/2017 12:24 | 27.0 | 3.17 | 0.108 | 0.158 | |
| 6 | 8/15/2017 11:46 | 8/15/2017 11:59 | 8/15/2017 12:00 | 26.6 | 3.17 | 0.012 | 0.095 | |
| 7 | 8/15/2017 9:56 | 8/15/2017 10:08 | 8/15/2017 10:11 | 25.6 | 3.17 | 0.027 | 0.052 | |
| 8 | 8/15/2017 9:16 | 8/15/2017 9:34 | 8/15/2017 9:36 | 23.9 | 3.17 | 0.040 | 0.009 | |
| 9 | 8/15/2017 8:51 | 8/15/2017 9:03 | 8/15/2017 9:04 | 21.6 | 3.17 | 0.046 | 0.015 | |
| 10 | 8/15/2017 8:18 | 8/15/2017 8:33 | 8/15/2017 8:35 | 19.0 | 3.17 | NA[e] | 0.750 | 0.026 |
| 11 | 8/15/2017 7:45 | 8/15/2017 7:58 | 8/15/2017 8:02 | 16.1 | 3.17 | NA[e] | 0.007 | |
| 12 | 8/11/2017 13:27 | 8/11/2017 14:45 | 8/11/2017 14:46 | 13.2 | 5.59 | 0.812 | 0.014 | |
| 13 | 8/11/2017 12:36 | 8/11/2017 12:48 | 8/11/2017 12:50 | 11.0 | 5.59 | 0.054 | 0.006 | |
| 14 | 8/11/2017 12:13 | 8/11/2017 12:25 | 8/11/2017 12:27 | 10.1 | 5.59 | 0.055 | 0.112 | |
| 15 | 8/11/2017 11:19 | 8/11/2017 11:28 | 8/11/2017 11:30 | 11.0 | 5.59 | 0.244 | 0.015 | |
| 16 | 8/11/2017 11:48 | 8/11/2017 12:02 | 8/11/2017 12:03 | 13.2 | 5.59 | 0.183 | 0.007 | |
| 17 | 8/11/2017 10:22 | 8/11/2017 11:06 | 8/11/2017 11:07 | 16.1 | 5.59 | 0.686 | 0.034 | |
| 18 | 8/15/2017 13:56 | 8/15/2017 14:09 | 8/15/2017 14:10 | 19.0 | 3.17 | 0.015 | 0.705 | 0.052 |
| **Restrikes** | | | | | | | | |
| 2 | 8/16/2017 8:19 | 8/16/2017 8:19 | 8/16/2017 8:23 | 23.9 | 2.65 | 0.017 | 0.029 | |

### Well Information

**Well No.:** 9
Municipal Address: [redacted]
Distance from Turbine Centre: 2568 m

**Well No.:** 10
Municipal Address: [redacted]
Distance from Turbine Centre: 1769 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Data for Well 9 was not available for August 15, 2017 during driving of piles 10 and 11 while awaiting site security changes implemented following an incident at the Well 9 property the evening of August 14, 2017. Highlighted values for Well 9 on August 11, 2017 are higher than and inconsistent with other measurements during pile driving at the T28 site. On August 11, 2017, construction activities were underway along the entrance road to T32, located as close as about 100 m from Well 9. These activities included: hammering, movements of large construction equipment (e.g., loaders, dump trucks, excavators, "stone throwers"), and equipment travelled on access road site without construction mats, equipment operating on T32 access resulted in "pounding" sounds. The Well 9 area is also subject to heavy passing traffic on Countryview Line (74 m from well) including: fuel trucks, loaded dump trucks, large transport trucks, a bus, and cranes/boom trucks among other vehicles. Further analysis of Well 9 vibration data was undertaken for 10 minute periods on August 11, 2017 during which pile driving was not occuring between 08:32:00 and 08:42:00, 09:12:00 and 09:22:00, 11:22:00 and 11:32:00, and 13:48:00 and 13:58:00. During these periods the maximum velocities (regardless of direction) of the Well 9 casing ranged from 0.011 to 1.2 mm/s. Data shown for Well 9 during driving of Piles 12, 15, 16 and 17 (highlighted) are considered unrepresentative of pile driving and associated with other vibration sources. The piston pump for Well 9 is within the barn approximately 4 to 5 m from the well location. When the Well 9 pump was deliberately operated on September 8, 2017, in the absence of pile driving, well casing velocities were up to 0.04 mm/s. When the pump for Well 10 was operating, well casing vibrations of as much as 1.25 mm/s were measured. "No pump" data is provided to indicate measurements exclusive of data consistent with typical pump operations. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and end of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T30**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells Particle Velocity (mm/s)[c, d] | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 9 | Well 10 | No Pump[e] |
| 1 | 8/4/2017 14:24 | 8/4/2017 14:42 | 8/4/2017 15:01 | 23.0 | 4.70 | 0.054 | 0.815 | 0.014 |
| 1A | 8/9/2017 9:30 | 8/9/2017 9:51 | 8/9/2017 9:58 | 23.5 | 2.41 | 0.080 | 0.935 | 0.027 |
| 2 | 8/8/2017 8:42 | 8/8/2017 8:52 | 8/8/2017 9:03 | 24.6 | 3.17 | 0.061 | 0.049 | |
| 3 | 8/8/2017 9:17 | 8/8/2017 9:25 | 8/8/2017 9:35 | 25.6 | 3.17 | 0.041 | 0.883 | 0.009 |
| 4 | 8/8/2017 7:49 | 8/8/2017 8:02 | 8/8/2017 8:10 | 26.0 | 3.17 | 0.035 | 1.251 | 0.036 |
| 5 | 8/4/2017 16:24 | 8/4/2017 16:32 | 8/4/2017 16:40 | 25.6 | 4.70 | 0.061 | 0.007 | |
| 6 | 8/4/2017 15:57 | 8/4/2017 16:03 | 8/4/2017 16:11 | 24.6 | 4.70 | 0.059 | 0.003 | |
| 7 | 8/4/2017 15:24 | 8/4/2017 15:34 | 8/4/2017 15:39 | 23.0 | 4.70 | 0.082 | 0.028 | |
| 8 | 8/4/2017 10:57 | 8/4/2017 11:03 | 8/4/2017 11:06 | 20.8 | 4.70 | 0.032 | 0.540 | 0.033 |
| 9 | 8/3/2017 13:33 | 8/3/2017 13:38 | 8/3/2017 13:46 | 18.1 | 5.33 | 0.076 | 0.088 | |
| 10 | 8/3/2017 13:07 | 8/3/2017 13:16 | 8/3/2017 13:20 | 15.2 | 5.33 | 0.088 | 0.014 | |
| 11 | 8/3/2017 11:46 | 8/3/2017 11:52 | 8/3/2017 11:56 | 9.1 | 5.33 | 0.029 | 0.007 | |
| 12 | 8/3/2017 11:25 | 8/3/2017 11:29 | 8/3/2017 11:34 | 10.1 | 5.33 | 0.066 | 0.005 | |
| 13 | 8/3/2017 10:44 | 8/3/2017 10:53 | 8/3/2017 10:59 | 12.4 | 5.33 | 0.059 | 0.876 | 0.005 |
| 14 | 8/3/2017 14:04 | 8/3/2017 14:11 | 8/3/2017 14:19 | 15.2 | 5.33 | 0.061 | 0.023 | |
| 15 | 8/3/2017 14:34 | 8/3/2017 14:47 | 8/3/2017 14:50 | 18.1 | 5.33 | 0.032 | 0.005 | |
| 16 | 8/4/2017 8:50 | 8/4/2017 8:55 | 8/4/2017 9:08 | 20.8 | 4.70 | 0.048 | 0.032 | |
| 17 | 8/4/2017 9:32 | 8/4/2017 9:38 | 8/4/2017 9:43 | 23.0 | 4.70 | 0.051 | 0.002 | |
| 18 | 8/4/2017 10:17 | 8/4/2017 10:33 | 8/4/2017 10:36 | 24.6 | 4.70 | 0.024 | 0.004 | |
| **Restrikes** | | | | | | | | |
| 15C | 8/4/2017 8:15 | 8/4/2017 8:15 | 8/4/2017 8:21 | 18.1 | 4.70 | 0.044 | 0.022 | |
| 1 | 8/8/2017 15:19 | 8/8/2017 15:19 | 8/8/2017 15:25 | 23.0 | 3.17 | 0.080 | 0.006 | |
| 5 | 8/8/2017 8:15 | 8/8/2017 8:15 | 8/8/2017 8:20 | 25.6 | 3.17 | 0.056 | 1.016 | 0.006 |
| 6 | 8/8/2017 9:40 | 8/8/2017 9:40 | 8/8/2017 9:41 | 24.6 | 3.17 | 0.041 | 1.116 | 0.146 |

**Well Information**

**Well No.:** 9
Municipal Address: [redacted]
Distance from Turbine Centre: 1808 m

**Well No.:** 10
Municipal Address: [redacted]
Distance from Turbine Centre: 1385 m

ISO 2631 2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Piles noted with "A" represent piles installed to replace similarly-numbered piles. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes" (where applicable). Piles noted with "C" were those that were started on one day and continued on a separate day; therefore, additional well monitoring data is presented for the time periods during which piling continued on till/rock. When the pump for Well 10 was operating, well casing vibrations of as much as 1.25 mm/s were measured. "No pump" data is provided to indicate measurements exclusive of data consistent with typical pump operations. Total driving duration between till/rock start and end times noted above for Pile 1 is not representative and actual driving duration was 00:11:50 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T31**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | |
|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 7 | Well 8 |
| 1 | 7/17/2017 13:18 | 7/17/2017 13:24 | 7/17/2017 13:26 | 8.1 | 2.92 | 0.042 | 0.028 |
| 2 | 7/17/2017 14:46 | 7/17/2017 14:52 | 7/17/2017 14:54 | 9.1 | 2.92 | 0.038 | 0.034 |
| 3 | 7/18/2017 7:39 | 7/18/2017 7:47 | 7/18/2017 7:49 | 11.4 | 4.19 | 0.016 | 0.075 |
| 4 | 7/18/2017 8:03 | 7/18/2017 8:10 | 7/18/2017 8:13 | 14.3 | 4.19 | 0.023 | 0.005 |
| 5 | 7/17/2017 12:56 | 7/17/2017 13:01 | 7/17/2017 13:05 | 17.2 | 2.92 | 0.020 | 0.071 |
| 6 | 7/17/2017 11:49 | 7/17/2017 11:53 | 7/17/2017 11:54 | 19.8 | 2.92 | 0.100 | 0.099 |
| 7 | 7/17/2017 11:25 | 7/17/2017 11:30 | 7/17/2017 11:35 | 22.0 | 2.92 | 0.014 | 0.028 |
| 8 | 7/17/2017 10:25 | 7/17/2017 10:31 | 7/17/2017 10:36 | 23.6 | 2.92 | 0.044 | 0.028 |
| 9 | 7/17/2017 8:03 | 7/17/2017 8:09 | 7/17/2017 8:30 | 24.6 | 2.92 | 0.011 | 0.041 |
| 10 | NA | NA | NA | 25.0 | | NA | NA |
| 11 | 7/14/2017 16:18 | 7/14/2017 16:25 | 7/14/2017 16:28 | 24.6 | 5.46 | 0.041 | NA |
| 12 | 7/13/2017 15:38 | 7/13/2017 15:44 | 7/13/2017 15:45 | 23.6 | 5.08 | 0.037 | 0.034 |
| 13 | 7/13/2017 16:12 | 7/13/2017 16:26 | 7/13/2017 16:30 | 24.6 | 5.08 | 0.012 | 0.015 |
| 14 | 7/14/2017 8:22 | 7/14/2017 8:47 | 7/14/2017 8:48 | 25.0 | 5.46 | 0.072 | 0.023 |
| 15 | 7/13/2017 16:56 | 7/13/2017 17:06 | 7/13/2017 17:08 | 24.6 | 5.08 | 0.156 | 0.020 |
| 16 | 7/14/2017 11:18 | 7/14/2017 11:23 | 7/14/2017 11:29 | 23.6 | 5.46 | 0.044 | 0.034 |
| 17 | 7/14/2017 11:40 | 7/14/2017 11:48 | 7/14/2017 11:51 | 22.0 | 5.46 | 0.074 | 0.075 |
| 18 | 7/14/2017 12:10 | 7/14/2017 12:16 | 7/14/2017 12:21 | 19.8 | 5.46 | 0.050 | 0.041 |

**Well Information**

**Well No.:** 7
Municipal Address: [redacted]
Distance from Turbine Centre: 636 m

**Well No.:** 8
Municipal Address: [redacted]
Distance from Turbine Centre: 2497 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** On July 14, 2017 at about 14:00, Golder was informed that piling operations at T31 were concluded. At 15:45 instruments were therefore turned off at Well 8 in preparation for removal for the day. Piling resumed at approximately 16:15. As a result, data was not captured for Wells 7 or 8 when driving Pile 10 and Well 8 when driving Pile 11. Well monitoring undertaken during periods of time when pile driving was not occuring measured maximum particle velocities of as much as 0.37 mm/s at Well 7. Total driving duration between till/rock start and end times noted above for Pile 9 is not representative and actual driving duration was 00:04:00 due to pauses in actual hammering. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** **T32**

| Pile No.: | Pile Driving Times and Dates Start[a] | Rock/Till | End[a] | Vibration Measurements at Turbine Site Geophone Dist. (m) | Daily Maximum Particle Velocity (mm/s)[b] | Vibration Measurements at Wells Particle Velocity (mm/s)[c, d] Well 9 | Well 10 | No Pump[c] |
|---|---|---|---|---|---|---|---|---|
| 1 | 8/11/2017 14:41 | 8/11/2017 14:43 | 8/11/2017 15:01 | 25.0 | 3.43 | 0.069 | 0.020 | |
| 2 | 8/14/2017 15:43 | 8/14/2017 15:46 | 8/14/2017 16:19 | 23.3 | 4.83 | 0.050 | 0.013 | |
| 3 | 8/14/2017 16:25 | 8/14/2017 16:28 | 8/14/2017 16:57 | 21.1 | 4.83 | 0.045 | 0.045 | |
| 4 | 8/14/2017 14:51 | 8/14/2017 14:55 | 8/14/2017 15:21 | 18.4 | 4.83 | 0.046 | 0.697 | |
| 5 | 8/14/2017 13:52 | 8/14/2017 13:55 | 8/14/2017 14:11 | 15.5 | 4.83 | 0.059 | 0.035 | |
| 6 | 8/14/2017 13:12 | 8/14/2017 13:15 | 8/14/2017 13:33 | 12.7 | 4.83 | 0.055 | 0.009 | |
| 7 | 8/14/2017 11:40 | 8/14/2017 11:42 | 8/14/2017 12:18 | 10.4 | 4.83 | 0.062 | 0.049 | |
| 8 | 8/14/2017 11:20 | 8/14/2017 11:23 | 8/14/2017 11:33 | 9.5 | 4.83 | 0.050 | 0.880 | |
| 9 | 8/14/2017 7:47 | 8/14/2017 7:50 | 8/14/2017 7:54 | 10.4 | 4.83 | 0.041 | 0.733 | |
| 10 | 8/14/2017 10:59 | 8/14/2017 11:04 | 8/14/2017 11:12 | 12.7 | 4.83 | 0.028 | 0.010 | |
| 11 | 8/11/2017 10:53 | 8/11/2017 10:56 | 8/11/2017 11:00 | 15.5 | 3.43 | 1.090 | 0.049 | |
| 12 | 8/11/2017 10:42 | 8/11/2017 10:44 | 8/11/2017 10:47 | 18.4 | 3.43 | 0.871 | 0.014 | |
| 13 | 8/11/2017 10:28 | 8/11/2017 10:30 | 8/11/2017 10:34 | 21.1 | 3.43 | 1.346 | 0.738 | 0.005 |
| 14 | 8/11/2017 10:14 | 8/11/2017 10:19 | 8/11/2017 10:21 | 23.3 | 3.43 | 0.068 | 0.051 | |
| 15 | 8/11/2017 9:00 | 8/11/2017 9:03 | 8/11/2017 9:07 | 25.0 | 3.43 | 0.037 | 0.764 | 0.004 |
| 16 | 8/11/2017 11:07 | 8/11/2017 11:10 | 8/11/2017 11:14 | 26.0 | 3.43 | 0.229 | 0.034 | |
| 17 | 8/11/2017 13:12 | 8/11/2017 13:14 | 8/11/2017 13:19 | 26.4 | 3.43 | 0.230 | 0.684 | 0.009 |
| 18 | 8/11/2017 13:26 | 8/11/2017 13:28 | 8/11/2017 13:42 | 26.0 | 3.43 | 0.135 | 0.713 | 0.004 |

**Restrikes**

**Well Information**

**Well No.:** 9
Municipal Address: [redacted]
Distance from Turbine Centre: 680 m

**Well No.:** 10
Municipal Address: [redacted]
Distance from Turbine Centre: 1122 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Highlighted values for Well 9 on August 11, 2017 are higher than and inconsistent with other measurements during pile driving at the T32 site. On August 11, 2017, construction activities were underway along the entrance road to T32, located as close as about 100 m from the well. These activities included: hammering, movements of large construction equipment (e.g., loaders, dump trucks, excavators, aggregate delivery equipment), and equipment travelled on site access road without construction mats, equipment operating on T32 access road resulted in "pounding" sounds. Well 9 area is subject to heavy passing traffic on Countryview Line (74 m from well) including: fuel trucks, loaded dump trucks, large transport trucks, a bus, and cranes/boom trucks among other vehicles. Further analysis of Well 9 vibration data was undertaken for 10 minute periods on August 11, 2017 during which pile driving was not occuring between 08:32:00 and 08:42:00, 09:12:00 and 09:22:00, 11:22:00 and 11:32:00, and 13:48:00 and 13:58:00. During these periods, the maximum velocities (regardless of direction) of the Well 9 casing ranged from 0.011 to 1.2 mm/s. Data shown for Well 9 during driving of Piles 12, 15, 16 and 17 (highlighted) are considered unrepresentative of pile driving and associated with other vibration sources. The piston pump for Well 9 is within the barn approximately 4 to 5 m from the well location. When the Well 9 pump was deliberately operated on September 8, 2017, in the absence of pile driving, well casing velocities were up to 0.04 mm/s. When the pump for Well 10 was operating, well casing vibrations of as much as 1.25 mm/s were measured. "No pump" data is provided to indicate measurements exclusive of data consistent with typical pump operations. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
# Preliminary Vibration Monitoring Report

## Turbine Location: T33

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 3 | Well 4 | No Pump[e] |
| 1 | 9/5/2017 13:10 | 9/5/2017 13:16 | 9/5/2017 13:25 | 10.9 | 5.3 | 0.015 | 0.118 | |
| 2 | 9/5/2017 13:46 | 9/5/2017 13:55 | 9/5/2017 14:03 | 11.8 | 5.3 | 0.011 | 0.138 | |
| 3 | 9/5/2017 14:11 | 9/5/2017 14:20 | 9/5/2017 14:27 | 14.0 | 5.3 | 0.056 | 0.174 | |
| 4 | 9/5/2017 14:38 | 9/5/2017 14:46 | 9/5/2017 14:54 | 16.8 | 5.3 | 0.035 | 0.082 | |
| 5 | 9/5/2017 15:05 | 9/5/2017 15:13 | 9/5/2017 15:18 | 19.7 | 5.3 | 0.049 | 0.137 | |
| 6 | 9/5/2017 15:34 | 9/5/2017 15:44 | 9/5/2017 15:48 | 22.4 | 5.3 | 0.009 | 0.072 | |
| 7 | 9/5/2017 17:02 | 9/5/2017 17:10 | 9/5/2017 17:10 | 24.6 | 5.3 | 0.030 | 0.298 | |
| 8 | 9/5/2017 17:32 | 9/5/2017 17:41 | 9/5/2017 17:49 | 26.3 | 5.3 | 0.036 | 0.131 | |
| 9 | 9/5/2017 18:14 | 9/5/2017 18:21 | 9/5/2017 18:28 | 27.4 | 5.3 | 0.034 | 0.083 | |
| 10 | 9/6/2017 9:30 | 9/6/2017 9:47 | 9/6/2017 9:53 | 27.8 | 3.2 | 0.004 | 0.243 | |
| 11 | 9/6/2017 10:09 | 9/6/2017 10:25 | 9/6/2017 10:35 | 27.4 | 3.2 | 0.004 | 0.089 | |
| 12 | 9/6/2017 12:03 | 9/6/2017 12:16 | 9/6/2017 12:26 | 26.3 | 3.2 | 0.005 | 0.179 | |
| 13 | 9/6/2017 12:58 | 9/6/2017 13:08 | 9/6/2017 13:16 | 24.6 | 3.2 | 0.003 | 0.162 | |
| 14 | 9/6/2017 13:33 | 9/6/2017 13:43 | 9/6/2017 13:58 | 22.4 | 3.2 | 0.004 | 0.161 | |
| 15 | 9/6/2017 14:37 | 9/6/2017 14:45 | 9/6/2017 14:54 | 19.7 | 3.2 | 0.005 | 4.987 | |
| 16 | 9/6/2017 16:01 | 9/6/2017 16:08 | 9/6/2017 16:20 | 16.8 | 3.2 | 0.006 | 0.277 | |
| 17 | 9/6/2017 15:29 | 9/6/2017 15:35 | 9/6/2017 15:45 | 14.0 | 3.2 | 0.003 | 0.175 | |
| 18 | 9/6/2017 14:13 | 9/6/2017 14:24 | 9/6/2017 14:36 | 11.8 | 3.2 | 0.004 | 0.622 | |
| **Restrikes** | | | | | | | | |
| 6 | 9/6/2017 18:15 | 9/6/2017 18:15 | 9/6/2017 18:23 | 22.4 | 3.2 | 0.009 | 4.858 | |
| 5 | 9/6/2017 17:02 | 9/6/2017 17:02 | 9/6/2017 17:03 | 19.7 | 3.2 | 0.023 | 0.129 | |

**Well Information**

**Well No.:** 3
Municipal Address: [redacted]
Distance from Turbine Centre: 1778 m

**Well No.:** 4
Municipal Address: [redacted]
Distance from Turbine Centre: 2080 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz

Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time. During vibration monitoring on September 5, 2017, a forklift operated close to the geophone between 16:00:00 and 16:30:00 and triggered a maximum peak particle velocity of 6.2 mm/s. Value shown above excludes the peak measurement triggered by the forklift. On September 5, 2017, tractors, harvest haul trucks and other equipment travelled through Well 3 property frequently from 12:48 to 15:55 and occasionally thereafter until 16:50. On September 5, 2017, St. Clair Road traffic passing at 78 m from Well 4 was observed to include large tractor-trailers, concrete mixers and dump trucks at a rate of about 1 heavy vehicle every 1.5 to 2 minutes. Passenger vehicle movements on the Well 4 property passed and were parked near the well at 12:10, 14:40, 14:47, 15:06, 15:17, 15:42, 16:16, 16:35 and 19:02. On September 6, 2017, heavy vehicle traffic near Well 4 was similar to September 5, 2017. Combine harvesting was on-going as close as 25 to 30 m from Well 4, starting at 8:53 and continuing to after 14:30 on September 6, 2017. Passenger vehicle traffic on September 6, 2017 adjacent to Well 4 on the property was noted at 7:41, 10:40 - 10:45, 10:56 - 11:04, 11:46 - 11:52, 12:57 - 12:59, 13:22, 14:31, 14:36, 16:35, 16:42, 16:49, and 18:34. Various individuals were at and in the well shed at 16:35 to 16:54. Prior to September 6, 2017 obersvations by Golder personnel indicated that a pump was not connected at Well 4. During the afternoon of September 6, 2017 a pump was connected and operational. From 17:02 to 17:18 the newly connected Well 4 pump was cycled on and off, operating for periods of 1 to more than 7 minutes. The owner was physically working on Well 4 after 17:18 and returning to well shed frequently. All data highlighted above is considered to have been significantly influenced by near-well activities, particularly work directly related to the Well 4 pump and shed.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T35**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 5 | Well 6 | No Pump[e] |
| 1 | 6/21/2017 9:16 | 6/21/2017 9:31 | 6/21/2017 9:58 | 25.3 | 4.32 | 0.005 | 0.011 | |
| 1A | 7/4/2017 14:09 | 7/4/2017 14:15 | 7/4/2017 14:20 | 25.8 | 4.70 | 0.011 | 0.085 | |
| 2 | 6/28/2017 11:40 | 6/28/2017 11:50 | 6/28/2017 11:56 | 27.0 | 6.86 | 0.004 | 0.002 | |
| 3 | 6/29/2017 11:15 | 6/29/2017 11:26 | 6/29/2017 11:37 | 28.1 | 4.70 | 0.004 | 0.080 | 0.009 |
| 4 | 6/29/2017 11:45 | 6/29/2017 12:28 | 6/29/2017 12:35 | 28.4 | 4.70 | 0.002 | 0.003 | |
| 5 | 6/29/2017 10:36 | 6/29/2017 10:53 | 6/29/2017 10:59 | 28.1 | 4.70 | 0.003 | 0.008 | |
| 6 | 6/29/2017 9:49 | 6/29/2017 10:09 | 6/29/2017 10:19 | 27.0 | 4.70 | 0.002 | 0.017 | |
| 7 | 6/28/2017 16:45 | 6/28/2017 16:55 | 6/28/2017 16:59 | 25.3 | 6.86 | 0.002 | 0.006 | |
| 8 | 6/28/2017 16:19 | 6/28/2017 16:28 | 6/28/2017 16:36 | 23.0 | 6.86 | 0.004 | 0.008 | |
| 9 | 6/29/2017 15:55 | 6/29/2017 16:03 | 6/29/2017 16:09 | 20.3 | 4.70 | 0.003 | 0.011 | |
| 10 | 6/28/2017 15:23 | 6/28/2017 15:35 | 6/28/2017 15:43 | 17.4 | 6.86 | 0.002 | 0.010 | |
| 11 | 6/28/2017 14:34 | 6/28/2017 14:52 | 6/28/2017 14:56 | 14.6 | 6.86 | 0.002 | 0.081 | 0.011 |
| 12 | 6/28/2017 14:04 | 6/28/2017 14:19 | 6/28/2017 14:23 | 12.4 | 6.86 | 0.003 | 0.016 | |
| 13 | 6/26/2017 16:52 | 6/26/2017 17:15 | 6/26/2017 17:22 | 11.6 | 4.06 | 0.004 | 0.093 | 0.015 |
| 13A | 6/30/2017 10:53 | 6/30/2017 11:24 | 6/30/2017 11:36 | 11.6 | 4.19 | 0.001 | 0.093 | 0.015 |
| 14 | 6/28/2017 8:34 | 6/28/2017 8:59 | 6/28/2017 9:16 | 12.4 | 6.86 | 0.005 | 0.110 | 0.023 |
| 15 | 6/26/2017 16:03 | 6/26/2017 16:26 | 6/26/2017 16:28 | 14.6 | 4.06 | 0.002 | 0.009 | |
| 15A | 7/4/2017 12:54 | 7/4/2017 13:00 | 7/4/2017 13:21 | 15.1 | 4.70 | 0.008 | 0.130 | |
| 16 | 6/28/2017 9:32 | 6/28/2017 9:52 | 6/28/2017 9:57 | 17.4 | 6.86 | 0.002 | 0.004 | |
| 17 | 6/26/2017 7:45 | 6/26/2017 8:19 | 6/26/2017 8:20 | 20.3 | 4.06 | 0.012 | 0.002 | |
| 17A | 7/4/2017 13:39 | 7/4/2017 13:45 | 7/4/2017 13:51 | 20.8 | 4.70 | 0.004 | 0.105 | |
| 18 | 6/28/2017 10:40 | 6/28/2017 10:55 | 6/28/2017 11:25 | 23.0 | 6.86 | 0.004 | 0.015 | |
| **Restrikes** | | | | | | | | |
| 1 | 6/26/2017 7:39 | 6/26/2017 7:39 | 6/26/2017 7:39 | 25.3 | 4.06 | 0.007 | 0.007 | |
| 17 | 6/28/2017 12:54 | 6/28/2017 12:54 | 6/28/2017 13:14 | 20.3 | 6.86 | 0.004 | 0.014 | |
| 10 | 6/29/2017 13:31 | 6/29/2017 13:31 | 6/29/2017 13:32 | 17.4 | 4.70 | 0.006 | 0.004 | |
| 13 | 6/29/2017 13:37 | 6/29/2017 13:37 | 6/29/2017 13:42 | 11.6 | 4.70 | 0.004 | 0.002 | |
| 14 | 6/29/2017 13:47 | 6/29/2017 13:47 | 6/29/2017 13:50 | 12.4 | 4.70 | 0.006 | 0.003 | |
| 16 | 6/29/2017 13:54 | 6/29/2017 13:54 | 6/29/2017 13:56 | 17.4 | 4.70 | 0.005 | 0.003 | |
| 15 | 6/29/2017 14:20 | 6/29/2017 14:20 | 6/29/2017 14:25 | 14.6 | 4.70 | 0.008 | 0.011 | |
| **PDA** | | | | | | | | |
| 13A | 7/6/2017 10:06 | 7/6/2017 10:06 | 7/6/2017 10:15 | 12.1 | 5.21 | 0.005 | 0.138 | |
| 13 | 7/6/2017 11:05 | 7/6/2017 11:05 | 7/6/2017 11:23 | 11.6 | 5.21 | 0.006 | 0.219 | |
| 15A | 7/6/2017 11:39 | 7/6/2017 11:39 | 7/6/2017 11:40 | 15.1 | 5.21 | 0.009 | 0.130 | |
| 17A | 7/6/2017 11:55 | 7/6/2017 11:55 | 7/6/2017 11:56 | 20.8 | 5.21 | 0.010 | 0.061 | |
| 1A | 7/6/2017 12:18 | 7/6/2017 12:18 | 7/6/2017 12:18 | 25.8 | 5.21 | 0.011 | 0.084 | |

**Well Information**

**Well No.:** 5
Municipal Address: [redacted]
Distance from Turbine Centre: 623 m

**Well No.:** 6
Municipal Address: [redacted]
Distance from Turbine Centre: 880 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 tc approximately 0.07 mm/s

**Monitoring Notes:** Tractor was observed operating frequently near Well 6. Water pump was observed cycling on and off during pile driving operations and remaining on for periods of 2 to 4 minutes. When pump was operating, casing at Well 6 exhibited particle velocities in the range of 0.08 to 0.12 mm/s and dominated analysis of data. Pile restrike events were of short duration with the following total number of hammer blows shown in parentheses: Pile 1 (20), Pile 10 (5 to 7), 13 (205), 14 (140), 16 (51), 15 (214). Pile 17 experienced 446 hammer blows over a period of 9 minutes. Piles noted with PDA indicate restrike events during which pile dynamics analyzer monitoring was completed. Piles noted with "A" represent piles installed to replace similarly-numbered piles. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Monitoring of deliberate pump operation at Well 6 on July 13, 2017, during a period when no pile driving was occuring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Where total driving duration between till/rock start and end times noted above is not representative, actual driving duration is shown in parentheses in minutes and seconds: 13A(10:00), 15A(6:24), 17 restrike (14:00), 13PDA(6:20). Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T36

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 5 | Well 6 | No Pump[e] |
| 1 | 7/26/2017 10:33 | 7/26/2017 10:38 | 7/26/2017 10:48 | 23.3 | 7.87 | 0.005 | 0.086 | |
| 2 | 7/26/2017 18:16 | 7/26/2017 18:21 | 7/26/2017 18:28 | 21.1 | 7.87 | 0.003 | 0.016 | |
| 3 | 7/26/2017 19:24 | 7/26/2017 19:28 | 7/26/2017 19:42 | 18.4 | 7.87 | 0.002 | 0.005 | |
| 4 | 7/26/2017 18:37 | 7/26/2017 19:07 | 7/26/2017 19:19 | 15.5 | 7.87 | 0.002 | 0.027 | |
| 5 | 7/26/2017 17:59 | 7/26/2017 18:04 | 7/26/2017 18:10 | 12.7 | 7.87 | 0.012 | 0.016 | |
| 6 | 7/26/2017 17:30 | 7/26/2017 17:34 | 7/26/2017 17:44 | 10.4 | 7.87 | 0.004 | 0.032 | |
| 7 | 7/26/2017 17:10 | 7/26/2017 17:13 | 7/26/2017 17:23 | 9.5 | 7.87 | 0.010 | 0.044 | |
| 8 | 7/26/2017 16:41 | 7/26/2017 16:45 | 7/26/2017 16:56 | 10.4 | 7.87 | 0.007 | 0.038 | |
| 9 | 7/26/2017 16:19 | 7/26/2017 16:23 | 7/26/2017 16:33 | 12.7 | 7.87 | 0.004 | 0.010 | |
| 10 | 7/26/2017 15:48 | 7/26/2017 15:51 | 7/26/2017 16:03 | 15.5 | 7.87 | 0.005 | 0.070 | |
| 11 | 7/26/2017 15:12 | 7/26/2017 15:15 | 7/26/2017 15:23 | 18.4 | 7.87 | 0.004 | 0.045 | |
| 12 | 7/26/2017 14:32 | 7/26/2017 14:45 | 7/26/2017 14:57 | 21.1 | 7.87 | 0.005 | 0.048 | |
| 13 | 7/26/2017 14:15 | 7/26/2017 14:21 | 7/26/2017 14:28 | 23.3 | 7.87 | 0.014 | 0.018 | |
| 14 | 7/26/2017 13:58 | 7/26/2017 14:03 | 7/26/2017 14:08 | 25.0 | 7.87 | 0.009 | 0.031 | |
| 15 | 7/26/2017 13:16 | 7/26/2017 13:20 | 7/26/2017 13:32 | 26.0 | 7.87 | 0.005 | 0.111 | 0.029 |
| 16 | 7/26/2017 12:48 | 7/26/2017 12:53 | 7/26/2017 13:05 | 26.4 | 7.87 | 0.011 | 0.038 | |
| 17 | 7/26/2017 11:41 | 7/26/2017 11:47 | 7/26/2017 11:56 | 26.0 | 7.87 | 0.005 | 0.021 | |
| 18 | 7/26/2017 11:08 | 7/26/2017 11:12 | 7/26/2017 11:22 | 25.0 | 7.87 | 0.006 | 0.068 | |
| **Restrikes** | | | | | | | | |
| 16 | 7/27/2017 7:36 | 7/27/2017 7:36 | 7/27/2017 7:37 | 26.4 | 0.89 | 0.003 | 0.437 | 0.028 |

**Well Information**

**Well No.:** 5
Municipal Address: [redacted]
Distance from Turbine Centre: 4201 m

**Well No.:** 6
Municipal Address: [redacted]
Distance from Turbine Centre: 3380 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 3, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** A single restrike event occured on the day following with a total of 24 hammer blows on Pile 16 during a period of approximately 65 seconds. After installation, one pile was struck again with the hammer to demonstrate resistance performance and this event is noted under "restrikes". Water pump was observed cycling on and off during pile driving operations and remaining on for periods of 2 to 4 minutes. When pump was operating during pile driving, casing at Well 6 exhibited particle velocities of up to 0.44 mm/s and this dominated analysis of data. Monitoring of deliberate pump operation at Well 6 on July 13, 2017, during a period when no pile driving was occuring, measured maximum particle velocities of 0.08 to 0.8 mm/s. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location: T43**

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[e] |
| 1 | 8/18/2017 12:35 | 8/18/2017 12:45 | 8/18/2017 12:52 | 24.8 | 5.59 | 0.006 | 0.008 | |
| 2 | 8/18/2017 13:01 | 8/18/2017 13:12 | 8/18/2017 13:20 | 23.8 | 5.59 | 0.006 | 0.007 | |
| 3 | 8/21/2017 8:28 | 8/21/2017 8:38 | 8/21/2017 8:48 | 22.2 | 3.18 | 0.010 | 0.007 | |
| 4 | 8/21/2017 12:47 | 8/21/2017 12:59 | 8/21/2017 13:10 | 20.0 | 3.18 | 0.007 | 0.006 | |
| 5 | 8/21/2017 9:03 | 8/21/2017 9:16 | 8/21/2017 9:23 | 17.4 | 3.18 | 0.006 | 1.468 | 0.009 |
| 6 | 8/21/2017 7:56 | 8/21/2017 8:08 | 8/21/2017 8:17 | 14.5 | 3.18 | 0.024 | 0.024 | |
| 7 | 8/18/2017 14:32 | 8/18/2017 14:43 | 8/18/2017 14:50 | 11.6 | 3.18 | 0.006 | 0.006 | |
| 8 | 8/18/2017 13:37 | 8/18/2017 13:49 | 8/18/2017 13:57 | 9.3 | 3.18 | 0.007 | 0.005 | |
| 9 | 8/15/2017 15:09 | 8/15/2017 15:18 | 8/15/2017 15:27 | 8.3 | 7.37 | 0.086 | 0.005 | |
| 10 | 8/15/2017 13:21 | 8/15/2017 13:28 | 8/15/2017 13:37 | 9.3 | 7.37 | 0.004 | 0.002 | |
| 11 | 8/15/2017 12:22 | 8/15/2017 12:34 | 8/15/2017 12:35 | 11.6 | 7.37 | 0.002 | 0.006 | |
| 12 | 8/15/2017 11:58 | 8/15/2017 12:10 | 8/15/2017 12:13 | 14.5 | 7.37 | 0.018 | 0.018 | |
| 13 | 8/15/2017 9:19 | 8/15/2017 9:42 | 8/15/2017 11:40 | 17.4 | 7.37 | 0.003 | 0.002 | |
| 14 | 8/15/2017 15:46 | 8/15/2017 15:57 | 8/15/2017 16:10 | 20.0 | 7.37 | 0.006 | 0.013 | |
| 15 | 8/18/2017 9:17 | 8/18/2017 9:23 | 8/18/2017 9:31 | 22.2 | 5.59 | 0.005 | 0.009 | |
| 16 | 8/18/2017 9:43 | 8/18/2017 9:50 | 8/18/2017 9:59 | 23.8 | 5.59 | 0.012 | 0.009 | |
| 17 | 8/18/2017 10:10 | 8/18/2017 10:17 | 8/18/2017 10:28 | 24.8 | 5.59 | 0.004 | 0.018 | |
| 18 | 8/18/2017 11:45 | 8/18/2017 12:02 | 8/18/2017 12:21 | 25.2 | 5.59 | 0.008 | 0.004 | |
| **Restrikes** | | | | | | | | |
| 14 | 8/21/2017 10:43 | 8/21/2017 10:43 | 8/21/2017 10:43 | 20.0 | 3.18 | 0.012 | 0.010 | |
| 16(1) | 8/21/2017 10:30 | 8/21/2017 10:30 | 8/21/2017 10:30 | 23.8 | 3.18 | 0.011 | 0.010 | |
| 16(2) | 8/21/2017 11:52 | 8/21/2017 11:52 | 8/21/2017 11:54 | 22.2 | 3.18 | 0.005 | 0.029 | |

**Well Information**

**Well No.: 11**
Municipal Address: [redacted]
Distance from Turbine Centre: 4092 m

**Well No.: 12**
Municipal Address: [redacted]
Distance from Turbine Centre: 4359 m

ISO 2631 2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. Maximum vibration measurements for Well 11 were 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. Maximum vibration measurements for Well 12 were 0.896 mm/s and the pump was mounted on the well casing. During pile driving for turbine T3, on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Note that driving/restriking of some piles occured in relatively rapid succession and, therefore, the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Driving of pile 13 was started and stopped on multiple occasions because of problems with fuel pump resulting in a total of approximately 88 minutes of standby between driving intervals for a total driving time on till/rock of 14:45 (minutes:seconds). Pile 18 total driving time on till/rock was 8:46 (minutes:seconds) due to intermittant stops and starts. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T45

| | Pile Driving Times and Dates | | | Vibration Measurements at Turbine Site | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[e] |
| 1 | 8/23/2017 11:47 | 8/23/2017 11:53 | 8/23/2017 12:18 | 14.8 | 7.75 | 0.025 | 0.010 | |
| 2 | 8/23/2017 14:20 | 8/23/2017 14:27 | 8/23/2017 14:41 | 12.0 | 7.75 | 0.024 | NA[e] | |
| 3 | 8/23/2017 15:10 | 8/23/2017 15:17 | 8/23/2017 15:27 | 9.6 | 7.75 | 0.017 | 0.005 | |
| 4 | 8/23/2017 16:49 | 8/23/2017 16:55 | 8/23/2017 17:05 | 8.7 | 7.75 | 0.008 | 1.148 | |
| 5 | 8/23/2017 17:22 | 8/23/2017 17:30 | 8/23/2017 17:44 | 9.6 | 7.75 | 0.011 | 0.007 | |
| 6 | 8/23/2017 10:50 | 8/23/2017 11:00 | 8/23/2017 11:16 | 12.0 | 7.75 | 0.018 | 0.016 | |
| 7 | 8/24/2017 8:30 | 8/24/2017 8:38 | 8/24/2017 8:47 | 14.8 | 3.30 | 0.014 | 0.014 | |
| 8 | 8/24/2017 9:05 | 8/24/2017 9:14 | 8/24/2017 9:21 | 17.7 | 3.30 | 0.021 | 0.040 | |
| 9 | 8/24/2017 9:36 | 8/24/2017 9:44 | 8/24/2017 10:48 | 20.4 | 3.30 | 0.018 | 1.511 | |
| 10 | 8/23/2017 12:49 | 8/23/2017 12:58 | 8/23/2017 13:15 | 22.6 | 7.75 | 0.009 | 0.005 | |
| 11 | 8/24/2017 13:32 | 8/24/2017 13:42 | 8/24/2017 13:48 | 24.2 | 3.30 | 0.004 | 0.018 | |
| 12 | 8/24/2017 15:06 | 8/24/2017 15:15 | 8/24/2017 15:23 | 25.2 | 3.30 | 0.007 | 0.008 | |
| 13 | 8/24/2017 15:35 | 8/24/2017 15:44 | 8/24/2017 15:53 | 25.6 | 3.30 | 0.026 | 0.034 | |
| 14 | 8/24/2017 16:05 | 8/24/2017 16:14 | 8/24/2017 16:22 | 25.2 | 3.30 | 0.012 | 0.061 | |
| 15 | 8/24/2017 16:40 | 8/24/2017 16:46 | 8/24/2017 16:55 | 24.2 | 3.30 | 0.015 | 0.007 | |
| 16 | 8/24/2017 17:11 | 8/24/2017 17:18 | 8/24/2017 17:24 | 22.6 | 3.30 | 0.012 | 0.004 | |
| 17 | 8/24/2017 17:33 | 8/24/2017 17:39 | 8/24/2017 17:45 | 20.4 | 3.30 | 0.006 | 0.009 | |
| 18 | 8/24/2017 17:57 | 8/24/2017 18:08 | 8/24/2017 18:12 | 17.7 | 3.30 | 0.005 | 0.006 | |
| **Restrikes** | | | | | | | | |
| 6 | 8/23/2017 13:28 | 8/23/2017 13:28 | 8/23/2017 13:29 | 12.0 | 7.75 | 0.043 | 0.017 | |
| 1 | 8/23/2017 13:13 | 8/23/2017 13:13 | 8/23/2017 13:13 | 14.8 | 7.75 | 0.009 | 0.005 | |
| 15 | 8/25/2017 7:45 | 8/25/2017 7:45 | 8/25/2017 7:47 | 24.2 | 5.97 | 0.015 | 0.032 | |
| 16 | 8/25/2017 9:11 | 8/25/2017 9:11 | 8/25/2017 9:13 | 22.6 | 5.97 | 0.007 | 2.335 | 0.008 |
| 17 | 8/25/2017 9:03 | 8/25/2017 9:03 | 8/25/2017 9:06 | 20.4 | 5.97 | 0.007 | 0.019 | |
| 18 | 8/25/2017 8:51 | 8/25/2017 8:51 | 8/25/2017 8:55 | 17.7 | 5.97 | 0.011 | 0.011 | |
| 1 | 8/25/2017 11:44 | 8/25/2017 11:44 | 8/25/2017 11:45 | 14.8 | 5.97 | 0.013 | 0.037 | |
| 12 | 8/25/2017 9:22 | 8/25/2017 9:22 | 8/25/2017 9:25 | 25.2 | 5.97 | 0.024 | 0.010 | |
| 18 | 8/25/2017 9:16 | 8/25/2017 9:16 | 8/25/2017 9:18 | 17.7 | 5.97 | 0.011 | 0.011 | |
| 4 | 8/25/2017 8:43 | 8/25/2017 8:43 | 8/25/2017 8:45 | 8.7 | 5.97 | 0.013 | 0.007 | |
| 5 | 8/25/2017 8:36 | 8/25/2017 8:36 | 8/25/2017 8:37 | 9.6 | 5.97 | 0.013 | 0.013 | |
| 7 | 8/25/2017 8:30 | 8/25/2017 8:30 | 8/25/2017 8:32 | 14.8 | 5.97 | 0.006 | 0.028 | |
| 8 | 8/25/2017 8:25 | 8/25/2017 8:25 | 8/25/2017 8:26 | 17.7 | 5.97 | 0.006 | 0.018 | |
| 10 | 8/25/2017 9:28 | 8/25/2017 9:28 | 8/25/2017 10:19 | 22.6 | 5.97 | 0.021 | 0.011 | |
| 13 | 8/25/2017 7:53 | 8/25/2017 7:54 | 8/25/2017 7:59 | 25.6 | 5.97 | 0.013 | 0.007 | |
| 9 | 8/25/2017 8:09 | 8/25/2017 8:09 | 8/25/2017 8:19 | 20.4 | 5.97 | 0.028 | 0.010 | |
| 11 | 8/25/2017 8:03 | 8/25/2017 8:03 | 8/25/2017 8:05 | 24.2 | 5.97 | 0.008 | 0.024 | |
| **Spliced** | | | | | | | | |
| 13 | 8/30/2017 11:06 | 8/30/2017 11:06 | 8/30/2017 11:07 | 25.6 | 6.10 | 0.006 | 0.012 | |
| 2 | 8/30/2017 10:06 | 8/30/2017 10:06 | 8/30/2017 10:06 | 12.0 | 6.10 | 0.005 | 0.018 | |
| 3 | 8/30/2017 10:09 | 8/30/2017 10:09 | 8/30/2017 10:10 | 9.6 | 6.10 | 0.005 | 0.018 | |
| 4 | 8/30/2017 10:14 | 8/30/2017 10:14 | 8/30/2017 10:16 | 8.7 | 6.10 | 0.011 | 0.014 | |
| 5 | 8/30/2017 10:19 | 8/30/2017 10:19 | 8/30/2017 10:20 | 9.6 | 6.10 | 0.011 | 0.014 | |
| 6 | 8/30/2017 10:23 | 8/30/2017 10:23 | 8/30/2017 10:25 | 12.0 | 6.10 | 0.013 | 0.016 | |
| 7 | 8/30/2017 10:27 | 8/30/2017 10:27 | 8/30/2017 10:29 | 14.8 | 6.10 | 0.013 | 0.016 | |
| 8 | 8/30/2017 10:32 | 8/30/2017 10:32 | 8/30/2017 10:34 | 17.7 | 6.10 | 0.013 | 0.013 | |
| 10 | 8/30/2017 10:40 | 8/30/2017 10:40 | 8/30/2017 11:00 | 22.6 | 6.10 | 0.003 | 0.018 | |
| **Replacement Piles** | | | | | | | | |
| 6A | 9/12/2017 7:51 | 9/12/2017 7:59 | 9/12/2017 9:41 | 13.0 | 4.70 | 0.014 | 0.007 | |
| 10A | 9/12/2017 8:29 | 9/12/2017 8:36 | 9/12/2017 9:37 | 23.6 | 4.70 | 0.015 | 0.003 | |
| 13A | 9/12/2017 9:07 | 9/12/2017 9:13 | 9/12/2017 9:29 | 26.6 | 4.70 | 0.015 | 0.011 | |

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Well Information**

**Well No.:** 11
Municipal Address: [redacted]
Distance from Turbine Centre: 1223 m

**Well No.:** 12
Municipal Address: [redacted]
Distance from Turbine Centre: 1635 m

ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Vibration measurements were undertaken on August 17, 2017 at Wells 11 and 12 during water quality sampling events in the absence of pile driving within the cluster. Both pumps turned on and operated during the sampling events. The maximum vibration measurement for Well 11 was 0.016 mm/s and this pump was located within the residence approximately 40 m from the well. The maximum vibration measurement for Well 12 was 0.896 mm/s and the pump was mounted on the well casing. The maximum vibration measurement of the Well 12 casing during all monitoring completed to the date of report issue was about 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Note that driving/restriking of some piles occured in relatively rapid succession and, therefore, the vibration measurement data for the 10 minute periods of analysis are applicable to multiple piles. Data for Well 12 during driving of Pile 2 on August 23, 2017 was not captured when data logger battery failed and then changed. Total driving time on till/rock for Pile 9 was interrupted by repairs to the pile driving hammer and the actual driving duration on till/rock was 8:00 (minutes:seconds) for this pile. Total driving time on till/rock for restrike of Pile 10 was interrupted by damage to the pile top, splicing and welding and total driving duration on till/rock was 5:48 (minutes:seconds). Driving time on till/rock for driving of Pile 6A was interrupted from 8:07:35 to 8:10:35 and from 8:12:45 to 9:40:28. Driving time on till/rock for driving of Pile 10A was interrupted from 8:49:30 to 9:37:05. Driving time on till/rock for driving of Pile 13A was interrupted from 9:18:45 to 9:26:30. Total pile driving durations derived from start and end times noted above includes labour breaks, equipment work, splicing, welding and other standby time.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.

# NORTH KENT 1
## Preliminary Vibration Monitoring Report

**Turbine Location:** T46

| | Vibration Measurements at Turbine Site | | | | | Vibration Measurements at Wells | | |
|---|---|---|---|---|---|---|---|---|
| | Pile Driving Times and Dates | | | | Daily Maximum Particle Velocity | Particle Velocity (mm/s)[c, d] | | |
| Pile No.: | Start[a] | Rock/Till | End[a] | Geophone Dist. (m) | (mm/s)[b] | Well 11 | Well 12 | No Pump[e] |
| 1 | 8/29/2017 8:38 | 8/29/2017 8:44 | 8/29/2017 9:10 | 26.5 | 5.80 | NA[e] | 0.002 | |
| 2 | 8/29/2017 9:24 | 8/29/2017 9:33 | 8/29/2017 9:49 | 25.5 | 5.80 | NA[e] | 0.003 | |
| 3 | 8/29/2017 10:14 | 8/29/2017 10:19 | 8/29/2017 10:30 | 23.8 | 5.80 | NA[e] | 0.037 | |
| 4 | 8/29/2017 12:41 | 8/29/2017 12:52 | 8/29/2017 13:01 | 21.5 | 5.80 | 0.004 | 0.010 | |
| 5 | 8/29/2017 12:00 | 8/29/2017 12:09 | 8/29/2017 12:28 | 18.9 | 5.80 | NA[e] | 0.003 | |
| 6 | 8/29/2017 11:02 | 8/29/2017 11:11 | 8/29/2017 11:25 | 16.0 | 5.80 | NA[e] | 0.006 | |
| 7 | 8/28/2017 16:35 | 8/28/2017 16:47 | 8/28/2017 16:53 | 13.1 | 7.85 | 0.015 | 0.071 | |
| 8 | 8/28/2017 16:02 | 8/28/2017 16:12 | 8/28/2017 16:20 | 10.9 | 7.85 | 0.007 | 1.551 | 0.039 |
| 9 | 8/28/2017 13:25 | 8/28/2017 13:34 | 8/28/2017 13:36 | 10.0 | 7.85 | 0.006 | 0.011 | |
| 10 | 8/28/2017 12:44 | 8/28/2017 12:56 | 8/28/2017 12:59 | 10.9 | 7.85 | 0.006 | 0.008 | |
| 11 | 8/28/2017 11:25 | 8/28/2017 11:34 | 8/28/2017 11:41 | 13.1 | 7.85 | NA[e] | 0.011 | |
| 12 | 8/28/2017 10:07 | 8/28/2017 10:17 | 8/28/2017 10:20 | 16.0 | 7.85 | 0.003 | 0.009 | |
| 13 | 8/28/2017 9:33 | 8/28/2017 9:43 | 8/28/2017 9:49 | 18.9 | 7.85 | 0.021 | 0.015 | |
| 14 | 8/28/2017 9:00 | 8/28/2017 9:12 | 8/28/2017 9:16 | 21.5 | 7.85 | 0.003 | 0.003 | |
| 15 | 8/28/2017 8:30 | 8/28/2017 8:44 | 8/28/2017 8:47 | 23.8 | 7.85 | 0.004 | 0.004 | |
| 16 | 8/28/2017 13:53 | 8/28/2017 14:03 | 8/28/2017 14:07 | 25.5 | 7.85 | 0.002 | 0.006 | |
| 17 | 8/28/2017 14:27 | 8/28/2017 14:38 | 8/28/2017 14:48 | 26.5 | 7.85 | 0.017 | 0.004 | |
| 18 | 8/29/2017 7:53 | 8/29/2017 8:01 | 8/29/2017 8:05 | 26.9 | 5.80 | NA[e] | 0.002 | |
| **Restrikes** | | | | | | | | |
| 9 | 8/29/2017 13:14 | 8/29/2017 13:14 | 8/29/2017 13:16 | 10.0 | 5.80 | 0.005 | 0.006 | |
| 8 | 8/29/2017 13:25 | 8/29/2017 13:25 | 8/29/2017 13:26 | 10.9 | 5.80 | 0.003 | 0.052 | |
| 16 | 8/29/2017 13:36 | 8/29/2017 13:36 | 8/29/2017 13:38 | 25.5 | 5.80 | 0.003 | 0.006 | |

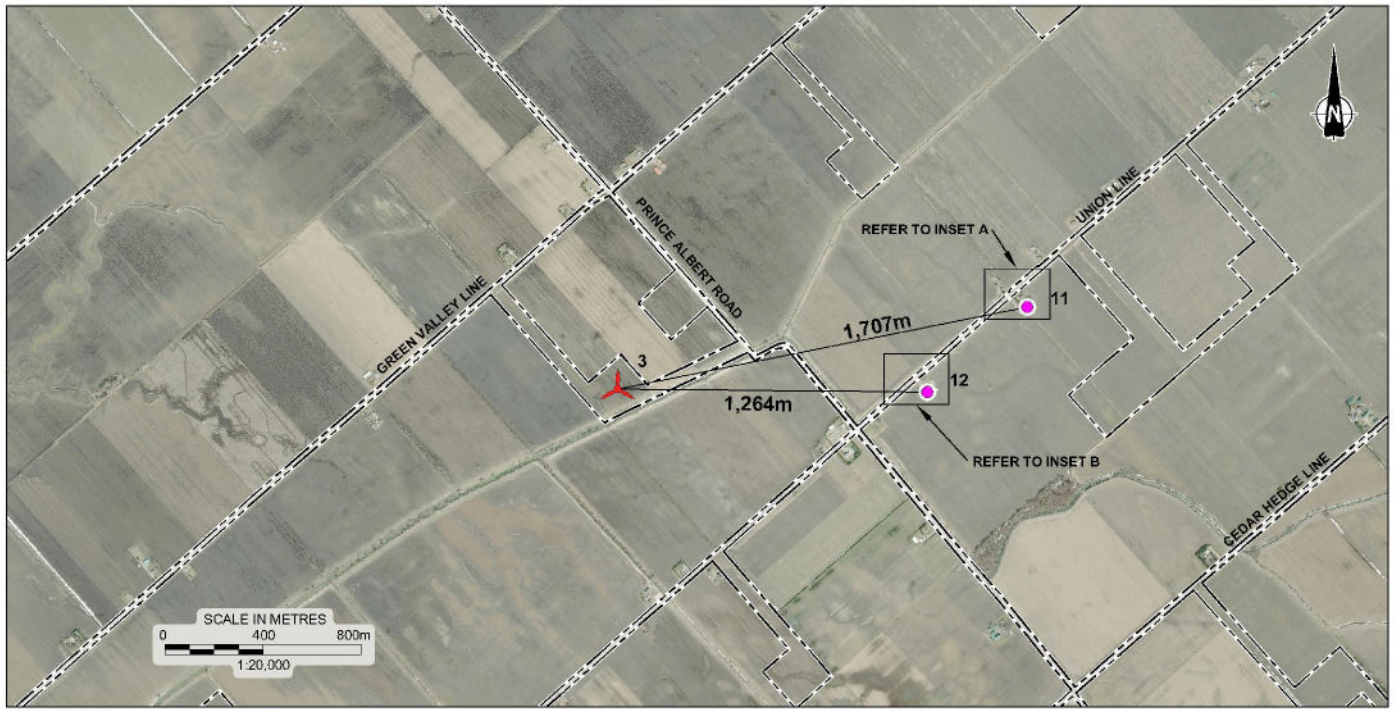
**Well Information**

| | | | |
|---|---|---|---|
| ***Well No.:*** | ***11*** | **Well No.:** | 12 |
| Municipal Address: | | Municipal Address: | |
| Distance from Turbine Centre: | 1697 m | Distance from Turbine Centre: | 2170 m |

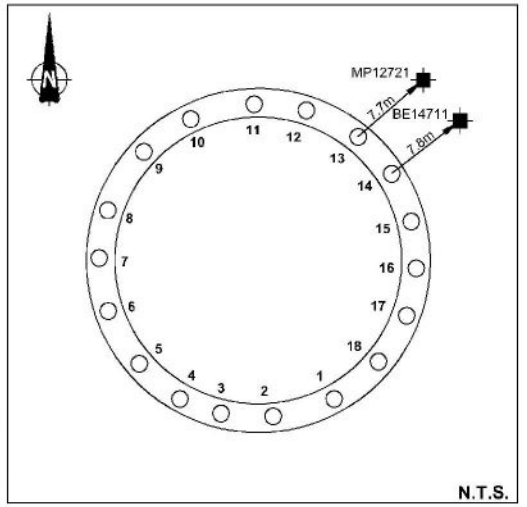
ISO 2631-2 particle velocity threshold for human perception is 0.1 mm/s between approximately 8 to 100 Hz
Background values at T5 and T42 test pile sites and Wells 1 and 2, when other common activities observed ranged from <0.01 to approximately 0.07 mm/s

**Monitoring Notes:** Data obtained during pile dynamic analyses is pending. Piles noted with "A" represent piles installed to replace similarly-numbered piles. After installation, selected piles were struck again with the hammer to demonstrate resistance performance and these are noted as "restrikes". Total duration for pile driving on rock/till based on times noted above is not representative for Piles 1 and where the actual duration for driving on till/rock was (minutes:seconds): 1(11:30) and 5(18:32) . Maximum vibrations for Well 12 were 1.55 mm/s for August 29, 2017. The pump was mounted on the well casing. During pile driving on August 23, 2017, the maximum vibration measurement of the Well 12 casing was 2.4 mm/s for clearly definable periods during which the pump was operating. Data shown for the "no pump" condition was obtained during pile driving when the pump was not operating. Data not available for Piles 1, 2, 3, 5, 6, 11 and 18 at Well 11 on August 28 and 29, 2017 due to several separate battery failures in monitoring equipment. Batteries were subsequently replaced upon discovery.

**Footnotes:** a) start and stop of pile driving are start and stop times for active hammering; b) values shown are maximum daily values regardless of direction; c) preliminary values subject to further data review/analysis; d) values shown are based on fast Fourier transform analyses of consecutive 1 second intervals for a total period of 10 minutes during pile driving on till/rock (600 seconds) and represent the maximum of the 1 second interval peak velocity values during these periods regardless of measurement direction; e) see monitoring notes above.




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

| | |
|---|---|
| | INSTANTEL MINIMATE GEOPHONE |
| | WATER WELL |
| | TURBINE BEING CONSTRUCTED |
| MN | MAGNETIC NORTH |
| UTM-N | UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH |

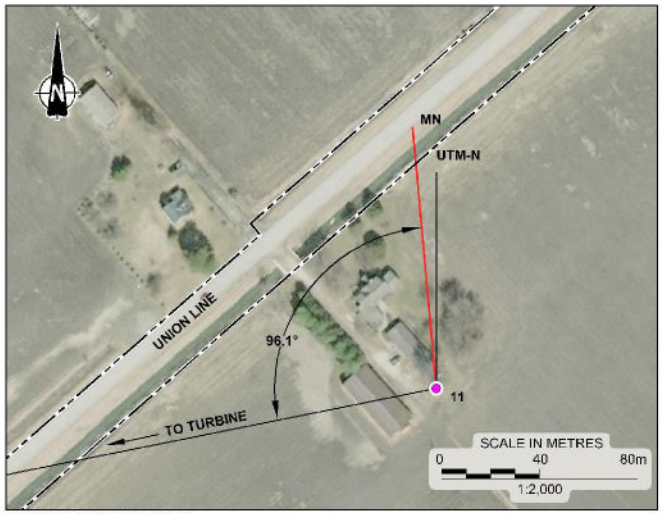
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

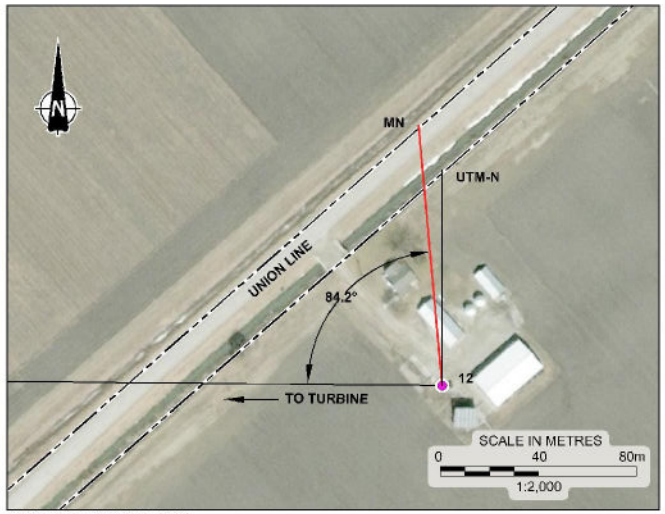
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

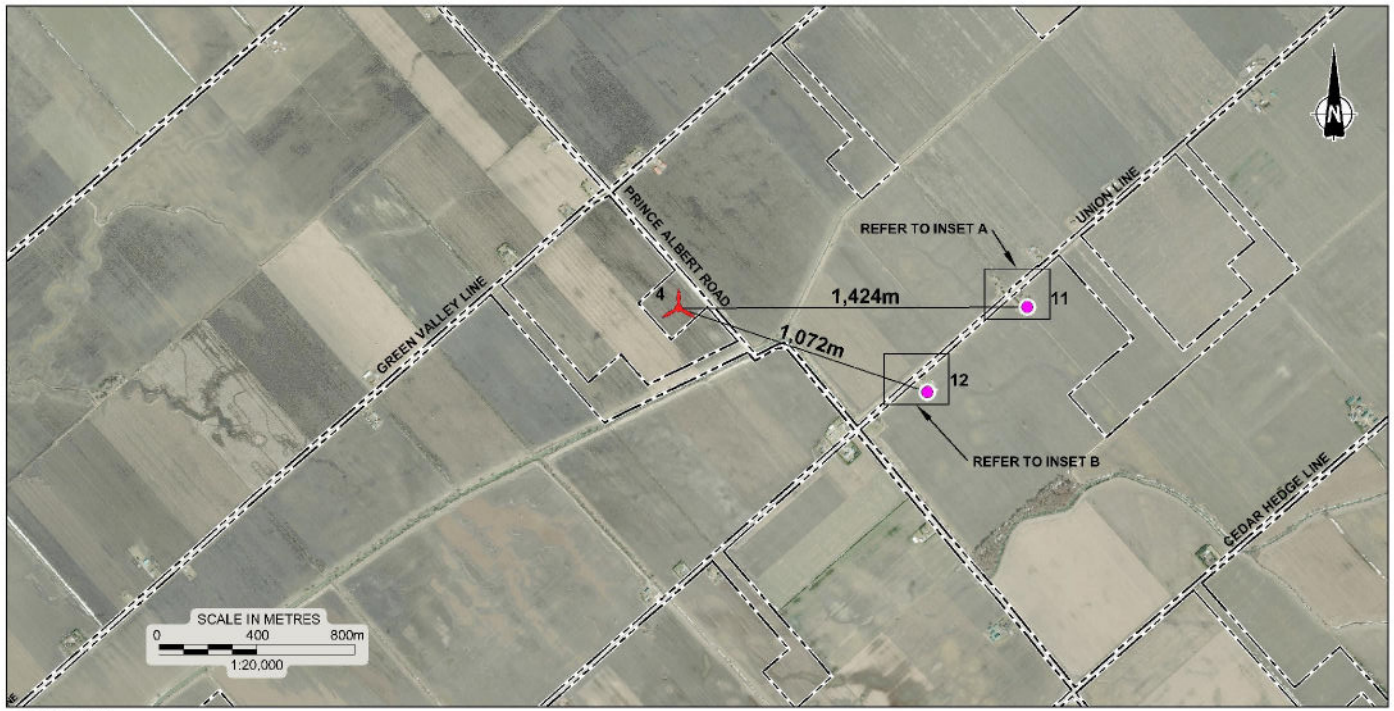
**TURBINE PILES AND WATER WELL LOCATION PLAN, T3**

Golder Associates

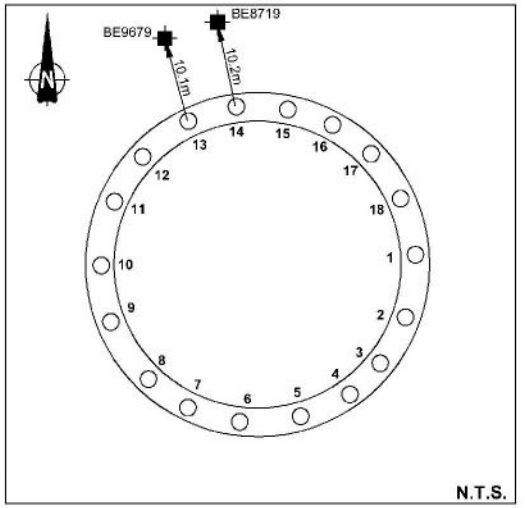
| | | | |
|---|---|---|---|
| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R020T3 |
| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T3

Drawing file: 1668031-2000-R020T3.dwg Sep 20, 2017 - 2:49pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

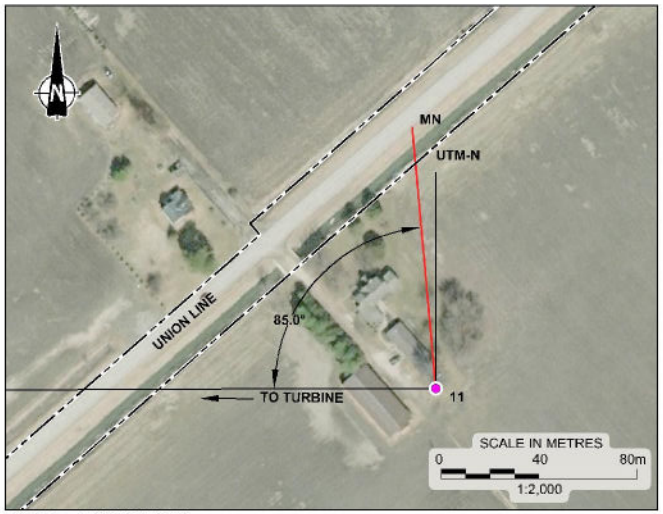
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

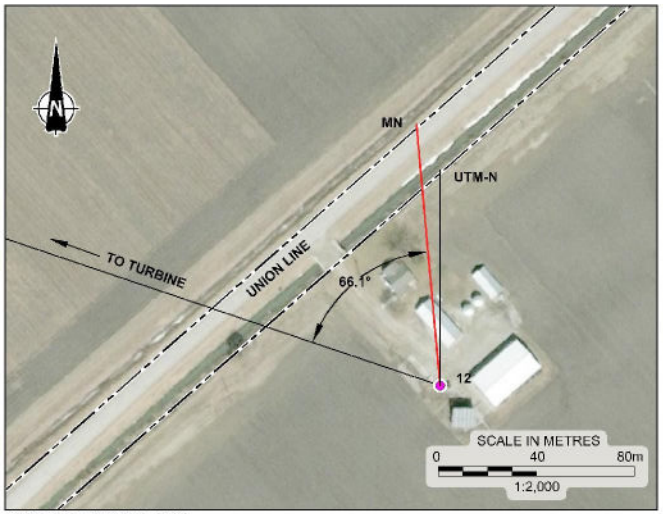
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T4**

Golder Associates

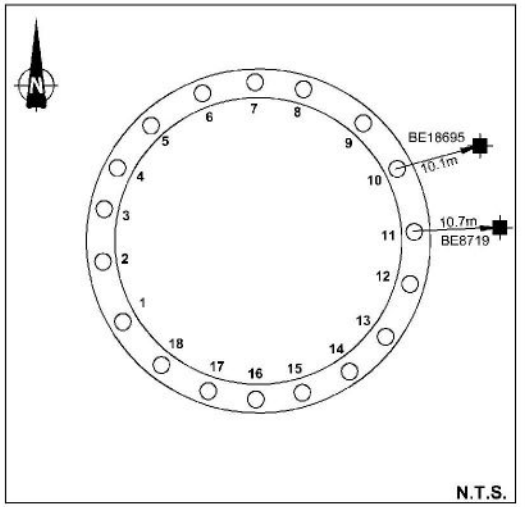
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| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R020T4 |
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| CADD | DGH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T4

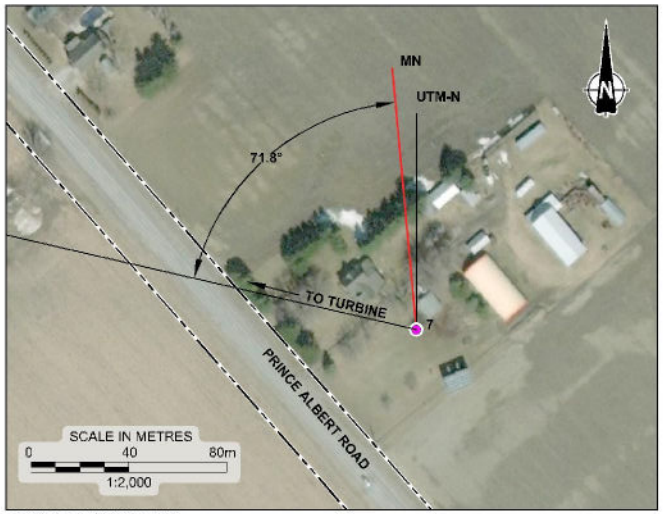
Drawing file: 668031 2000 R020T4.dwg Sep 20, 2017 12:51pm



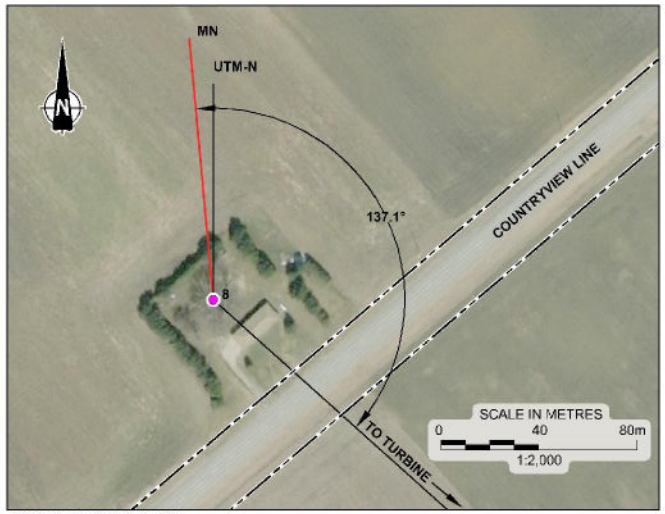

SITE PLAN




TURBINE PILE LAYOUT




INSET A (WELL #7)




INSET B (WELL #8)

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T6**

Golder Associates

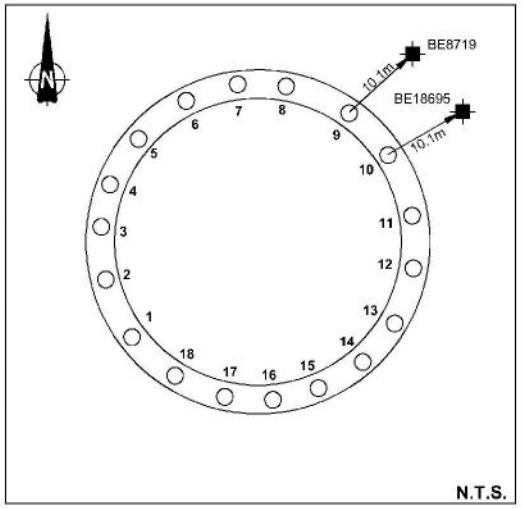
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| DESIGN | | SCALE | AS SHOWN |
| CADD | DCH/ZJE Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T6

Drawing file: 1658031-2000-R02016.dwg Sep 20, 2017 - 2:52pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

| | |
|---|---|
| | INSTANTEL MINIMATE GEOPHONE |
| | WATER WELL |
| | TURBINE BEING CONSTRUCTED |
| MN | MAGNETIC NORTH |
| UTM-N | UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH |

## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

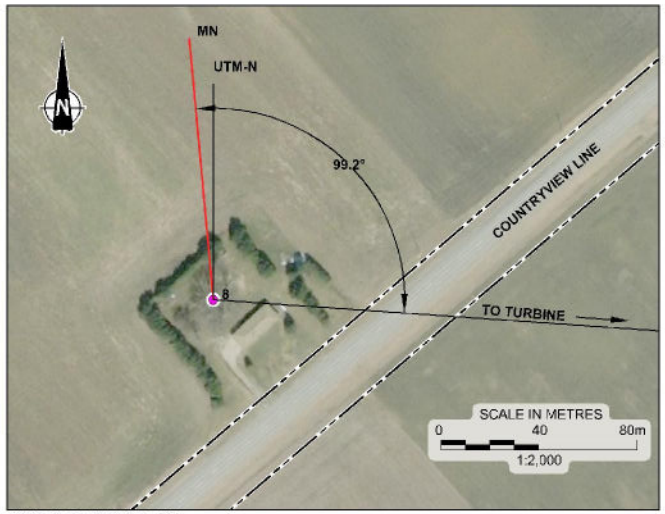
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #7)




INSET B (WELL #8)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T7**

Golder Associates

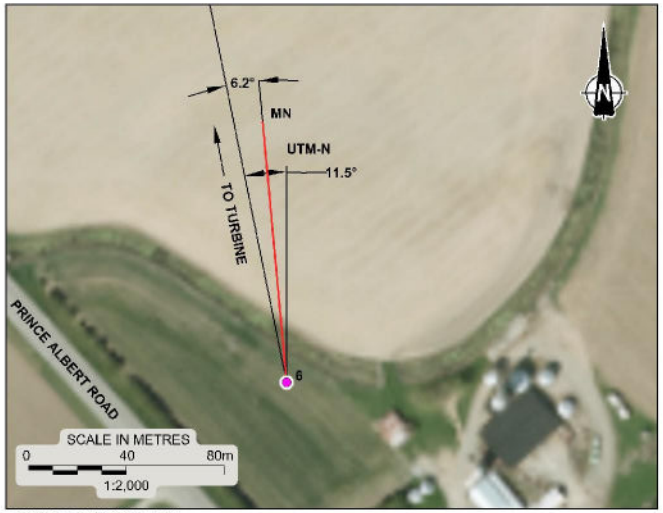
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| CADD | DCH/ZJB | Sept. 18/17 | REV. |
| CHECK | | | |

FIGURE T7

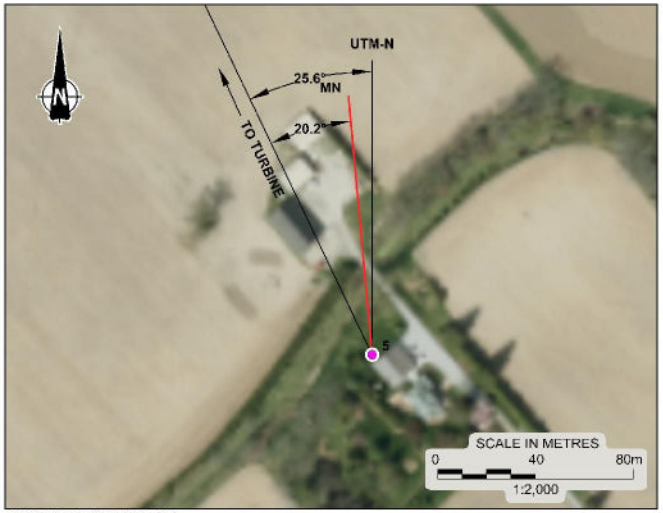
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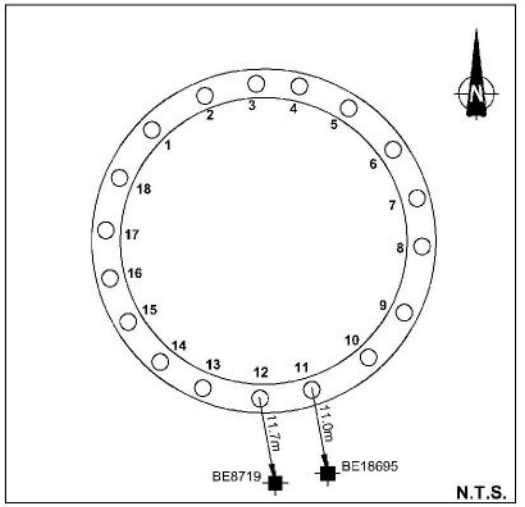

SITE PLAN




INSET A (WELL #6)




INSET B (WELL #5)




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T12**

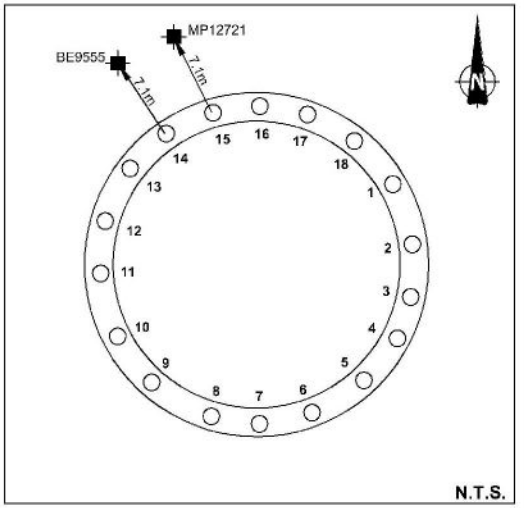
Golder Associates

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| CADD | DCH/ZJB | Sept. 20/17 | | FIGURE T12 |
| CHECK | | | | |

Drawing file: 1658031-2000-R02T12.dwg Sep 20, 2017 - 12:39pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

| | |
|---|---|
| | INSTANTEL MINIMATE GEOPHONE |
| | WATER WELL |
| | TURBINE BEING CONSTRUCTED |
| MN | MAGNETIC NORTH |
| UTM-N | UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH |

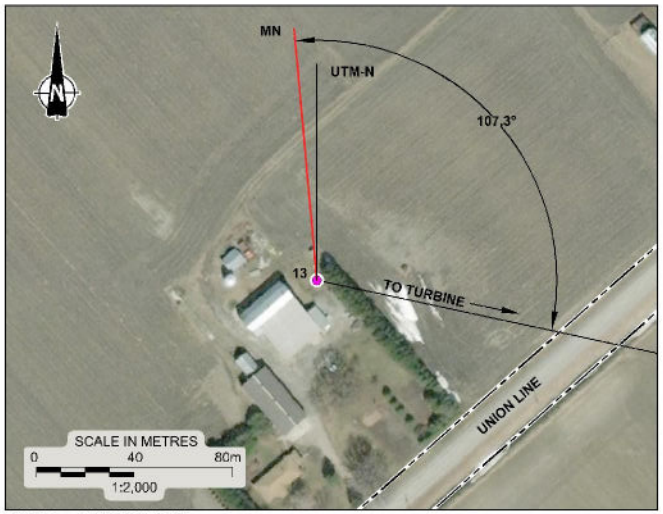
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

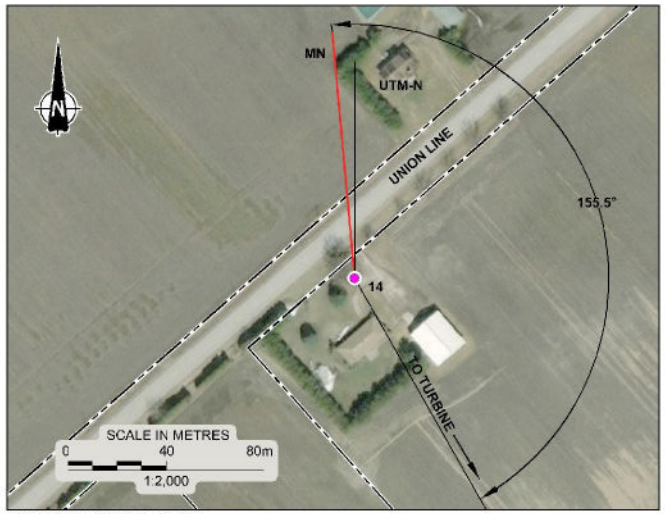
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #13)




INSET B (WELL #14)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T14**

Golder Associates

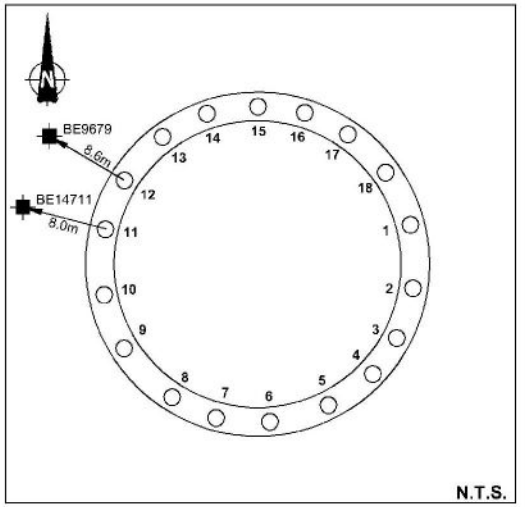
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| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 18/17 | | |
| CHECK | | | | |

FIGURE T14

Drawing file: 668031 2000 R02T14.dwg Sep 18, 2017 4:46pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN MAGNETIC NORTH
- UTM-N UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

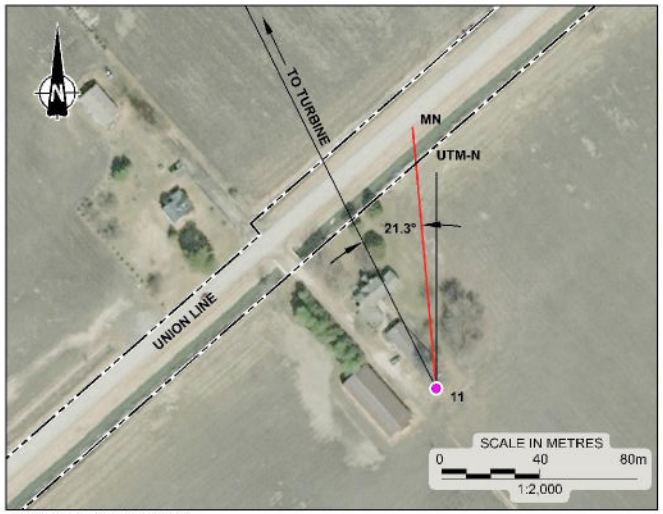
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

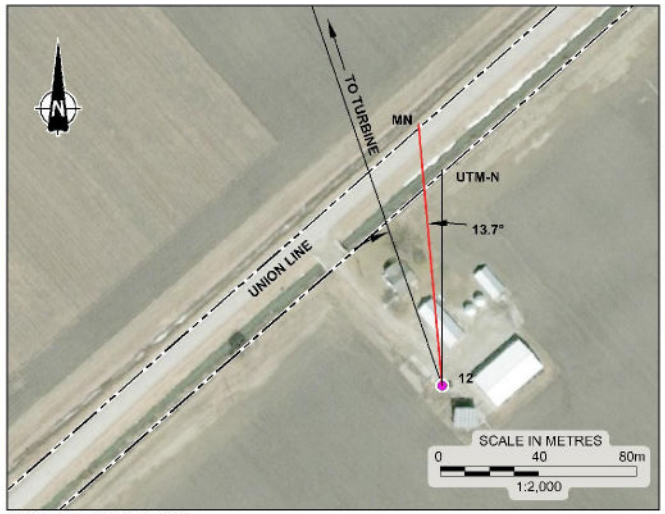
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T20**

Golder Associates

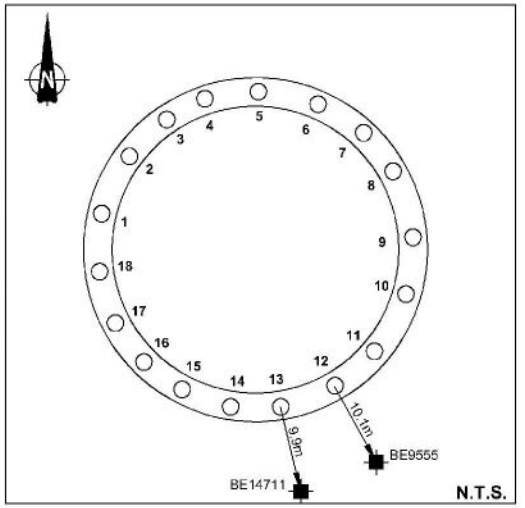
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| CADD | DCH/ZJB | Sept. 18/17 | | |
| CHECK | | | | |

FIGURE T20

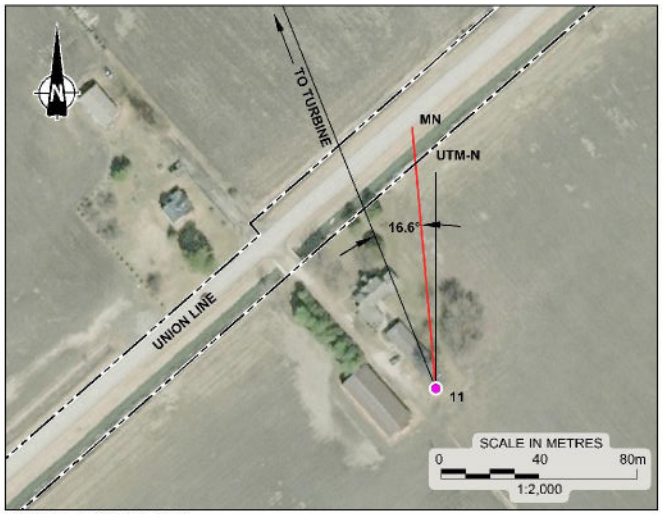
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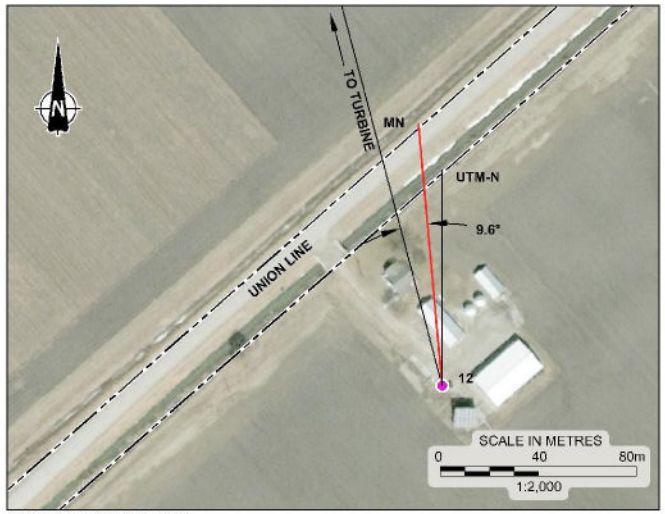

SITE PLAN




TURBINE PILE LAYOUT




INSET A (WELL #11)




INSET B (WELL #12)

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T21**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT No. | | | 1668031 |
| CADD | DCH/ZJB | Sept. 18/17 | |
| CHECK | | | |

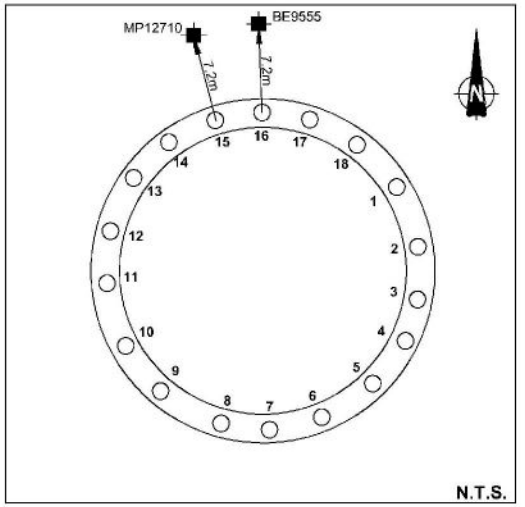
FILE No. 1668031-2000-RG2T21
SCALE AS SHOWN REV.

FIGURE T21

Drawing file: 668031 2000 RG2T21.dwg Sep 18, 2017 2:24pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

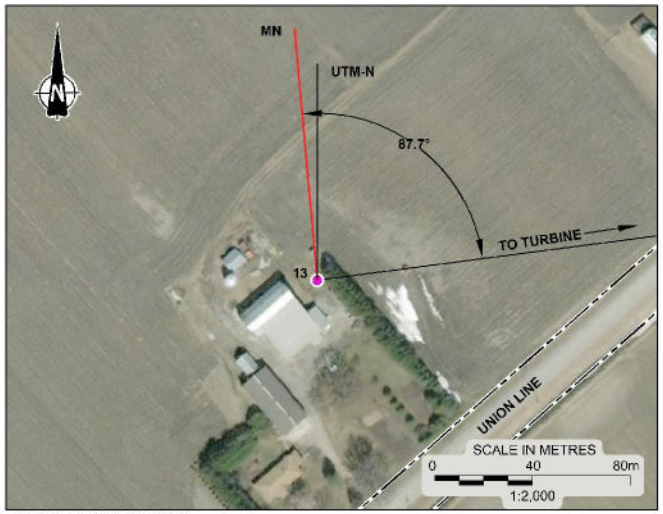
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

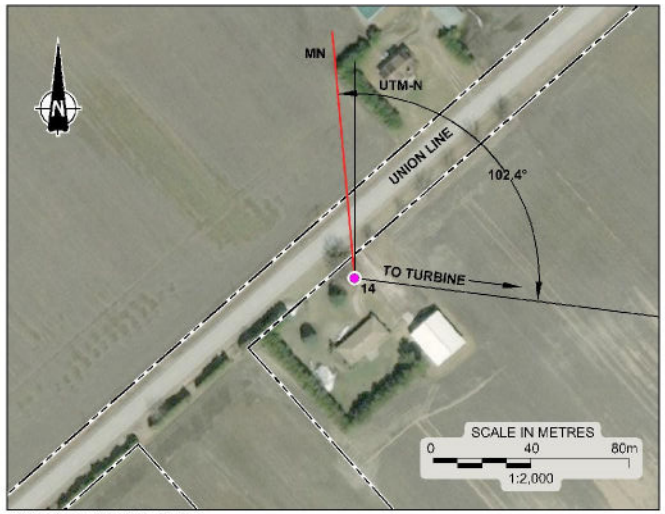
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #13)




INSET B (WELL #14)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T26**

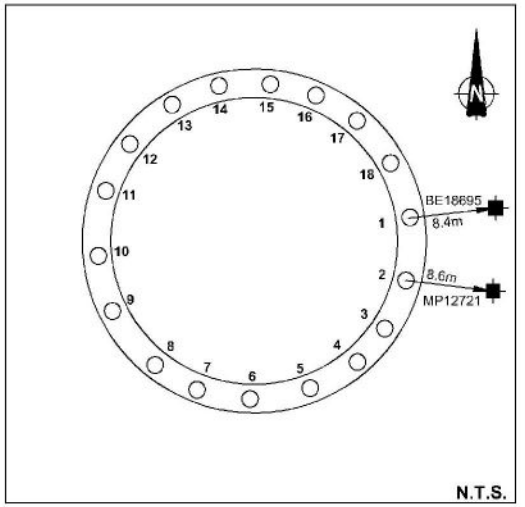
Golder Associates

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| PROJECT No. | | | 1668031 | FILE No. 1668031-2000-R02T26 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | FIGURE T26 |
| CHECK | | | | |

Drawing file: 1668031-2000-R02T26.dwg Sep 20, 2017 - 11:15am




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

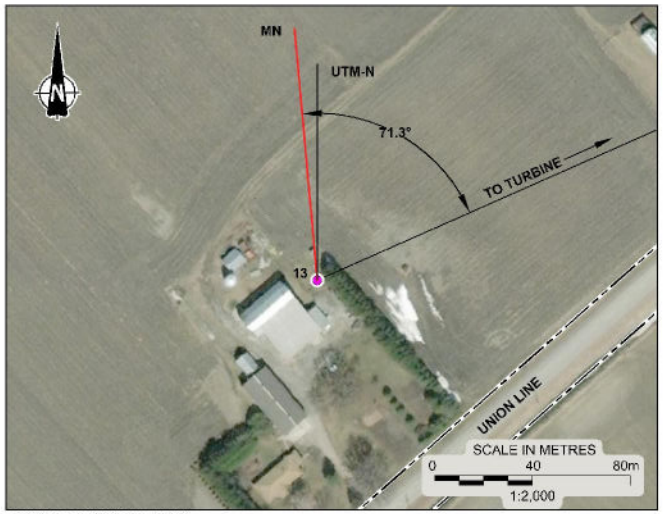
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

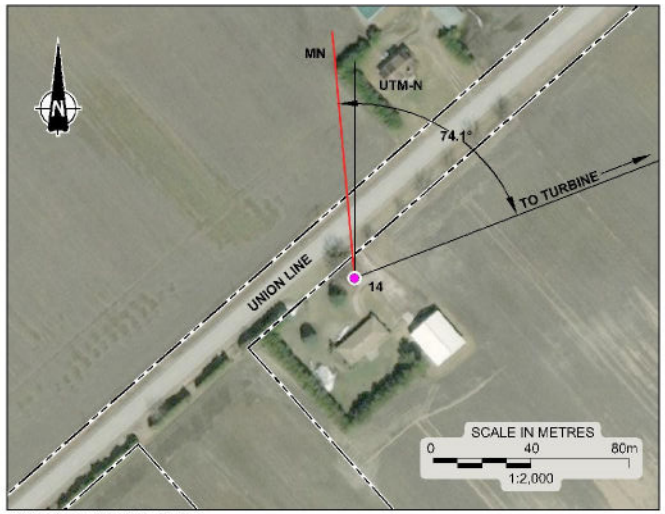
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #13)




INSET B (WELL #14)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

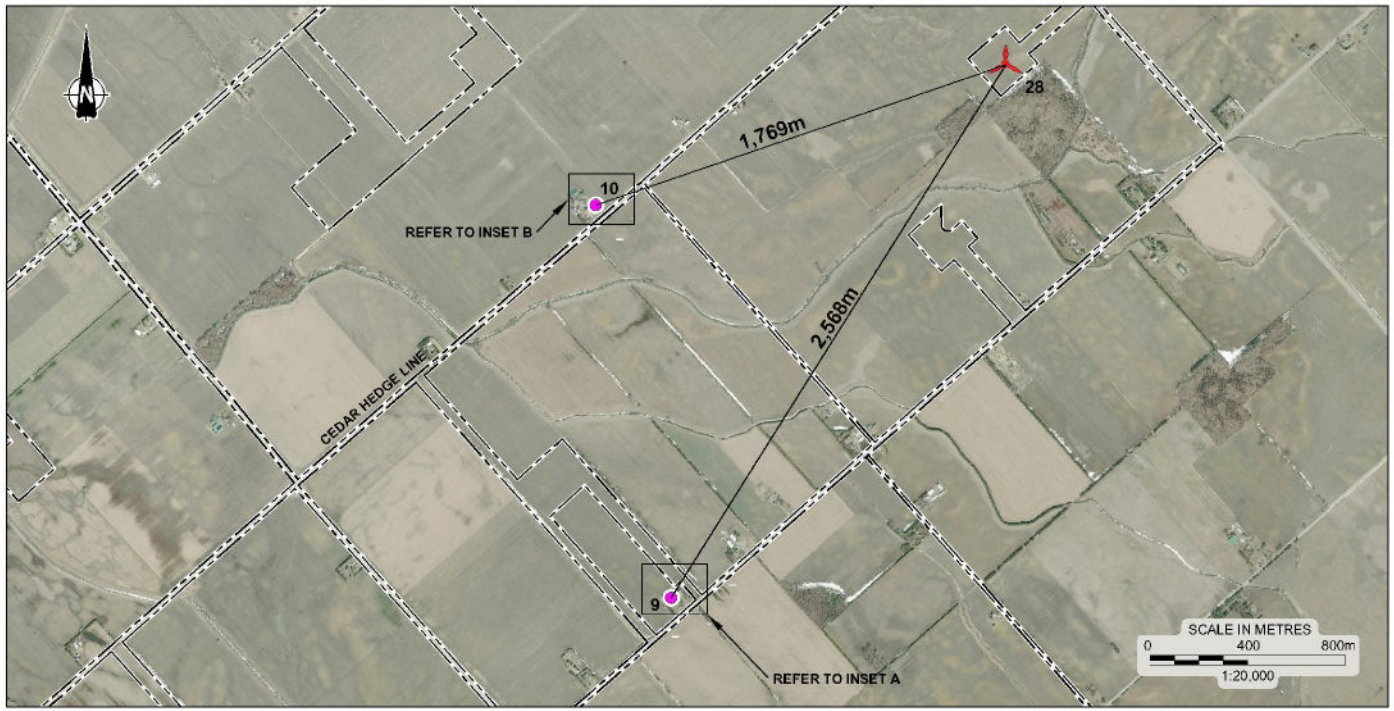
**TURBINE PILES AND WATER WELL LOCATION PLAN, T27**

Golder Associates

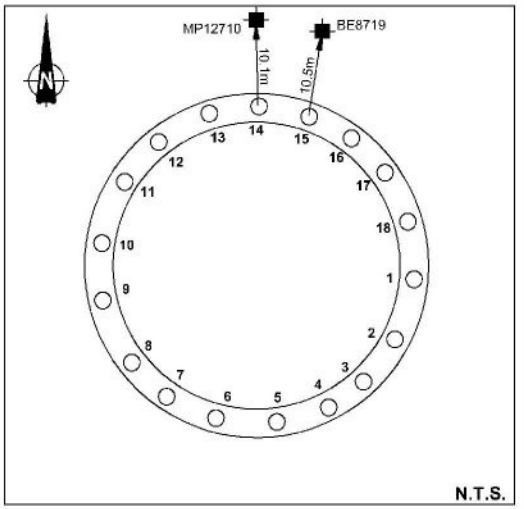
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| | | | SCALE AS SHOWN | REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | |
| CHECK | | | | |

FIGURE T27

Drawing file: 1668031-2000-R02727.dwg Sep 20, 2017 - 11:10am




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

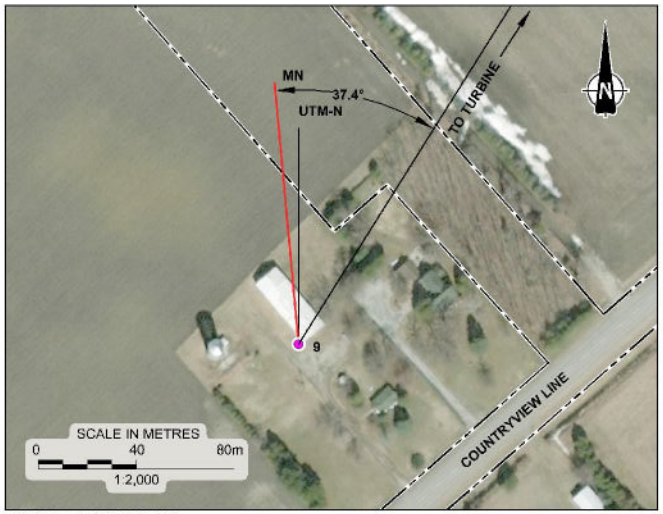
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

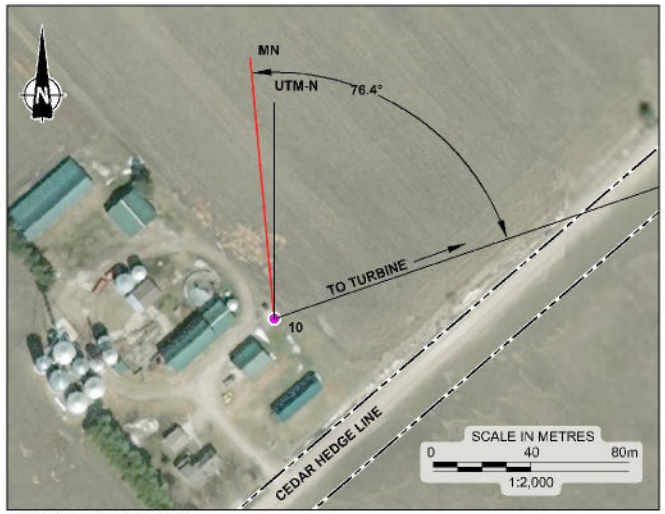
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #9)




INSET B (WELL #10)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T28**

Golder Associates

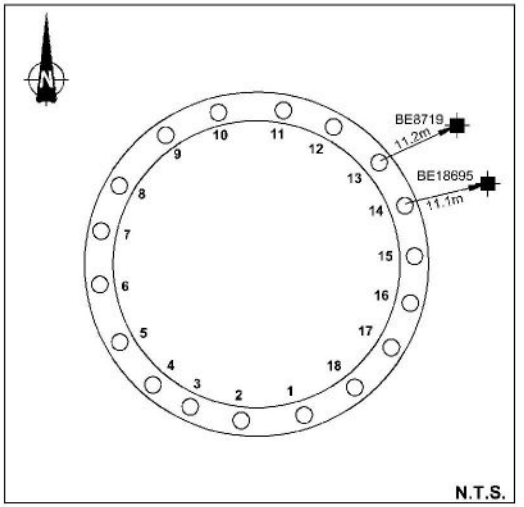
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| CADD | DCH/ZJB | Sept. 20/17 | | |
| CHECK | | | | |

FIGURE T28

Drawing file: 668031 2000 R02T28.dwg Sep 20, 2017 12:39pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

| | |
|---|---|
| | INSTANTEL MINIMATE GEOPHONE |
| | WATER WELL |
| | TURBINE BEING CONSTRUCTED |
| MN | MAGNETIC NORTH |
| UTM-N | UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH |

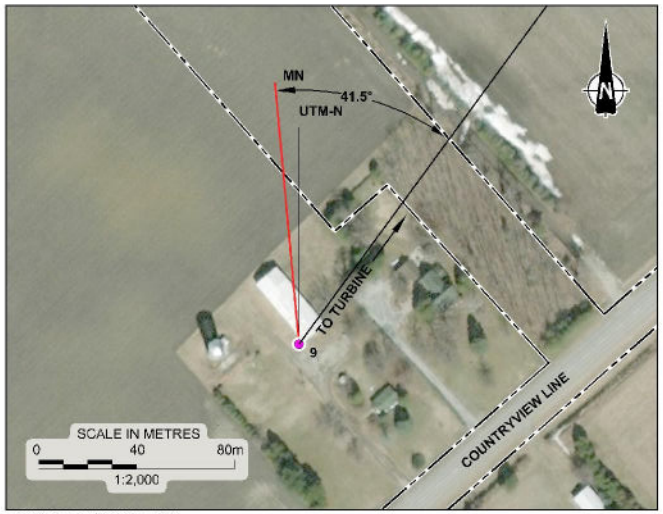
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

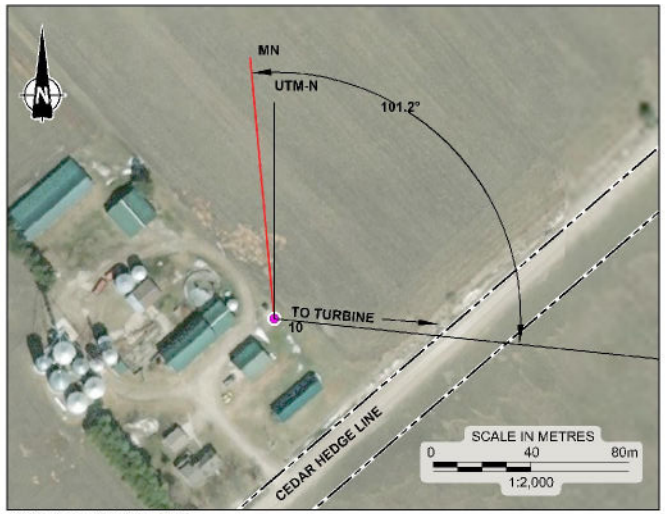
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #9)




INSET B (WELL #10)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T30**

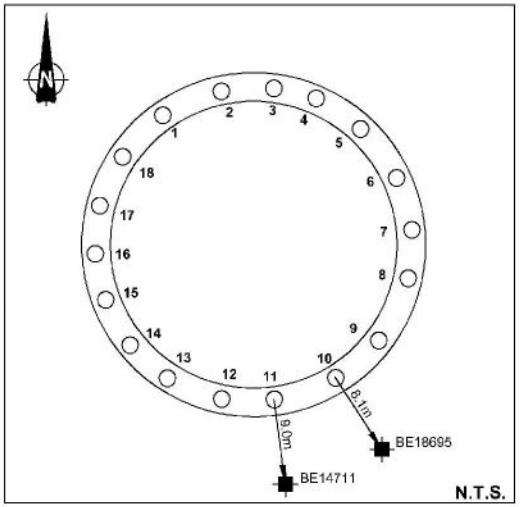
Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT No. | | | 1668031 | FILE No. 1668031-2000-R02T30 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DCH/ZJB | Sept. 20/17 | | |
| CHECK | | | | FIGURE T30 |

Drawing file: 1668031-2000-R02T30.dwg Sep 20, 2017 - 2:41pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

| | |
|---|---|
| | INSTANTEL MINIMATE GEOPHONE |
| | WATER WELL |
| | TURBINE BEING CONSTRUCTED |
| MN | MAGNETIC NORTH |
| UTM-N | UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH |

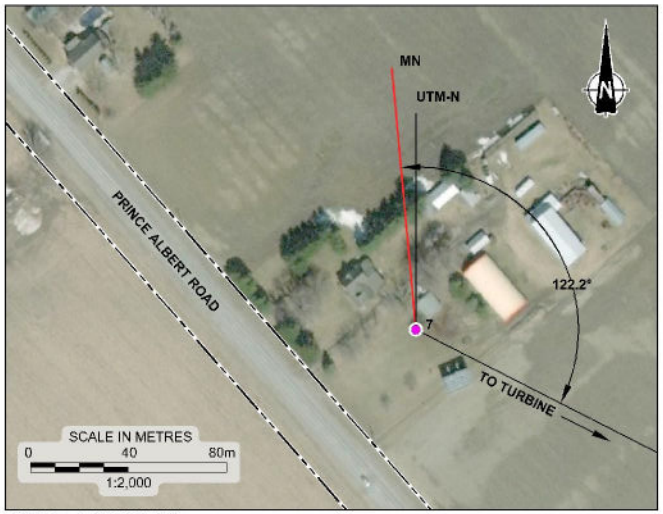
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

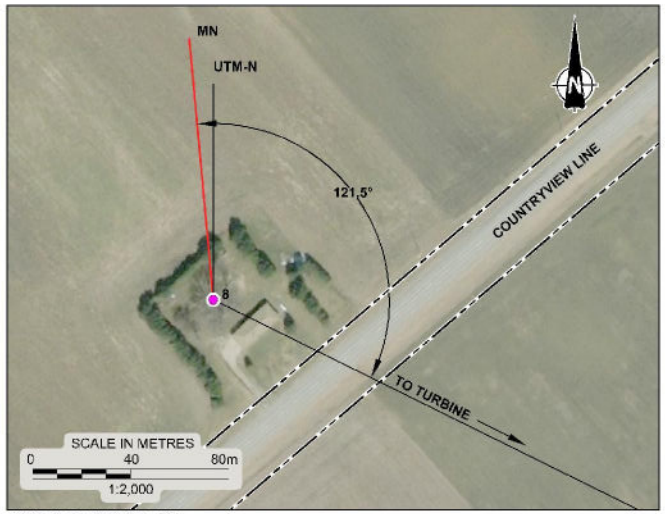
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #7)




INSET B (WELL #8)

PROJECT
NORTH KENT 1
VIBRATION MONITORING

TITLE
**TURBINE PILES AND WATER WELL LOCATION PLAN, T31**

Golder Associates

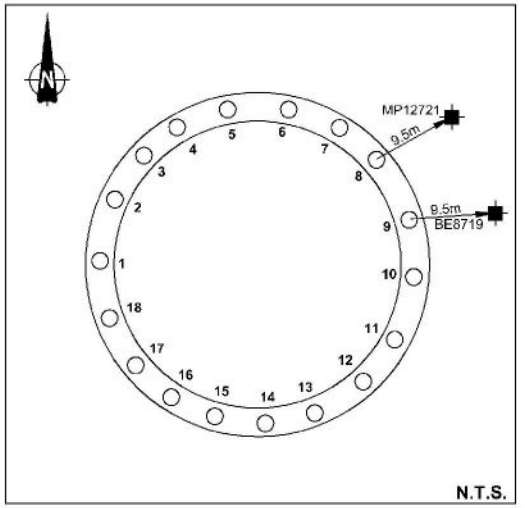
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| PROJECT No. | 1668031 | | FILE No. | 1668031-2000-RG2T31 |
| | | | SCALE | AS SHOWN |
| CADD | DDI/ZJB | Sept. 18/17 | REV. | |
| CHECK | | | | |

FIGURE T31

Drawing file: 668031 2000 RG2T31.dwg Sep 20, 2017 12:42pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

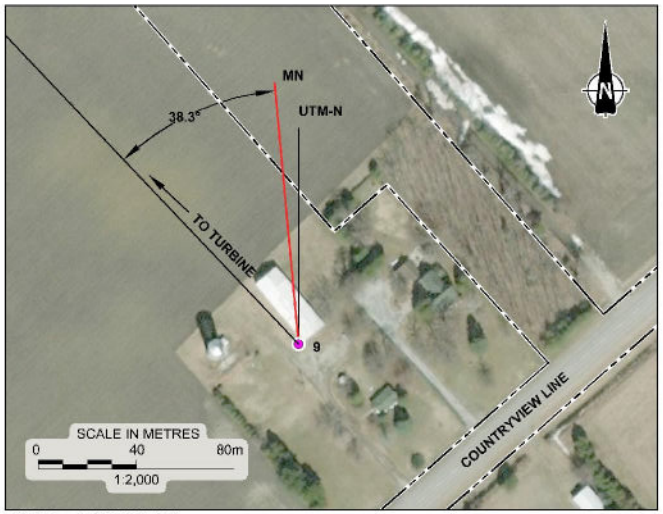
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

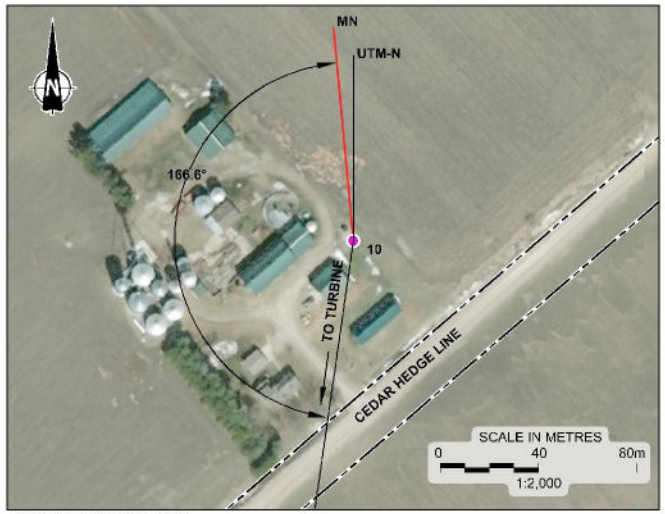
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #9)




INSET B (WELL #10)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T32**

Golder Associates

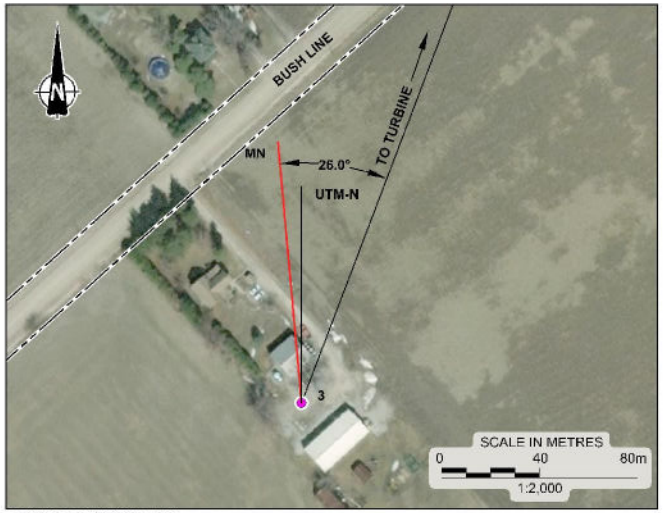
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|---|---|---|---|
| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R02T32 |
| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T32

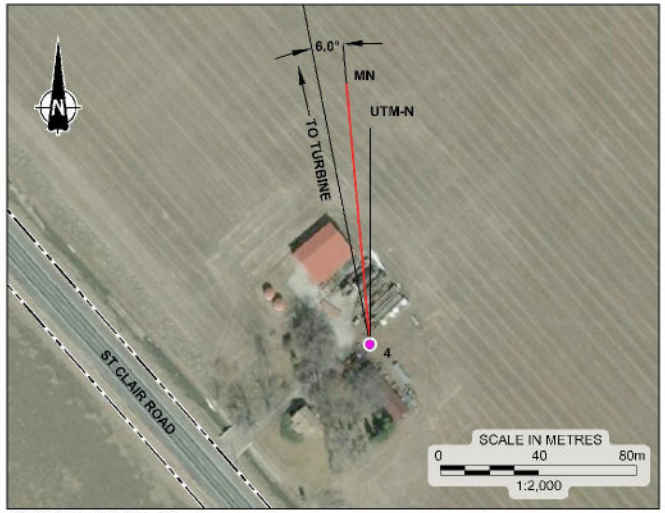
Drawing file: 668031 2000 R02T32.dwg Sep 20, 2017 12:55pm



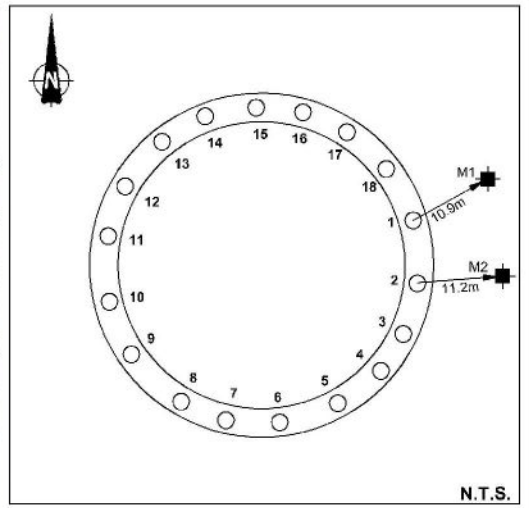

SITE PLAN




INSET A (WELL #3)




INSET B (WELL #4)




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

# TURBINE PILES AND WATER WELL LOCATION PLAN, T33

Golder Associates

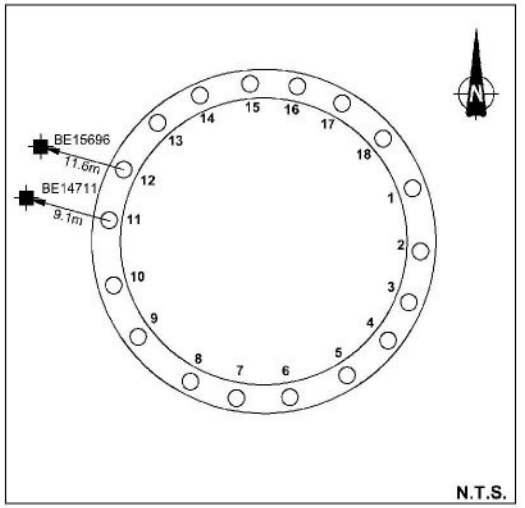
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| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T33

Drawing file: 1668031-2000-R02T33.dwg Sep 20, 2017 - 2:46pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

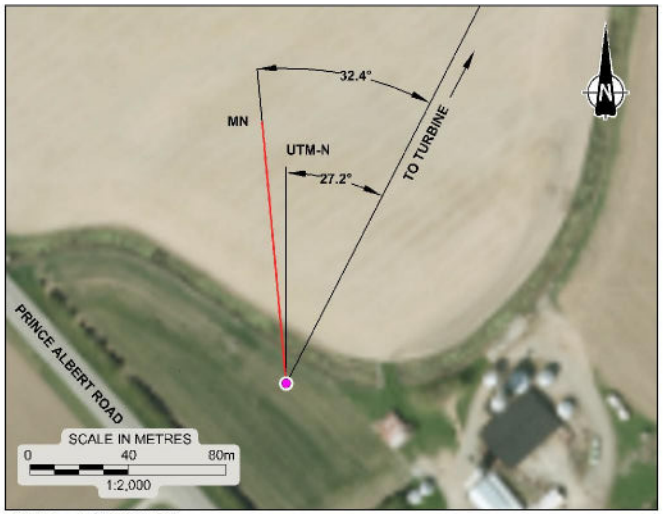
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

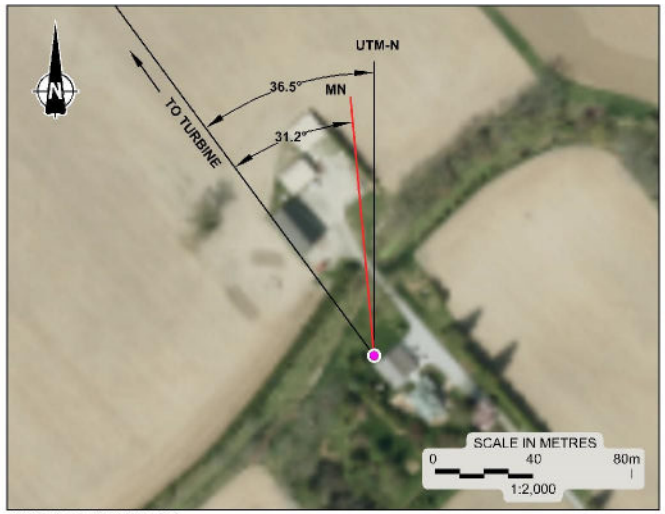
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #6)




INSET B (WELL #5)

PROJECT
NORTH KENT 1
VIBRATION MONITORING

TITLE
**TURBINE PILES AND WATER WELL LOCATION PLAN, T35**

Golder Associates

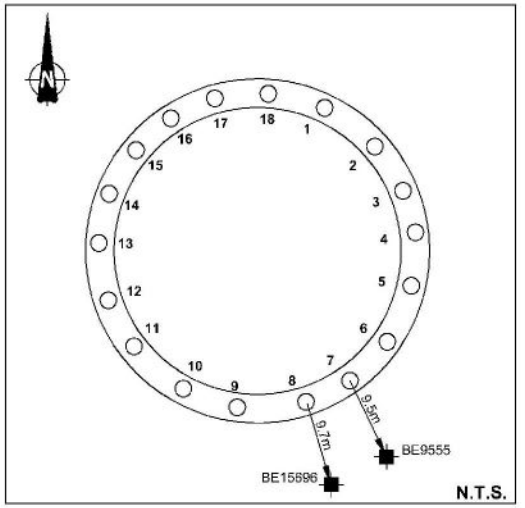
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|---|---|---|
| | | SCALE AS SHOWN REV. |
| CADD | DDH/ZJB Sept. 18/17 | |
| CHECK | | |

FIGURE T35

Drawing file: 1668031 2000 R02T35.dwg Sep 20, 2017 12:47pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

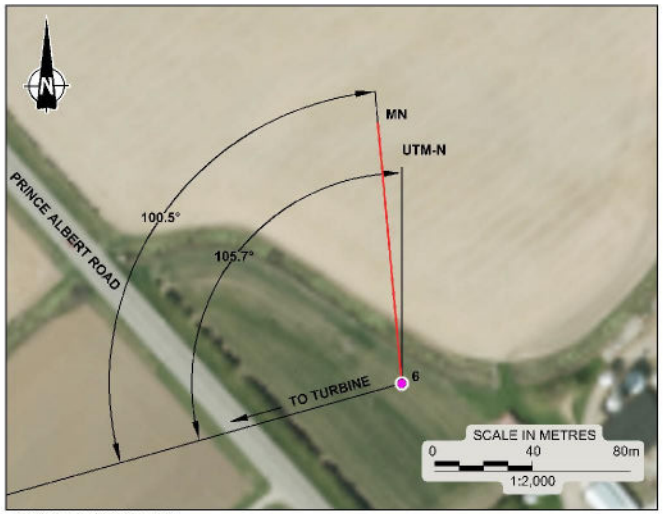
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

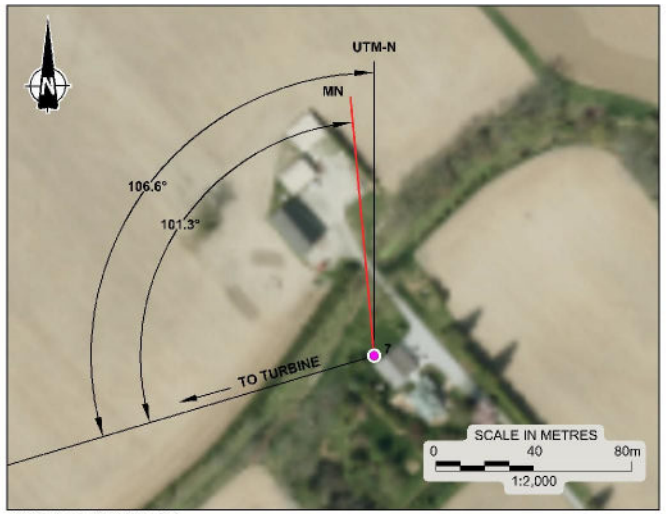
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #6)




INSET B (WELL #5)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T36**

Golder Associates

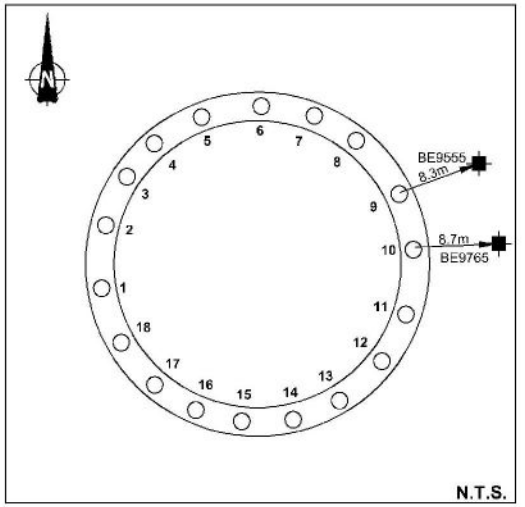
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|---|---|---|---|---|
| PROJECT No. | 1668031 | | FILE No. | 1668031-2000-R02T36 |
| CADD | DCH/ZJB | Sept. 20/17 | SCALE | AS SHOWN |
| CHECK | | | REV. | |

FIGURE T36

Drawing file: 1668031-2000-R02T36.dwg Sep 20, 2017 - 2:49pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

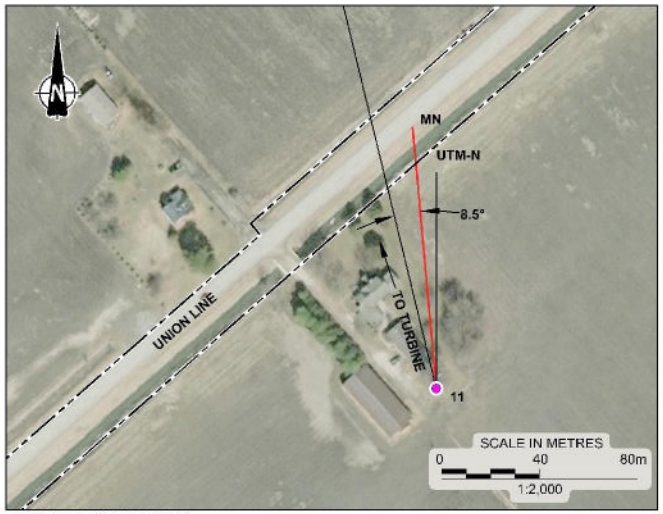
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT. INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

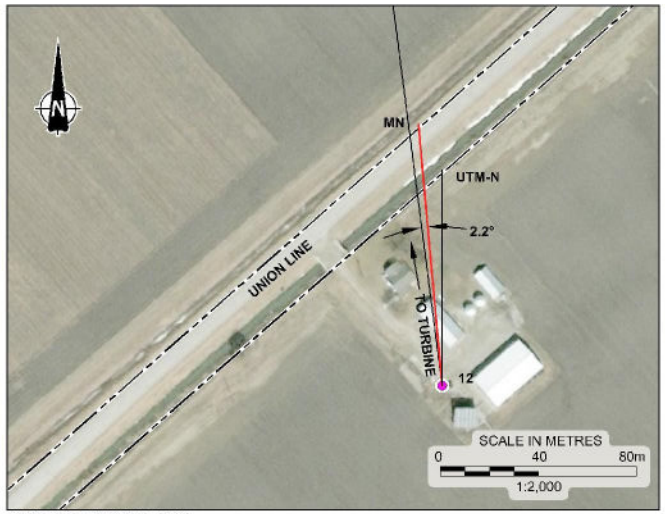
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T43**

Golder Associates

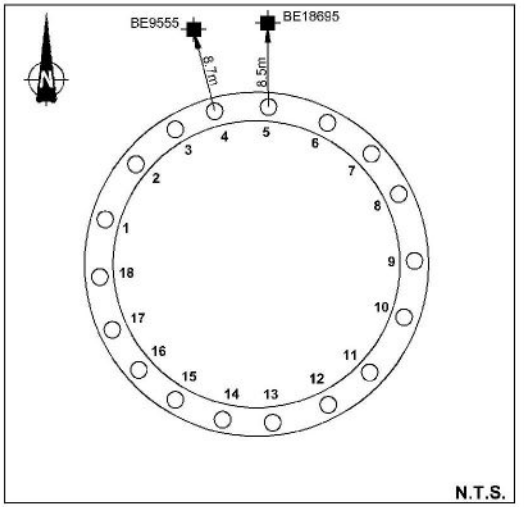
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| | | SCALE | AS SHOWN |
| CADD | DCH/ZJR Sept. 20/17 | REV. | |
| CHECK | | | |

FIGURE T43

Drawing file: 1668031-2000-R02T43.dwg Sep 20, 2017 - 2:08pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

- INSTANTEL MINIMATE GEOPHONE
- WATER WELL
- TURBINE BEING CONSTRUCTED
- MN — MAGNETIC NORTH
- UTM-N — UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH

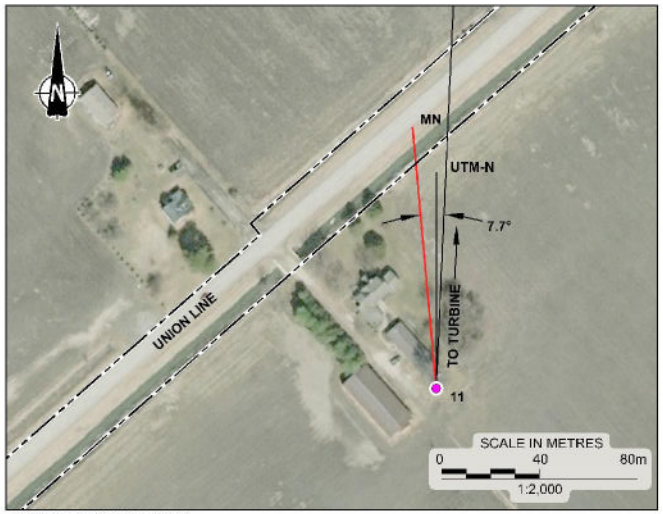
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

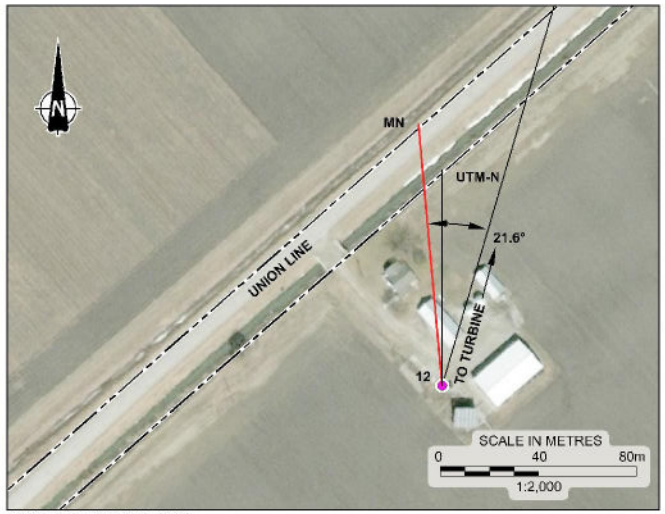
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T45**

Golder Associates

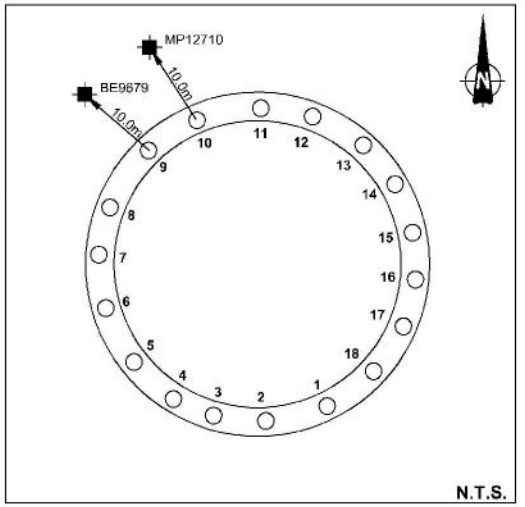
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|---|---|---|---|
| PROJECT No. | 1668031 | FILE No. | 1668031-2000-R02T45 |
| CADD | DCH/ZJB Sept. 18/17 | SCALE | AS SHOWN |
| CHECK | | REV. | |

FIGURE T45

Drawing file: 1668031-2000-R02T45.dwg Sep 18, 2017 - 2:07pm




SITE PLAN




TURBINE PILE LAYOUT

## LEGEND

| | |
|---|---|
| | INSTANTEL MINIMATE GEOPHONE |
| | WATER WELL |
| | TURBINE BEING CONSTRUCTED |
| MN | MAGNETIC NORTH |
| UTM-N | UNIVERSAL TRANSVERSE MERCATOR GEOGRAPHIC NORTH |

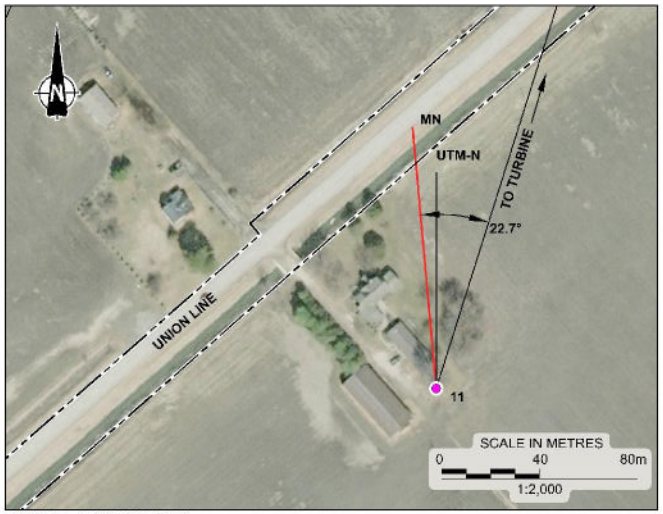
## REFERENCE

DRAWING BASED ON 2010 AERIAL IMAGERY PROVIDED BY THE MUNICIPALITY OF CHATHAM-KENT, INCLUDES MATERIAL c 2015 OF THE QUEEN'S PRINTER FOR ONTARIO; AND "FOUNDATION PLAN", ENTUITIVE, PROJECT No. C017-0190, DWG No. S002.

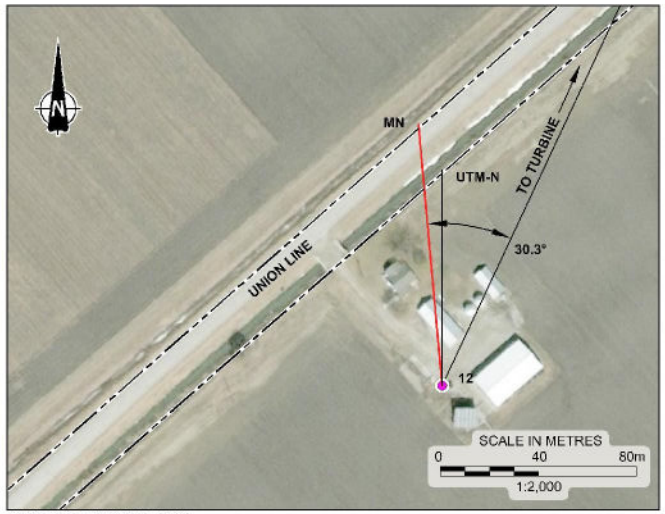
## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.




INSET A (WELL #11)




INSET B (WELL #12)

PROJECT

NORTH KENT 1
VIBRATION MONITORING

TITLE

**TURBINE PILES AND WATER WELL LOCATION PLAN, T46**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT No. | 1658031 | FILE No. | 1658031-2000-R02T46 |
| | | SCALE | AS SHOWN |
| CADD | DCH/ZJB Sept. 18/17 | REV. | |
| CHECK | | | |

FIGURE T46

Drawing file: 1658031 2000 R02T46.dwg Sep 18, 2017 2:07pm

# Attachment C

## Water Quality Data

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

**CLIENT NAME:** **AECOM CANADA LTD**
**105 COMMERCE VALLEY DR.W 7TH FLOOR**
**MARKHAM, ON L3T7W3**
**(905) 886-7022**

**ATTENTION TO:** **Erin Wilson**

**PROJECT:** **60343599**

**AGAT WORK ORDER:** **17T178566**

**MICROBIOLOGY ANALYSIS REVIEWED BY:** **Elizabeth Polakowska, MSc (Animal Sci), PhD (Agri Sci), Inorganic Lab Supervisor**

**WATER ANALYSIS REVIEWED BY:** **Mike Muneswar, BSc (Chem), Senior Inorganic Analyst**

**DATE REPORTED:** **Jan 24, 2017**

**PAGES (INCLUDING COVER):** **10**

**VERSION*:** **1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

**All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.**



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Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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*Results relate only to the items tested and to all the items tested*
*All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request*

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

# Certificate of Analysis

**AGAT WORK ORDER: 17T178566**

**PROJECT: 60343599**

**CLIENT NAME: AECOM CANADA LTD**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:**

## Microbiological Analysis (water)

**DATE RECEIVED: 2017-01-17**

**DATE REPORTED: 2017-01-24**

| | | | | 007530004[redacted] |
|---|---|---|---|---|
| | | | SAMPLE DESCRIPTION: | Line |
| | | | SAMPLE TYPE: | Water |
| | | | DATE SAMPLED: | 2017-01-16 |
| Parameter | Unit | G / S | RDL | 8131175 |
| Escherichia coli | CFU/100mL | 0 | 1 | ND |
| Total Coliforms | CFU/100mL | 0 | 1 | ND |

**Comments:** RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to SDWA - Microbiology

**8131175** ND - Not Detected.

Certified By: Elizabeth Rolakowska



*Results relate only to the items tested and to all the items tested*

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

# Certificate of Analysis

**AGAT WORK ORDER: 17T178566**

**PROJECT: 60343599**

**CLIENT NAME: AECOM CANADA LTD**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:**

## North Kent - Groundwater Samples

**DATE RECEIVED: 2017-01-17**

**DATE REPORTED: 2017-01-24**

| | | | | 007530004[redacted] |
|---|---|---|---|---|
| | | | SAMPLE DESCRIPTION: | Line |
| | | | SAMPLE TYPE: | Water |
| | | | DATE SAMPLED: | 2017-01-16 |
| Parameter | Unit | G / S | RDL | 8131175 |
| Electrical Conductivity | uS/cm | | 2 | 1410 |
| pH | pH Units | (6.5-8.5) | NA | 8.15 |
| Total Hardness (as CaCO3) | mg/L | (80-100) | 0.5 | 59.5 |
| Total Dissolved Solids | mg/L | 500 | 20 | **724** |
| Total Suspended Solids | mg/L | | 10 | <10 |
| Alkalinity (as CaCO3) | mg/L | (30-500) | 5 | 262 |
| Fluoride | mg/L | 1.5 | 0.05 | 1.04 |
| Chloride | mg/L | 250 | 0.50 | **294** |
| Nitrate as N | mg/L | 10.0 | 0.05 | <0.05 |
| Nitrite as N | mg/L | 1.0 | 0.05 | <0.05 |
| Bromide | mg/L | | 0.05 | 0.71 |
| Sulphate | mg/L | 500 | 0.10 | <0.10 |
| Ammonia as N | mg/L | | 0.02 | 0.23 |
| Dissolved Organic Carbon | mg/L | 5 | 0.5 | 1.3 |
| Colour | TCU | 5 | 5 | **8** |
| Turbidity | NTU | 5 | 0.5 | 2.9 |
| Calcium | mg/L | | 0.10 | 14.5 |
| Magnesium | mg/L | | 0.10 | 5.66 |
| Sodium | mg/L | 20 (200) | 0.10 | **253** |
| Potassium | mg/L | | 0.10 | 2.05 |
| Iron | mg/L | 0.3 | 0.010 | 0.123 |
| Manganese | mg/L | 0.05 | 0.002 | 0.008 |

**Comments:** RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O.Reg.169/03(mg/L)

**8131175** Elevated RDLs for Anions & Cations indicate the degree of dilution prior to analysis in order to keep analytes within the calibration range of the instruments and to reduce matrix interferences.

Certified By: [signature]



*Results relate only to the items tested and to all the items tested*

AGAT Laboratories

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# Guideline Violation

**AGAT WORK ORDER: 17T178566**

**PROJECT: 60343599**

**CLIENT NAME: AECOM CANADA LTD**

**ATTENTION TO: Erin Wilson**

| SAMPLEID | SAMPLE TITLE | GUIDELINE | ANALYSIS PACKAGE | PARAMETER | UNIT | GUIDEVALUE | RESULT |
|---|---|---|---|---|---|---|---|
| 8131175 | 007530004 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Chloride | mg/L | 250 | 294 |
| 8131175 | 007530004 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Colour | TCU | 5 | 8 |
| 8131175 | 007530004 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Sodium | mg/L | 20 (200) | 253 |
| 8131175 | 007530004 [redacted] | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Total Dissolved Solids | mg/L | 500 | 724 |



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# Quality Assurance

**CLIENT NAME: AECOM CANADA LTD**

**AGAT WORK ORDER: 17T178566**

**PROJECT: 60343599**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:**

## Microbiology Analysis

| RPT Date: Jan 24, 2017 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **Microbiological Analysis (water)** | | | | | | | | | | | | | | | |
| Escherichia coli | 8131106 | 8131106 | ND | ND | NA | < 1 | | | | | | | | | |
| Total Coliforms | 8131106 | 8131106 | ND | ND | NA | < 1 | | | | | | | | | |

Comments: ND - Not Detected, NA - % RPD Not Applicable

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Microbiological Analysis (water)** | | | | | | | | | | | | | | | |
| Escherichia coli | 8131209 | 8131209 | ND | ND | NA | < 1 | | | | | | | | | |
| Total Coliforms | 8131209 | 8131209 | ND | ND | NA | < 1 | | | | | | | | | |

Comments: ND - Not Detected, NA - % RPD Not Applicable

Certified By: Elizabeth Rolakowska



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# Quality Assurance

**CLIENT NAME: AECOM CANADA LTD**

**AGAT WORK ORDER: 17T178566**

**PROJECT: 60343599**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:**

## Water Analysis

| RPT Date: Jan 24, 2017 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| **North Kent - Groundwater Samples** | | | | | | | | | | | | | | | |
| Electrical Conductivity | 8131677 | | 880 | 874 | 0.7% | < 2 | 105% | 80% | 120% | NA | | | NA | | |
| pH | 8131677 | | 8.32 | 8.17 | 1.8% | NA | 100% | 90% | 110% | NA | | | NA | | |
| Total Dissolved Solids | 8131887 | | 384 | 392 | 2.1% | < 20 | 104% | 80% | 120% | NA | | | NA | | |
| Total Suspended Solids | 8131106 | 8131106 | < 10 | <10 | NA | < 10 | 100% | 80% | 120% | NA | | | NA | | |
| Alkalinity (as CaCO3) | 8131677 | | 268 | 265 | 1.1% | < 5 | 99% | 80% | 120% | NA | | | NA | | |
| Fluoride | 8129049 | | 1.07 | 1.09 | 1.9% | < 0.05 | 94% | 90% | 110% | 94% | 90% | 110% | 91% | 80% | 120% |
| Chloride | 8129049 | | 73.2 | 73.3 | 0.1% | < 0.10 | 93% | 90% | 110% | 102% | 90% | 110% | 102% | 80% | 120% |
| Nitrate as N | 8129049 | | <0.05 | <0.05 | NA | < 0.05 | 95% | 90% | 110% | 98% | 90% | 110% | 106% | 80% | 120% |
| Nitrite as N | 8129049 | | <0.05 | <0.05 | NA | < 0.05 | NA | 90% | 110% | 100% | 90% | 110% | 96% | 80% | 120% |
| Bromide | 8129049 | | 0.44 | 0.42 | 4.7% | < 0.05 | 109% | 90% | 110% | 96% | 90% | 110% | 108% | 80% | 120% |
| Sulphate | 8129049 | | <0.10 | <0.10 | NA | < 0.10 | 99% | 90% | 110% | 100% | 90% | 110% | 107% | 80% | 120% |
| Ammonia as N | 8131155 | 8131155 | 0.05 | 0.04 | NA | < 0.02 | 94% | 90% | 110% | 100% | 90% | 110% | 102% | 80% | 120% |
| Dissolved Organic Carbon | 8131106 | 8131106 | 0.9 | 0.9 | NA | < 0.5 | 98% | 90% | 110% | 99% | 90% | 110% | 92% | 80% | 120% |
| Colour | 8128881 | | <5 | <5 | NA | < 5 | 102% | 90% | 110% | NA | | | NA | | |
| Turbidity | 8131106 | 8131106 | 2.7 | 2.7 | 0.0% | < 0.5 | 104% | 90% | 110% | NA | | | NA | | |
| Calcium | 8131119 | 8131119 | 14.3 | 13.9 | 2.8% | < 0.05 | 101% | 90% | 110% | 100% | 90% | 110% | 97% | 70% | 130% |
| Magnesium | 8131119 | 8131119 | 5.38 | 5.20 | 3.4% | < 0.05 | 98% | 90% | 110% | 97% | 90% | 110% | 95% | 70% | 130% |
| Sodium | 8131119 | 8131119 | 149 | 145 | 2.7% | < 0.05 | 100% | 90% | 110% | 101% | 90% | 110% | 96% | 70% | 130% |
| Potassium | 8131119 | 8131119 | 1.95 | 1.88 | 3.7% | < 0.05 | 98% | 90% | 110% | 98% | 90% | 110% | 97% | 70% | 130% |
| Iron | 8131106 | 8131106 | 0.421 | 0.438 | 4.0% | < 0.010 | 108% | 90% | 110% | 100% | 90% | 110% | 106% | 70% | 130% |
| Manganese | 8131106 | 8131106 | 0.006 | 0.006 | NA | < 0.002 | 105% | 90% | 110% | 105% | 90% | 110% | 87% | 70% | 130% |

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:



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# Method Summary

**CLIENT NAME: AECOM CANADA LTD**

**AGAT WORK ORDER: 17T178566**

**PROJECT: 60343599**

**ATTENTION TO: Erin Wilson**

**SAMPLING SITE:**

**SAMPLED BY:**

| PARAMETER | AGAT S.O.P | LITERATURE REFERENCE | ANALYTICAL TECHNIQUE |
|---|---|---|---|
| **Microbiology Analysis** | | | |
| Escherichia coli | MIC-93-7010 | EPA 1604 | Membrane Filtration |
| Total Coliforms | MIC-93-7010 | EPA 1604 | Membrane Filtration |
| **Water Analysis** | | | |
| Electrical Conductivity | INOR-93-6000 | SM 2510 B | PC TITRATE |
| pH | INOR-93-6000 | SM 4500-H+ B | PC TITRATE |
| Total Hardness (as CaCO3) | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Total Dissolved Solids | INOR-93-6028 | SM 2540 C | BALANCE |
| Total Suspended Solids | INOR-93-6028 | SM 2540 D | BALANCE |
| Alkalinity (as CaCO3) | INOR-93-6000 | SM 2320 B | PC TITRATE |
| Fluoride | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Chloride | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Nitrate as N | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Nitrite as N | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Bromide | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Sulphate | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Ammonia as N | INOR-93-6059 | QuikChem 10-107-06-1-J & SM 4500 NH3-F | LACHAT FIA |
| Dissolved Organic Carbon | INOR-93-6049 | EPA 415.1 & SM 5310 B | SHIMADZU CARBON ANALYZER |
| Colour | INOR-93-6046 | SM 2120 B | SPECTROPHOTOMETER |
| Turbidity | INOR-93-6044 | SM 2130 B | NEPHELOMETER |
| Calcium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Magnesium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Sodium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Potassium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Iron | MET-93-6103 | EPA SW-846 6020A & 200.8 | ICP-MS |
| Manganese | MET-93-6103 | EPA SW-846 6020A & 200.8 | ICP-MS |



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CLIENT NAME: AECOM CANADA LTD
105 COMMERCE VALLEY DR.W 7TH FLOOR
MARKHAM, ON L3T7W3
(905) 886-7022

ATTENTION TO: Jason Murchison

PROJECT: 60343599

AGAT WORK ORDER: 17T260419

MICROBIOLOGY ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

WATER ANALYSIS REVIEWED BY: Parvathi Malemath, Data Reviewer

DATE REPORTED: Sep 19, 2017

PAGES (INCLUDING COVER): 8

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request

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# Certificate of Analysis

AGAT WORK ORDER: 17T260419

PROJECT: 60343599

CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: Jason Murchison

SAMPLING SITE:

SAMPLED BY:

## Microbiological Analysis (water)

DATE RECEIVED: 2017-09-15

DATE REPORTED: 2017-09-19

| | | SAMPLE DESCRIPTION: | | 007530004 |
|---|---|---|---|---|
| | | SAMPLE TYPE: | | Water |
| | | DATE SAMPLED: | | 2017-09-14 |
| Parameter | Unit | G / S | RDL | 8720033 |
| Escherichia coli | CFU/100mL | 0 | 1 | ND |
| Total Coliforms | CFU/100mL | 0 | 1 | ND |

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to SDWA - Microbiology
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8720033 ND – Not detected;

Certified By: Vivine Basily



Results relate only to the items tested and to all the items tested

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# Certificate of Analysis

AGAT WORK ORDER: 17T260419
PROJECT: 60343599

CLIENT NAME: AECOM CANADA LTD
SAMPLING SITE:

ATTENTION TO: Jason Murchison
SAMPLED BY:

## North Kent - Groundwater Samples

DATE RECEIVED: 2017-09-15

DATE REPORTED: 2017-09-19

| | | SAMPLE DESCRIPTION: | | 007530004 |
|---|---|---|---|---|
| | | SAMPLE TYPE: | | Water |
| | | DATE SAMPLED: | | 2017-09-14 |
| Parameter | Unit | G / S | RDL | 8720033 |
| Electrical Conductivity | uS/cm | | 2 | 1420 |
| pH | pH Units | (6.5-8.5) | NA | 8.49 |
| Total Hardness (as CaCO3) | mg/L | (80-100) | 0.5 | 61.0 |
| Total Dissolved Solids | mg/L | 500 | 20 | 690 |
| Total Suspended Solids | mg/L | | 10 | <10 |
| Alkalinity (as CaCO3) | mg/L | (30-500) | 5 | 267 |
| Fluoride | mg/L | 1.5 | 0.05 | 1.25 |
| Chloride | mg/L | 250 | 2.50 | 309 |
| Nitrate as N | mg/L | 10.0 | 0.25 | <0.25 |
| Nitrite as N | mg/L | 1.0 | 0.05 | 0.07 |
| Bromide | mg/L | | 0.05 | <0.05 |
| Sulphate | mg/L | 500 | 0.50 | <0.50 |
| Ammonia as N | mg/L | | 0.02 | 0.27 |
| Dissolved Organic Carbon | mg/L | 5 | 0.5 | 4.4 |
| Colour | Apparent CU | 5 | 5 | 27 |
| Turbidity | NTU | 5 | 0.5 | 2.1 |
| Calcium | mg/L | | 0.50 | 14.4 |
| Magnesium | mg/L | | 0.50 | 6.08 |
| Sodium | mg/L | 20 (200) | 0.50 | 267 |
| Potassium | mg/L | | 0.50 | 1.98 |
| Iron | mg/L | 0.3 | 0.010 | 0.278 |
| Manganese | mg/L | 0.05 | 0.002 | 0.010 |

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O.Reg.169/03(mg/L)
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8720033 Elevated RDL indicates the degree of sample dilution prior to the analysis in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

Certified By:






Results relate only to the items tested and to all the items tested

AGAT Laboratories

# Guideline Violation

AGAT WORK ORDER: 17T260419

PROJECT: 60343599

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CLIENT NAME: AECOM CANADA LTD

ATTENTION TO: Jason Murchison

| SAMPLEID | SAMPLE TITLE | GUIDELINE | ANALYSIS PACKAGE | PARAMETER | UNIT | GUIDEVALUE | RESULT |
|---|---|---|---|---|---|---|---|
| 8720033 | 007530004 | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Chloride | mg/L | 250 | 309 |
| 8720033 | 007530004 | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Colour | Apparent CU | 5 | 27 |
| 8720033 | 007530004 | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Sodium | mg/L | 20 (200) | 267 |
| 8720033 | 007530004 | O.Reg.169/03(mg/L) | North Kent - Groundwater Samples | Total Dissolved Solids | mg/L | 500 | 690 |



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# Quality Assurance

CLIENT NAME: AECOM CANADA LTD

AGAT WORK ORDER: 17T260419

PROJECT: 60343599

ATTENTION TO: Jason Murchison

SAMPLING SITE:

SAMPLED BY:

## Microbiology Analysis

| RPT Date: Sep 19, 2017 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Microbiological Analysis (water) | | | | | | | | | | | | | | | |
| Escherichia coli | 8720026 | 8720026 | ND | ND | NA | < 1 | | | | | | | | | |
| Total Coliforms | 8720026 | 8720026 | ND | ND | NA | < 1 | | | | | | | | | |

Comments: ND – Not detected; NA - % RPD Not Applicable

Certified By: Nivine Basily



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# Quality Assurance

CLIENT NAME: AECOM CANADA LTD

AGAT WORK ORDER: 17T260419

PROJECT: 60343599

ATTENTION TO: Jason Murchison

SAMPLING SITE:

SAMPLED BY:

## Water Analysis

RPT Date: Sep 19, 2017

| PARAMETER | Batch | Sample Id | DUPLICATE | | | Method Blank | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dup #1 | Dup #2 | RPD | | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| North Kent - Groundwater Samples | | | | | | | | | | | | | | | |
| Electrical Conductivity | 8721372 | | 2440 | 2500 | 2.4% | < 2 | 109% | 80% | 120% | | | | | | |
| pH | 8721372 | | 7.92 | 7.91 | 0.1% | NA | 99% | 90% | 110% | | | | | | |
| Total Dissolved Solids | 8720026 | 8720026 | 544 | 568 | 4.3% | < 20 | 98% | 80% | 120% | | | | | | |
| Total Suspended Solids | 8719893 | | 863 | 882 | 2.2% | < 10 | 96% | 80% | 120% | | | | | | |
| Alkalinity (as CaCO3) | 8721372 | | 386 | 381 | 1.3% | < 5 | 101% | 80% | 120% | | | | | | |
| Fluoride | 8722422 | | <0.05 | <0.05 | NA | < 0.05 | 101% | 90% | 110% | 98% | 90% | 110% | 103% | 80% | 120% |
| Chloride | 8722422 | | 4.33 | 4.34 | 0.2% | < 0.50 | 91% | 90% | 110% | 108% | 90% | 110% | 104% | 80% | 120% |
| Nitrate as N | 8722422 | | <0.05 | <0.05 | NA | < 0.05 | 90% | 90% | 110% | 107% | 90% | 110% | 91% | 80% | 120% |
| Nitrite as N | 8722422 | | <0.05 | <0.05 | NA | < 0.05 | NA | 90% | 110% | 97% | 90% | 110% | 88% | 80% | 120% |
| Bromide | 8722422 | | <0.05 | <0.05 | NA | < 0.05 | 104% | 90% | 110% | 108% | 90% | 110% | 104% | 80% | 120% |
| Sulphate | 8722422 | | <0.10 | 0.46 | NA | < 0.10 | 95% | 90% | 110% | 107% | 90% | 110% | 103% | 80% | 120% |
| Ammonia as N | 8722931 | | <0.02 | <0.02 | NA | < 0.02 | 92% | 90% | 110% | 100% | 90% | 110% | 89% | 80% | 120% |
| Dissolved Organic Carbon | 8720026 | 8720026 | 7.2 | 6.7 | 7.2% | < 0.5 | 93% | 90% | 110% | 105% | 90% | 110% | 95% | 80% | 120% |
| Colour | 8720026 | 8720026 | 15 | 15 | NA | < 5 | 105% | 90% | 110% | | | | | | |
| Turbidity | 8720026 | 8720026 | 1.4 | 1.4 | NA | < 0.5 | 100% | 90% | 110% | | | | | | |
| Calcium | 8713953 | | 15.9 | 15.8 | 0.6% | < 0.10 | 96% | 90% | 110% | 97% | 90% | 110% | 98% | 70% | 130% |
| Magnesium | 8713953 | | 4.39 | 4.32 | 1.6% | < 0.10 | 97% | 90% | 110% | 98% | 90% | 110% | 98% | 70% | 130% |
| Sodium | 8713953 | | 51.9 | 51.5 | 0.8% | < 0.10 | 99% | 90% | 110% | 99% | 90% | 110% | 101% | 70% | 130% |
| Potassium | 8713953 | | 2.10 | 2.06 | 1.9% | < 0.10 | 99% | 90% | 110% | 99% | 90% | 110% | 100% | 70% | 130% |
| Iron | 8720026 | | 0.178 | 0.174 | 2.3% | < 0.010 | 97% | 90% | 110% | 103% | 90% | 110% | 107% | 70% | 130% |
| Manganese | 8720026 | | 0.010 | 0.010 | 0.0% | < 0.002 | 101% | 90% | 110% | 105% | 90% | 110% | 109% | 70% | 130% |

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the Reporting Limit (RL), the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:






AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested

AGAT Laboratories

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# Method Summary

CLIENT NAME: AECOM CANADA LTD

AGAT WORK ORDER: 17T260419

PROJECT: 60343599

ATTENTION TO: Jason Murchison

SAMPLING SITE:

SAMPLED BY:

| PARAMETER | AGAT S.O.P | LITERATURE REFERENCE | ANALYTICAL TECHNIQUE |
|---|---|---|---|
| Microbiology Analysis | | | |
| Escherichia coli | MIC-93-7010 | EPA 1604 | Membrane Filtration |
| Total Coliforms | MIC-93-7010 | EPA 1604 | Membrane Filtration |
| Water Analysis | | | |
| Electrical Conductivity | INOR-93-6000 | SM 2510 B | PC TITRATE |
| pH | INOR-93-6000 | SM 4500-H+ B | PC TITRATE |
| Total Hardness (as CaCO3) | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Total Dissolved Solids | INOR-93-6028 | SM 2540 C | BALANCE |
| Total Suspended Solids | INOR-93-6028 | SM 2540 D | BALANCE |
| Alkalinity (as CaCO3) | INOR-93-6000 | SM 2320 B | PC TITRATE |
| Fluoride | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Chloride | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Nitrate as N | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Nitrite as N | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Bromide | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Sulphate | INOR-93-6004 | SM 4110 B | ION CHROMATOGRAPH |
| Ammonia as N | INOR-93-6059 | QuikChem 10-107-06-1-J & SM 4500 NH3-F | LACHAT FIA |
| Dissolved Organic Carbon | INOR-93-6049 | EPA 415.1 & SM 5310 B | SHIMADZU CARBON ANALYZER |
| Colour | INOR-93-6046 | SM 2120 C | SPECTROPHOTOMETER |
| Turbidity | INOR-93-6044 | SM 2130 B | NEPHELOMETER |
| Calcium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Magnesium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Sodium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Potassium | MET-93-6105 | EPA SW-846 6010C & 200.7 | ICP/OES |
| Iron | MET-93-6103 | EPA SW-846 6020A & 200.8 | ICP-MS |
| Manganese | MET-93-6103 | EPA SW-846 6020A & 200.8 | ICP-MS |



Results relate only to the items tested and to all the items tested