GRAND RENEWABLE ENERGY PARK
DESIGN AND OPERATIONS REPORT

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Prepared for:

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Executive Summary

Samsung C&T (Samsung), Korea Electric Power Corporation (KEPCO) and Pattern Energy (Pattern) are proposing to develop, construct, and operate the Grand Renewable Energy Park (the "Project") in response to the Government of Ontario's initiative to promote the development of renewable electricity in the Province. Together, these companies (referred to herein as "SPK") will be involved in the development of the first phase of the energy cluster development.

The Project is proposed within the County of Haldimand and is generally bounded by Townline Road to the north, Haldimand Road 20 to the west, the Grand River to the east and Lake Erie to the south. It consists of a 148.6 MW (nameplate capacity) wind project, a 100 MW (nameplate capacity) solar project located on privately owned and Ontario Realty Corporation (ORC) managed lands and a transmission line to convey electricity to the existing power grid.

The basic components of the Project include 67 wind turbines, approximately 425,000 photovoltaic (PV) solar panels installed on fixed ground-mounted racking structures organized into 100-1 MW solar modules, a collector sub-station, interconnect station and Operations and Maintenance building, temporary storage and staging areas, approximately 20 km of 230 kV transmission lines along Haldimand Road 20, approximately 82 km of new overhead and/or underground 34.5 kV collector lines along public roads, approximately 48 km of new underground collector lines along turbine access roads, approximately 45 km of turbine access roads and 40 km of solar panel maintenance roads.

SPK has retained Stantec Consulting Ltd. (Stantec) to prepare a Renewable Energy Approval (REA) application, as required under Ontario Regulation 359/09 - Renewable Energy Approvals under Part V.0.1 of the Act of the *Environmental Protection Act* (O. Reg. 359/09). According to subsection 6(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. This Design and Operations Report is one component of the REA application for the Project, and has been prepared in accordance with O. Reg. 359/09, the Ontario Ministry of Natural Resources' (MNR's) *Approval and Permitting Requirements Document for Renewable Energy Projects* (September 2009), and MOE's "Technical Guide to renewable Energy Approvals (July 2011)".

The following table summarizes the documentation requirements as specified under O. Reg. 359/09:

Design and Operations Report Requirements (as per O. Reg. 359/09 – Table 1)

Requirements	Completed	Section Reference
1. Set out a site plan of the project location at which the renewable energy project will be engaged in, including, i. one or more maps or diagrams of,		
A. all buildings, structures, roads, utility corridors, rights of way and easements required in respect of the renewable energy generation facility and situated within 300 m of the facility,	✓	Attachment A
B. any ground water and surface water supplies used at the facility,	N/A	N/A
C. any things from which contaminants are discharged into the air,	N/A	N/A
D. any works for the collection, transmission, treatment and disposal of sewage,	N/A	N/A
E. any areas where waste, biomass, source separated organics and farm material are stored, handled, processed or disposed of,	N/A	N/A
F. the project location in relation to any of the following within 125 m: properties described in Column 1 of the Table to section 19, heritage resources, archaeological resources, the portion of the Oak Ridges Moraine Conservation Plan Area that is subject to the Oak Ridges Moraine Conservation Plan, the area of the Niagara Escarpment Plan, the Protected Countryside, the Lake Simcoe watershed, and	✓	Attachment A
G. any noise receptors or odour receptors that may be negatively affected by the use or operation of the facility,	✓	Attachment B
ii. a description of each item diagrammed under subparagraph i, and	✓	3.1
iii. one or more maps or diagrams of land contours, surface water drainage and any of the following, if they have been identified in complying with this Regulation: properties described in Column 1 of the Table to section 19, heritage resources, archaeological resources, water bodies, significant or provincially significant natural features and any other natural features identified in the Protected Countryside or in the portion of the Oak Ridges Moraine Conservation Plan Area that is subject to the Oak Ridges Moraine Plan.	✓	Attachment A
Set out conceptual plans, specifications and descriptions related to the design of the renewable energy generation facility, including a description of,		
i. any works for the collection, transmission, treatment and disposal of sewage, including details of any sediment control features and storm water management facilities,	✓	3.1, 4.0, Attachment A
ii. any things from which contaminants are discharged into the air, and	✓	4.0, 5.0
iii. any systems, facilities and equipment for receiving, handling, storing and processing any waste, biomass, source separated organics, farm material and biogas.	N/A	N/A
2. Set out conceptual plans, specifications and descriptions related to the operation of the renewable energy generation facility, including, i. in respect of any water takings,	✓	4.6.1, 5.2.1

Design and Operations Report Requirements (as per O. Reg. 359/09 – Table 1)

Requirements	Completed	Section Reference
A. a description of the time period and duration of water takings expected to be associated with the operation of the facility,	✓	4.6.1, 5.2.1
B. a description of the expected water takings, including rates, amounts and an assessment of the availability of water to meet the expected demand, and	✓	4.6.1, 5.2.1
C. an assessment of and documentation showing the potential for the facility to interfere with existing uses of the water expected to be taken,	✓	4.6.1, 5.2.1
ii. a description of the expected quantity of sewage produced and the expected quality of that sewage at the project location and the manner in which it will be disposed of, including details of any sediment control features and storm water management facilities,	✓	4.6.2, 4.6.3
iii. a description of any expected concentration of air contaminants discharged from the facility,	✓	5.6
iv. in respect of any biomass, source separated organics and farm material at the facility,	N/A	N/A
A. the maximum daily quantity that will be accepted,	N/A	N/A
B. the estimated annual average quantity that will be accepted,	N/A	N/A
C. the estimated average time that it will remain at the facility, and	N/A	N/A
D. the estimated average rate at which it will be used, and	N/A	N/A
v. in respect of any waste generated as a result of processes at the project location, the management and disposal of such waste, including, A. the expected types of waste to be generated,	✓	5.10
B. the estimated maximum daily quantity of waste to be generated, by type,	✓	5.10
C. processes for the storage of waste, and	✓	5.10
D. processes for final disposal of waste.	✓	5.0
Include an environmental effects monitoring plan in respect of any negative environmental effects that may result from engaging in the renewable energy project, setting out,		
i. performance objectives in respect of the negative environmental effects,	✓	5.1
ii. mitigation measures to assist in achieving the performance objectives mentioned in subparagraph i,	✓	5.0
iii. a program for monitoring negative environmental effects for the duration of the time that the project is engaged in, including a contingency plan to be implemented if any mitigation measures fail.	✓	5.0, 6.0
Include a response plan setting out a description of the actions to be taken while engaging in the renewable energy project to inform the public, aboriginal communities and municipalities, local roads boards and Local Services Boards with respect to the project, including,		
i. measures to provide information regarding the activities occurring at the project location, including emergencies,	✓	7.0

Design and Operations Report Requirements (as per O. Reg. 359/09 – Table 1)

Requirements	Completed	Section Reference
ii. means by which persons responsible for engaging in the project may be contacted, and	✓	7.0
iii. means by which correspondence directed to the persons responsible for engaging in the project will be recorded and addressed.	✓	7.0
If the project location is in the Lake Simcoe watershed, a description of whether the project requires alteration of the shore of Lake Simcoe, the shore of a fresh water estuary of a stream connected to Lake Simcoe or other lakes or any permanent or intermittent stream and,		
i. how the project may impact any shoreline, including the ecological functions of the shoreline, and	N/A	N/A
ii. how the project will be engaged in to,	N/A	N/A
A. maintain the natural contour of the shoreline through the implementation of natural shoreline treatments, such as planting of natural vegetation and bioengineering, and	N/A	N/A
B. use a vegetative riparian area, unless the project location is used for agricultural purposes and will continue to be used for such purposes.	N/A	N/A

Provided the identified protective and mitigation measures are properly applied to the environmental features discussed, in conjunction with the monitoring plans and contingency measures, the operation phase of the Project is not likely to cause significant net environmental effects. Further, the Project will positively contribute economic resources to the community, while not contributing green house gases.

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1.0 Overview

Samsung C&T (Samsung), Korea Electric Power Corporation (KEPCO) and Pattern Energy (Pattern) are proposing to develop, construct, and operate the Grand Renewable Energy Park (the “Project”) in response to the Government of Ontario’s initiative to promote the development of renewable electricity in the Province. Together, these companies (referred to herein as “SPK”) will be involved in the development of the first phase of the energy cluster development.

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The basic components of the Project include 67 wind turbines, approximately 425,000 photovoltaic (PV) solar panels installed on fixed ground-mounted racking structures organized into 100-1 MW solar modules, a collector sub-station, interconnect station and Operations and Maintenance building, temporary storage and staging areas, approximately 20 km of 230 kV transmission lines along Haldimand Road 20, approximately 82 km of new overhead and/or underground 34.5 kV collector lines along public roads, approximately 48 km of new underground collector lines along turbine access roads, approximately 45 km of turbine access roads and 40 km of solar panel maintenance roads. The Project site plan which depicts the Project Location during operation is provided in **Attachment A**.

The Project Location includes all land and buildings/structures associated with the Project and any air space in which the Project will occupy. This includes structures such as turbines, solar panels, access roads and power lines that will be utilized during the operation of the Project. This also includes the corridors surrounding infrastructure such as access roads in which the final infrastructure may be located.

For the purposes of the identification of natural heritage features and the assessment of potential effects, a “Zone of Investigation” has been identified based on the requirements of Ontario Regulation 359/09 (O. Reg. 359/09) and the Ministry of Natural Resources’ (MNR’s) *Approval and Permitting Requirements Document for Renewable Energy Projects* (APRD) (September 2009). The zone of investigation encompasses the Project Location and an additional 120 m surrounding the Project Location. This ensures that negative environmental effects that may result from operational activities have been assessed within this report.

SPK has retained Stantec Consulting Ltd. (Stantec) to prepare a Renewable Energy Approval (REA) application, as required under O. Reg. 359/09. According to subsection 6.(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. This Design and Operations Report is one component of the REA application for the Project, and has been prepared in accordance with O. Reg. 359/09, the MNR's APRD, and the Ministry of the Environments' (MOE) "Technical Guide to Renewable Energy Approvals (July 2011)".

2.0 Site Plan

The Project Site Plan is provided in **Attachment A**. The Site Plan provides the following information:

- Facility components, including: turbine locations, access roads, underground and overhead collector lines, solar panels, transformers and substation, operation and maintenance building, and a transmission line.
- Project Location: the outer limit of all components of the Project, including corridors surrounding infrastructure such as access roads in which the final infrastructure may be located. The Project Location is used for defining setback and site investigation distances.
- Public Roads.
- Location of the stormwater management (SWM) system.
- Location of property lines.
- Natural features and water bodies.
- Noise receptors (non-participating and vacant lots). These features are illustrated within the Noise Assessment Report (**Attachment B**). Additionally, setbacks to noise receptors and associated noise calculation tables are provided within **Attachment B**.
- Visual representation of setback buffer areas from the Project Location to water bodies and significant or provincially significant natural features.

A detailed description of the Project components and cultural and natural features is provided in Sections 3, 4 and 5. The locations of archaeological and heritage resources are shown within the **Archaeological and Heritage Report**.

2.1 SETBACK DISTANCES

O. Reg. 359/09 provides setback distances between the Project Location and:

- Significant and provincially significant natural features;
- Provincial parks and conservation reserves; and
- Water bodies.

O. Reg. 359/09 also provides setback distances between wind turbine base and:

- Property lines;
- Public road right-of-ways;
- Railway right-of-ways; and
- Noise receptors.

O. Reg. 359/09 also provides setbacks between transformers and noise receptors.

Visual representation of the setback distances are illustrated on the Site Plan (**Attachment A**) and within the Noise Assessment Report (**Attachment B**). Where the Project Location is within the setback distances (e.g. to natural features or property lines), additional information is provided within the **Natural Heritage Assessment/Environmental Impact Study** (**NHA/EIS**) and the Property Line Setback Assessment (**Attachment D** to this report).

All turbines are located at a minimum distance of 550 m from the nearest non-participating receptor. In accordance with Section 53 of O. Reg. 359/09, all turbines must be located at least 100 m (hub height) from the nearest non-participating property line. When this setback is not achievable, a setback of 59 m (blade length plus 10 m) can be utilized with the completion of a written assessment of the potential effects and preventative measures associated with the turbine location. Written assessments have been prepared (**Attachment D**) for turbines that have utilized a minimum setback of 59 m but are closer than 100 m to the nearest non-participating property line. In addition, all turbines have been located at least 59 m from public roads and railway rights-of-way.

The collector substation has been assessed as part of the Noise Assessment Report (**Attachment B**) and thus setbacks do not apply. In addition, a sound attenuation wall will be built around the perimeter of the two power transformers to minimize the escape of transformer noise into the surrounding environment.

3.0 Facility Design Plan

This section provides a description of the key facility design components identified on the Site Plan (**Attachment A**). The key mitigation strategy used to address potential environmental effects from operation of the facility was avoidance of significant natural features and water bodies to the extent possible during siting of the Project. Potential effects and mitigation measures associated with Project operations are discussed below in Section 5.

3.1 FACILITY COMPONENTS OVERVIEW

The basic Project components include wind turbines, access roads, underground and overhead collector lines, solar panels, transformers and a substation, an operation and maintenance building, and a 230 kV transmission line. No equipment in the facility design relate to groundwater and surface water supplies, air discharges and/or water and biomass management.

3.1.1 Wind Component

3.1.1.1 Turbines

The Project will include 67 Siemens SWT-2.3 wind turbines with a total nameplate capacity of 148.6 MW. Sixty-five (65) of the turbines will have a nameplate capacity of 2.221 MW and two with a nameplate capacity of 2.126 MW. Details of the turbine are provided below in Table 3.1. The nacelle for the turbine includes the electric generator, as well as blade and turbine control equipment, wind speed and direction sensing equipment, and auxiliary equipment. These components are located at the top of the 100 m supporting tower, and are connected to the blades via a main shaft. Each tower has a concrete foundation which is buried to a depth of up to approximately 2.4 m and is approximately 16.7 m wide depending upon subsurface conditions (land base is 0.02 hectares per turbine foundation).

Table 3.1: Turbine Description – Siemens SWT-2.3

Operating Data	Specification
General	
Rated capacity (kW)	2221 and 2126
Cut-in wind speed (m/s)	3-5
Cut-out wind speed (m/s)	25
Rotor	
Number of rotor blades	3 (49 m long each)
Rotor diameter (m)	101
Swept area (m^2)	8000
Rotor speed (rpm)	6-16
Tower	
Hub height (m)	100
Tip height (m)	149

3.1.1.2 Turbine Access Roads and Crane Pads

Access roads are required to access each turbine site from existing roads during the operation phase of the Project. Access roads are approximately 5 m wide (see drawings in **Attachment A**). Access roads will be constructed of native materials or engineered fill and generally consist of approximately 750 mm of granular material. Alternatively, a woven geotextile or cement stabilized soil could also be utilized with a reduced granular material depth. Flexibility in the final location of the access roads has been incorporated into the Project Location design by designating a 50 m wide “constructible area” for the access roads (see **Attachment A**) which indicate where access roads may be ultimately located (the constructible area has been reduced in size where constraints exist that would prohibit a 50 m wide area such as wetlands and property lines). The assessment of potential effects has been based on the 50 m wide constructible area as well as for the determination of the zone of influence boundary. A total of approximately 45 km of access roads will be required.

After construction, crane pads will be removed and the native topsoil replaced. However, if crane pads are required to be reinstalled for maintenance purposes, the crane pads will be adjacent to the turbine locations (within the designated constructible area around each turbine as shown in **Attachment A)**. The general crane pad area will be approximately 20 m x 40 m, and will typically consist of the same make up as the access road, whereas the crane platform (where the crane sits) may consist of a heavier granular make up depending on site conditions.

3.1.1.3 Step-up Transformers and Collector Circuits (Lines)

A generator step-up transformer (GSU), located immediately adjacent to each turbine, is required to transform the electricity generated in the nacelle of each turbine to a common collection system line voltage (i.e. 690 V to 34.5 kV). From each GSU, 34.5 kV underground and overhead collector circuits carry the electricity to the Project’s substation located near Haldimand Road 20 and Wilson Road. The collector lines will be buried underground on private property from the turbines to the municipal road rights-of-way at which time the lines may be switched to overhead lines or remain underground. The overhead lines will be constructed on single wooden pole structures, similar to existing distribution lines located throughout the area. In most cases, the underground lines will be built within the proposed access roads to minimize the amount of land disturbed during construction of the Project. Typically the collector lines will be buried at a minimum depth of 1.2 m so that agricultural production can continue on the lands above the collector lines. A total of approximately 130 km of collector lines will be required (48 km underground and 82 km aboveground and/or underground).

3.1.2 Solar Component

3.1.2.1 Solar Panels

The solar power generation part of the Project will include the installation of approximately 425,000 solar photovoltaic (PV) panels on land designated for this purpose bounded by Mt.

Olivet Rd on the west, Meadows Rd on the north, Sutor Rd on the east and Haldimand Rd 20 on the south (see **Attachment A**). Some additional solar PV panels will be located south of Haldimand Rd 20 on land facing the solar farm to the north. Each solar PV panel is fabricated using multicrystalline manufacturing techniques and is mounted on structural aluminum or galvanized steel racks in rows. Each rack is fixed position, facing south and angled 28 - 35 degrees to the horizon. The rows of racks are supported by vertical structural steel posts that are founded in the ground to a depth below the frost line, nominally 1.2 m.

The basic building block of the solar farm is a 1 MW rated solar units. There are 100 solar units forming the entire solar farm. A 1 MW solar unit consists of rows of 60 solar PV panels mounted on racks in straight rows. Approximately 72 rows of solar PV panels constitute a solar unit of 1 MW. Physical arrangements may vary slightly from unit to unit to accommodate physical, environmental and archaeological constraints within the designated solar farm area and may also slightly vary based on the manufacturer's panel specifications. Each solar PV panel in a row generates Direct Current (DC) power and the power is collected through a low voltage wiring system along a row and interconnected to the adjacent rows within the typical unit.

A 2.4 m high chain link fence will be installed around the entire perimeter of the solar farm to prevent unauthorized access to the solar panel area. In addition, a 6 m wide berm will be constructed to provide a landscaping barrier for landowners of adjacent residences where close proximity occurs to the solar PV panels.

3.1.2.2 Solar Land Stormwater Management System

The solar land stormwater management system will be a passive system comprised of local vegetated ditches/swales alongside the access roads constructed through the area. Because the solar cells are mounted above the ground, infiltration, filtration through vegetation and other natural hydrologic process will continue similar to existing conditions. Drainage will generally be directed to existing receiving systems (drainage paths, roadside ditches, etc.) as under current conditions. Therefore, a general area-wide stormwater treatment and/or detention systems are not required. The small increase in runoff from the gravel access roads will be attenuated and filtered through local ditches and no formal basins or other management techniques are required.

3.1.2.3 Solar Farm Access Roads

Solar access roads (laneways) are required to access each row of solar PV panels during the maintenance phase of the Project. The minimum road width between solar panel rows will be 3 m; however these access roads will not be gravelled. Instead, the roads will be seeded with native grassland species following construction and used sparingly during maintenance activities. Solar panel support structures including racks will take place adjacent to the access roads at selected areas within the solar farm land area. Snowmobiles and ATV's will be used to access the laneways during operation.

Around the outside of each 1 MW solar unit, a 4 m wide gravel road will be constructed for construction and operational purposes. Approximately 40 km of gravelled access road will be required.

3.1.2.4 Step Up Transformers and Collector Circuits

The power from each solar PV panel row is collected by a wiring system and this wiring system is connected to one of two 500 Kilowatt (kW) DC to Alternating Current (AC) power inverter panels located at each of the 100 solar units. Each power inverter panel is mounted on a precast concrete base foundation at a central point of each solar unit. The AC output from the inverter panels is connected to an adjacent solar step up (SSU) pad-mounted transformer rated at 1 MW. Each SSU is mounted on a precast concrete vault to facilitate cable entry/exit. Each SSU is positioned in close proximity to the solar inverter panels to minimize power loss. The output voltage of the SSU is 34,500 Volts. The power output from each of the 1 MW SSUs (100 MW in total) is connected via 5 underground 34.5 kV power cable circuits to the collector substation located within the solar farm land area.

3.1.3 Electrical Transmission Component

3.1.3.1 Collector Substation

A Collector substation will be built to accumulate the power circuits from the wind and solar generation equipment outlined above. The accumulated power of approximated 248 MW at 34.5 kV will arrive via both underground cable collector circuits and overhead pole line conductor circuits. The power will be transformed from a 34.5 kV collection voltage to a 230 kV transmission voltage. The substation will be located near Haldimand Road 20 and Mt. Olivet Road (see **Attachment A**) within the solar lands of the Project.

The Collector substation will consist of a prepared area of approximately 85 m by 85 m in size. It will be built on a prepared base of engineered fill and crushed stone to a depth of 600 mm. A grounding grid will be built within the crushed stone and extend to 1 m beyond the 2.4 m high perimeter chain link fence for the substation.

Within the substation will be located a prefabricated modular electrical building (EHouse) wherein all the incoming underground 34.5 kV collector circuits will terminate on interior switchgear. The EHouse will be founded on concrete foundations that are constructed below grade to below frost depth. Cable vaults will be installed beneath the EHouse to facilitate cable entry.

Reactive Power Capacitors and control will be located within the Collector Substation. Either one of D-VAR or S-VAR will be installed as approved by local authority(s). The capacitors will be 34.5 kV rated and there will be up to 6 capacitor banks installed in separate concrete containment foundations, founded below grade to below the frost line. The containment will be large enough to hold any insulating fluid that may leak from the capacitors. The dynamic controller will be a Statcom (or similar) controller located adjacent to the capacitors within the substation and on its own concrete foundation founded below grade to below the frost line.

There are two power transformers within the collector substation that will be used to step up the power to 230 kV. The wind power transformer is rated 100/133/166 MVA while the solar power transformer is rated 65/86/108 MVA. Each transformer is mounted on a concrete base foundation within an oil containment facility that would capture all of the oil insulating fluid within each transformer in the event of a leak. A sound attenuation wall will be constructed around the perimeter of the two power transformers to minimize the escape of transformer noise into the surrounding environment. The sound attenuation wall will be constructed with a minimum density of 20 kg/m2 that will break the line of sight with any noise receptors.

Each of the 230 kV outputs of the two transformers are delivered via a 3 phase air bus (aluminum pipe) to a 1200 Amp 230 kV circuit breaker, isolation disconnect switch and Capacitive Voltage Transformers (CVT). The 230 kV outputs from the final isolation disconnect switches are coupled and connected to a 230 kV termination gantry complete with 230 kV lightning arrestors. The 230 kV termination gantry facilitates the connection of the collector substation to the overhead transmission tower adjacent to the substation. Each of the 230 kV devices located within the collector substation are founded on concrete foundations that extend below finished grade to below the frost line.

3.1.3.2 Collector Substation Stormwater Management System

Area drainage from the collector substation will be accomplished through a series of swales adjacent to the proposed access road that will collect and convey runoff from the substation area and associated access road west and south towards Haldimand Rd 20. The total drainage area associated with the substation and access road “hard” surfaces is less than 2 ha and therefore a “wet” water quality control pond (i.e. one containing a permanent pool) is inappropriate, as per the MOE *SWM Planning and Design Guidelines Manual (2003)*. In addition to the conveyance of runoff, the series of grassed swales will also provide water quality control, which is a suitable stormwater management practice for such an area according to the MOE guidelines. Water quantity control will be provided using a dry detention pond for the storage and slow release of runoff to the existing ditch and drainage system along Haldimand Road 20. Drainage from the solar lands will largely be conveyed around the substation facility, access road, and associated stormwater management measures through the use of diversion swales given that it does not require treatment or detention.

Within the substation footprint itself, the two transformers will be equipped with oil containment storage areas to capture oil in the event of a leak. Additionally, an oil/water separator will be incorporated into the design to treat any effluent before it enters the storm drainage swales.

3.1.3.3 Collector Substation Access Road

An access road for the collector substation and main access to the solar lands will be constructed from Haldimand Rd 20 (see **Attachment A**). The gravel surface of the access road is approximately 8 m wide with grassed swale drainage ditches of variable top width on either side, for stormwater runoff conveyance and treatment. The depth of the roadbed will generally consist of 750 mm of granular material.

3.1.3.4 Transmission Line

From the substation, a 20 km long overhead 230 kV transmission line, consisting of single, 3 conductor aluminum circuit will be constructed to connect the power generated by the wind and solar generation equipment to the Ontario electricity grid that is accessible at a location south of Hagersville, Ontario. The transmission line will be located along Haldimand Road 20 within the municipal road right-of-way (see **Attachment A**).

The transmission line will be constructed overhead using bare aluminum conductors. They are vertically isolated from ground via 230 kV insulators and monopole structures measuring 28 m in height. The monopole structures will be erected on concrete foundations located within the existing Haldimand Rd 20 right-of-way. The structures will be spaced approximately 200 m apart except where significant changes in line direction occur along the route. In these cases, the spacing will be closer to reduce the overhead line tension to a practical construction limit. There will also be closer spacing of the structures at the collector substation, the transition stations around Nelles Corners and the interconnect station near the transmission corridor east of Hagersville.

At a location just east of Nelles Corners (intersection of Haldimand Rd 20 and Highway 3), the overhead transmission line will make a transition to underground cable housed within a concrete encased ductbank. The underground cable is required as the overhead transmission line would violate safety clearances over the built infrastructure of Nelles Corners. The 230 kV ductbank would be constructed a minimum of 1.2 m below grade and be backfilled with thermal fill to dissipate heat of cable power losses throughout the ground.

The ductbank will be nominally 700 m long and will be constructed entirely within the Haldimand Rd 20 right-of-way beneath the village of Nelles Corners. To facilitate the transitioning of the overhead transmission line to underground cable east of Nelles Corners and to overhead line from underground cable west of Nelles Corners, two transitioning stations will be required to be constructed.

The transitioning stations will contain an A-frame galvanized steel lattice type structure complete with 230 kV lightning arrestors. The structure will be anchored to a concrete foundation that is founded to a depth of ground below the frost line. Each transitioning station will consist of a prepared area of 20 m by 20 m in size. It will be built on a prepared base of engineered fill and crushed stone to a depth of 600 mm. A grounding grid will be built within the crushed stone and extend to 1 m beyond the 2.4 m high perimeter chain link fence for each station.

3.1.3.5 Transmission Line Interconnect Station

The 230 kV transmission line will terminate at an interconnect station located on the north side of Haldimand Rd 20, just east of the transmission corridor east of Hagersville. The transmission line overhead conductors will terminate on a termination gantry (structure) contained within the station area. The station will be enclosed by a chain link fence measuring 40 m wide x 40 m long x 2.4 m high. The station will contain two termination gantries complete with 230 kV lightning arrestors. One will be used for the termination of the 230 kV transmission line and the other will be used to facilitate Hydro One's connection of the power collection circuit to the existing transmission circuit originating at the Nanticoke Power Generating Station. Each gantry will be anchored to a concrete foundation that is founded to a depth of ground below the frost line. The station will consist of a prepared area of 40 m by 40 m in size. It will be built on a prepared base of engineered fill and crushed stone to a depth of 600 mm. A grounding grid will be built within the crushed stone and extend to 1 m beyond the 2.4 m high perimeter chain link fence.

In addition, a 230 kV isolation switch and 230 kV-1200 amp circuit breaker will be installed on a concrete foundations between the two termination gantry structures. The foundation will extend below grade to below the frost line. A small EHouse will be installed within the fenced enclosure for the station. The EHouse will be founded on concrete foundations that are constructed below grade to below frost depth. Cable vaults will be installed beneath the EHouse to facilitate control cable entry.

3.1.3.6 Interconnect Station Stormwater Management System

The interconnect station has a small footprint (less than 0.3 ha of disturbed area) and therefore requires minimal stormwater management infrastructure and no water quantity controls. Water quality control will be provided through the use of grassed swales alongside the proposed access roads that convey drainage from the site to the existing ditches alongside Haldimand Road 20.

3.1.3.7 Operations and Maintenance Building

An operations and maintenance building will be constructed on land on the south side of Haldimand Rd 20 opposite the solar farm land area, just east of Mt. Olivet Rd (see **Attachment A**). The building will be a prefabricated engineered structure and will likely measure 24 m wide by 85 m long by 7 m high. It will be founded on concrete foundations that are extended below grade to below the frost line. The building will be used as an operations and maintenance facility and it will likely contain several offices, employee welfare facilities, control facilities, solar farm and wind farm spare parts storage space, a public greeting centre, common areas, maintenance work area and vehicle storage facilities.

The employee welfare facilities will be supported by an aboveground potable water tank, filled by tanker trucks, as well as septic system for approximately 20 workers.

An access road to the operations and maintenance building will intersect with Haldimand Rd 20 and proceed south to the building parking area located directly south of the woodlot on the north end of the property. The outdoor vehicle and parts storage areas surrounding the operations and maintenance building will be gravelled. This area will also be fenced in via a 2.4 m high chain link fence.

Electrical power for the operations and maintenance facility will be provided from Haldimand County Hydro power circuits located on Haldimand Rd 20. The power will be delivered by overhead wires on overhead poles installed adjacent to the access road from Haldimand Rd 20. The overhead line will terminate on a transformer pole adjacent to the operations and maintenance building. The transformer will step down the power supply to a voltage that can be utilized within the building. The final connection of the power will be made through underground cable from the transformer pole to the building electrical service located within the building.

3.1.3.8 Operations and Maintenance Building Stormwater Management System

The operations and maintenance facility has a total area of about 3.2 ha including building storage and parking areas as well as the access road, plus a septic system and stormwater management facility. Total impervious coverage of the facility and access road footprints is expected to be about 90%. Drainage from this area is generally southerly towards the existing channel at the south property limit. Stormwater management (conveyance, treatment, and detention) will be achieved through a combination of grassed swale drainage ditches and an end-of-pipe constructed wetland stormwater management facility. While the developed drainage area is slightly less than that recommended by the MOE *Design Manual* for application of a ‘wet’ end-of-pipe facility, the relatively high degree of impervious coverage and ‘tight’ nature of on-site soils mean that the drainage area ought to generate sufficient flows to maintain a permanent pool. Drainage from the access road and operations and maintenance building/parking areas will be conveyed to the end-of-pipe facility through grassed swale drainage ditches which themselves provide water quality treatment benefits, in addition to moderate peak flow reduction. Swale runoff to the stormwater management facility will discharge into a small inlet micropool / forebay for energy dissipation and sediment retention prior to passing through the constructed wetland cell, which contains a permanent pool depth of approximately 0.3 m. The basin will provide both water quality treatment (sediment removal) and water quantity control (discharge rate restricted to existing conditions) and will be planted with vegetation species tolerant to a variety of moisture conditions. The basin will discharge in a non-erosive fashion to the existing channel at the southern boundary of the property.

4.0 Facility Operations Plan

Operation activities include daily monitoring of the wind turbines and solar panels, operation of the operations and maintenance building, maintenance activities, and monitoring of meteorological data.

4.1 SITE SUPERVISION AND STAFF TRAINING

SPK may hire a specialized Operation and Maintenance Contractor for specific maintenance tasks. SPK and/or the Operation and Maintenance Contractor would carry out the various on-going activities, including daily operation, associated with the facility. It is expected that approximately 17 operation and maintenance staff would be employed by the Project during the operation phase.

During pre-operational mobilization, SPK and/or the Operation and Maintenance Contractor would develop an operation and maintenance program. The program would be designed to ensure compliance with any applicable municipal, provincial, and/or federal requirements. As appropriate, the program would cover staff training, predictive/preventive maintenance, routine maintenance, unscheduled maintenance (including appropriate environmental mitigation measures), annual overhauling, inspection of equipment and components, and procurement of spare parts. It would also include a schedule for regular inspections of the Project's facilities.

4.2 PLANNED MAINTENANCE

The maintenance of the turbines and solar panels would be the responsibility of SPK and/or the Operation and Maintenance Contractor. The maintenance staff would be able to monitor the performance of all turbines and solar panels on-line in real time basis. Monitoring of the turbines and solar panels would occur 24 hours a day/7 days a week within the operations and maintenance building. The on-line system would identify any potential problems so that pro-active inspection and maintenance can be undertaken. Potentially damaged turbines and solar panels would be shut down until maintenance staff can perform a site inspection, since for example, damaged turbines may have increased noise emissions. Regular maintenance of Project equipment would be a key method of mitigating potential effects such as equipment failure. Scheduled maintenance will likely cover the following:

- Visual inspection;
- Inspection of mechanical components, stormwater management, high voltage systems;
- Inspection of electrical components; and
- Greasing and general maintenance.

Although the exact oil and grease requirements for the wind component of the Project are not known at this time, oil changes will be completed in accordance with oil analysis recommendations. The amount of oil and grease stored on site would depend on availability, transportation schedules, and the service cycle. Used oil would be stored in a designated area of the operation and maintenance building, and picked up by certified contractor with the appropriate manifests in place.

Drainage from the transformer pit would be removed by either manually operating a sump pump to discharge the liquid to the stormwater management pond via the catch basin collection system if there is no oil/grease in the liquid, or automatically operating the pump to discharge to the SWM Pond. In either case, an oil/grease sensor would be mounted on the pump to detect any oil/grease in the liquid. If there is oil/grease detected, the liquid would be removed from site via a licensed waste hauler and the source of the leakage would be determined and rectified.

4.3 UNSCHEDULED MAINTENANCE

SPK and/or the Operation and Maintenance Contractor will provide unscheduled maintenance of the Project when required including maintenance such as snow removal.

4.4 MONITORING METEOROLOGICAL DATA

Each turbine would have sensors to measure wind speed and direction. This data would be used to determine when the turbines are operating as well as to control the pitch of the blades and the orientation of the nacelle.

Meteorological data will be collected from sensor equipment mounted with the solar panels. This data may include ambient temperature and wind speed. The data would be used to monitor the operational efficiency of the solar panels.

More information on monitoring activities during operation of the entire Project can be found in Section 6.

4.5 OTHER ACTIVITIES

The facility would generate waste lubricating and hydraulic oils associated with turbine maintenance and operation. During operation, the operation and maintenance building will produce waste materials typical of an office setting, including recyclables and domestic waste.

4.6 KEY PROCESS FEATURES

4.6.1 Water Taking

An aboveground water tank, filled by tanker trucks, would be used to service the operation and maintenance building. Therefore, no groundwater or surface water takings are part of the facility design and operations.

4.6.2 Sewage Management

The operation and maintenance building will have rest rooms which would be serviced by a septic system. The septic system will have its contents emptied at regular intervals using tankers.

4.6.3 Stormwater Management

The ability of any stormwater management practice to continue functioning as designed relies on the development and implementation of an operations and maintenance program. While the following outlines the details of the program components anticipated at the time of design, the adoption of a broader adaptive management philosophy acknowledges the potential for refinement of the program to reflect actual field observations recorded as part of the monitoring program.

The various components of the stormwater systems proposed for implementation within the Project are typical of standard practice and represent straightforward activities. Typical stormwater management measures incorporated within the proposed strategy include the use of grassed swale (ditch) conveyance systems as well as dry and constructed wetland end-of-pipe quality / quantity control facilities.

Grassed Swale (Ditch) Conveyance Systems

Grassed swale (ditch) conveyance systems represent a familiar, passive, and simple type of stormwater management practice, with operational and maintenance requirements to match. Generally speaking, the treatment benefits of a grassed swale are the result of the contact between the flows being conveyed and the vegetation within the swale. Given this, inspection, operational, and maintenance activities can be generally limited to:

- Routine observations as to the presence of trash/debris within the swale that could be conveyed downstream and/or affect the conveyance capacity of the system and removal of same as needed.
- For the first two years following construction, a semi-annual walking inspection should be completed to identify areas of bare soil and/or the formation of erosive gullies (annually thereafter). Remediative efforts would typically involve re-grading the area

and/or re-vegetating with sod or appropriate seed mix, with fertilizer and water applied as necessary to ensure germination and stabilization.

- Concurrent with the walking inspections, a visual assessment of any areas of isolated ponding or sediment build-up should be identified. Minor areas of ponding can be resolved with re-grading / re-stabilization, if the magnitude of associated nuisance warrants such action. From a stormwater management perspective, there are no functional concerns associated with ponding and, therefore, remediation is not strictly required. Excessive sedimentation is an issue requiring attention if it remains in a non-vegetated condition and is, therefore, prone to re-suspension and transport downstream, if it creates an isolated ponding area as described above, or if it occurs to an extent that it impacts on the conveyance capacity of the swale. If any such condition occurs, the sediment should be removed and the area re-stabilized.

- Vegetation management is not a strict requirement in that excess growth will serve to improve water quality treatment benefits. If the density of vegetation reaches a level where conveyance capacity is impacted, a cutting operation should be undertaken. A minimum vegetation height of 0.15 m (6”) should be maintained.

End-of-Pipe Stormwater Management Facilities

Long-term operation and maintenance responsibilities at end-of-pipe stormwater management facilities include regular facility inspections and the implementation of associated remediative actions. For the first two years following construction, inspections should be undertaken following each significant rainfall event (averaging approximately 4 inspections / year) to gain confidence that the facilities are functioning as designed. Following this period, the frequency of inspections can be reduced to an annual or as-needed basis.

The types of information that operations staff should be recording and rectifying, if required, include questions such as:

- Are the regular pond levels above the permanent pool elevation after the predicted extended detention drawdown times outlined herein? This situation could be indicative of outlet blockage by trash or sediment; visual inspection should be completed to confirm.

- Within a ‘wet’ stormwater management facility, such as the constructed wetland stormwater management facility proposed as part of the operations and maintenance infrastructure design, pond levels should be assessed to determine if they are lower than the normal permanent pool elevation. Such a condition could be indicative of a blockage of the inlet or leakage through the pond’s invert; visual inspection of inlet should be completed to confirm clear passage. Given the predominantly clay characteristic of on-site soils at location of the subject facility, significant leakage is not anticipated. Weather conditions in the days and weeks leading up to the inspection should also be considered as evaporative losses during a hot, dry spell could be significant.

- Is there damage to facility structures including headwalls, pipes, berms, maintenance accesses, etc.? Maintenance requirements in this regard should be performed on an as required basis.
- What are the visual characteristics of water in the facilities (i.e., oily sheen, frothy, colour, etc.)? Issues in this regard could be indicative of an upstream spill and the need for cleanup.
- Is the vegetation around the facilities unhealthy or dying? Are there areas around the ponds with easy access to open water? Deficiencies in this regard could be indicative of either poor species selection at design, or any number of chronic causes. Lack of vegetation, particularly around the water's edge, increase attractiveness and use by waterfowl, often leading to degradation in effluent water quality (i.e., increased bacteria loadings). Replanting should be undertaken to ensure sufficient vegetation densities.
- Sediment depth and oil accumulation within the forebay or main cell. Within a 'wet' facility, sediment depth can be measured with a graduated pole at a standardized location (can be identified with a marker that is left in the facilities). Sediment should be removed when the permanent pool depth is reduced to 1.0 m within the forebay areas. Owing to the increased sediment loadings anticipated during construction, the clean-out frequencies estimated during the design process might be reduced during the interval prior to complete stabilization of the upstream contributing drainage areas. In any event, the removal and disposal of sediment from all facilities should be completed by a qualified party and/or licensed contractor.
- Erosion around outlet structures or downstream areas requiring stabilization work. All noticeable erosion and damage within and immediately outside the basin should be repaired and stabilized as quickly as possible.
- Draining of the operation and maintenance building stormwater management facility will be accomplished through pumping when maintenance is required.

5.0 Potential Environmental Effects

O. Reg. 359/09 requires that any adverse environmental effects that may result from operations activities be described within an area referred to as the zone of investigation (120 m from the boundary of the Project Location). The sections below describe the potential effects, mitigation measures (if required) and net effects that may result from operations activities within the zone of investigation. Mapping provided in Attachment A shows the zone of investigation and the Project Location.

Descriptions of the existing natural heritage, water, archaeological and built heritage environments in the general Project area and/or Project Location can be found within the **Natural Heritage Assessment & Environmental Impact Study (NHA/EIS)**, **Water Body and Water Assessment Report**, and **Archaeological and Heritage Report**. These reports form part of the REA application and are provided under separate cover.

A more detailed description of potential effects and mitigation measures for portions of the Project Location which are within the specified setbacks (e.g. Significant Wildlife Habitat) within O. Reg. 359/09 is provided in the **NHA/EIS**, **Water Body and Water Assessment Report**, and **Archaeological and Heritage Report**.

For some natural environment and socio-economic features, mitigation measures are anticipated to eliminate all effects. The need, assessment, and selection of protection and mitigation measures discussed in the following sections have been predicated on the principles of:

- avoidance – the elimination of adverse environmental effects by siting, scheduling, and design considerations;
- minimization – reduction or control of adverse environmental effects through Project modifications or implementation of protection and mitigation measures; and
- compensation – enhancement or rehabilitation of affected areas.

The application of these principles has greatly reduced the potential for adverse environmental effects from the Project as demonstrated in the following subsections. The key mitigation strategy used to address potential environmental effects from operation of the facility was avoidance of significant natural features and water bodies to the extent possible during siting of the Project.

5.1 PERFORMANCE OBJECTIVES

The key performance objective for each of the features discussed below is avoiding and/or minimizing potential effects (through the use of appropriate mitigation measures) to the features throughout the operation phase of the Project. The proposed mitigation measures would assist in achieving this performance objective. Additional information related to specific performance objectives is provided in **Table 6.1** below.

5.2 WATERBODIES AND AQUATIC RESOURCES

5.2.1 GROUNDWATER

5.2.1.1 All Project Components

Potential Effects

Some materials, such as fuel, lubricating oils and other fluids associated with Project maintenance and/or the septic system at the operations and maintenance building, have the potential for discharge to the on-site environment through accidental spills and thus potentially infiltrate groundwater supplies.

Water withdrawal requirements for the Project are expected to be minimal as no water is required for operation and maintenance of the turbines, solar panels or transmission component of the Project. Water is not anticipated to be required for solar panel washing as rain water and snow should be sufficient for the cleaning of panels. Given that a water tank will be utilized for the operations and maintenance building (serviced by water tankers) no water takings are required for the operations and maintenance building staff (approx. 20 workers).

Mitigation Measures

Mitigation measures for accidental spills are listed in Section 5.12.

Net Effects

Accidental spills would be spatially limited and of short duration and protocols to minimize their impact would be provided in the Emergency Response Plan. See Sections 6.3 and 5.12 for more information on the Emergency Response Plan.

5.2.2 SURFACE WATER, STORMWATER, AND FISH AND FISH HABITAT

Surface water bodies (e.g. lakes, streams) within 120 m of the Project Location are described in the **Water Body and Water Assessment Report** (extended to 300 m in a review of Lake Trout lakes). This includes information obtained during the records review and site investigations.

A fish habitat assessment was also conducted to determine the quality of fish habitat within 120 m of the Project Location. The assessment of fish habitat followed the criteria established by the MNR (1994), which has been developed based on levels of protection required for proposed developments in and around lakes and streams. This assessment was also used to characterize watercourses according to Fisheries and Oceans Canada (DFO) fish habitat types. Information related to the site investigations is provided in the **Water Body and Water Assessment Report**.

The Project Location encompasses eight subwatersheds located between the south bank of the Grand River and the north shore of Lake Erie. The eight subwatersheds fall within the jurisdiction of two Conservation Authorities, as presented below:

Long Point Region Conservation Authority (LPRCA)

- Stoney Creek
- Hemlock Creek
- Wardells Creek
- Evans Creek

Grand River Conservation Authority (GRCA)

- Unnamed Grand River Tributaries
- Holmes Creek and Sulphur Creek
- Unnamed Lake Erie Tributaries
- Mazi Drain

Potential effects and mitigation measures vary by Project component, and are discussed in the following sections.

5.2.2.1 Wind Component

Potential Effects

The potential for effects on watercourses exists from soil erosion resulting from unavoidable removal of stabilizing vegetative cover during maintenance activities. Erosion can cause downstream sediment transport and a short-term increase in surface water turbidity, including associated impacts to fish and fish habitat. Due to the Project Location's rural and agricultural land uses, the watercourses are not highly sensitive to temporary disturbances. However, the magnitude and duration of potential effects to watercourses depend on the specific characteristics of each watercourse (e.g. flow regime, water velocity, bed substrates, bank conditions, local soils and the extent and duration of exposure).

In addition, some materials, such as fuel, lubricating oils and other fluids associated with turbine maintenance and/or the septic system, have the potential for release to the environment in the event of accidental spills.

Turbine access roads cross several water bodies. Culvert design and installation must not impede fish movement or water passage and where possible, habitat enhancement measures should be incorporated into the design. Culvert requirements have been detailed within the **Water Body and Water Assessment Report** and within the **NHA/EIS**. Surface water flows/stormwater is not anticipated to be impacted as a result of the operation of the wind component of the Project.

Mitigation Measures

Vegetation removal on the slopes of watercourses will be minimized to the extent possible, to minimize the risk of slope failure and siltation. Stream banks (i.e. the area between erosion control fences) will not be disturbed until necessary for maintenance activities. Materials removed or stockpiled (e.g. excavated soil, backfill material, etc.) will be deposited and contained in a manner to ensure sediment does not enter a watercourse.

As soon as possible following completion of the maintenance activity, stream banks will be restored to their original grade.

Even with properly installed erosion and siltation control measures, extreme runoff events could result in collapse of silt fencing, slope or trench failures and other problems which could lead to siltation of water bodies. If siltation to a watercourse occurs, activities should cease immediately until the situation is rectified.

Mitigation measures related to accidental spills are outlined in Section 5.12. No additional mitigation measures are required for the operation and maintenance of correctly installed culverts.

Net Effects

The application of the above mitigation measures as necessary during operation and maintenance activities would ensure that effects to surface water are minimized, and that any potential net effects are spatially and temporarily limited.

5.2.2.2 Solar Component

Potential Effects

The potential for effects on watercourses exists from soil erosion resulting from unavoidable removal of stabilizing vegetative cover during maintenance activities. Erosion can cause downstream sediment transport and a short-term increase in surface water turbidity, including associated impacts to fish and fish habitat. Due to the Project Location's agricultural land use, the watercourses are not highly sensitive to temporary disturbances. However, the magnitude and duration of potential effects to watercourses depend on the specific characteristics of each watercourse (e.g. flow regime, water velocity, bed substrates, bank conditions, local soils and the extent and duration of exposure). In addition, some materials, such as fuel, lubricating oils and other fluids associated with Project maintenance, have the potential for release to the environment in the event of accidental spills.

Because the solar cells are mounted above the ground, infiltration, filtration through vegetation and other natural hydrologic process will continue similar to existing conditions. Drainage will generally be directed to existing receiving systems (drainage paths, roadside ditches, etc.) as under current conditions. Therefore, a general area-wide stormwater treatment and/or detention systems are not required. The small increase in runoff from the gravel access roads will be attenuated and filtered through local ditches and no formal basins or other management techniques are required.

Mitigation Measures

Vegetation removal on the slopes of watercourses would be minimized to the extent possible, to minimize the risk of slope failure and siltation. Stream banks (i.e. the area between erosion control fences) would not be disturbed until necessary for maintenance activities. Materials removed or stockpiled (e.g. excavated soil, backfill material, etc.) would be deposited and contained in a manner to ensure sediment does not enter a watercourse.

As soon as possible following completion of the maintenance activity, stream banks would be restored to their original grade.

Even with properly installed erosion and siltation control measures, extreme runoff events could result in collapse of silt fencing, slope or trench failures and other problems which could lead to siltation of water bodies. If siltation to a watercourse occurs, activities should cease immediately until the situation is rectified.

Mitigation measures related to accidental spills are outlined in Section 5.12.

Net Effects

The application of the above mitigation measures as necessary during maintenance activities will ensure that effects to surface water are minimized, and that any potential net effects are spatially and temporarily limited.

5.2.2.3 Electrical Transmission Component

Potential Effects

The potential for effects on watercourses exists from soil erosion resulting from unavoidable removal of stabilizing vegetative cover during maintenance activities. Erosion can cause downstream sediment transport and a short-term increase in surface water turbidity, including associated impacts to fish and fish habitat. Due to the Project Location's rural and agricultural land uses, the watercourses are not highly sensitive to temporary disturbances. However, the magnitude and duration of potential effects to watercourses depend on the specific characteristics of each watercourse (e.g. flow regime, water velocity, bed substrates, bank conditions, local soils and the extent and duration of exposure).

In addition, some materials, such as fuel, lubricating oils and other fluids associated with electrical equipment operation and maintenance have the potential for release to the environment in the event of accidental spills.

Mitigation Measures

Vegetation removal on the slopes of watercourses would be minimized to the extent possible, to minimize the risk of slope failure and siltation. Stream banks (i.e. the area between erosion control fences) would not be disturbed until necessary for maintenance activities. Materials removed or stockpiled (e.g. excavated soil, backfill material, etc.) would be deposited and contained in a manner to ensure sediment does not enter a watercourse.

As soon as possible following completion of the maintenance activity, stream banks would be restored to their original grade.

Even with properly installed erosion and siltation control measures, extreme runoff events could result in collapse of silt fencing, slope or trench failures and other problems which could lead to siltation of water bodies. If siltation to a watercourse occurs, activities should cease immediately until the situation is rectified.

Area drainage from the collector substation will be accomplished through a series of swales adjacent to the proposed access road that will collect and convey runoff from the substation area and associated access road west and south towards Haldimand Rd 20. The total drainage area associated with the substation and access road "hard" surfaces is less than 2 ha and therefore a "wet" water quality control pond (i.e. one containing a permanent pool) is inappropriate, as per the MOE *SWM Planning and Design Guidelines Manual (2003)*. In addition to the conveyance of runoff, the series of grassed swales will also provide water quality control, which is a suitable stormwater management practice for such an area according to the MOE guidelines. Water quantity control will be provided using a dry detention pond for the storage and slow release of runoff to the existing ditch and drainage system along Haldimand Road 20. Drainage from the solar lands will largely be conveyed around the substation facility, access road, and associated stormwater management measures through the use of diversion swales given that it does not require treatment or detention.

Stormwater management for the operations and maintenance building (conveyance, treatment, and detention) will be achieved through a combination of grassed swale drainage ditches and an end-of-pipe constructed wetland stormwater management facility. While the developed drainage area is slightly less than that recommended by the MOE *Design Manual* for application of a 'wet' end-of-pipe facility, the relatively high degree of impervious coverage and 'tight' nature of on-site soils mean that the drainage area ought to generate sufficient flows to maintain a permanent pool. Drainage from the access road and operations and maintenance building/parking areas will be conveyed to the end-of-pipe facility through grassed swale drainage ditches which themselves provide water quality treatment benefits, in addition to moderate peak flow reduction. Swale runoff to the stormwater management facility will discharge into a small inlet micropool / forebay for energy dissipation and sediment retention prior to passing through the constructed wetland cell, which contains a permanent pool depth of approximately 0.3 m. The basin will provide both water quality treatment (sediment removal) and water quantity control (discharge rate restricted to existing conditions) and will be planted with vegetation species tolerant to a variety of moisture conditions. The basin will discharge in a non-erosive fashion to the existing channel at the southern site boundary.

Mitigation measures related to accidental spills are outlined in Section 5.12. Within the collector substation footprint itself, the two transformers will be equipped with oil containment storage areas to capture oil in the event of a leak. Additionally, an oil/water separator will be incorporated into the design to treat any effluent before it enters the storm drainage swales.

Net Effects

The application of the above mitigation measures as necessary during maintenance activities would ensure that effects to surface water are minimized, and that any potential net effects are spatially and temporarily limited.

5.3 WETLANDS AND WOODLANDS

5.3.1 Wind Component

Potential Effects

Significant natural areas found within 120 m of the Project Location include wetlands and significant woodland. A detailed analysis of the functions of these features and the potential effects from the Project is provided in the **NHA/EIS** document.

All wind components of the Project (turbines, access roads, substation etc.) are located outside of all wetland boundaries. While the majority of the Project infrastructure has been sited outside of significant woodlands, is one new access road and turbine within a plantation, one access road along an existing farm laneway through a deciduous forest and three buried collector lines proposed along existing farm laneways through significant woodlands (potential effects related to these crossings are discussed in the **Construction Plan Report** and **NHA/EIS**.

During operation of the facility, some materials such as lubricating oils and other fluids associated with turbine maintenance have the potential for discharge to the on-site environment through accidental spills resulting in a potential impact to the natural features. Improper disposal of wastes (fluids, containers, cleaning materials) could also have a negative impact on the features.

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 5.4. The dust and disturbance to vegetation as a result of maintenance vehicle traffic is expected to be negligible due to the infrequency of these activities.

Mitigation Measures and Net Effects

Accidental spills would be spatially limited and of short duration and protocols to minimize their impact would be provided in the Emergency Response Plan (Section 5.12).

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 5.4. Other indirect effects to wetlands and woodlands as a result of maintenance vehicle traffic and turbine operation are expected to be negligible and as a result, no mitigation is recommended.

5.3.2 Solar Component

Potential Effects

Significant natural areas found within 120 m of the Project Location include wetlands and significant woodland. A detailed analysis of the functions of these features and the potential effects from the Project is provided in the **NHA/EIS** document.

All components of the Project (solar panels and associated access roads and electrical equipment) are located at least 25 to 30 m from wetland and woodland boundaries.

During operation of the facility, some materials such as lubricating oils and other fluids associated with solar panel and equipment maintenance have the potential for discharge to the on-site environment through accidental spills resulting in a potential impact to the natural features. Improper disposal of wastes (fluids, containers, cleaning materials) could also have a negative impact on the features.

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 5.4. The dust and disturbance to vegetation as a result of maintenance vehicle traffic is expected to be negligible due to the infrequency of these activities.

Mitigation Measures and Net Effects

Accidental spills would be spatially limited and of short duration and protocols to minimize their impact would be provided in the Emergency Response Plan (Section 6.3).

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 5.4. The implementation of setbacks to wetlands and significant woodlands will attenuate disturbance effects due to operational activities including solar panel and vegetation maintenance. Other indirect effects to wetlands and woodlands as a result of maintenance vehicle traffic and human activity are expected to be negligible and as a result, no mitigation is recommended.

5.3.3 Electrical Transmission Component

Potential Effects

Significant natural areas found in or within 120 m of the Project Location include wetlands and significant woodland. A detailed analysis of the functions of these features and the potential effects from the Project is provided in the **NHA/EIS** document. The wetlands and woodlands along Haldimand Road 20 currently experience higher impact from daily vehicle traffic and maintenance of the roadway than natural features located elsewhere in the Project Location.

During operation, some materials such as lubricating oils and other fluids associated with transmission line maintenance have the potential for discharge to the on-site environment through accidental spills resulting in a potential impact to the natural features. Improper disposal of wastes (fluids, containers, cleaning materials) could also have a negative impact on the features.

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 5.4. The dust and disturbance to vegetation as a result of maintenance vehicle traffic is expected to be negligible due to the infrequency of these activities, particularly when considered in the context of the existing disturbance from Haldimand Road 20.

Mitigation Measures and Net Effects

Accidental spills would be spatially limited and of short duration and protocols to minimize their impact would be provided in the Emergency Response Plan (Section 6.3).

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 5.4. Indirect effects to wetlands and woodlands as a result of maintenance vehicle traffic and human activity are expected to be negligible, especially in comparison to the existing disturbance from Haldimand Road 20 and as a result, no mitigation is recommended.

5.4 WILDLIFE AND WILDLIFE HABITATS

5.4.1 Wind Component

Potential Effects

Direct effects of Project operation to wildlife and their habitats, other than birds and bats which are discussed in the following sections, are expected to be minimal. More detail is provided in Table 6.1 of the **NHA/EIS**. Potential direct impacts include increased risk of mortality to frogs, snakes and turtles on new access roads. Roads can impact wildlife populations through direct mortality from vehicles, as well as through the increased isolation of populations resulting in decreased genetic diversity (LesBarreres, 2007). Traffic speed is one of the key factors which influences mortality (Farmer and Brooks, 2007), and traffic volume influences both mortality (Fahrig, 2007) and connectivity. During operation of the Project, access roads would experience very little traffic on a daily basis and both mortality and barrier effects are expected to be negligible. Amphibians are most susceptible in spring, particularly cool spring nights.

There are potential indirect disturbance effects to wildlife and their habitats. Some large mammals may avoid wind facilities if there is high level of human activity relative to baseline conditions (Arnett et al., 2007). Current agricultural, recreational and hunting activities provide some disturbance, and none of the amphibians, reptiles or mammals occupying the area are known to be particularly wary of human activity, so it is anticipated that they will adapt to the presence of operational turbines.

Masking of auditory environmental signals, such as amphibian calls, may be significant immediately underneath the turbine (Rabin et al., 2006), but the effects rapidly decline with distance from the turbine. Also, a study of low frequency noise and vibration at a modern wind farm determined that vibration is 1/5th to 1/100th of the limit of human perception within 25 m of the turbine base (Legerton et al., 1996). While amphibians may be more perceptive of vibration, vibration magnitude drops off significantly as distance increases (K. Smith, Aercoustics, pers. comm. in Stantec, 2011). No turbines are located within 60 m of significant amphibian breeding habitat (base) and 9 of the 11 turbines within 120 m of significant amphibian habitat are located more than 100 m from turbine centre to the features assumed to support significant woodland amphibian populations. These are considered sufficient setbacks to mitigate any noise and vibration effects to amphibians.

During operation there may be occasional system maintenance within 120 m of significant wildlife habitats. However, noise and disturbance from these activities is expected to be lower impact than the regular disturbance impacts from day to day use of the road system and maintenance activities associated with the road.

Birds

Project effects on forest breeding birds may occur indirectly from disturbance or directly through mortality. Disturbance from operation has the potential to affect use of adjacent habitats by birds and bird collisions with turbines may result in direct mortality during operations. Destruction, fragmentation, and disturbance of habitat as a result of wind energy projects were identified as larger threats to breeding birds than direct mortality (Kingsley and Whittam, 2007).

During operation, direct mortality of birds may occur from collisions with turbines. Various studies throughout North America have documented bird collisions at wind facilities and investigated the underlying mechanisms. In general, resident breeding birds breeding tend to have lower collision rates than non-residents, at least partly because they become familiar with the turbines and avoid them (Kingsley and Whittam, 2007).

Most studies indicate that direct mortality at wind facilities is low, especially when compared to other anthropogenic structures (Arnett et al., 2007; Kingsley and Whittam, 2007; National Academy of Sciences, 2007; Nation Wind Coordinating Committee, 2010), and are not expected to be significant at a population level (Arnett et al., 2007; National Wind Coordinating Committee, 2010).

Some grassland breeding bird species have been shown to nest in lower densities when turbines are present (Leddy et al., 1999). The Project Location has been found to provide a function of supporting populations of grassland species, some of which have been identified as priority species by Partners in Flight (2006).

Disturbance of birds may also occur as a result of increased human activities on-site. However, these activities have a similar level of disturbance to wildlife compared to the ongoing level of agricultural activities that currently occur adjacent to the feature. It is likely that resident birds have adapted to these levels of periodic human activity.

Sound levels during operations might also result in disturbance effects to breeding birds. Habib et al. (2007) found that sound from compressor stations (which produce sound at 75 to 90 dB(A) at the source) reduced pairing success of Ovenbirds (a forest songbird) by 15%. Reijnen et al. (1996) suggest that sound levels that are below 47 dB(A) would not have significant effects on breeding birds. Sound from wind turbines likely has the greatest effect on wildlife at low wind speeds, whereas at high wind speeds the sound from the turbines is masked by the sound of the wind.

Wind industry-specific studies indicate that breeding bird productivity does not appear to be negatively affected at many wind facilities (Kingsley and Whittam, 2007). However, most studies to date that document avoidance, disturbance or displacement effects have focused mainly on grassland or open country birds. There is relatively little research on effects on wind energy disturbance on forest breeding birds.

Bats

Bat mortality has been documented at wind power facilities in a variety of habitats across North America. Nearly every monitored wind power facility in the United States and Canada has reported bat mortality with minimum annual mortality varying from < 1 to 50 bat fatalities/ turbine/year (MNR, 2006). The majority of bat fatalities at wind power facilities occur in the late summer and fall, and the long-distance migratory bats (i.e., hoary bat, eastern red bat, silver-haired bat) appear to be most vulnerable to collisions with moving turbine blades. Specific factors causing bat mortality and affecting species vulnerability to wind turbine mortality remain unclear, although recent evidence from Alberta suggests that air pressure differences in the blade vortices may contribute to bat mortality.

Mitigation Measures

The basis of the mitigation is the Environmental Effects Management Plan for Wildlife and Wildlife Habitats (**Attachment C**). This document outlines the post-construction monitoring program, the performance objectives and contingency measures should these objectives not be met.

In summary, the post-construction monitoring plan consists of:

- Mortality monitoring of breeding birds, migratory land birds, migratory raptors and bats in accordance with the MNR bird and bat guidelines;
- A point count-based study to assess disturbance effects to declining forest breeding birds (Feature 42);

- A transect-based study to assess disturbance effects to migratory land birds resulting from wind turbine operation during migration; and
- Visual monitoring for changes to hydrological conditions in wetlands and significant woodlands, weekly during construction and seasonally for one year following construction.

Bird and bat mortality monitoring will be conducted according to MNR's *Birds and Bird Habitats: Guidelines for Wind Power Projects* (August, 2010) and *Bats and Bat Habitats: Guidelines for Wind Power Projects* (March, 2010). Post-construction monitoring for disturbance effects would occur for one year pre-construction and two years post-construction.

Operational mitigation is required where annual post-construction mortality monitoring exceeds 10 bats per turbine per year (MNR, 2010). Post-construction mitigation, including operational controls, will be considered if annual mortality of birds exceeds 18 birds/ turbine/year at individual turbines or turbine groups; 0.2 raptors or vultures/turbine/year or 0.1 raptors of provincial conservation concern/turbine/year across the wind power project, or if bird mortality during a single mortality monitoring survey exceeds 10 or more birds at any one turbine or 33 or more birds (including raptors) at multiple turbines.

MNR, along with the proponent and other relevant agencies, will collectively review the results of the post-construction disturbance effects monitoring to determine if an ecologically significant disturbance/avoidance effect to birds or amphibians is occurring, and whether such effect is attributed to the Project and not external factors. These discussions will determine whether contingency measures, which may include operational controls, will be undertaken.

Net Effects

With respect to net effects for Significant Wildlife Habitat, additional information is provided within the **NHA/EIS** document.

Most North American studies have shown that direct bird mortality attributable to wind facilities is low, especially when compared to other anthropogenic structures (Arnett et al., 2007; Kingsley and Whittam, 2007; National Academy of Sciences, 2007), and for birds, is not expected to be significant at a population level (Arnett et al., 2007). Mortality of bats is anticipated to be focused in late summer and to primarily affect migratory species.

5.4.2 Solar Component

Potential Effects

No removal of natural vegetation is proposed with the exception of hedgerows. The panels will be suspended above grade within existing agricultural fields. Areas beneath and surrounding the solar panels will be vegetated with native grassland species. The installation of fence may disrupt animal movement however small rodents, amphibians, and mammals are anticipated to be able to cross the site.

No direct effects to significant wildlife habitats in the vicinity of the Project or the birds, amphibians, and wintering deer using the habitat are anticipated as a result of operation of the Project. Potential indirect negative effects could result from an increase in human activity during maintenance periods. Light pollution can disrupt natural diurnal rhythms of wildlife, and is particularly harmful to nocturnal and migratory animals and animals in flight.

With respect to potential effects and the associated mitigation measures for wildlife including Significant Wildlife Habitat, additional detailed analysis is provided within the **NHA/EIS**.

Mitigation Measures and Net Effects

A minimum 30 m setback has been provided between the Project location and significant wildlife habitat. The lands immediately adjacent to the woodlands and wetlands have been disturbed by agricultural activities and provide little benefit in terms of ecological function, habitat or natural vegetation. Enhancing these areas through the establishment of naturalized buffers will benefit and enhance the adjacent natural features and associated habitat. The corridor between Features 30 and 31 will be maintained and enhanced through planting of native species (see **NHA/EIS**).

The 2.4 m high fence surrounding the solar components will interfere with the movement of large mammals. Amphibians and small mammals will continue to be able to pass through this fence structure. The installation of measures to facilitate the passage of wildlife species is encouraged. A gap in the security fencing will be maintained along the north side of the access road and transmission line that will be fenced off to maintain a secure perimeter around the solar modules, but will maintain a 10 to 15 m wide corridor to allow for the free movement of deer in an east-west direction. The potential effects of artificial light pollution can be mitigated by ensuring that direct glare is not visible beyond the substation boundaries, which can be avoided by installing low intensity and downward pointing lights. All outdoor lighting should be turned off when not in use, except where used for security and safety purposes, where motion sensors should be used.

With respect to potential effects and the associated mitigation measures for wildlife including Significant Wildlife Habitat, additional detailed analysis is provided within the **NHA/EIS**. Post-construction monitoring plans to evaluate the disturbance effects to winter wildlife and the establishment of native species within the proposed buffer area are outlined within the **NHA/EIS**.

5.4.3 Electrical Transmission Component

Potential Effects, Mitigations Measures and Net Effects

During operation, there is very little potential for disturbance to wildlife and their habitats from the transmission line. Any maintenance activities would introduce a very small incremental increase in human activity over the existing disturbance from Haldimand Road 20. As a result, no specific mitigation is proposed. Post-construction monitoring plans to evaluate the establishment of native species within the proposed buffer area are outlined within the **NHA/EIS**.

5.5 LAND-USE AND RESOURCES

5.5.1 Wind Component

Potential Effects

Agricultural Lands and Soils

The existing land use within 120 m of the Project Location for the wind farm components includes primarily agricultural lands (both private and Ontario Realty Corporation (ORC) managed). In addition, six turbines are proposed on lands previously used by the Dunnville Airport. The agricultural land used for the turbines, access roads and collector lines are primarily Class 3 agricultural lands and potential effects are related to the change in use from agricultural to renewable energy development. However, where lands are being used for Project infrastructure, landowners are being financially compensated for the lease of the private lands and thus offset the effect of removing the land from agricultural production.

Impacts to livestock during the operations of the Project are anticipated to be minimal. Dust emissions from operations activities are associated with vehicular traffic from maintenance equipment, personnel vehicles and waste management haulers. Dust emissions are expected to be short-term in duration and highly localized. No potential physical effects are anticipated on agricultural lands and operations from dust during operations of the Project. Therefore, no mitigation measures are required.

Provincial Plans, Policies and Recreational Uses

There are no areas protected under provincial plans and policies within 120 m of the Project Location that may be impacted by the operation of the Project. Much of the land within the area including lands within 120 m of the Project Location is used for recreational purposes such as hunting and off-roading. Hunting and other recreational uses will be permitted on lands occupied and adjacent to the Project (not withstanding private property restrictions). No fisheries resources will be impacted during the operation of the wind component of the Project. In addition, the operation of the Project will not result in the creation of access to previously inaccessible areas as the Project is located in areas already cleared for agricultural uses.

Minerals, Aggregates and Petroleum Resources

While lands designated for mineral and aggregate resource extraction may be present within proximity to the Project Location, the operation of the Project will not have any potential effects on these resources as the lands required for the Project have been granted for renewable energy development instead of mineral and aggregate extraction by each participating landowner.

Numerous petroleum resources operations (pipelines, abandoned wells, capped wells, active wells, suspended wells, and unknown wells) are located within 75 m of the Project Location (shown in the **Construction Plan Report**). As works will be conducted prior to construction of the Project to identify potential effects to the petroleum resources operations and mitigation measures implemented to minimize or eliminate any potential effects, no adverse effects are anticipated to petroleum resources during operation of the facility.

Telecommunications and Radar

Wind turbines have the potential to interfere with radio, TV, or internet signals as a result of a turbine being in the “line-of-sight” between a receiver and the signal source (AWEA, 2006). Studies have shown that the rotating blades and support structure of a wind turbine can impact AM (amplitude modulated) and RF (Radio Frequency) signals. FM (frequency modulated) signals are much more immune to this phenomena and may only become impaired in very close proximity to the wind turbines (RABC, 2005).

Signal interference from turbines may potentially occur in three ways:

1. Static Ghosting: This occurs when a broadcast signal is reflected off the support towers of the wind turbines and results in the signal being delayed to the television receiver (Polisky, 2005).

2. Signal Blockage: A signal may become blocked from reaching a receiver as a result of the turbine being located directly between the television station and the reception point (Polisky, 2005). Similarly, wireless internet could be blocked if a turbine is located within the path of point to point communications.

3. Dynamic Interference/Pulsing: This occurs when the receiver picks up an interference signal, in addition to the direct signal, as a result of the signal reflecting off of the blades of one or more of the wind turbines. This results in periodic variations in a TV’s picture brightness and/or colour occurring in time with the rotation of the blades (Levert and Munro, 2006).

HDTV receivers have built-in ghost-cancelling circuits not found in regular NTSC receivers. Thus, HDTV greatly reduces or even eliminates static interference created by wind turbines. The greatest number of interference problems occurs when the wind turbine is positioned directly between the signal source (i.e. television station) and the point of reception (Polisky, 2005).

The presence of wind turbines also presents a potential hazard to low flying aircraft. Aviation safety lighting and marking of the turbines is required by Transport Canada's Aerodrome Safety Branch as specified in the Canada Aviation Regulations and Standards. Aviation safety lights, which serve to increase night-time visibility of the turbines to aviators, are required at the top of turbines as part of the lighting requirements. These safety lights may also brighten the night sky. Transport Canada standards state that wind farms require a red obstruction lighting system consisting of fading on and off aviation red beacons. These are used for night marking of wind turbines between the heights of 90 m and 150 m (including blade length) above ground level and spaced approximately 900 m apart. Final aviation lighting requirements would be in accordance with Transport Canada Regulations and Standards and would be confirmed prior to construction.

The only known airport within the Project Location is the Dunnville Airport. The airport is going to be deregistered as a public airport. The private airport will be operated with users flying at their own risk given the intent of six turbines to be located on the property. Transport Canada has confirmed this approach and will remove the airport from the Transport Canada database (Canadian Flight Information). Local pilots who frequently utilize the airport have been consulted with regarding this additional land use and their concerns have been taken into consideration in the placement of the turbines.

Additional information related to potential impacts to telecommunications networks and radar systems are provided in the **Consultation Report**. This includes comments/clearances provided agencies such as the Canadian Coast Guard, Transport Canada, Meteorological Service of Canada, Department of National Defence, and the Royal Canadian Mounted Police.

Provincial and Local Infrastructure

No potential effects are anticipated during operations of the facility on Provincial, Municipal or other major infrastructure other than to roadways. There may be instances during maintenance activities where excess loads (e.g. turbine and transformer components) would require special traffic planning.

Local Economy and Viewscape

Operation of the facility is expected to continue for a minimum of approximately 20 years. During operations, it is expected that up to 12 operation and maintenance staff would be employed to maintain and operate the wind component of the Project. SPK may hire a specialized Operation and Maintenance Contractor for specific maintenance tasks. To the extent possible, local hiring would be emphasized during the operations period providing work for existing tradespersons and labourers. Trades that could be provided locally may include pipefitters, electricians, ironworkers, millwrights and carpenters. Since it is likely that the majority of the labour force would be supplied through local and neighbouring communities no special housing, healthcare or food facilities would be required as part of the Project operations activities.

While the increased number of personnel present in the area during operations would increase the demand for some goods and services from the local area (e.g. lodging, food, and banking), the demand is expected to be minimal.

Local economic benefits would also include a minimum of 20 years of land lease payments to participating landowners in addition to municipal taxes to be paid by SPK.

Siting of turbines and ancillary facilities would alter the visual landscape. However, visibility of the turbines will vary from receptor to receptor based on the following factors:

- Surficial patterns: landform – largely determined by physiography and tree cover;
- Topography: slope – the greater the slope the greater the visibility of the turbines from more vantage points;
- Observer position: viewing – distance from the turbines reduces scale and the apparent size of a project is directly related to the angle between the viewer's line-of-sight and the slope upon which the project is to take place;
- Atmospheric conditions: clarity – air pollution, natural haze, fogging, snow affect daytime and night-time visibility; and
- Turbine marking: lighting – primarily affecting night-time visibility.

Mitigation Measures

Agricultural Lands and Soils

Given that agricultural land will be required during the operation of the turbines, access roads and collector lines, landowners are being financially compensated for the lease of the private lands and thus offset the effect of removing the land from agricultural production. To the greatest extent possible, efforts have been made to site the turbines, access roads and collector lines in such a way as to minimize disturbances to existing agricultural lands and operations. In particular, siting of turbines and access roads are completed with the approval of the participating landowner. Operational and maintenance activities would be restricted to the delineated Project areas such as access roads.

Provincial Plans, Policies and Recreational Uses

Given that the Project Location is outside of areas protected under provincial plans and policies and that recreational activities will be permitted during operation of the Project, no mitigation measures are required.

Minerals, Aggregates and Petroleum Resources

As no potential effects are anticipated to existing mineral, aggregate, or petroleum resources, no mitigation measures are necessary.

Telecommunications and Radar

Although no effects are anticipated, in the unlikely event that signal disruption is experienced, mitigation measures are available to alleviate the impact. This may include replacing the receiving antenna with one that has a better discrimination to the unwanted signals, relocating either the transmitter or receiver, or switching to an alternate means of receiving the information (fibre optic or other means). SPK would review potential incidents of telecommunications interference on a case by case basis.

According to Transport Canada's Aerodrome Safety Branch guidelines, a wind turbine more than 900 m from another wind turbine with a light requires its own lighting. Turbine lighting must conform to Transport Canada standards. In order to reduce rural light pollution, lights would be selected with the minimal allowable flash duration, narrow beam, and would be synchronized. It should be pointed out that turbine marking and lighting are secondary safety measures for aircraft. The turbines, approximately 149 m tall when one blade is upright, are below the minimum flight floor of 500 feet (152.4 m) above ground level. It is illegal for aircraft to fly below 500 feet (152.4 m) unless they have been granted a special clearance for a low level flight. Low-level aircraft such as ultra-lights and crop dusters are to be familiar with the area they are flying over and are prohibited from night-time flights. Nav Canada would be responsible for updating all aeronautical charts with the turbine locations.

Provincial and Local Infrastructure

Permits from the MTO may be required to facilitate the transportation of components used for maintenance (e.g. cranes) on provincial highways. As appropriate, for public safety all non-conventional loads would have front and rear escort or "pilot" vehicles accompany the truck movement on public roads. Although there are no requirements for formal public notification of wind turbine component load movements, SPK may provide notification of non-conventional load movements, with potential methods of notification including postings on the Project website. This notification would be provided in the interest of public safety, minimization of disruption of other road users, and good community relations.

Local Economy and Viewscape

To the extent possible, SPK and/or the Operation and Maintenance Contractor would source required goods and services from qualified local suppliers where these items are available in sufficient quantity and at competitive prices.

There are limited opportunities for potential mitigation strategies given the height of the wind turbines and the landscape patterns. However, SPK is attempting to coordinate lighting of turbines with other developers within the area so as to minimize the visual interruption of the turbine safety lights.

Net Effects

Disturbances to agricultural lands and operations are expected to be temporary and spatially limited. With the application of the above mitigation measures, no significant adverse net effects on telecommunications and radar networks are anticipated during operation of the facility. No significant effects are anticipated to provincial and local infrastructure during operation of the Project. Some disturbance to the viewscape is unavoidable due to the height of the turbines. The changed visual landscape would be present during the life of the facility.

A positive net effect is anticipated on the local economy during operations of the facility. The operation of the Project would provide positive income, employment, and fiscal benefits to the local area, including the County and participating landowners. The County would receive ongoing property tax income from the Project and participating landowners would receive land lease payments.

5.5.2 Solar Component

Potential Effects

Agricultural Lands and Soils

The existing land use within 120 m of the Project Location for the solar components includes primarily agricultural lands that are Class 3 agricultural lands. Potential effects are related to the change in use from agricultural to renewable energy development. However, where lands are being used for Project infrastructure, landowners are being financially compensated and thus offset the effect (financial) of removing the land from agricultural production. Additional agri-business related effects are discussed below under the “Local Economy and Viewscape” heading. This assessment of potential effects does not include an assessment of the “energy vs. food” debate related to the use of agricultural lands for non-agricultural purposes as this is outside of the scope of the REA process.

In order to prevent soil erosion, provide dust control and maintain an annual grassland type appearance under the solar panels during operation, SPK may plant a vegetated understory of native grassland species that will mimic natural grassland vegetation. This type of vegetation should require only minimal maintenance and irrigation and would assist in preventing the invasion of non-native grassland species.

Provincial Plans, Policies and Recreational Uses

There are no areas protected under provincial plans and policies within 120 m of the solar Project Location that may be impacted by the operation of the Project. Much of the land within the area including lands within 120 m of the Project Location is used for recreational purposes such as hunting and off-roading. Hunting and other recreational uses will not be permitted on the solar lands due to public safety concerns. No fisheries resources will be impacted during operation of the Project and will not result in the creation of access to previously inaccessible areas as the Project is located in areas already cleared for agricultural uses.

Minerals, Aggregates and Petroleum Resources

As the lands for the solar component of the Project are in agricultural production, the operation of the solar component of the Project is not anticipated to have any potential effects on mineral or aggregate resources as these lands have not been earmarked for mineral or aggregate extraction.

Numerous petroleum resources operations (abandoned and unknown wells and one active well) are located within 75 m of the Project Location (shown in the **Construction Plan Report**). As works will be conducted prior to construction of the Project to identify potential effects to the petroleum resources operations and mitigation measures implemented to minimize or eliminate any potential effects, no adverse effects are anticipated to petroleum resources during operation of the facility.

Telecommunications and Radar

The operation of the solar component of the Project is not anticipated to have any negative effects to telecommunication or radar systems.

Provincial and Local Infrastructure

No significant effects are anticipated during operations of the facility on Provincial, Municipal or other major infrastructure other than to roadways. There may be instances during maintenance activities where excess loads (e.g. solar panel and transformer components) would require special traffic planning.

Local Economy and Viewscape

Operation of the facility is expected to continue for a minimum of approximately 20 years. During operations, it is expected that approximately five operation and maintenance staff from SPK and the Operation and Maintenance Contractor would be employed during operation of the solar component. SPK may hire a specialized Operation and Maintenance Contractor for specific maintenance tasks. To the extent possible, local hiring would be maximized during the operations period providing work for existing tradespersons and labourers. Trades that could be provided locally may include pipefitters, electricians, ironworkers, millwrights and carpenters. Since it is likely that the majority of the labour force would be supplied through local and neighbouring communities no special housing, healthcare or food facilities would be required as part of the Project operations activities.

While the increased number of personnel present in the area during operations would increase the demand for some goods and services from the local area (e.g. lodging, food, and banking), the demand is expected to be minimal.

Local economic benefits would also include a minimum of 20 years of land lease payments to participating landowners in addition to increases in municipal taxes to be paid by SPK.

The removal of the solar lands from agricultural production is not anticipated to have a noticeable impact on the local agri-business economy given the magnitude of the Project and the inherent variability in crop production.

Concerns have been raised from local residents regarding the visual impact the solar Project may have on local roads and adjacent private residences given the change in land use from agricultural to solar farm development. The Project will alter the existing viewscape of the solar farm lands given the large scale development of the Project, however the significance of the change/impact is subjective based on the persons opinion of the Project and the use of agricultural land for renewable energy development. With respect to glare from the panels, each panel will be laminated with anti-reflection coating and the panels absorb over 90 percent of the light received and thus glare from the panels impacting adjacent areas is not anticipated to be a concern. No lights are proposed around the Project perimeter to minimize the potential visual impact of the Project.

With regards to a property being within visual distance of the solar farm and the potential effects to property values, there is no available evidence to-date (via systematic reviews of property value impacts) which links the location of a solar farm with impacts on property values.

Mitigation Measures

Agricultural Lands and Soils

Given that agricultural land will be required during the operation of the Project, landowners are being financially compensated for the lease of the lands and thus offset the effect (financial) of removing the land from agricultural production.

As noted above, In order to prevent soil erosion, provide dust control and maintain an annual grassland type appearance under the solar panels during operation, SPK may plant a vegetated understory of native grassland species that will mimic annual grassland vegetation.

Provincial Plans, Policies and Recreational Uses

Hunting and other recreational uses will not be permitted on the solar lands due to public safety concerns and to protect Project infrastructure. As such, there are no mitigation measures available for recreational users of Project lands during the operation of the Project.

Minerals, Aggregates and Petroleum Resources

As no effects are anticipated to existing mineral, aggregate, or petroleum resources, no mitigation measures are necessary.

Telecommunications and Radar

As no effects are anticipated to telecommunication and radar systems, no mitigation measures are necessary.

Provincial and Local Infrastructure

As appropriate, for public safety all non-conventional loads would have front and rear escort or "pilot" vehicles accompany the truck movement on public roads. Although there are no requirements for formal public notification of excess load movements, SPK may provide notification of non-conventional load movements, with potential methods of notification including postings on the Project website. This notification would be provided in the interest of public safety, minimization of disruption of other road users, and good community relations.

Local Economy and Viewscape

To the extent possible, SPK and/or the Operation and Maintenance Contractor would source required goods and services from qualified local suppliers where these items are available in sufficient quantity and at competitive prices. In addition, local economic benefits will also include a minimum of 20 years of land lease payments to participating landowners in addition to municipal taxes to be paid by SPK.

To minimize any potential visual obtrusiveness of the Project on public roads and adjacent private lands, a minimum 9 m wide buffer area will be used between the solar farm and perimeter property lines. In addition, excavated material from the access roads will be bermed (approximately 6 m wide) along the outer edge of the solar farm lands to provide a landscaping barrier for landowners of adjacent residences where close proximity occurs to the solar panels. The berm in addition to the buffer areas will help minimize any potential visual obtrusiveness of the Project.

Net Effects

Disturbances to agricultural lands and operations are expected to be temporary and spatially limited. No significant effects are anticipated to provincial and local infrastructure during operation of the Project. The changed visual landscape would be present during the life of the facility, however mitigation measures such as a berm and buffer area will assist in minimizing the potential visual obtrusiveness of the Project.

A positive net effect is anticipated on the local economy during operations of the facility. The operation of the Project would provide positive income, employment, and fiscal benefits to the local area, including the County and participating landowners. The County would receive ongoing property tax income from the Project and participating landowners would receive land lease payments.

5.5.3 Electrical Transmission Component

Potential Effects

Agricultural Lands and Soils

The Project's substation and operations and maintenance building are proposed to be located on Class 3 agricultural lands while the transmission line is proposed directly within municipal road allowances and thus will not displace agricultural lands. The total amount of agricultural land required for the substation (1.7 acres) and operations and maintenance building (3.2 hectares) is approximately 3.9 hectares. Potential effects are related to the change in use from agricultural to renewable energy development. However, where lands are being used for Project infrastructure, landowners are being financially compensated and thus offset the effect (financial) of removing the land from agricultural production.

Provincial Plans, Policies and Recreational Uses

There are no areas protected under provincial plans and policies within 120 m of the electrical component of the Project Location that may be impacted by the operation of the Project. Much of the land within the area including lands within 120 m of the Project Location is used for recreational purposes such as hunting and off-roading. Hunting and other recreational uses will be permitted on lands occupied and adjacent to the transmission line and operations and maintenance building (not withstanding private property restrictions). No access will be available for recreational uses in proximity to the collector substation as it is enclosed within the solar lands. No fisheries resources will be impacted during the operation of the wind component of the Project. In addition, the operation of the Project will not result in the creation of access to previously inaccessible areas as the Project is located in areas already cleared for agricultural uses.

Minerals, Aggregates and Petroleum Resources

While lands designated for mineral and aggregate resource extraction may be present within proximity to the Project Location, the operation of the Project will not have any potential effects on these resources as the lands required for the Project have been granted for renewable energy development instead of mineral and aggregate extraction by each participating landowner.

Numerous petroleum resources operations (pipelines, abandoned wells, capped wells, active wells, suspended wells, and unknown wells) are located within 75 m of the Project Location (shown in the **Construction Plan Report**). As works will be conducted prior to construction of the Project to identify potential effects to the petroleum resources operations and mitigation measures implemented to minimize or eliminate any potential effects, no adverse effects are anticipated to petroleum resources during operation of the facility.

Telecommunications and Radar

There are no anticipated significant effects to telecommunication/radar systems during the operation of the Project.

Provincial and Local Infrastructure

During operations of the electrical transmission component of the Project, no effects are anticipated to provincial and local infrastructure. Operation of the operation and maintenance building and scheduled maintenance activities are anticipated to occur during regular business hours and there are no anticipated effects as a result of increased traffic due to the relatively small workforce required during operation.

Local Economy and Viewscape

Operation of the facility is expected to continue for a minimum of approximately 20 years. During operations, it is expected that approximately 17 operation and maintenance staff would be employed and would be located within the operations and maintenance building (total for all three Project components). SPK may hire a specialized Operation and Maintenance Contractor for specific maintenance tasks. To the extent possible, local hiring would be maximized during the operations period providing work for existing tradespersons and labourers. Since it is likely that the majority of the labour force would be supplied through local and neighbouring communities no special housing, healthcare or food facilities would be required as part of the Project operations activities.

While the increased number of personnel present in the area during operations would increase the demand for some goods and services from the local area (e.g. lodging, food, and banking), the demand is expected to be minimal.

Local economic benefits would also include a minimum of 20 years of land lease payments to participating landowners in addition to municipal taxes to be paid by SPK.

The removal of the lands from agricultural production for the substation and operations and maintenance building is not anticipated to have a noticeable impact on the local agri-business economy given the magnitude of the Project and the inherent variability in crop production.

The transmission line is proposed within the Haldimand Road 20 road right-of-way which currently has existing power lines. Thus, the installation of the transmission line will not result in new significant visual impacts along the transmission line route. The substation is located within the solar lands and thus is not anticipated to have a visual impact on surrounding properties. The operations and maintenance building will be located on agricultural lands and thus will result in a change in viewscape for surrounding properties; however the building will be of similar design to existing maintenance facilities located throughout the area. No lights are proposed around the Project perimeter to minimize the potential visual impact of the Project.

Mitigation Measures

Agricultural Lands and Soils

Given that agricultural land will be required during the operation of the Project, landowners are being financially compensated for the lease of the lands and thus offset the effect (financial) of removing the land from agricultural production.

Provincial Plans, Policies and Recreational Uses

Hunting and other recreational uses will not be permitted on the substation and operations and maintenance building properties due to public safety concerns. As such, there are no mitigation measures available for recreational users of Project lands during the construction of the Project.

Minerals, Aggregates and Petroleum Resources

As no effects are anticipated to existing mineral, aggregate, or petroleum resources, no mitigation measures are necessary.

Telecommunications and Radar

As no effects are anticipated to telecommunication and radar systems, no mitigation measures are necessary.

Provincial and Local Infrastructure

As no effects are anticipated to provincial and local infrastructure, no mitigation measures are necessary.

Local Economy and Viewscape

To the extent possible, SPK and/or the Operation and Maintenance Contractor would source required goods and services from qualified local suppliers where these items are available in sufficient quantity and at competitive prices. In addition, local economic benefits will also include a minimum of 20 years of land lease payments to participating landowners in addition to municipal taxes to be paid by SPK.

Net Effects

Disturbances to agricultural lands and operations are expected to be temporary and spatially limited. No significant effects are anticipated to provincial and local infrastructure during operation of the Project. Some disturbance to the viewscape is unavoidable due to the size of the operations and maintenance building and location of the transmission line. The changed visual landscape would be present during the life of the facility.

A positive net effect is anticipated on the local economy during operations of the facility. The operation of the Project would provide positive income, employment, and fiscal benefits to the local area, including the County and participating landowners. The County would receive ongoing property tax income from the Project and participating landowners would receive land lease payments.

5.6 AIR QUALITY

5.6.1 All Project Components

Potential Effects

During operations, minor localized air emissions would occur from the periodic use of maintenance equipment to repair Project infrastructure over the life of the Project and from personnel vehicles and waste management haulers travelling to and from the operations and maintenance building during regular business hours.

Mitigation Measures

To reduce emissions from equipment and vehicles, several mitigation measures may be employed:

- Multi-passenger vehicles should be utilized to the extent practical;
- Company and maintenance personnel should avoid idling of vehicles when not necessary for operations activities;
- Equipment and vehicles should be maintained in good working order with functioning mufflers and emission control systems as available;
- All vehicles should be fitted with catalytic converters as required;
- All operations equipment and vehicles should meet the emissions requirements of the MOE and/or Ministry of Transportation;
- As appropriate, records of vehicle maintenance should be retained and made available for periodic review by SPK; and
- All vehicles identified through the monitoring program that fail to meet the minimum emission standards would be repaired immediately or replaced as soon as practicable.

Net Effects

The application of the recommended mitigation measures during operations should limit air emissions to the work areas and limit the magnitude of combustion emissions. As a result, any adverse net effects to air quality from air emissions during operation of the Project are anticipated to be short-term in duration and highly localized.

5.7 ENVIRONMENTAL NOISE

5.7.1 Wind Components

Potential Effects

Mechanical and aerodynamic sound would be emitted from the wind turbines and their associated transformers. All turbines proposed as part of the Project are located at a distance of at least 550 m from the nearest non-participating noise receptor. In addition, a Noise Assessment Report has been completed for the Project (**Attachment B**) in accordance with the MOE "*Noise Guidelines for Wind Farms*", dated October 2008 and O. Reg. 359/09.

Based upon the Project design, the analysis carried out in the Noise Assessment Report indicates that sound produced by the Project was found to be within the acceptable limits established by the MOE at all noise receptors. The analysis includes the combined impacts of the wind turbines, substation, and other wind turbines within a three kilometre radius.

Mitigation Measures

The noise assessment has concluded that the environmental noise effect from the operation of the Project is in compliance with the applicable MOE environmental noise guidelines at all wind speeds modeled.

The Project would be required to operate according to the terms and conditions of the REA. In the event the Project does not operate according to the terms and conditions of the REA, the non-compliant turbine(s) may be shut down until the problem is resolved. A regular maintenance program would largely mitigate potential effects related to noise from damaged turbines.

Net Effects

Application of regular maintenance during operations should limit noise emissions and mitigate potential effects related to noise from damaged turbines. Given that the noise assessment has concluded that the environmental noise effect from the operation of the Project is in compliance with the applicable MOE environmental noise guidelines at all wind speeds modeled, no significant net effects are anticipated.

5.7.2 Solar Component

Potential Effects

The solar panels themselves do not generate noise; however the two associated inverter panels will generate a small amount of noise. Additional noise will be generated by the solar step up (SSU) pad-mounted transformer. However, according to O. Reg. 359/09, the inverters and SSU transformers are not included in the Noise Assessment Report as they will operate at voltages below the threshold of 50 kV.

Mitigation Measures

The Noise Assessment Report has concluded that the environmental noise effect from the operation of the Project is in compliance with the applicable MOE environmental noise guidelines at all receptors.

The Project would be required to operate according to the terms and conditions of the REA. In the event the Project does not operate according to the terms and conditions of the REA, the non-compliant components may be shut down until the problem is resolved. A regular maintenance program would largely mitigate potential effects related to noise from damaged components.

Net Effects

Application of regular maintenance during operations should limit noise emissions and mitigate potential effects related to noise from damaged components. Given that the noise assessment has concluded that the environmental noise effect from the operation of the Project is in compliance with the applicable MOE environmental noise guidelines, no significant net effects are anticipated.

5.7.3 Electrical Transmission Component

Potential Effects

During operations of the Project, sound would be generated by the periodic use of maintenance equipment in addition to personnel vehicles and waste management haulers that would travel to and from the operations and maintenance building during regular business hours. The audible sound at receptors beyond the operations and maintenance building is expected to be a minor, short-term in disruption.

Additional noise will be generated by the Project's collector substation. Based upon the Project design, the analysis carried out in the Noise Assessment Report (**Attachment B**) indicates that sound produced by the Project was found to be within the acceptable limits established by the MOE at all noise receptors. The analysis includes the combined impacts of the substation, wind turbines, and other wind turbines within a three kilometre radius.

Mitigation Measures

To minimize inconvenience brought on by noise during the use of vehicles during the operations phase of the Project, all engines associated with maintenance equipment would be equipped with mufflers and/or silencers in accordance with MOE and/or MTO guidelines and regulations. Noise levels arising from maintenance equipment would also be compliant with sound levels established by the MOE.

Routine facility maintenance to ensure infrastructure is operating properly and efficiently would be performed as required. To the greatest extent possible, operations activities that could create excessive noise would be restricted to regular business hours, when residents are less sensitive to noise, and adhere to any local noise by-laws. If maintenance activities that cause excessive noise must be carried out outside of these time frames, adjacent residents would be notified in advance and by-law conformity would occur, as required.

A sound attenuation wall will also be constructed around the collector substation to further attenuate noise produced by the Project.

Net Effects

Application of the recommended mitigation measures during operations should limit noise emissions to the general vicinity of the turbine locations and substation property. Given that the noise assessment has concluded that the environmental noise effect from the operation of the Project is in compliance with the applicable MOE environmental noise guidelines, no significant net effects are anticipated.

5.8 TRAFFIC AND ROAD USAGE

5.8.1 All Project Components

Potential Effects

There is potential for an increase of traffic during operations on roadways within the area due to the commuting workforce, maintenance equipment and removal of waste materials. The number of vehicles required during operation would be minimal. A small number of light trucks would be required for typical maintenance activities, however occasionally larger vehicles would be required to transport larger Project components. Waste management vehicles would typically access the operation and maintenance building on a weekly basis for waste collection and the contractor responsible for collecting used oil would likely be required on a semi-annual basis.

The increase in traffic may result in short-term, localized disturbance to traffic patterns or increases in traffic volume, and/or create potential traffic safety hazards. Project related traffic would be restricted to a limited to a small, defined workforce.

Mitigation Measures

There may be instances during maintenance activities where excess loads (e.g. large Project components) would require special traffic planning. In addition, widening of turning radii and road widths and the creation of new ingress/egress nodes from the work areas may be required. As appropriate, permits would be obtained to implement these activities. As appropriate, for public safety all non-conventional loads would have front and rear escort or “pilot” vehicles accompany the truck movement on public roads.

Although there are no requirements for formal public notification of excess load movements, SPK may provide notification of non-conventional load movements that may interfere with local traffic, with potential methods of notification including postings on the Project website. This notification would be provided in the interest of public safety, minimization of disruption of other road users, and good community relations.

Net Effects

Road safety is not expected to be an issue during operations; however the potential for accidents along the haul routes and on-site cannot be totally disqualified. Truck traffic would increase on some roads during maintenance activities and from personnel vehicles, and waste management haulers, however this traffic would be short-term in duration and intermittent.

The effect of operating the Project is anticipated to have a limited, short term effect on traffic only during non-conventional load movements.

5.9 PUBLIC HEALTH AND SAFETY

5.9.1 Wind Component

Potential Effects

Wind power has been identified as a clean renewable energy source that does not contribute to global warming and is without known emissions or harmful wastes (WHO, 2004). Contrary to many other electricity generation processes such as the burning of coal, wind turbines do not result in the emission of environmental contaminants (e.g., NO_X, CO_2) that contribute to poor air quality and have the potential to negatively impact human health.

Although wind power has been harnessed by humans for hundreds of years as a source of power, its widespread use as a significant source of energy in Ontario is relatively recent. It is felt that the majority of the public supports the use of wind power as a renewable source of energy, as does the MOE. As is the case with the introduction of any new technology, there are some that are concerned about its potential to adversely affect health of residents living nearby wind turbines.

Overall, it is the standpoint of SPK that the operation of the Project will not lead to adverse human health effects. This statement is based on the analysis provided in **Attachment F** which provides a comprehensive review of information related to the potential effects to human health and safety as a result of wind farm operation.

In addition to the analysis provided in **Attachment F**, stakeholders have expressed concerns related to the potential to feel vibrations from the turbines as a result of turbines being potentially anchored to bedrock. It has been found that ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans (Colby, 2009).

Mitigation Measures

Mitigation measures are detailed within **Attachment F** as they relate to each potential effect such as infrasound.

Net Effects

With the implementation of appropriate operations protocols and built-in safety features of the turbines, there is minimal increased or new risk to public health and safety from the operation of the Project. In addition, the Project meets the setback requirements of O. Reg. 359/09.

5.9.2 Solar Component

Potential Effects

The operation of the solar panels does not pose a threat to human and environmental health and safety as no emissions are produced (Fthenakis, 2003). Due to the thick layers of plastic or glass surrounding the photovoltaic cells, there is essentially no risk of photovoltaic compounds being ingested or inhaled unless the panel is ground to a fine dust (Fthenakis, 2003). Therefore, the normal use of a solar panel would not produce any dust particles or vapours.

There is the potential for exposure to toxic vapours should a fire consume the solar panel. However, given the melting points of the potentially harmful substances within the photovoltaic cells (Fthenakis, 2003) and the lack of burnable materials in a solar panel, the risk of fires and the generation of hazardous fumes are extremely limited.

Mitigation Measures

For public safety reasons, a 2 m high chain link fence will be installed around the entire perimeter of the solar farm to prevent unauthorized access to the solar panel area.

Net Effects

With the implementation of appropriate operations protocols and fencing around the solar panels, there is minimal increased or new risk to public health and safety from the operation of the Project.

5.9.3 Electrical Transmission Component

Potential Effects

Electromagnetic Fields (EMFs) are invisible forces that surround any wire that carries electricity, including outdoor power lines. Despite human reliance on electricity, there are some concerns that daily exposure to EMFs produced through the generation, collection, and use of electric power might adversely affect human health.

Transmission and distribution power lines can be located either overhead or underground. All transmission and distribution lines produce both electric and magnetic fields, but electric fields from underground lines do not reach the land surface (National Grid, 2006). Therefore, humans are exposed to both electric and magnetic fields from overhead lines and to magnetic fields only from underground lines. In the case of this project, EMFs are produced from electrical cables that run from the turbines and solar panels to the substation and the transmission line.

Since the 1960s, researchers from around the world have been investigating potential health effects associated with human exposure to EMF. These studies include laboratory research into effects on cells and animals, as well as epidemiological (human health) studies looking at possible associations between exposures and diseases in the general population. The consensus among agencies and the literature reviewed is that:

- Available evidence is not strong enough to conclude that EMF causes cancer in children or occupationally exposed adults;
- There is insufficient evidence linking EMF to any other human health effects; and

- More studies are needed to draw firm conclusions.

As a result of the insufficient evidence supporting the claim that EMF are linked to health problems, at this point in time neither the provincial nor the federal governments have established standards limiting occupational or residential exposure to EMF. Additional information regarding EMFs is available in **Attachment F**. In addition, the electrical components of the Project will be designed and constructed in accordance with applicable rules, regulations and standards (e.g. CSA).

Mitigation Measures

Physical objects such as vegetation, buildings and fences can reduce electric fields to a lower level, but magnetic fields can pass through most objects. As such, shielding works well for electric fields, but not as well for magnetic fields. Effective shielding options are available for underground power lines such as achieving greater cancellation and lower magnetic fields by placing the individual conductors of the power line close together (touching) and insulation (National Grid, 2006).

With the understanding that the Project will operate well within the range of voluntary standards in North America, and that the potential health effects from EMF remain inconclusive, no adverse net effects on human health are expected from operation of the Project. A fence will be installed around the substation and interconnect station in order to limit the proximity to which members of the public may approach these facilities.

Net Effects

There are no significant net adverse health effects anticipated as a result of the operation of the Project.

5.10 WASTE MATERIAL DISPOSAL

5.10.1 All Project Components

Potential Effects

Lubricating and hydraulic oils associated with Project maintenance and operation would be used for the facility, and waste materials, such as oil, grease, batteries, and air filters and a minor amount of domestic waste (i.e. garbage, recycling, and organics), would be generated during standard operation and maintenance activities.

Waste materials would be temporarily stored at the operation and maintenance building and would require reuse, recycling, and/or disposal at an appropriate MOE approved off-site facility. Improper disposal of waste material generated during operations may result in contamination to soil, groundwater, and/or surface water resources on and off the Project sites. Litter generated during operations may also become a nuisance to nearby residences if not appropriately contained and allowed to blow off site. There would be no on-site disposal of waste during the operation of the facility. Used oil would be stored in a designated area of the operation and maintenance building, and picked up by certified contractor with the appropriate manifests in place.

The operation and maintenance building would have restroom facilities which would be serviced by a septic system. The septic system would have capacity for storage only, with its contents being emptied at regular intervals using tankers. High level alarms with audible and visual warning would be used for level monitoring.

Mitigation Measures

During operations, SPK and/or the Operation and Maintenance Contractor would implement a site-specific waste collection and disposal management plan, which may include good site practices such as:

- systematic collection and separation of waste materials within on-site storage areas in weather-protected areas located at the operation and maintenance building;
- contractors would be required to remove all waste materials from Project sites during maintenance activities;
- all waste materials and recycling would be transported off-site by private waste material collection contractors licensed with a Certificate of Approval – Waste Management System;
- labelling and proper storage of liquid wastes (e.g. used oil, drained hydraulic fluid, and used solvents) in a secure area that would ensure containment of the material in the event of a spill. As per S.13 of the EPA, all spills that could potentially have an adverse environmental effect, are outside the normal course of events, or are in excess of the prescribed regulatory levels would be reported to the MOE's Spills Action Centre;
- as appropriate, spill kits (e.g. containing absorbent cloths and disposal containers) would be provided on-site during maintenance activities and at the operation and maintenance building;
- dumping or burying wastes within the Project sites would be prohibited;
- disposal of non-hazardous waste at a registered waste disposal site(s);
- if waste is classified as waste other than solid non-hazardous, a Generator Registration Number is required from the MOE and the generator would have obligations regarding manifesting of waste. Compliance with Schedule 4 of Regulation 347 is mandatory when determining waste category; and

- implementation of an on-going waste management program consisting of reduction, reuse, and recycling of materials.

Net Effects

With the application of the mitigation measures outlined above, no net effects from waste material disposal would occur on-site during operation. However, as with all wastes, it is possible that disposal would have a minor incremental effect on soil, groundwater, and surface water at the waste disposal site(s) depending on municipal on-site containment practices and quality of the landfill protection mechanisms (e.g. use of geotextiles to contain leachate). It is assumed that licensed waste disposal sites are legally compliant.

5.11 HERITAGE AND ARCHAEOLOGICAL RESOURCES

In accordance with O. Reg. 359/09, a **Archaeological and Heritage Report** has been prepared for the Project (included under separate cover). The **Archaeological and Heritage Report** contains a Built Heritage and Cultural Heritage Landscape Inventory Assessment, a Protected Properties Assessment, along with a Stage I and II Archaeological Assessment. As the following provides a summary, please see the **Archaeological and Heritage Report** for more information related to resources found within and near the Project Location along with a detailed assessment of potential effects and mitigation measures to each feature.

5.11.1 All Project Components

Potential Effects

There are no areas that would be excavated during the operation phase that would not have been previously assessed prior to construction; therefore no effects are anticipated to archaeological resources during operation.

Potential impacts to built and cultural heritage resources and protected properties during operation are related to destruction, alteration, shadowing which alters the appearance of the resource, isolation of the resource, direct or indirect obstruction of views of or from within the resource, change in land use of the resource, and land disturbances which may impact the resource. Identified potential impacts to each of the various built and cultural heritage resources and protected properties are fully described within the **Archaeological and Heritage Report**.

Mitigation Measures

Given that there are no anticipated effects to known archaeological resources during operation of the Project, mitigation measures are not required.

The primary mitigation measure to avoid potential impacts to built and cultural heritage resources and protected properties is to avoid the use of the properties and resources during the construction of the Project as minimal mitigation measures are available once the Project has been constructed. Mitigation measures to minimize potential effects from visual disturbances during operation of the facility are discussed in Section 5.5.1.

Net Effects

No significant adverse net effects on archaeological resources are anticipated during operation of the Project. While visual impacts are unavoidable, no negative impacts of significant magnitude have been identified to heritage resources or protected properties.

5.12 ACCIDENTS AND MALFUNCTIONS

The accidents and malfunctions discussed below are those that may have consequences to the public and/or environment. Accidents and malfunctions relating to worker health and safety are considered to be adequately addressed by SPK and their contractors' adherence to Occupational Health and Safety Guidelines, and therefore, not addressed further in this document.

5.12.1 Wind Component

Potential Effects

The potential exists for full or partial blade detachment from the turbine, resulting in damage to the landing area from the impact. Garrad Hassan Canada undertook a review of publicly-available literature on turbine rotor failures resulting in full or partial blade throws (Garrad Hassan Canada, 2007). Such events were found to be very rare; therefore data describing these events are scarce.

Root causes of blade failure have been continuously addressed through developments in best practice in design, testing, manufacture and operation; much of these developments have been captured in the International Electrotechnical Commission (IEC) standards to which all current large wind turbines comply (Garrad Hassan Canada, 2007). There has been widespread introduction of turbine design certification and approval that certifies compliance with standards and requires a dynamic test that simulates the complete life loading on the blade (Garrad Hassan Canada, 2007). The certification body also performs a quality audit of the blade manufacturing facilities and performs strength testing of construction materials. This approach has effectively eliminated blade design as a root cause of failures (Garrad Hassan Canada, 2007).

The reported main causes of blade failure include:

- Human interference with the control system;
- A lightning strike; and
- A manufacturing defect in the blade.

Turbine control systems are subjected to rigorous specification in the design standards for wind turbines (IEC 61400-1) and exhaustive analysis in the certification process. Turbines with industry certification must have a safety system completely independent of the control system. In the event of a failure of one system, the other is designed to control the rotor speed.

Lightning protection systems for wind turbines have developed significantly over the past decade and best practices have been incorporated into the industry standards to which all modern turbines must comply. This has led to a significant reduction in events where lightning causes structural damage. A review of available literature, conducted by the Chatham-Kent Public Health Unit (2008), revealed only four documented turbine failure issues in Ontario due to lightning strikes that required the turbine to be shut down for repair.

The occurrence of structural manufacturing defects in rotor blades has also diminished significantly due to experience and improved quality control in the industry. Design practice has evolved to improve structural margins against any manufacturing deficiencies. Even in the rare event of a blade failure in modern turbines, it is much more likely that the damaged structure would remain attached to the turbine rather than separating (Garrad Hassan Canada, 2007). Reviews of available information did not find any recorded evidence of injury to the public as a result of turbine blade or structural failure (Garrad Hassan Canada, 2007; Chatham-Kent Public Health Unit, 2008).

Given that accidents or malfunctions of the turbines are considered to be infrequent events, and turbines would be located at least the minimum regulated setback distance from any residence, the event of a failure of the structure would likely not fall beyond the setback distance and not affect public health and safety.

The possibility also exists for accidents related to third party damage of the wind turbines. However, give the location of the turbines (set back in agricultural fields) and the structural integrity of the turbines, major structural impacts to the turbines are highly unlikely.

Some materials, such as fuel, lubricating oils and other fluids associated with turbine maintenance and/or the step-up transformers, have the potential for discharge to the on-site environment through accidental spills.

Mitigation Measures

Modern wind turbines must meet strict international engineering standards. Standards include the ability to withstand the forces of a Level 2 tornado (i.e., wind speeds of approximately 55 m/s), and structures must be built to meet earthquake loads as per the Ontario Building Code. The structural integrity of the turbines is designed to withstand wind speeds of approximately 55 m/s. However, during high wind events (i.e., greater than 24 m/s) the turbines are designed to cease operation. Turbine braking is accomplished by aerodynamic (blade pitch) control and friction brakes. The wind turbines would be designed, installed, operated and maintained according to applicable industry standards/certifications.

SPK and the Operation and Maintenance Contractor would aim to minimize accidents and malfunctions with proper maintenance techniques and proper training and education of staff operating the control system. County emergency response staff would also be trained to appropriately deal with any potential accidents and malfunctions resulting from the operation of the turbines. In addition, the turbines would be equipped with lightning protection systems and located at least the minimum regulated setback distance from receptors.

In terms of accidental spills or releases to the environment, standard containment facilities and emergency response materials would be maintained on-site as required (at each turbine location and/or within the operations and maintenance building). Refuelling, equipment maintenance, and other potentially contaminating activities would occur in designated areas, and as appropriate spills should be reported immediately to the MOE Spills Action Centre.

An Emergency Response Plan would be developed by SPK and/or the Operation and Maintenance Contractor and would include protocols for the proper handling of material spills and associated procedures to be undertaken in the event of a spill.

Net Effects

As a result of the structural integrity and design features of the turbines, no significant adverse net effects from structural failure of the turbines are anticipated during operation of the facility.

5.12.2 Solar Component

Potential Effects

Given the installation of large scale electrical equipment, there is an inherent risk of fire associated with an accident or malfunction. However, the solar panels and associated equipment result in a negligible increase in fire potential. There is the potential for exposure to toxic vapours should a fire consume the solar panel. However, given the melting points of the potentially harmful substances within the photovoltaic cells (Fthenakis, 2003) and the lack of burnable materials in a solar panel, the risk of fires and the generation of hazardous fumes are extremely limited.

A chain link fence will be built around the solar farm for public safety purposes and to protect the facility from third party damage.

Some materials, such as fuel, lubricating oils and other fluids associated with transformer maintenance and operation have the potential for discharge to the on-site environment through accidental spills.

Mitigation Measures

SPK and the Operation and Maintenance Contractor would aim to minimize accidents and malfunctions with proper training and education of staff operating the control system and maintaining the panels on a day to day basis. County emergency response staff would also be trained to appropriately deal with any potential accidents and malfunctions resulting from the operation of the solar farm. SPK and/or the relevant Contractor will also finalize a detailed Emergency Response Plan in collaboration with Haldimand County's Emergency Services Departments.

As standard when dealing with fires involving electrical equipment, additional care must be taken by emergency responders. Additional equipment beyond what is typically required to respond to electrical fires is not required for fires involving solar PV panels.

In addition, the solar panels and associated electrical equipment will be installed and maintained in accordance with applicable safety standards.

In terms of accidental spills or releases to the environment, standard containment facilities and emergency response materials would be maintained on-site as required (within the solar lands and/or within the operations and maintenance building). Refuelling, equipment maintenance, and other potentially contaminating activities would occur in designated areas, and as appropriate spills should be reported immediately to the MOE Spills Action Centre.

An Emergency Response Plan would be developed by SPK and/or the Operation and Maintenance Contractor and would include protocols for the proper handling of material spills and associated procedures to be undertaken in the event of a spill.

Net Effects

As a result of the structural integrity and design features of the solar farm in addition with routine maintenance in accordance with applicable safety standards, no significant adverse net effects are anticipated in the event of accidents or malfunctions during operation of the facility.

5.12.3 Electrical Transmission Component

Potential Effects

Accidents and malfunctions associated with the electrical component of the Project are primarily attributed to spills/leaks of hazardous materials and structural failure. Some materials, such as fuel, lubricating oils and other fluids associated with overall Project maintenance including the substation have the potential for discharge to the on-site environment through accidental spills. Each transformer within the substation will be mounted on a concrete base foundation within an oil containment facility that would capture all of the oil insulating fluid within each transformer in the event of a leak.

During operation, the transmission line and collector line towers/poles are designed to withstand extreme meteorological loads; however, a tower failure, although unlikely, is a possibility. Typically, if a tower does fail, adjacent towers will also be affected. In the event of a tower failure during operation, a line outage would probably occur, the duration of which would depend on the number of towers affected, the extent of the damages, the location, weather conditions at the time of the incident and the availability of response personnel. It is anticipated that the probability of tower failure occurring during operation is low, i.e., one occurrence in 150 years.

A chain link fence will be built around the substation, operations and maintenance building, transition stations and interconnect station for public safety purposes and to protect the facilities from third party damage.

Mitigation Measures

SPK and the Operation and Maintenance Contractor would aim to minimize accidents and malfunctions with proper training and education of staff operating the control system and maintaining the electrical system on a day to day basis. County emergency response staff would also be trained to appropriately deal with any potential accidents and malfunctions resulting from the operation of the electrical equipment. SPK and/or the relevant Contractor will also finalize a detailed Emergency Response Plan in collaboration with Haldimand County's Emergency Services Departments.

As standard when dealing with fires involving electrical equipment, additional care must be taken by emergency responders. Additional equipment beyond what is typically required to respond to electrical fires is not required for the Project's electrical components.

In terms of accidental spills or releases to the environment, standard containment facilities and emergency response materials would be maintained on-site as required (within the substation and within the operations and maintenance building). Refuelling, equipment maintenance, and other potentially contaminating activities would occur in designated areas, and as appropriate spills should be reported immediately to the MOE Spills Action Centre. An Emergency Response Plan would be developed by SPK and/or the Operation and Maintenance Contractor and would include protocols for the proper handling of material spills and associated procedures to be undertaken in the event of a spill.

The primary preventative measure taken to avoid tower failure during operation is at the design stage. At this stage, both the use of each tower (e.g., tower type) and the meteorological forces (e.g., icing and wind conditions) that the tower will be subjected to are considered in the design. As such, this information has been taken into consideration in the proposed design of the transmission and collector lines. In addition, the transmission and collector lines must be designed and constructed in accordance with applicable regulatory guidelines (e.g. International Electrical Commission standards).

Net Effects

As a result of the structural integrity and design features of the electrical transmission components including spill containment features in addition with routine maintenance in accordance with applicable safety standards, no significant adverse net effects are anticipated in the event of accidents or malfunctions during operation of the facility.

5.13 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

5.13.1 Climatic Fluctuations and Extreme Events

Accumulation of ice on the turbine blades can occur when specific conditions of temperature and humidity exist. This condition is not unique to wind turbines and has the potential to occur on any structure that is exposed to the elements. In Ontario, this condition is most likely to occur in the winter months in extreme weather events. Under these conditions the turbines may be subject to ice coating from freezing rain or interception of low clouds containing super-cooled rain.

There are two potential hazards associated with ice accumulation on wind turbines:

- The danger of falling ice that may accumulate on the turbine itself as a result of freeze-thaw of snow and ice; and
- The throwing of ice from the moving turbine blades.

Falling ice from an immobile turbine does not differ from other tall structures like telecommunication towers, power lines, and antenna masts. The potential ground area affected by falling ice from wind turbines depends to a large extent on the blade position and the prevailing wind speed and direction. Garrad Hassan Canada (2007) estimated that only very high winds may cause ice fragments of any significant mass to be blown beyond 50 m of the base of a modern, stationary 2 MW turbine. Operating staff and landowners are briefed on this situation; therefore the risk is considered minimal (Garrad Hassan Canada, 2007).

Wind turbines typically operate when the wind speed is within the range of 4 m/s to 25 m/s; when turbines are in operation they can accumulate ice on the rotor blades. Ice fragments which detach from the rotor blades can be thrown from the wind turbine; any fragments would land in the plane of the wind turbine rotor or downwind (Garrad Hassan Canada, 2007). Throwing distance varies depending upon the rotor azimuth, rotor speed, local radius, and wind speed. Also, the geometry of the ice fragments and its mass would affect the flight trajectory.

Observations have shown that the ice fragments do not maintain their shape and immediately break into smaller fragments upon detaching from a blade. This would decrease the ice fragment’s drag and potentially allow the ice fragment to be thrown greater distances. For human injury to result from wind turbine ice shed from the Project, several conditions would have to exist simultaneously:

- Sustained weather condition conducive to icing;
- Ice dislodging from the turbine blade;
- Ice pieces large enough to remain intact through the air;

- Ice traveling in a particular direction past setback guidelines; and
- A person in the path of the ice as it lands (Garrad Hassan Canada, 2007).

A risk assessment methodology was developed by Garrad Hassan Canada and Partners, in conjunction with the Finnish Meteorological Institute and Deutsches Windenergie-Institut, as part of a research Project on the implementation of Wind Energy in Cold Climates (WECO). Guidelines produced in the WECO Project were based on a combination of numerical modelling and observations. The WECO database of observed ice fragments determined that recorded ice fragments are typically thrown to distances less than 125 m from the base of the turbine (Seifert et al., 2003).

Garrad Hassan Canada developed an Ontario-specific risk assessment methodology for ice shed based on the findings of the WECO Project. Modelling was undertaken to determine the probability of an ice fragment landing within one square metre of ground area, as a function of distance from the turbine. The model result determined that the critical ice shed distance would be approximately 220 m from a turbine. At distances greater than 220 m, the probability of ice shed reaching ground level at a mass that would cause injury decreases rapidly. The critical distance can effectively be regarded as a “safe” distance, beyond which there is a negligible risk of injury from ice shed (Garrad Hassan Canada, 2007).

Example calculations were presented in the Garrad Hassan Canada (2007) report, using data representative of a typical wind farm Project in rural southern Ontario. These conditions would be considered representative of the Project. Risk to a fixed dwelling, vehicle travelling on a road, and individual person from being struck by an ice fragment thrown from an operating wind turbine were modelled, with the following results:

- Fixed dwelling: equivalent to 1 strike per 500,000 years;
- Vehicle travelling on a road: equivalent to 1 strike per 260,000 years; and
- Individual person: equivalent to 1 strike in 137,500,000 years.

These predictions seem markedly low; however, it is due to the fact that icing events are limited to only a few days per year. For example, Vestas Canada, which maintains turbines across Canada, has experienced no incidents related to falling ice in Canada (Jacques Whitford, 2006).

Extreme weather events that could occur during operation of the Project include rain, hail, ice storms, fire, tornadoes, earthquakes, and lightning strikes.

Mitigation Measures

Unlike telecommunication towers, the wind turbines proposed to be used for this Project would have a solid conical tower. This design reduces the potential for ice build up on the tower itself since there is no lattice or crevices where ice can accumulate.

In terms of ice shed, several control mitigation strategies are available to wind turbine operators. For example, when the rotor becomes unbalanced due to a change in blade weighting (e.g., caused by ice buildup), the turbine brake is automatically applied to stop the blades from turning (i.e., it shuts itself off). The blades would not restart their movement until the imbalance is removed (e.g., the majority of ice is removed). This design feature greatly reduces the potential ice shed from the turbines on the few days per year when icing is possible (additional details related to the turbine design are provided in the **Turbine Specifications Report**). Established protocols and procedures would make operational staff aware and take appropriate action when weather conditions could likely lead to ice accumulation on the blades. Signage would be posted in areas where icing potential exists.

Project components have been designed to withstand the effects from extreme weather events as follows:

- Rain – surficial drainage patterns would remain intact and continue to convey rain water;
- Hail – the turbine blades, nacelle, and tower, are constructed of materials able to withstand damage from the impact of hail. The solar panels can resist hail up to 1.1 inches in diameter at an impact speed of 86 km/h.;
- Ice storms/freezing rain and snow– as noted above, the turbines are designed to automatically shut down when ice load on the blades exceeds a predetermined threshold. The solar panels can operate between temperatures of – 40^{o} to +85^{o} C, withstand a snow load of 1.0kN/m^{2};
- Tornadoes –the blades would stop moving at wind speeds greater than 25 m/s, and generally, the structural integrity of turbines is designed to withstand gusts of greater than 59 m/s;
- Earthquakes – as noted above, structures would be designed to meet the earthquake loads as per the Ontario Building Code. The solar panels are designed to withstand seismic activity and wind forces (120 to 180 km/h); and
- Lightning – The turbines and solar panels are equipped with sophisticated lightning protection. Lightning strikes are safely absorbed by lightning conductors and the lightning current is conducted via a spark gap and cables into the ground.

Net Effects

Considering the design features of the turbines which act to reduce or eliminate the potential for ice accumulation that the nearest receptors are located at minimum required setbacks from the turbines no adverse net effects are expected due to ice fall and shed from turbines during operation of the facility. Consequently, no additional mitigation measures have been identified.

Considering the design features of the turbine and solar panels which act to reduce or eliminate the potential for damage from extreme weather events, no adverse net effects from extreme weather events are anticipated during operation of the facility.

6.0 Environmental Effects Monitoring Plan and Management Systems

The environmental effects monitoring plan for the Project has been designed to monitor implementation of the proposed protection and mitigation measures and to verify compliance of the Project with O. Reg. 359/09.

Environmental monitoring would provide data on key functions of natural environment and socio-economic features that may be affected during construction or operation of the Project, and on the effectiveness of mitigation measures implemented as part of the Project. The monitoring procedures noted herein are linked to the potential effects and protection and mitigation measures discussed throughout Section 5.0.

6.1 MONITORING REQUIREMENTS AND CONTINGENCY PLANS

Building upon the environmental management measures recommended to minimize potentially adverse effects, while enhancing the positive effects associated with the operation of the facility, the following operations monitoring and contingency planning program has been developed. The monitoring program is designed to allow SPK and/or the Operation and Maintenance Contractor to monitor and assess the effectiveness of the proposed management measures/mitigation measures and to verify compliance of the Project with O. Reg. 359/09.

SPK and/or the Operation and Maintenance Contractor would be the primary organization responsible for the implementation of the operational monitoring and contingency planning measures. Implementation of the measures would be undertaken consistent with SPK's and/or the Operation and Maintenance Contractor standard environmental and engineering practices.

6.1.1 Terrestrial Habitats and Significant Natural Features

Operation activities that have the potential to affect terrestrial flora and fauna (other than birds or bats) include equipment operation and accidental spills and/or leaks. Stringent monitoring of these activities is necessary to ensure terrestrial flora and fauna are protected.

As appropriate, records of vehicle maintenance would be retained and made available for periodic review by SPK and/or the Operation and Maintenance Contractor. All vehicles involved in maintenance activities must be maintained in good operating condition; all vehicles identified through the monitoring program that fail to meet the minimum emission standards would be repaired immediately or replaced as soon as practicable.

Monitoring would be required following the unlikely event of contamination from an accidental spill or leak (method for monitoring may be developed in consultation with the Spills Action Centre of the MOE). Contaminated soils would be removed and replaced as appropriate.

The Environmental Effects Monitoring Plan for Wildlife and Wildlife Habitats (**Attachment C**) outlines the post-construction monitoring program, the performance objectives and contingency measures should various objectives not be met. As noted in Section 5.4, post-construction monitoring for terrestrial habitats and significant natural features during the first two years of operation will consist of:

- Visual monitoring for changes to hydrological conditions in wetlands and significant woodlands, weekly during construction and seasonally for one year following construction.

Additional monitoring of winter wildlife and vegetated buffer areas is proposed within the **NHA/EIS** to confirm that the proposed mitigation measures are functioning appropriately.

6.1.2 Birds and Bats

The Environmental Effects Monitoring Plan for Wildlife and Wildlife Habitats (**Attachment C**) outlines the post-construction monitoring program, the performance objectives and contingency measures should the performance objectives not be met. As noted in Section 5.4, post-construction monitoring for birds and bats during the first two years of operation will consist of:

- Mortality monitoring of breeding birds, migratory land birds, migratory raptors and bats in accordance with the MNR bird and bat guidelines;
- A point count-based study to assess disturbance effects to declining forest breeding birds (Feature 42);
- A transect-based study to assess disturbance effects to migratory land birds resulting from wind turbine operation during migration

Bird and bat mortality monitoring will be conducted according to MNR's *Birds and Bird Habitats: Guidelines for Wind Power Projects* (August, 2010) and *Bats and Bat Habitats: Guidelines for Wind Power Projects* (March, 2010). Post-construction monitoring for disturbance effects would occur for one year pre-construction and two years post-construction.

Operational mitigation is required where annual post-construction mortality monitoring exceeds 10 bats per turbine per year (MNR, 2010). Post-construction mitigation, including operational controls, will be considered if annual mortality of birds exceeds 18 birds/ turbine/year at individual turbines or turbine groups; 0.2 raptors or vultures/turbine/year or 0.1 raptors of provincial conservation concern/turbine/year across the wind power project, or if bird mortality during a single mortality monitoring survey exceeds 10 or more birds at any one turbine or 33 or more birds (including raptors) at multiple turbines.

MNR, along with the proponent and other relevant agencies, will collectively review the results of the post-construction disturbance effects monitoring to determine if an ecologically significant disturbance/avoidance effect to birds or amphibians is occurring, and whether such effect is attributed to the Project and not external factors. These discussions will determine whether contingency measures, which may include operational controls, will be undertaken.

6.1.3 Surface Water Features and Aquatic Habitat

Operation activities that have the potential to affect aquatic habitat includes accidental spills and/or leaks. Proper storage of materials (e.g. maintenance fluids) within proper storage containers at the operations and maintenance building would greatly reduce the potential for accidental spills and/or leaks.

Appropriate remedial measures may be completed as necessary and additional follow-up monitoring conducted as appropriate in the event of an accidental spill and/or leak. The level of monitoring and reporting would be based on the severity of the spill/leak and may be discussed with the MOE Spills Action Centre and MNR. Additional site specific habitat enhancement measures, and associated fish community and benthic invertebrate monitoring may be required to demonstrate no net effects as a result of an accidental spill or leak.

If *Fisheries Act* approvals are required from DFO, some monitoring may be required that will be stated in the DFO Authorization. Monitoring typically includes photographic records during construction and for two to five years after the completion of construction to ensure survival of plantings and overall function of the installation. If significant habitat enhancement or compensation measures are required, monitoring may also include assessments of the fish community and habitat use.

Additional information related to monitoring/maintenance of the stormwater managements systems are discussed in Section 4.6.3.

6.1.4 Public Roads

For a period of one year after construction (first year of operation), local roads may be monitored following a heavy rain event and following spring runoff, to ensure no erosion, bank slumpage, road subsidence or major rutting has occurred as a result of construction activities. As appropriate, affected roadside ditches and drains will be repaired if required and monitored to ensure that they are functioning properly. Additional monitoring and contingency plans may be developed during ongoing discussions with Haldimand County.

6.1.5 Environmental Noise and Public Health and Safety

The *Environmental Protection Act* requires that noise emissions for any new project must not have adverse effects on the natural environment. The REA process is the mechanism through which the controls are administered under the *Environmental Protection Act*. Noise monitoring (if required), would be conducted in accordance with the REA for the Project. In the event of a malfunctioning turbine and/or transformer which results in noise emissions that are above MOE requirements, the problematic machinery would be shut down until corrective measures are taken. Routine maintenance and monitoring would also help minimize the likelihood of malfunctioning equipment resulting in excessive noise emissions.

Turbines and solar panels would be monitored electronically twenty-four hours a day, seven-days a week, to allow operational changes to be noted and assessed quickly. Turbine shut down would occur automatically upon detection of extreme weather. Inspections of turbines and solar panels would occur after extreme weather events.

6.1.6 Summary of Environmental Effects Monitoring Plan

Table 6.1 summarizes the potential negative effects, performance objectives, mitigation strategies and the monitoring/contingency plan measures of the operational stage of the Project. Additional s regarding monitoring of wildlife and wildlife habitat are also provided in the attached Environmental Effects Monitoring Plan (**Attachment C**).

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component		Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
Waterbodies and Aquatic Resources						
Groundwater	All Project Components	• Potential contamination from accidental spills	• No spills	• See "Accidents and Malfunctions"	• See "Accidents and Malfunctions"	5.2.1.1
Surface Water, Stormwater, Fish, and Fish Habitat	Wind Component	• Potential contamination from accidental spills • Erosion, sedimentation, and surface water turbidity during maintenance activities	• No spills • No erosion, sediment transport or surface water turbidity	• See "Accidents and Malfunctions" for spills • Minimize removal of vegetation on the slopes of watercourses. • Following completion of the maintenance activity, stream banks should be restored to their original grade. • If siltation to a watercourse occurs, activities should cease immediately until the situation is rectified.	• See "Accidents and Malfunctions" for spills. • If Fisheries Act approvals are required from DFO, some monitoring may be required, as stated in the DFO Authorization.	5.2.2.1; 6. 1.3
	Solar Component	• Potential contamination from accidental spills • Erosion, sedimentation, and surface water turbidity during maintenance activities	• No spills. • No erosion, sediment transport or surface water turbidity.	• See "Accidents and Malfunctions" for spills • Minimize removal of vegetation on the slopes of watercourses. • Following completion of the maintenance activity, stream banks should be restored to their original grade. • If siltation to a watercourse occurs, activities should cease immediately until the situation is rectified. • Use of stormwater management system	• See "Accidents and Malfunctions" for spills. • If Fisheries Act approvals are required from DFO, some monitoring may be required, as stated in the DFO Authorization. • Completion of inspection, operational, and maintenance activities associated with the stormwater management systems. • Minor areas of ponding within the stormwater management systems can be resolved with re-grading / re-stabilization, where appropriate.	5.2.2.2; 4.6.3; 6. 1.3
	Electrical Transmission Component	• Potential contamination from accidental spills • Erosion, sedimentation, and surface water turbidity during maintenance activities	• No spills. • No erosion, sediment transport or surface water turbidity.	• See "Accidents and Malfunctions" for spills • Minimize removal of vegetation on the slopes of watercourses. • Following completion of the maintenance activity, stream banks should be restored to their original grade. • If siltation to a watercourse occurs, activities should cease immediately until the situation is rectified. • Use of stormwater management system	• See "Accidents and Malfunctions" for spills. • If Fisheries Act approvals are required from DFO, some monitoring may be required, as stated in the DFO Authorization. • Completion of inspection, operational, and maintenance activities associated with the stormwater management systems. • Minor areas of ponding within the stormwater management systems can be resolved with re-grading / re-stabilization, where appropriate.	5.2.2.3; 4.6.3; 6. 1.3
Wetlands and Woodlots						
Wind Component		• Contamination through accidental spills. • Negligible effects to wetlands and woodlots caused by dust and disturbance. • Changes in hydrological conditions of wetlands	• No spills. • Minimize duration and magnitude or emissions. • No erosion or sediment transport.	• See "Accidents and Malfunctions" for spills • Maintain natural flow patterns to maintain hydrological functions.	• See "Accidents and Malfunctions" for spills. • Weekly visual inspection during construction, and once seasonally in spring and summer the first year post-construction to assess changes in hydrological functions. • Contingency measures will be developed on a site-specific basis, and may include installation of additional culverts to preserve pre-construction flow patterns.	5.3.1
Solar Component		• Contamination through accidental spills. • Negligible effects to wetlands and woodlots caused by dust and disturbance. • Changes in hydrological conditions of wetlands	• No spills. • Minimize duration and magnitude or emissions. • No erosion or sediment transport.	• See "Accidents and Malfunctions" for spills • Maintain natural flow patterns to maintain hydrological functions. • Installation of stormwater management system	• See "Accidents and Malfunctions" for spills. • Weekly visual inspection during construction, and once seasonally in spring and summer the first year post-construction to assess changes in hydrological functions. • Contingency measures will be developed on a site-specific basis, and may include installation of additional culverts to preserve pre-construction flow patterns.	5.3.2
Electrical Transmission Component		• Contamination through accidental spills. • Negligible effects to wetlands and woodlots caused by dust and disturbance. • Changes in hydrological conditions of wetlands	• No spills. • Minimize duration and magnitude or emissions. • No erosion or sediment transport.	• See "Accidents and Malfunctions" for spills • Maintain natural flow patterns to maintain hydrological functions. • Installation of stormwater management system	• See "Accidents and Malfunctions" for spills. • Weekly visual inspection during construction, and once seasonally in spring and summer the first year post-construction to assess changes in hydrological functions. • Contingency measures will be developed on a site-specific basis, and may include installation of additional culverts to preserve pre-construction flow patterns.	5.3.3

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component		Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
Wildlife and Habitat						
Terrestrial Habitat	Wind Component	• Mortality and barrier effects (negligible) • Indirect disturbance effects to wildlife and their habitats. • Noise and disturbance during system maintenance	• Minimize mortality and barrier effects • Minimize disturbance to flora, fauna and vegetation communities.	• Implementation of speed restrictions on access roads to minimize mortality. • Implementation of setbacks to significant wildlife habitat	• Stringent monitoring of equipment operation • Visual monitoring of wetland and woodland hydrology • Contingency measures to be developed with MNR and relevant agencies based on the results of monitoring.	5.4.1; 6. 1.1
	Solar Component	• The installation of fence may disrupt animal movement however small rodents, amphibians, mammals and adult deer will be able to cross the site. • Indirect negative effects from human activity. • Light pollution.	• Minimize disturbance to flora and vegetation communities.	• A minimum 30 m setback has been provided between the Project location and significant wildlife habitat. • Establishment of naturalized buffers. • The installation of measures to facilitate the passage of wildlife species through fencing and maintenance of natural corridors. • Naturalization of buffer areas • Maintenance of natural corridors • Installation of low intensity and downward pointing lights. • All outdoor lighting should be turned off when not in use, except where used for security and safety purposes, where motion sensors should be used. • Post-construction monitoring plans to evaluate the disturbance effects to winter wildlife.	• Stringent monitoring of equipment operation • Winter wildlife monitoring of winter deer movements across the site and through the proposed corridors • Monitoring of buffers to ensure establishment of native plant species • Contingency measures to be developed with MNR and relevant agencies based on the results of monitoring.	5.4.2; 6. 1.1
	Electrical Transmission Component	• Negligible increase in disturbance.	• Minimize disturbance to flora and vegetation communities.	• Implementation of speed restrictions on access roads to minimize mortality. • Implementation of setbacks to significant wildlife habitat	• Stringent monitoring of equipment operation • Amphibian monitoring in significant amphibian breeding areas. • Contingency measures to be developed with MNR and relevant agencies based on the results of monitoring.	5.4.3; 6. 1.1
Birds	Wind Component	• Disturbance and direct mortality to breeding and migratory birds. • Disturbance of habitat.	• Minimize mortality and disturbance.	• Post-construction mitigation, including operational controls, will be considered based on annual mortality levels	• Mortality monitoring and disturbance effects monitoring for birds through point count and transect studies. • Post-construction monitoring for disturbance effects would occur for one year pre-construction and two years post-construction. • Implementation of contingency measures may be developed to replace the habitat lost through displacement (if experienced)	5.4.1; 6. 1.2
	Solar Component	• Disturbance to breeding birds. • Disturbance of habitat.	• Minimize disturbance.	• Establishment of naturalized buffers. • A minimum 30 m setback has been provided between the Project location and significant wildlife habitat. •	• None.	5.4.2; 6. 1.2
	Electrical Transmission Component	• Disturbance to breeding birds. • Disturbance of habitat.	• Minimize disturbance.	• Post-construction mitigation, including habitat replacement will be considered based on annual survey results	• None.	5.4.3; 6. 1.2
Bats	Wind Component	• Direct mortality.	• Minimize mortality.	• Operational mitigation is required where annual post-construction mortality monitoring exceeds 10 bats per turbine per year.	• Mortality monitoring via carcass searches • Operational controls to be implemented as set out in the MNR's Bat Guidelines	5.4.1; 6. 1.2
	Solar Component	• Disturbance	• Minimize disturbance.	• If lighting is required, the use of low intensity and downward pointing lights. Lighting should be turned off when not in use, except where used for security and safety purposes, where motion sensors should be used.	• None	5.4.2; 6. 1.2

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component		Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
	Electrical Transmission Component	• None	• None	• None	• None	5.4.3
Land Use and Resources						
Wind Component		• Change in use from agricultural to renewable energy development. • Short-term dust emissions. • Potential to interfere with radio or TV signals. • Potential hazard to low-flying aircraft. • Special traffic planning required during maintenance activities with excess loads. • Increase in employment over the operations period (positive effect). • Local economic benefits from land lease payments, municipal taxes, etc. • Disruption to viewscape from siting of project infrastructure.	• Minimize disturbance to existing land uses. • Minimize potential for visual disturbance. • Create positive effects on local economy.	• Landowners financially compensated for lease of private land. • Siting to minimize disturbances to existing agricultural lands and operations. • Operational and maintenance activities would be restricted to the delineated Project areas. • In the unlikely event that signal disruption is experienced, mitigation measures will be implemented • SPK would review potential incidents of telecommunications interference on a case by case basis. • In order to reduce rural light pollution, lights would be selected with the minimal allowable flash duration, narrow beam, and would be synchronized. • Nav Canada would be responsible for updating all aeronautical charts with the turbine locations. • Necessary transportation permits would be obtained. • Public notification of unconventional load movements may occur. • To the extent possible, SPK and/or the Operation and Maintenance Contractor will source required goods and services from qualified local suppliers. • Limited opportunities to mitigate viewscape potential effects.	• Adherence to Complaint Response Protocol.	5.5.1; 7.2
Solar Component		• Change in use from agricultural to renewable energy development. • Potential for soil erosion and dust. • Removal of lands from recreational uses • Special traffic planning required during maintenance activities with excess loads. • Increase in employment over the operations period. • Local economic benefits from land lease payments, municipal taxes, etc. • Disruption to viewscape • Negligible impact to local agri-business	• Minimize disturbance to existing land uses. • Minimize potential for visual disturbance. • Create positive effects on local economy.	• Landowners financially compensated for lease of private land. • SPK may plant a vegetated understory of native grassland species that will mimic annual grassland vegetation. • Operational and maintenance activities would be restricted to the delineated Project areas. • Public notification of unconventional load movements may occur. • To the extent possible, SPK and/or the Operation and Maintenance Contractor will source required goods and services from qualified local suppliers. • A minimum 9 m wide buffer area will be used between the solar farm and perimeter property lines to reduce visual obtrusiveness of the Project. • Installation of a berm (approximately 6 m wide along the outer edge of the solar farm lands where panels are in close proximity to adjacent residences.	• Adherence to Complaint Response Protocol.	5.5.2; 7.2

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component	Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
	economy.				
Electrical Transmission Component	• Change in use from agricultural to renewable energy development. • Removal of lands from recreational uses • Disruption to viewscape • Increase in employment over the operations period. • Local economic benefits from land lease payments, municipal taxes, etc.	• Minimize disturbance to existing land uses. • Minimize potential for visual disturbance. • Create positive effects on local economy.	• Landowners financially compensated for lease of private land. • To the extent possible, SPK and/or the Operation and Maintenance Contractor would source required goods and services from qualified local suppliers. • Operational and maintenance activities would be restricted to the delineated Project areas. • Limited opportunities to mitigate viewscape potential effects.	• Adherence to Complaint Response Protocol.	5.5.3; 7.2
Air Quality					
All Components	• Emissions from equipment and vehicles.	• Minimize duration and magnitude of emissions.	• To reduce emissions from equipment and vehicles, several mitigation measures may be employed: • Multi-passenger vehicles should be utilized to the extent practical; • Company and maintenance personnel should avoid idling of vehicles when not necessary for operations activities; • Equipment and vehicles should be maintained in good working order with functioning mufflers and emission control systems as available; • All vehicles should be fitted with catalytic converters as required; • All operations equipment and vehicles should meet the emissions requirements of the MOE and/or Ministry of Transportation; • As appropriate, records of vehicle maintenance should be retained and made available for periodic review by SPK; and, • All vehicles identified through the monitoring program that fail to meet the minimum emission standards would be repaired immediately or replaced as soon as practicable.	• Adherence to Complaint Response Protocol	5.6.1
Environmental Noise					
Wind Component	• Noise emitted from a turbine and/or transformers.	• Noise at all non-participating to meet MOE Guidelines.	• Noise levels would be compliant with the applicable MOE environmental noise guidelines. • A regular maintenance program would largely mitigate potential effects related to noise from damaged turbines.	• Noise monitoring (if required), would be conducted in accordance with the REA for the Project. • Turbine shutdown in the event of a malfunctioning turbine or extreme weather event. • Turbine maintenance to ensure turbines are running properly and efficiently.	5.7.1; 6.1.5
Solar Component	• Noise emitted from the inverter panels and by the solar step up (SSU) pad-mounted transformer.	• Noise at all non-participating to meet MOE Guidelines.	• Noise levels would be compliant with the applicable MOE environmental noise guidelines. • A regular maintenance program would largely mitigate potential effects related to noise from damaged components.	• Noise monitoring (if required), would be conducted in accordance with the REA for the Project. • Maintenance to ensure components are running properly and efficiently.	5.7.2; 6.1.5
Electrical Transmission Component	• Noise generated by the periodic use of maintenance equipment, personnel vehicles and waste management haulers.	• Noise at all non-participating to meet MOE Guidelines.	• All engines associated with maintenance equipment would be equipped with mufflers and/or silencers in accordance with MOE and/or MTO guidelines and regulations. • Noise levels arising from maintenance equipment would also be compliant with sound levels established by the MOE. • Routine facility maintenance to ensure infrastructure is operating	• Noise monitoring (if required), would be conducted in accordance with the REA for the Project. • Maintenance to ensure components are running properly and efficiently.	5.7.3; 6.1.5

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component	Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
	• Noise generated by the collector substation.		properly and efficiently would be performed as required. • To the greatest extent possible, operations activities that could create excessive noise would be restricted to regular business hours, and adhere to any local noise by-laws. • If maintenance activities that cause excessive noise must be carried out outside of these time frames, adjacent residents would be notified in advance and by-law conformity would occur, as required. • Installation of a sound attenuation wall around the substation.		
Traffic and Road Usage					
All Components	• Short-term, localized disturbance to traffic patterns or increases in traffic volume, and/or creation of potential traffic safety hazards.	• Minimize disturbance to local traffic.	• Special traffic planning, widening of turning radiuses and road widths and the creation of new ingress/egress. As appropriate, permits would be obtained to implement these activities. • As appropriate, for public safety all non-conventional loads would have front and rear escort or "pilot" vehicles accompany the truck movement on public roads. • Although there are no requirements for formal public notification of excess load movements, SPK may provide notification of non-conventional load movements that may interfere with local traffic, with potential methods of notification including postings on the Project website.	• Local roads may be monitored following a heavy rain event and following spring • As appropriate, affected roadside ditches and drains will be repaired if required and monitored to ensure that they are functioning properly.	5.8.1; 6.1.4
Public Health and Safety					
Wind Component	• Structural failure • Ice throw or shed	• No structural failure of the turbines or ancillary equipment. • Limit potential for ice throw/shed to impact pedestrians.	• Project meets the setback requirements of O. Reg. 359/09 • The wind turbines would be designed, installed, operated and maintained according to applicable industry standards/certifications to minimize the potential of structural failure. • Proper training and education of staff operating the control system and maintaining the Project	• Turbine shutdown in the event of a malfunctioning turbine or extreme weather event. • Turbine maintenance to ensure turbines are running properly and efficiently. • SPK will examine any reasonable measures that could be put in place to mitigate unforeseen health effects. • Preparation and implementation of a Public Safety Plan and Emergency Response Plan. • Access restrictions may include "No Trespassing" signs on the turbine access roads and turbine tower site.	5.9.1; 6.1.5 6.3.4 6.3.5
Solar Component	• Risk of fire.	• No fires	• A 2 m high chain link fence will be installed around the entire perimeter of the solar farm to prevent unauthorized access to the solar panel area. • Proper training and education of staff operating the control system and maintaining the Project. • As standard when dealing with fires involving electrical equipment, additional care must be taken by emergency responders.	• Preparation and implementation of a Public Safety Plan and Emergency Response Plan. • Access restrictions may include "No Trespassing" signs.	5.9.2; 6.1.5 6.3.4 6.3.5
Electrical Transmission Component	• Stray voltage • Risk of fire • EMF	• No stray voltage produced from the Project. • No fires • Reduction of EMF levels	• Effective shielding options are available for underground power lines such as achieving greater cancellation and lower magnetic fields by placing the individual conductors of the power line close together (touching) and insulation. • A fence will be installed around the substation, operations and maintenance building, and interconnect station in order to limit the proximity to which members of the public may approach these facilities. • Proper training and education of staff operating the control system and maintaining the Project. • As standard when dealing with fires involving electrical equipment, additional care must be taken by emergency responders.	• Preparation and implementation of a Public Safety Plan and Emergency Response Plan. • Access restrictions may include "No Trespassing" signs.	5.9.3; 6.1.5 6.3.4 6.3.5

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component	Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
Waste Material Disposal					
All Components	• Contamination to soil, groundwater, and/or surface water resources • Litter may become a nuisance	• Ensure proper disposal of waste.	• A systematic collection and separation of waste materials within on-site storage areas in weather-protected areas located at the operation and maintenance building. • Contractors would be required to remove all waste materials from Project sites during maintenance activities. • All waste materials and recycling would be transported off-site by private waste material collection contractors licensed with a Certificate of Approval – Waste Management System. • Labelling and proper storage of liquid wastes. • As per S.13 of the EPA, all spills that could potentially have an adverse environmental effect, are outside the normal course of events, or are in excess of the prescribed regulatory levels would be reported to the MOE's Spills Action Centre; • As appropriate, spill kits (e.g. containing absorbent cloths and disposal containers) would be provided on-site during maintenance activities and at the operation and maintenance building. • Dumping or burying wastes within the Project sites would be prohibited. • Disposal of non-hazardous waste at a registered waste disposal site(s). • If waste is classified as waste other than solid non-hazardous, a Generator Registration Number is required from the MOE and the generator would have obligations regarding manifesting of waste. • Implementation of an on-going waste management program consisting of reduction, reuse, and recycling of materials.	• Implementation of the Emergency Response Plan in the event of an emergency (e.g. spill)	5.10.1; 6.3.5
Heritage and Archaeological Resources					
All Components	• Potential impacts to built and cultural heritage resources and protected properties during operation are related to destruction, alteration, shadowing, isolation of the resource, direct or indirect obstruction of views of or from within the resource, change in land use of the resource, and land disturbances which may impact the resource.	• Minimize potential for visual disturbance. • Minimize potential for impacts to built and cultural heritage resources.	• Avoid the use of the properties and resources where possible. • Limited opportunities to mitigate viewscape potential effects. • A minimum 9 m wide buffer area will be used between the solar farm and perimeter property lines to reduce visual obtrusiveness of the Project. • Installation of a berm (approximately 6 m wide along the outer edge of the solar farm lands where panels are in close proximity to adjacent residences.	• None	5.5; 5.11

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component	Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
Accidents and Malfunctions					
Wind Component	• Risk to public health and safety • Potential for accidental spills	• No structural failure of the turbines or ancillary equipment • No spills	• Adherence to the Emergency Response Plan • The wind turbines would be designed, installed, operated and maintained according to applicable industry standards/certifications. • Proper training and education of staff operating the control system • County emergency response staff would be trained to appropriately deal with any potential accidents and malfunctions. • The turbines would be equipped with lightning protection systems and located at least the minimum regulated setback distance from receptors. • In terms of accidental spills or releases to the environment, standard containment facilities and emergency response materials would be maintained on-site as required (at each turbine location and/or within the operations and maintenance building). • Refuelling, equipment maintenance, and other potentially contaminating activities would occur in designated areas.	• As appropriate, SPK and/or the Operation and Maintenance Contractor would develop or have an existing operations training program to ensure personnel receive appropriate training in relation to operation and maintenance programs, environmental, health, and safety procedures, and the Emergency Response Plan. • Monitoring would be required following the unlikely event of contamination from an accidental spill or leak (method for monitoring may be developed in consultation with the Spills Action Centre of the MOE). Contaminated soils would be removed and replaced as appropriate. • Turbines would be monitored electronically twenty-four hours a day, seven-days a week, to allow operational changes to be noted and assessed quickly. • Turbine shut down would occur automatically upon detection of extreme weather. • Inspections of turbines would occur after extreme weather events. • As appropriate spills should be reported immediately to the MOE Spills Action Centre.	5.12.1; 6.3.4; 6.3.5
Solar Component	• Risk of fires and the generation of hazardous fumes • Potential for accidental spills	• No fires • No spills	• Additional equipment beyond what is typically required to respond to electrical fires is not required for fires involving solar PV panels. • The solar panels and associated electrical equipment will be installed and maintained in accordance with applicable safety standards. • In terms of accidental spills or releases to the environment, standard containment facilities and emergency response materials would be maintained on-site as required (at each turbine location and/or within the operations and maintenance building). • Refuelling, equipment maintenance, and other potentially contaminating activities would occur in designated areas.	• As appropriate, SPK and/or the Operation and Maintenance Contractor would develop or have an existing operations training program to ensure personnel receive appropriate training in relation to operation and maintenance programs, environmental, health, and safety procedures, and the Emergency Response Plan. • Monitoring would be required following the unlikely event of contamination from an accidental spill or leak (method for monitoring may be developed in consultation with the Spills Action Centre of the MOE). Contaminated soils would be removed and replaced as appropriate. • Solar panels would be monitored electronically twenty-four hours a day, seven-days a week, to allow operational changes to be noted and assessed quickly. • Inspections of solar panels would occur after extreme weather events. • As appropriate spills should be reported immediately to the MOE Spills Action Centre.	5.12.2; 6.3.4; 6.3.5
Electrical Transmission Component	• Structural failure. • Risk of electrical fire • Potential for accidental spills.	• No structural failure of the electrical transmission component or ancillary equipment • No fires	• Transmission and collector lines must be designed and constructed in accordance with applicable regulatory guidelines. • Additional equipment beyond what is typically required to respond to electrical fires is not required for fires involving the transmission components. • In terms of accidental spills or releases to the environment, standard containment facilities and emergency response materials would be maintained on-site as required (at each turbine location and/or within the operations and maintenance building). • Refuelling, equipment maintenance, and other potentially contaminating activities would occur in designated areas.	• As appropriate, SPK and/or the Operation and Maintenance Contractor would develop or have an existing operations training program to ensure personnel receive appropriate training in relation to operation and maintenance programs, environmental, health, and safety procedures, and the Emergency Response Plan. • Monitoring would be required following the unlikely event of contamination from an accidental spill or leak (method for monitoring may be developed in consultation with the Spills Action Centre of the MOE). Contaminated soils would be removed and replaced as appropriate. • Inspections of transmission components will occur after extreme weather events. • As appropriate spills should be reported immediately to the MOE Spills Action Centre.	5.12.3; 6.3.4; 6.3.5

Table 6.1: Summary of the Potential Environmental Effects and the Environmental Effects Monitoring Plan during Operations

Environmental Feature and Project Component	Potential Adverse Effect	Performance Objective	Mitigation Strategy	Monitoring Requirements and Contingency Plans	Section Reference
Effects of the Environment on the Project					
Climatic Fluctuations and Extreme Events	• Potential damage to project infrastructure from extreme weather events.	• No structural failure of the Project components and equipment.	• Project components have been designed to withstand the effects from extreme events. • Established protocols and procedures would make operational staff aware and take appropriate action when weather conditions could likely lead to ice accumulation on the blades. Signage would be posted in areas where icing potential exists. • Failsafe devices are capable of shutting down the turbine blades in the event of excessive wind conditions, imbalance or malfunction of other turbine components.	• Turbines and solar panels would be monitored electronically twenty-four hours a day, seven-days a week, to allow operational changes to be noted and assessed quickly. • Turbine shut down would occur automatically upon detection of extreme weather. • Inspections of infrastructure would occur after extreme weather events.	5.13.1

6.2 ENVIRONMENTAL MANAGEMENT SYSTEMS

As part of the environmental monitoring objectives outlined above, several programs, plans, and procedures would be developed by SPK and/or the Operation and Maintenance Contractor (see Section 6.3). They would guide the operation of the Project to optimize its environmental performance. However, for the programs, plans, and procedures to be effective, appropriate management structures and contract documents must be firmly established.

6.2.1 Management Structures

SPK and/or the Operation and Maintenance Contractor would take steps to ensure that they have appropriately skilled personnel to carry out the environmental responsibilities as defined in this document. All organizations associated with Project development and operational activities would develop responsive reporting systems that clearly assign responsibility and accountability. As appropriate, SPK and/or the Operation and Maintenance Contractor would review these reporting documents.

6.2.2 Contract Documents

SPK is committed to operating the Project in an environmentally responsible manner and in compliance with all applicable environmental laws, regulations, and guidelines. All of SPK's contractors and subcontractors would be accountable for actions that have an adverse effect on the environment. As such, any contract documents executed by SPK and/or the Operation and Maintenance Contractor would incorporate appropriate provisions from documents prepared for the REA application.

Additionally, all contractors, subcontractors, and other associates of the Project would follow the guiding principles of the program, plans and procedures (Section 6.3) and the monitoring and contingency plan (see Section 6.1). These organizations would also comply with all applicable municipal, provincial, and federal legislation.

6.2.3 Change Management

During the operation of the facility, changes to operational plans may be required to address unforeseen or unexpected conditions or situations. SPK and/or the Operation and Maintenance Contractor would be responsible for ensuring environmental and safety issues are addressed for any such changes. SPK would undertake any significant changes to the Project programs, procedures and plans throughout the operation of the facility with the goal of avoiding or minimizing environmental effects.

6.3 PROGRAMS, PLANS, AND PROCEDURES

As appropriate, SPK and/or the Operation and Maintenance Contractor would implement the programs, plans, and procedures discussed below.

6.3.1 Operation and Maintenance Program

The operation and maintenance program, including turbine maintenance, is described in Section 4.0.

6.3.2 Environmental Procedures

SPK and/or the Operation and Maintenance Contractor would be responsible for implementing environmental procedures during the operation phase of the Project. Individual employee responsibilities would be assigned as necessary to support the full and effective implementation of the environmental procedures. As appropriate the following environmental procedures would address the following issues to prevent environmental contamination and injury to personnel and will be loaded into a Computerized Maintenance Management System:

- *Environmental calendar:* to establish the specific dates and times for environmental inspections of turbine and solar facilities, monitoring events, and emergency notifications;
- *Spills and releases:* to identify the specific procedures for the prevention, response, and notification of spills. In addition, it will establish the general procedures for spill clean-up, personnel training, and material handling and storage to prevent spills;
- *Hazardous waste management:* to outline the procedures for proper identification, storage, handling, transport, and disposal of hazardous waste. In addition, the procedures will outline specific requirements for personnel training, emergency response, product review and approval, and record keeping; and
- *Non-hazardous waste management:* to establish alternative procedures for the management and disposal of used lubricants, used drums, and general waste.

These procedures will ensure internal and external risks are fully evaluated and the information communicated to personnel in advance of any accident or malfunction.

6.3.3 Occupational Health and Safety Procedures

SPK and/or the Operation and Maintenance Contractor would ensure employee health and safety is maintained throughout their employment term and would also implement the following safety procedures and protocols as appropriate in an effort to ensure employee safety is addressed throughout operation and maintenance activities. Safety measures may include;

- Personal protective equipment, including non-slip footwear, eye protection, clothing, and hardhats, would be worn by operation and maintenance personnel when on duty;

- Elevated platforms, walkways, and ladders would be equipped with handrails, toe boards, and non-slip surfaces; and
- Electrical equipment would be insulated and grounded in compliance with the appropriate electrical code.

Incidents in the work place have the potential to cause personal injury and property damage. As appropriate, SPK and/or the Operation and Maintenance Contractor would maintain a master Incident Report that documents illnesses and accidents. Incident reporting would follow the requirements of the *Occupational Health and Safety Act*.

6.3.4 Training Program

As appropriate, SPK and/or the Operation and Maintenance Contractor would develop or have an existing operations training program to ensure personnel receive appropriate training in relation to operation and maintenance programs, environmental, health, and safety procedures, and the Emergency Response Plan. Training may cover the following issues:

Facility Safety

- Accident reporting;
- Chemical and hazardous materials handling;
- Fall and arrest protection;
- Eye, ear, head, hands, feet, and body protective equipment;
- First aid training and equipment;
- Equipment operation and hazards;
- Fire prevention and response;
- Lockout and tag out procedures; and
- Scaffolds and ladders.

Emergency Preparedness

- Fire preparedness and response;
- Natural disasters (i.e. extreme weather events);
- Hazardous materials and spill response;

- Medical emergencies; and
- Rescue procedures.

6.3.5 Emergency Response Plan

SPK and/or the relevant Contractor would finalize a detailed Emergency Response Plan for each Project phase in collaboration with Haldimand County's Emergency Services Departments.

The Emergency Response Plan would include a plan for the proper handling of material spills and associated procedures to be undertaken during a spill event. The plan would also specify containment and clean-up materials and their storage locations. The plan would include general procedures for personnel training. As appropriate, the plan may cover response actions to high winds, fire preparedness, evacuation procedures, and medical emergencies. Developing this plan with local emergency services personnel would allow SPK to determine the extent of emergency response resources and response actions of those involved.

The plan for each Project phase would include key contact information for emergency service providers, a description of the chain of communications and how information would be disseminated between SPK and/or the Contractor and the relevant responders. The plan would also indicate how SPK and/or the Contractor would directly contact (via phone or in-person) Project stakeholders who may be directly impacted by an emergency so that the appropriate actions can be taken to protect stakeholders health and safety.

6.3.6 Measurement of Performance

Once performance standards have been established and personnel have been trained (and are functional in procedural operations), the next step is to monitor the performance of the Project and individuals relative to the performance standards and programs.

Specific internal audits (e.g. management team and/or process team), and external audits against the plans, safety and environmental procedures, and other policies and procedures are all part of establishing performance standards necessary to minimize risks on a continuing basis.

As appropriate a formal audit program for the Project, with regard to loss control programs (i.e. health, safety, environment, and security) would be performed regularly.

7.0 Communications and Emergency Response Plan

The following sets out a description of the actions to be taken during all Project phases to inform the public, aboriginal communities, the County, leaseholders and relevant Ministries regarding activities occurring at the Project site (including emergencies), means by which stakeholders can contact SPK and/or the Contractor, and means by which correspondence sent to SPK and/or the Contractor would be recorded and addressed.

As appropriate, SPK and/or the Contractor would review the Emergency Response and Communications Plan prior to and during each phase of the Project. Notification of any changes to the Emergency Response and Communications Plan would be provided to stakeholders as outlined in Section 7.2.

7.1 PROJECT UPDATES AND ACTIVITIES

SPK and/or the Contractor will continue contact with Project stakeholders (public, aboriginal communities, and the County) during the operation of the Project for as long as this seems an effective two-way channel of communication including providing Project updates on the Project website (www.SamsungRenewableEnergy.ca). As a long-term presence in the County, SPK will continue to develop contacts and to develop local relationships and channels of communication, which could benefit the local area.

In the event of an emergency, SPK and/or the Operations Firm will initiate the Emergency Response Plan and will directly contact (via phone or in-person) Project stakeholders who may be directly impacted so that the appropriate actions can be taken to protect stakeholders health and safety. Additional updates (non-emergency related) may be provided via the website, letters/newsletters, newspaper notices, or direct contact.

7.2 COMMUNICATIONS AND COMPLAINT RESPONSE PROTOCOL

The following has been developed for all Project phases to address any reasonable concern from the public and would be implemented by SPK and/or the Contractor.

A telephone number for contacting SPK and/or the Contractor along with the mailing/e-mail address will be posted on the Project website (www.SamsungRenewableEnergy.ca) and provided directly to the County and MOE. These would be the direct contact points for SPK and/or the Contractor during all phases of the Project. The Emergency Response and Communications Plan will include key contact information for emergency service providers, a description of the chain of communications and how information would be disseminated between SPK and/or the Contractor and the relevant responders. This information will be obtained during consultations with the County's Emergency Services Departments.

The telephone number provided for the reporting of concerns and/or complaints would be equipped with a voice message system used to record the name, address, telephone number of the complainant, time and date of the complaint along with details of the complaint. All messages would be recorded in a Complaint Response Document to maintain a record of all complaints. SPK and/or the Contractor would endeavour to respond to messages within 24 hours. All reasonable commercial efforts would be made to take appropriate action as a result of concerns as soon as practicable. The actions taken to remediate the cause of the complaint and the proposed actions to be taken to prevent reoccurrences of the same complaint in the future would also be recorded within the Complaint Response Document. If appropriate, the MOE Spills Action Centre would be contacted to notify them of the complaint. Correspondence would be shared with other stakeholders, such as the MOE, as required and/or as deemed appropriate.

Ongoing stakeholder communication would allow SPK and/or the Contractor to receive and respond to community issues on an ongoing basis.

7.3 PUBLIC SAFETY PLAN

In addition to the Public Safety Plan that would be developed by the Construction Contractor for the protection of public safety during the construction and decommissioning phases, SPK and/or the Operation and Maintenance Contractor would prepare and implement a Public Safety Plan for operation of the Project. As previously noted and as appropriate, SPK and/or the Operation and Maintenance Contractor would develop or have an existing operations training program to ensure personnel receive appropriate training in relation to operation and maintenance programs, environmental, health and safety procedures, and an Emergency Response and Communications Plan. Proper training would ensure operational safety for Project personnel.

Operational safety to minimize potential risks to the public would include:

- Site access restrictions (with the exception of maintenance and emergency personnel);
- Development of an Emergency Response and Communications Plan; and
- Project design features and adherence to construction standards.

Signage may include, but would not be limited to signs associated with potential risks at the Project. Signs may be posted in the vicinity of buried cables, high voltage equipment, and warning of the presence of maintenance vehicles along the access roads.

Access restrictions may include “No Trespassing” signs on the turbine access roads and turbine tower site, the solar lands, interconnect station, and within the substation site. In addition, fencing would be placed around the substation, solar lands and interconnect station to restrict unauthorized access. Access roads would not have restricted access (e.g. gates), thus allowing emergency vehicles to access Project infrastructure in the event of an emergency.

As previously noted, during pre-operational mobilization SPK and/or the Operation and Maintenance Contractor would finalize an Emergency Response and Communications Plan for the operational activities in collaboration with the County's Emergency Services Department. The development of and proper execution of the Emergency Response and Communications Plan would help ensure public safety is maintained throughout the operation of the facility.

8.0 Closure

This Design and Operations Report for the Grand Renewable Energy Project has been prepared by Stantec for SPK in accordance with O. Reg. 359/09, and the Ministry of the Environments' (MOE) "Technical Guide to Renewable Energy Approvals (July 2011)".

This report has been prepared by Stantec for the sole benefit of SPK, and may not be used by any third party without the express written consent of SPK. The data presented in this report are in accordance with Stantec's understanding of the Project as it was presented at the time of reporting.

STANTEC CONSULTING LTD.

Rob Nadolny, Senior Project Manager

Mark Kozak, Project Manager

9.0 References

Arnett, E. B., D. B. Inkley, D. H. Johnson, R. P. Larkin, S. Manes, A. M. Manville, R. Mason, M. Morrison, M. D. Strickland and R. Thresher. 2007. Impacts of Wind Energy Facilties on Wildlife and Wildlife Habitat. Wildlife Society Technical Review 07-2. The Wildlife Society, Bethesda, Maryland, USA

American Wind Energy Association (AWEA). 2006. Wind Energy and the Environment.

Chatham-Kent Public Health Unit. 2008. The Health Impact of Wind Turbines: A Review of the Current White, Grey and Published Literature. June 2008.

Colby et al. 2009. Wind Turbine Sound and Health Effects – An Expert Panel Review. Prepared for the American Wind Energy Association and the Canadian Wind Energy Association.

Fahrig, L. (2007). Effects of Roads and Traffic on Populations of Small Animals: Implications for Transportation Planning. Roads and Ecopassages Forum. Toronto, Ontario, March 20-22, 2007.

Farmer, B. and R. J. Brooks. (2007). Factors Associated with Roadkill in Southern Ontario Parks. Roads and Ecopassages Forum. Toronto, Ontario, March 20-22, 2007.

Fthenakis, V.M. 2003. Overview of Potential Hazards. In T. Markvart and L. Castaner (Eds.), Practical Handbook of Photovoltaics: Fundamentals and Applications (Chapter VII-2). Published by Elsevier.

Garrad Hassan Canada. 2007. Recommendations For Risk Assessments Of Ice Throw And Blade Failure In Ontario. 38079/OR/01.

Habib, E. M. Bayne, and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds Seiurus aurocapilla. Journal of Applied Ecology. 44:176-184

Kingsley, A. and B. Whittam. 2007. Wind Turbines and Birds: A Background Review for Environmental Assessment. Prepared for the Canadian Wildlife Service. Draft April 2, 2007.

Leddy, K. L., K. F. Higgins and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bulletin 111(1): 100-104.

LesBarreres, D. (2007). Highway and Amphibians I: Genetic Impact of Roads. Roads and Ecopassages Forum. Toronto, Ontario, March 20-22, 2007.

Levert, M. and Munro, I. 2006. CBC Technology Review – Effects of Windmills on Television Reception. CBC Technology.

Maxell, B. and G. Hokit. (1999). Amphibians and Reptiles, Effects of Recreation on Rocky Mountain Wildlife: A Review for Montana. Montana Chapter of the Wildlife Society, September 1999. www.montanatws.org/chapters/mt/PDF%20Files/2hp1.pdf.

National Academy of Sciences. 2007. Environmental Impacts of Wind-Energy Projects. Committee on Environmental Impacts of Wind-Energy Projects, Board on Environmental Studies and Toxicology, Division on Earth and Life Studies, National Research Council of the National Academies. The National Academies Press, Washington, D.C., USA.

National Grid EMF Unit (National Grid). 2006. Available online at: http://www.emfs.info/

NWCC (National Wind Coordinating Committee). 2010. Wind Turbine Interactions with Birds, Bats and their Habitats: A Summary of Research Results and Priority Questions. www.nationalwind.org.

Ontario Partners in Flight. 2008. Ontario Landbird Conservation Plan: Lower Great Lakes/St. Lawrence Plain, North American Bird Conservation Region 13. Ontario Ministry of Natural Resources, Bird Studies Canada, Environment Canada.

Penna, M., H. Pottstock and N. Velasquez. (2005). Effect of natural and synthetic noise on evoked vocal responses in a frog of the temperate austral forest. Animal Behaviour 70:639-651.

Polisky, L. 2005. White Paper – Identifying and Avoiding Radio Frequency Interference for Wind Turbine Facilities. Comsearch, Andrew Corporation.

RABC. 2005. Technical Information on the Assessment of the Potential Impact of Wind Turbines on Radiocommunication Systems. CBC Technology.

Reijnen, R., R. Foppen, C. Terbraak, and J. Thissen. 1996. The effects of car traffic on breeding bird populations in woodland. III. Reduction of density in relation to the proximity of main roads. Journal of Applied Ecology 32: 187–202.

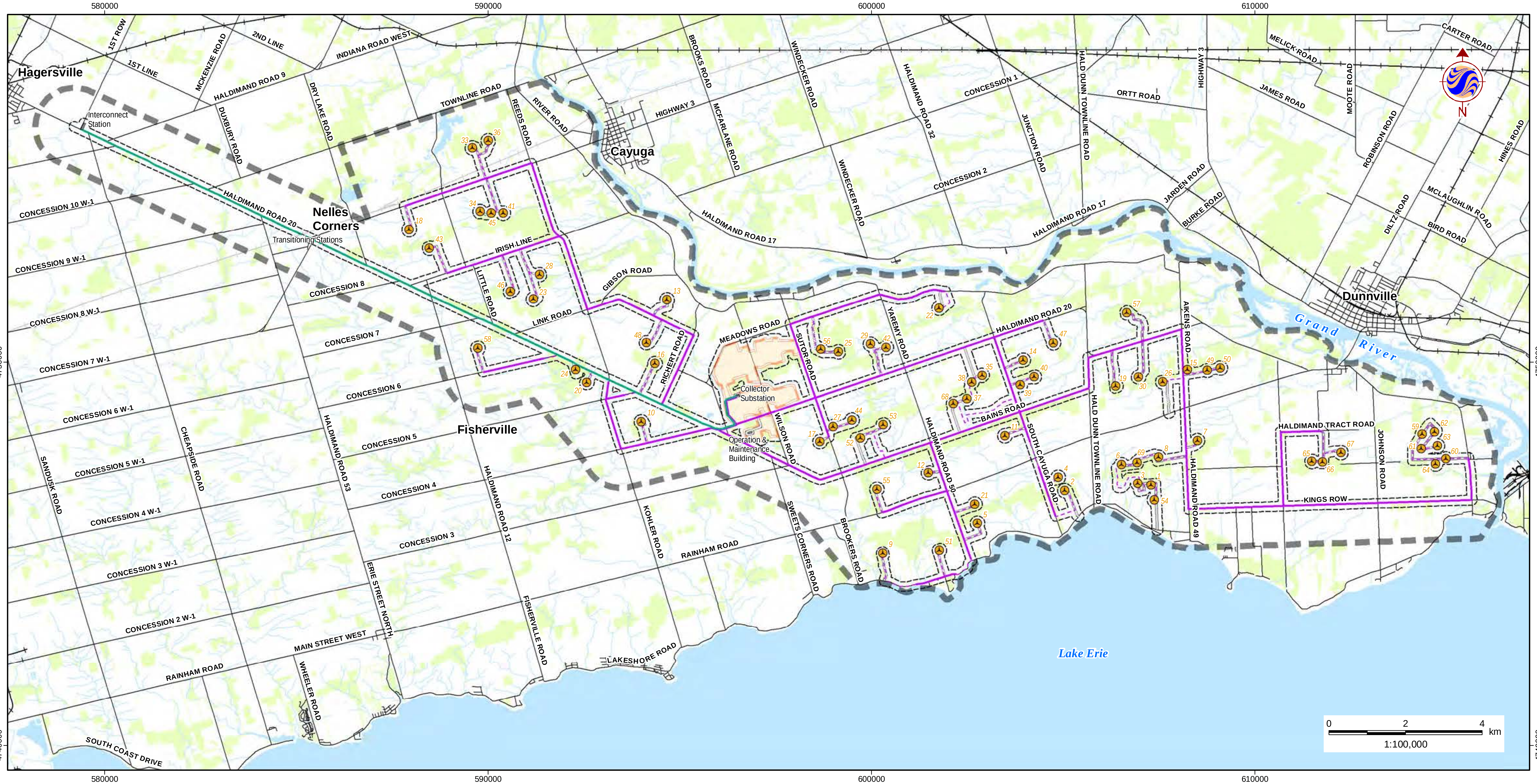
Seifert, H., Westerhellweg, A. and J. Kroning. 2003. Risk Analysis of Ice Throw From Wind Turbines. Paper Presented at BOREAS 6, 9 to 11 April, Pyha, Finland.

Sun, W.C. and P.M. Narins. (2004). Anthropogenic sounds differentially affect amphibian call rate. Biological Conservation 121:419-427.

World Health Organization (WHO). 2004. Fourth Ministerial Conference on Environment and Health. Energy, Sustainable Development and Health

Attachment A

Site Plans



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October 2011
160960577

Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
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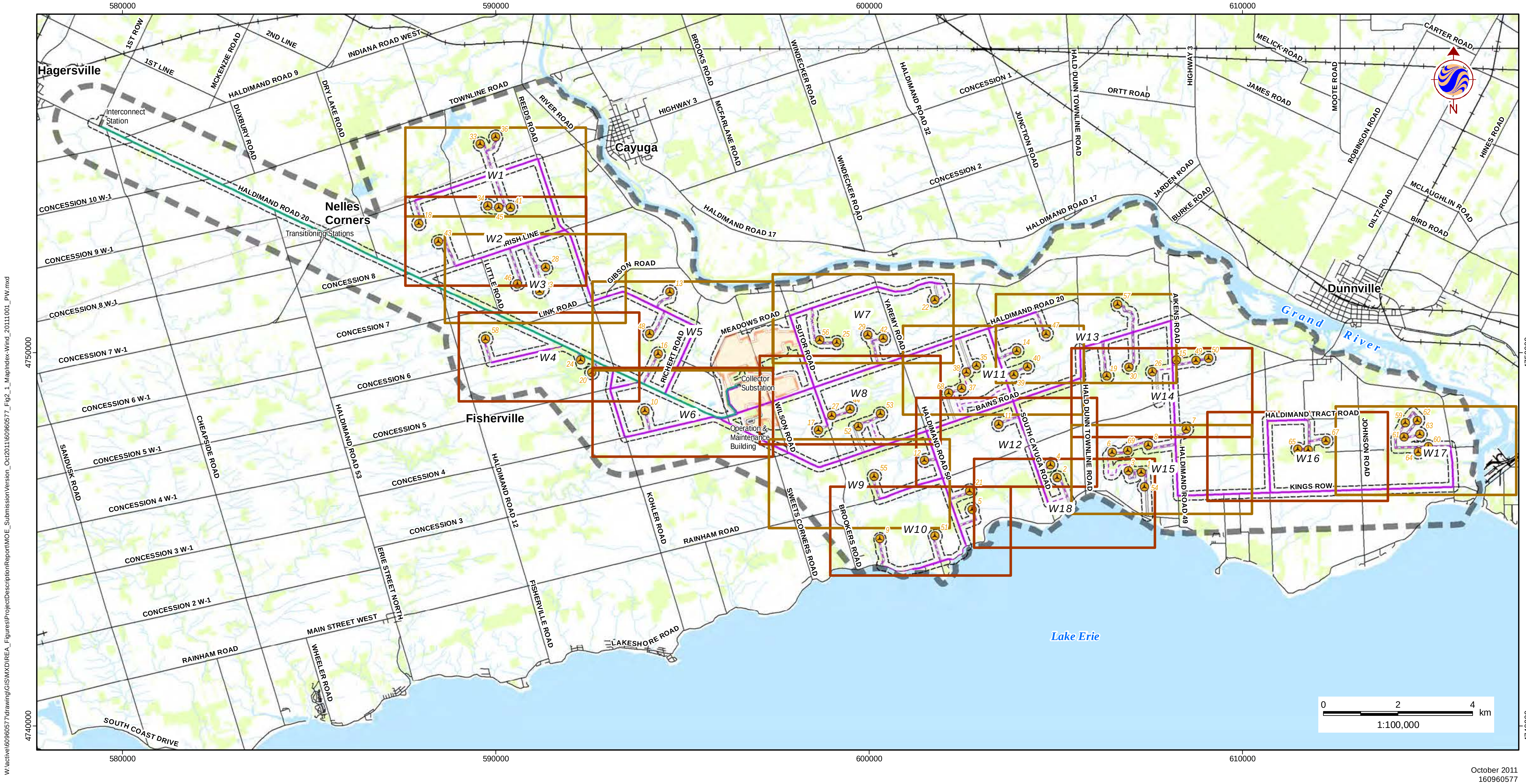
GRAND RENEWABLE ENERGY PARK

Figure No.

1.0

Title

STUDY AREA



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- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

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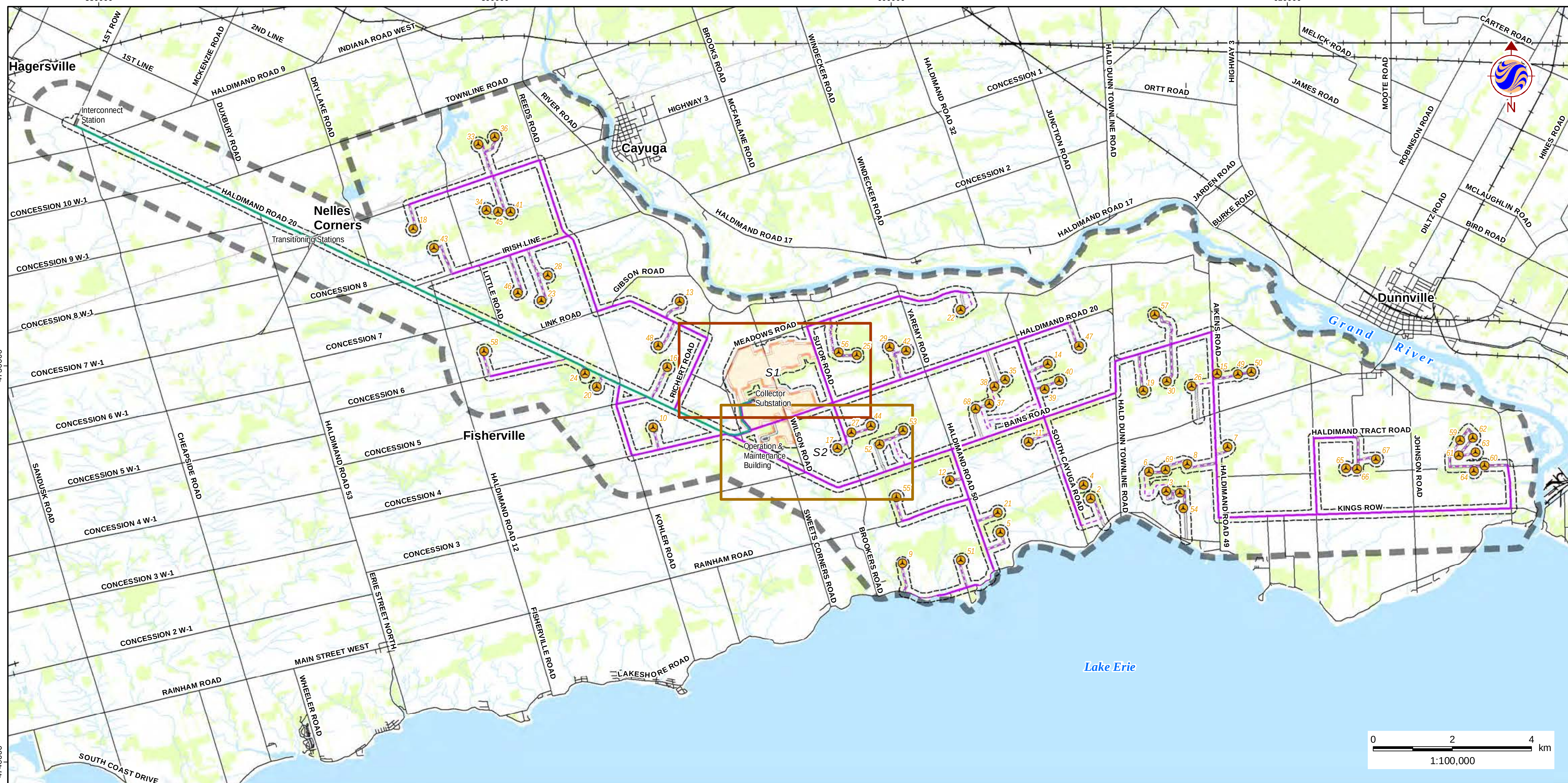
Figure No.
2.1

Title
MAPPING INDEX - WIND PROJECT



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Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

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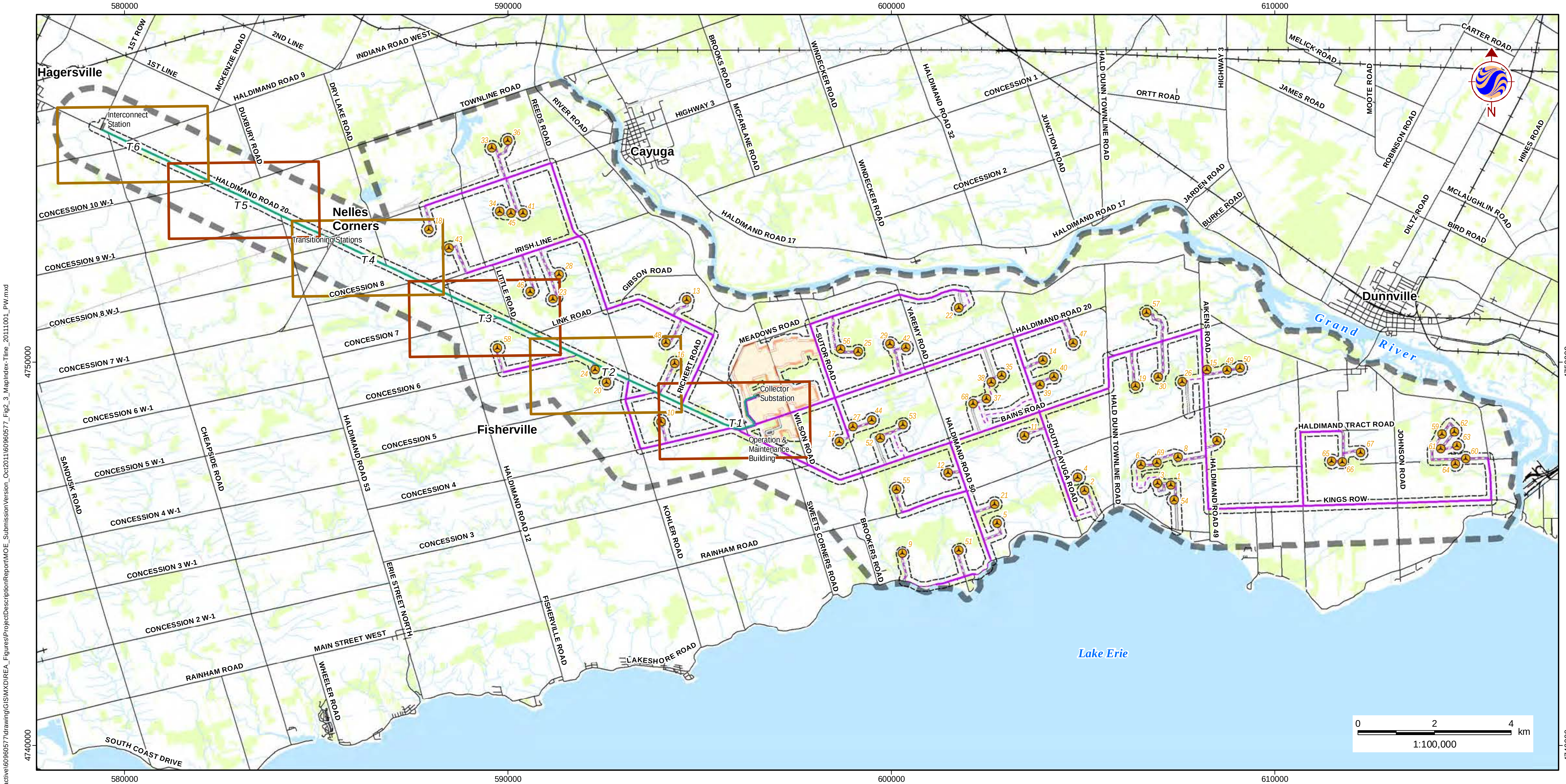
GRAND RENEWABLE ENERGY PARK

Figure No.

2.2

Title

MAPPING INDEX - SOLAR PROJECT



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Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

Notes

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GRAND RENEWABLE ENERGY PARK

Figure No.

2.3

Title

MAPPING INDEX - TRANSMISSION LINE

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Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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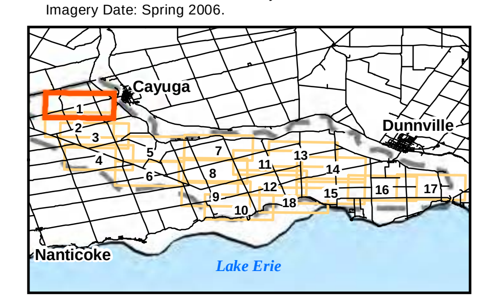
3. Image Source: © Terrapoint, 2011 - Imagery Date: July 2009; Grand River Conservation Authority © First Base Solutions, 2011 - Imagery Date: Spring 2006.



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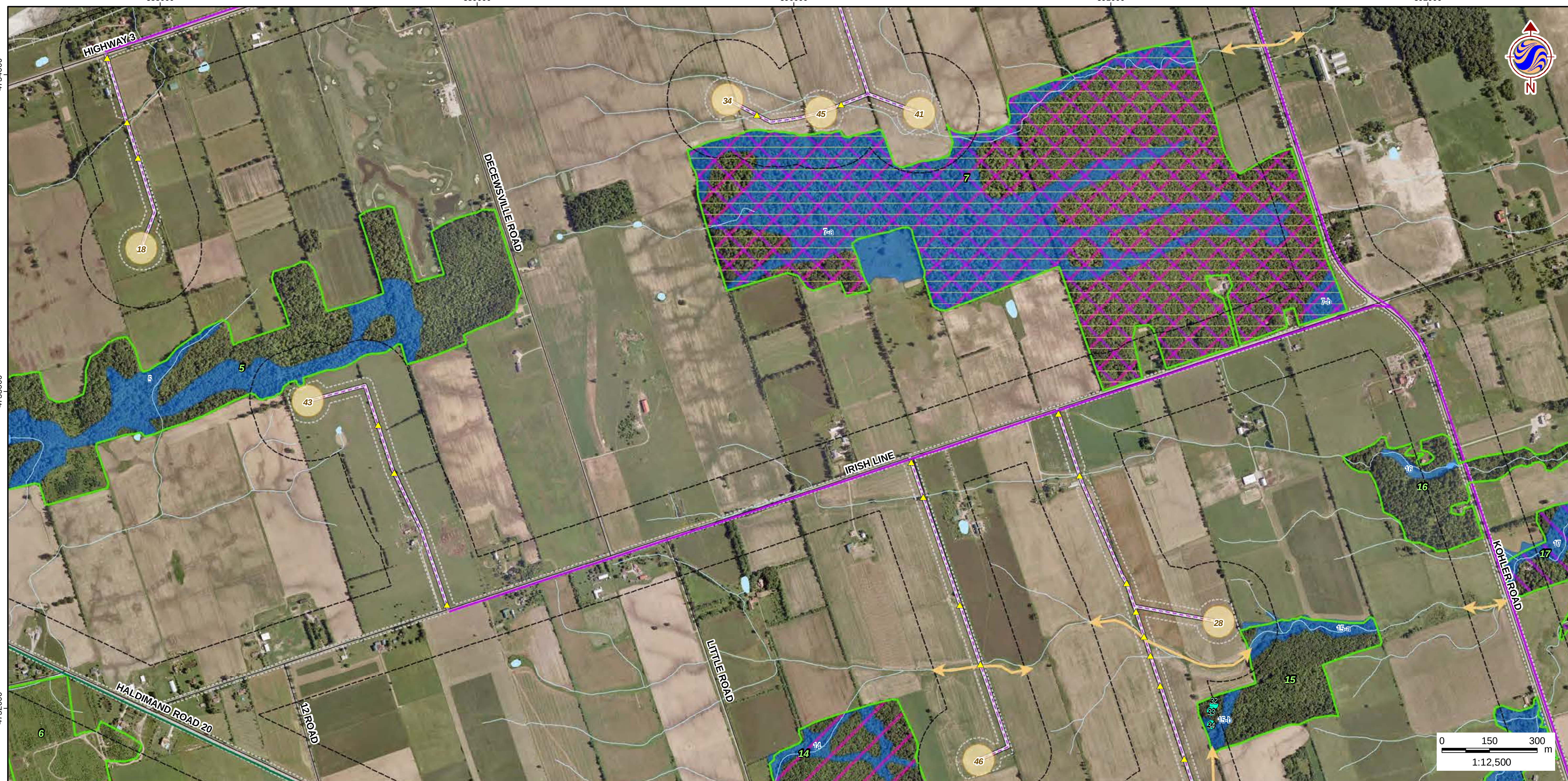
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.1

Title

SIGNIFICANT NATURAL FEATURES - W1



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October 2011
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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location
Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location
Solar Lands

Transmission Line
Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features
Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)
Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features
Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat
Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Sensitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts
Wildlife & Flow Culvert
Other Culvert

Notes

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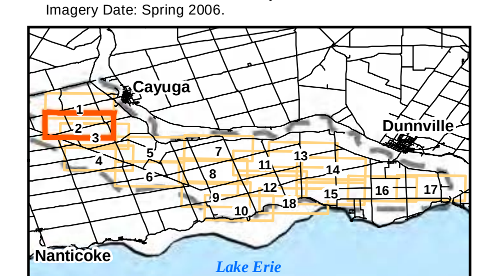


Client/Project

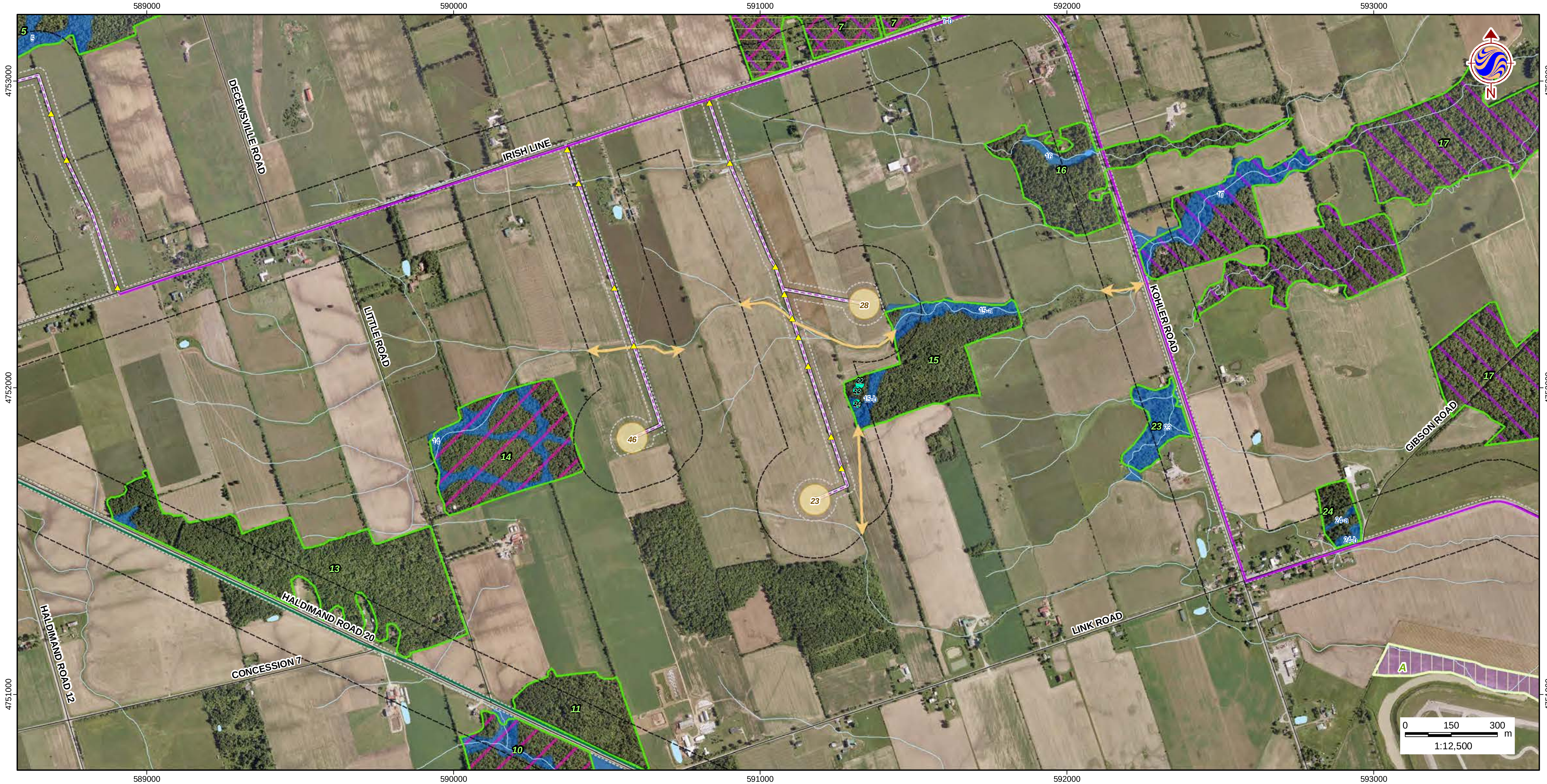
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.2

Title

SIGNIFICANT NATURAL FEATURES - W2



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Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- 9-a Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- A Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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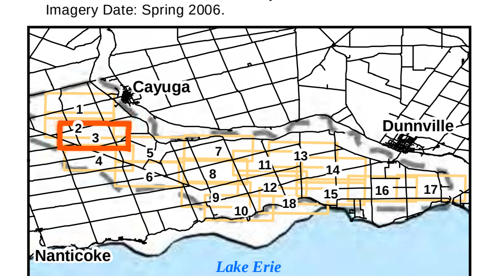

Stantec

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.3

Title

SIGNIFICANT NATURAL FEATURES - W3

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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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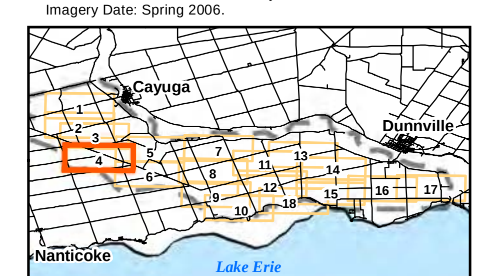

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.4

Title

SIGNIFICANT NATURAL FEATURES - W4

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Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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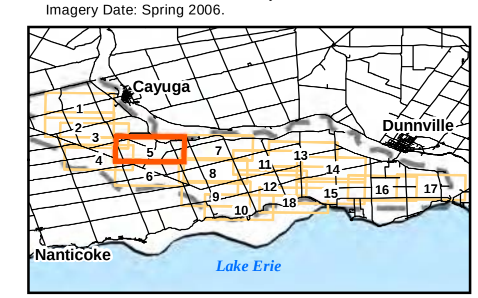

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.5

Title

SIGNIFICANT NATURAL FEATURES - W5

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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
9-a Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
A Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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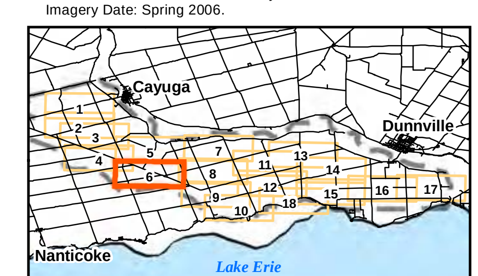
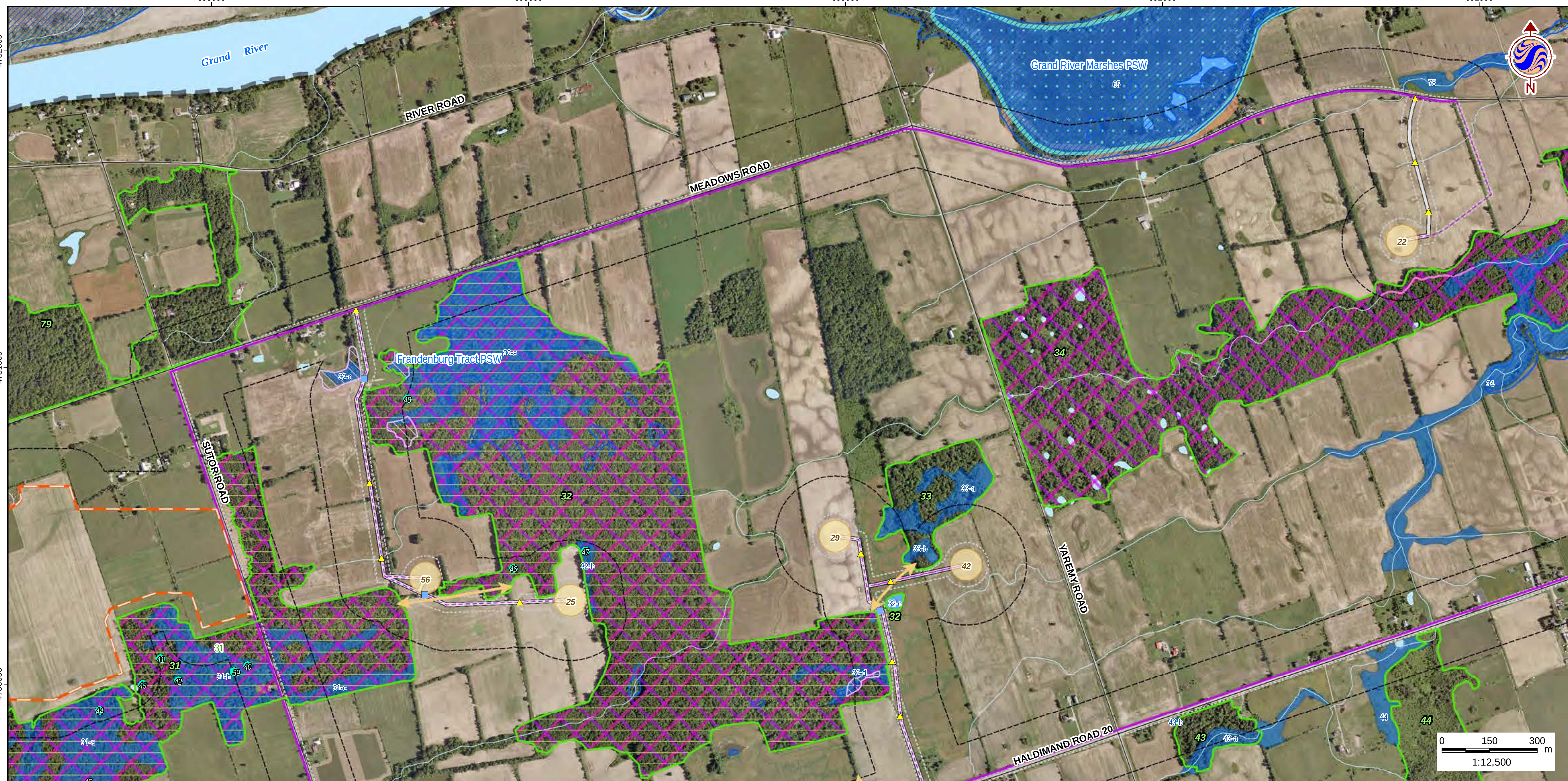


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.6

Title
SIGNIFICANT NATURAL FEATURES - W6



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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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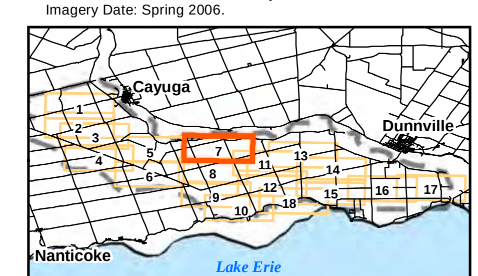

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.7

Title

SIGNIFICANT NATURAL FEATURES - W7

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Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location
- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location
- Solar Lands

Transmission Line
- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features
- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)
- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features
- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat
- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts
- Wildlife & Flow Culvert
- Other Culvert

Notes

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Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.8

Title

SIGNIFICANT NATURAL FEATURES - W8

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October 2011
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Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Sensitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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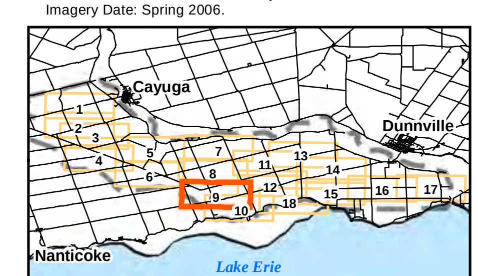


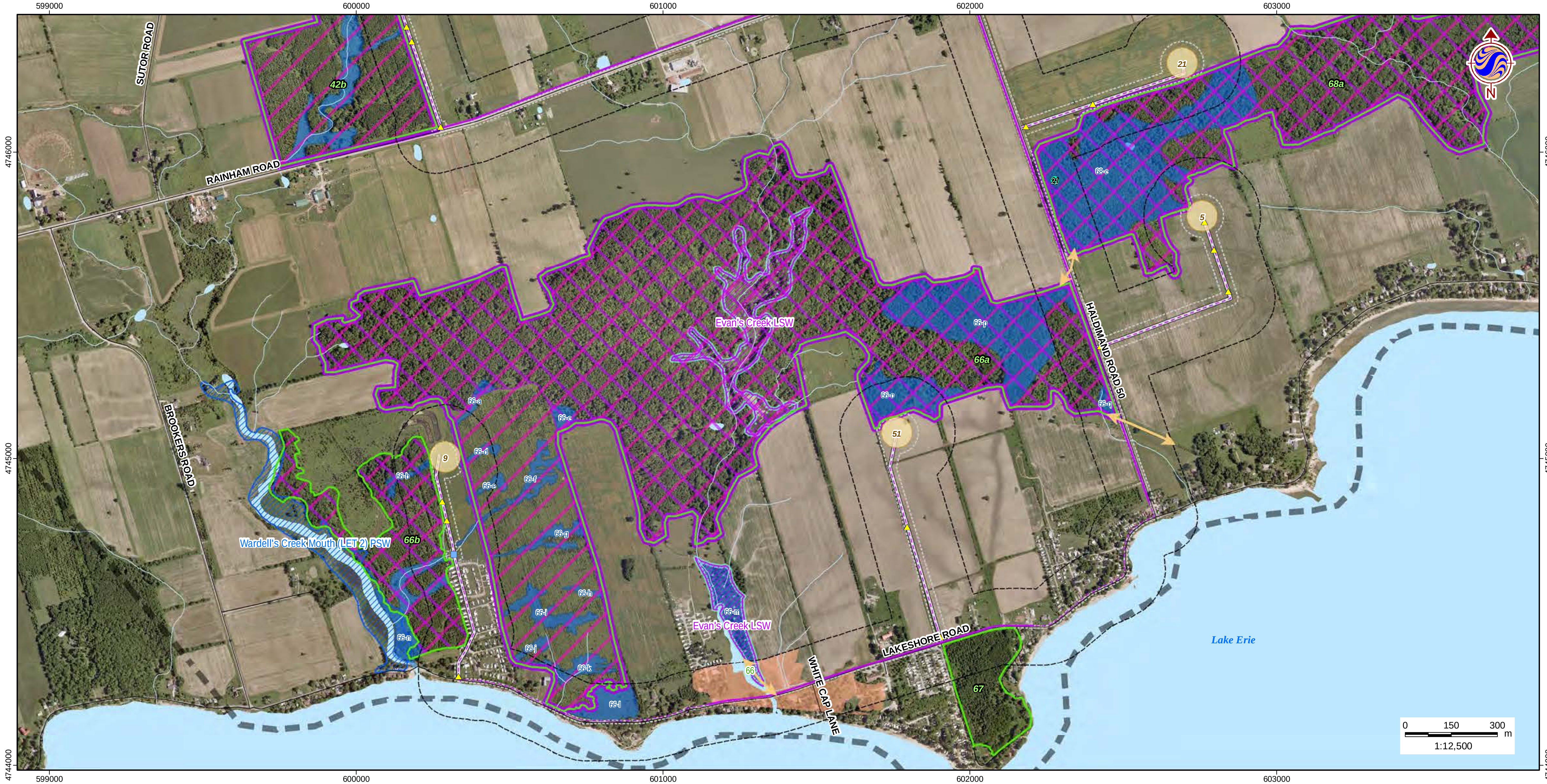
Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.9

Title

SIGNIFICANT NATURAL FEATURES - W9



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Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location
- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location
- Solar Lands

Transmission Line
- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features
- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)
- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features
- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat
- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts
- Wildlife & Flow Culvert
- Other Culvert

Notes

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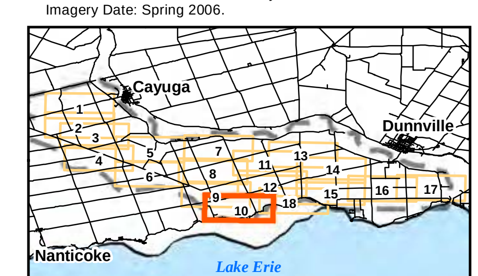
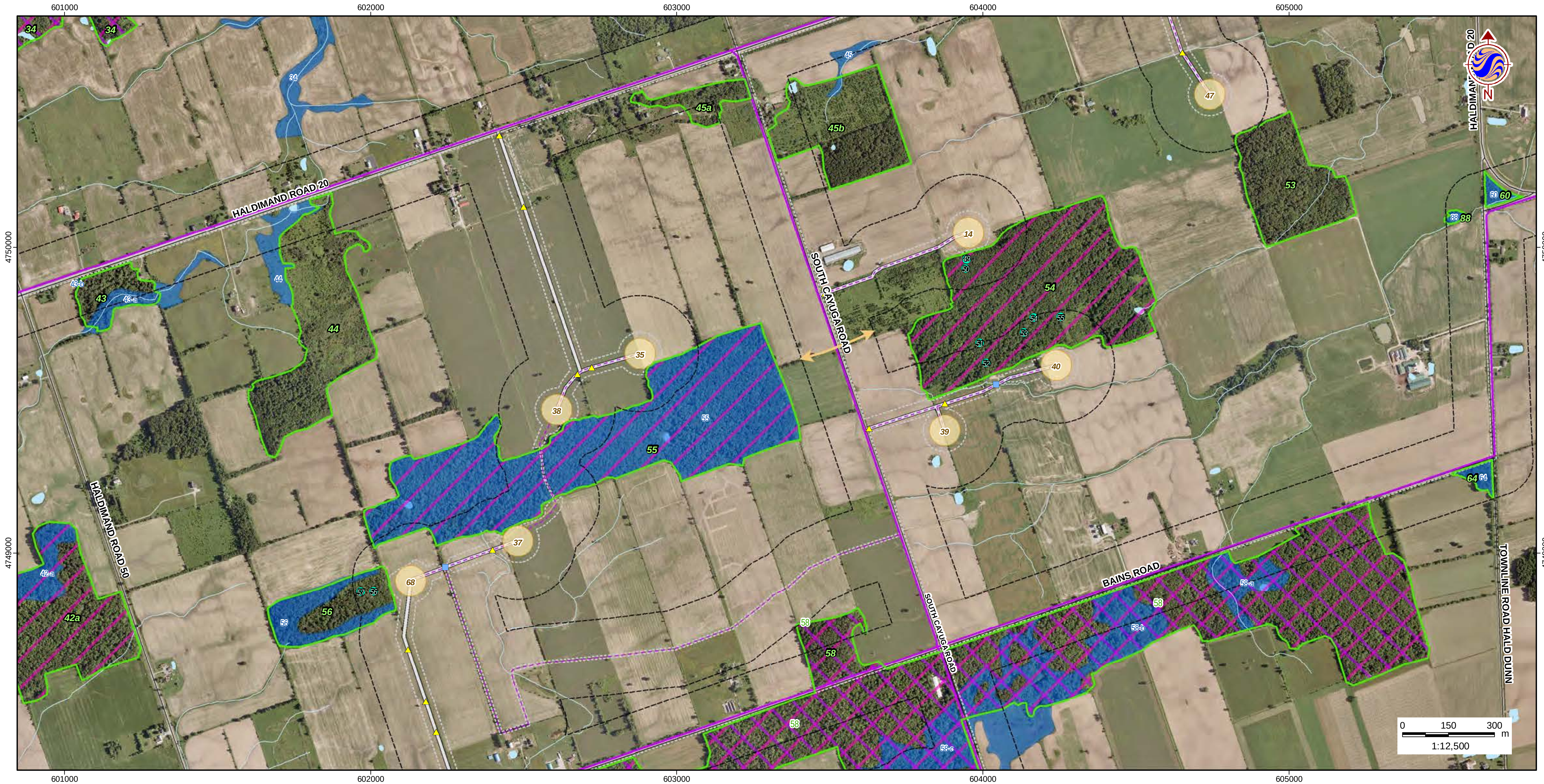


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.10

Title
SIGNIFICANT NATURAL FEATURES - W10



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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Sensitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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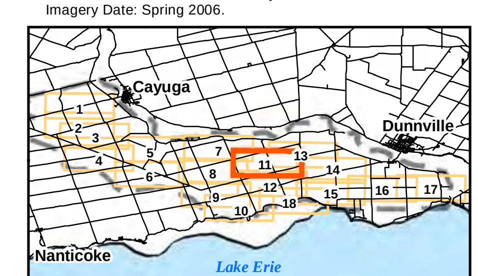


Client/Project

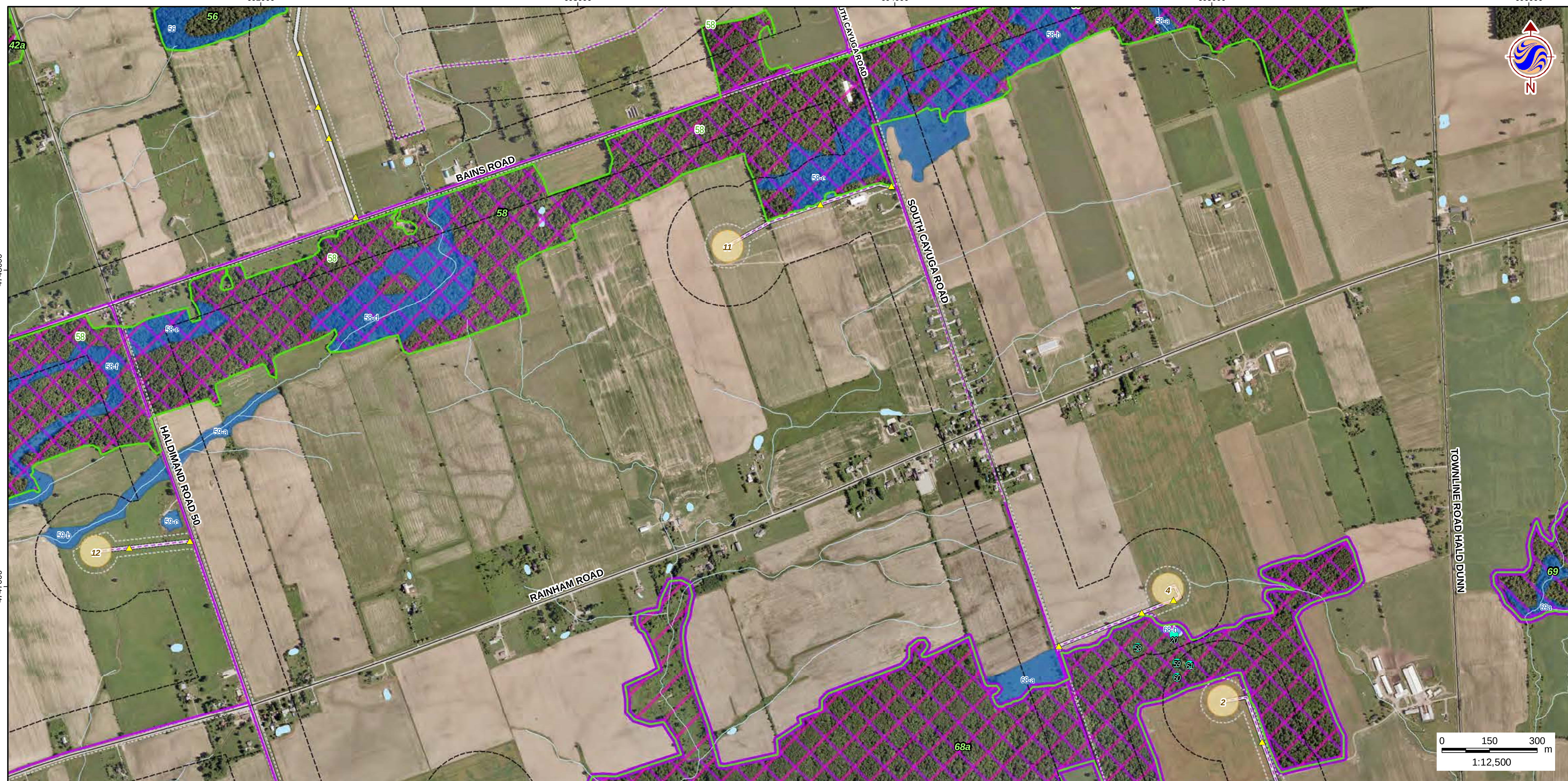
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.11

Title

SIGNIFICANT NATURAL FEATURES - W11



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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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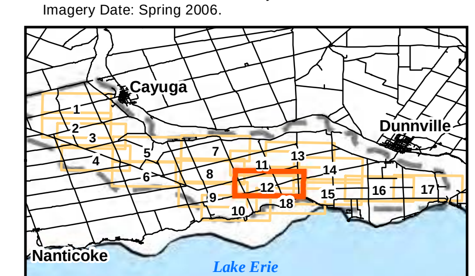


Client/Project

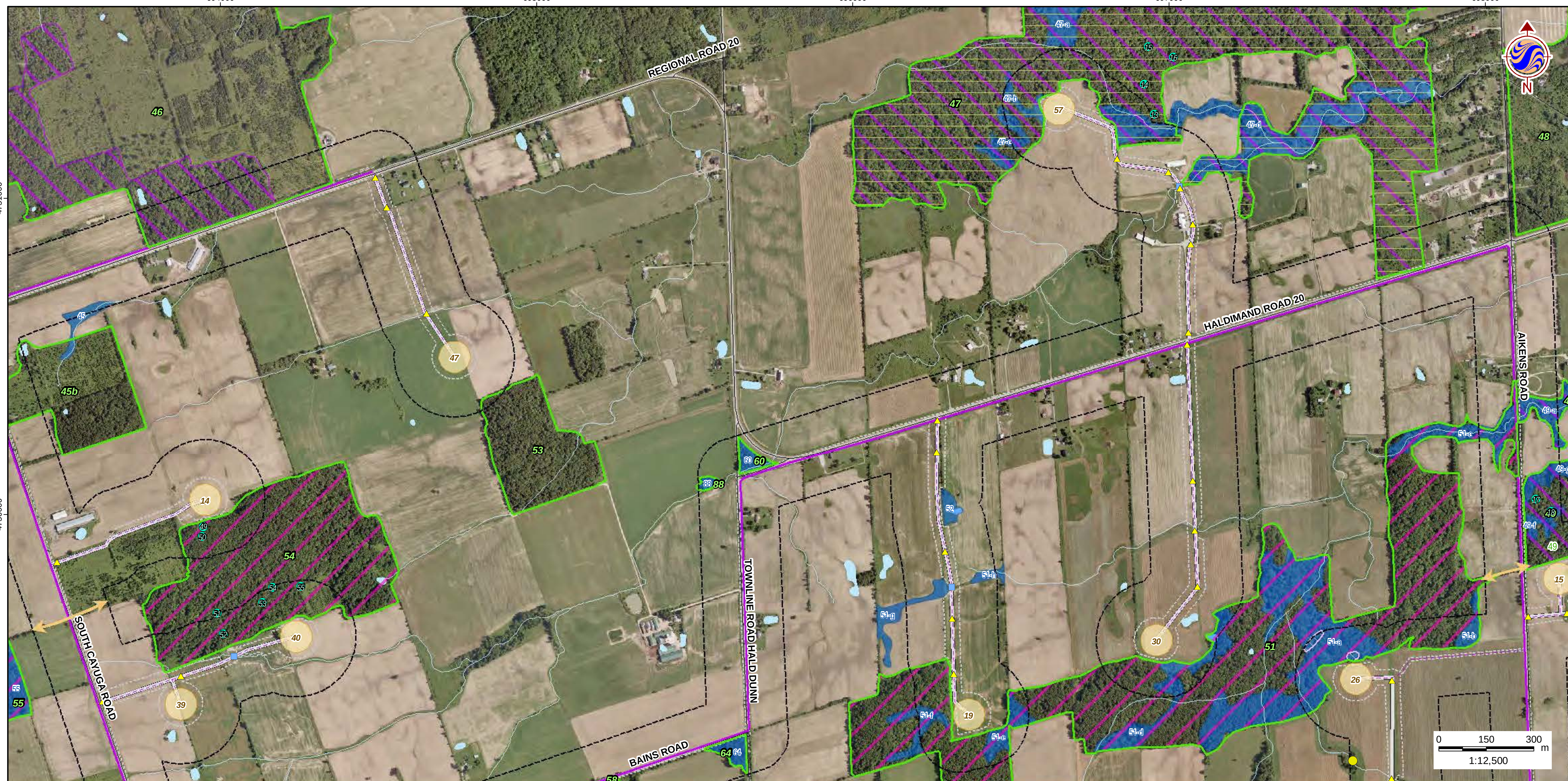
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.12

Title

SIGNIFICANT NATURAL FEATURES - W12



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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location
Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location
Solar Lands

Transmission Line
Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features
Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)
Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features
Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat
Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Sensitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts
Wildlife & Flow Culvert
Other Culvert

Notes

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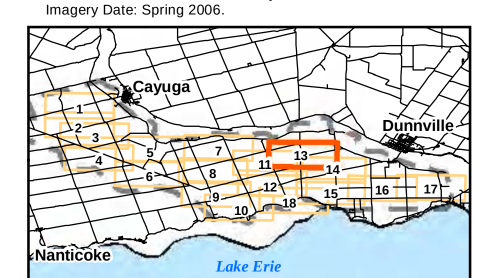
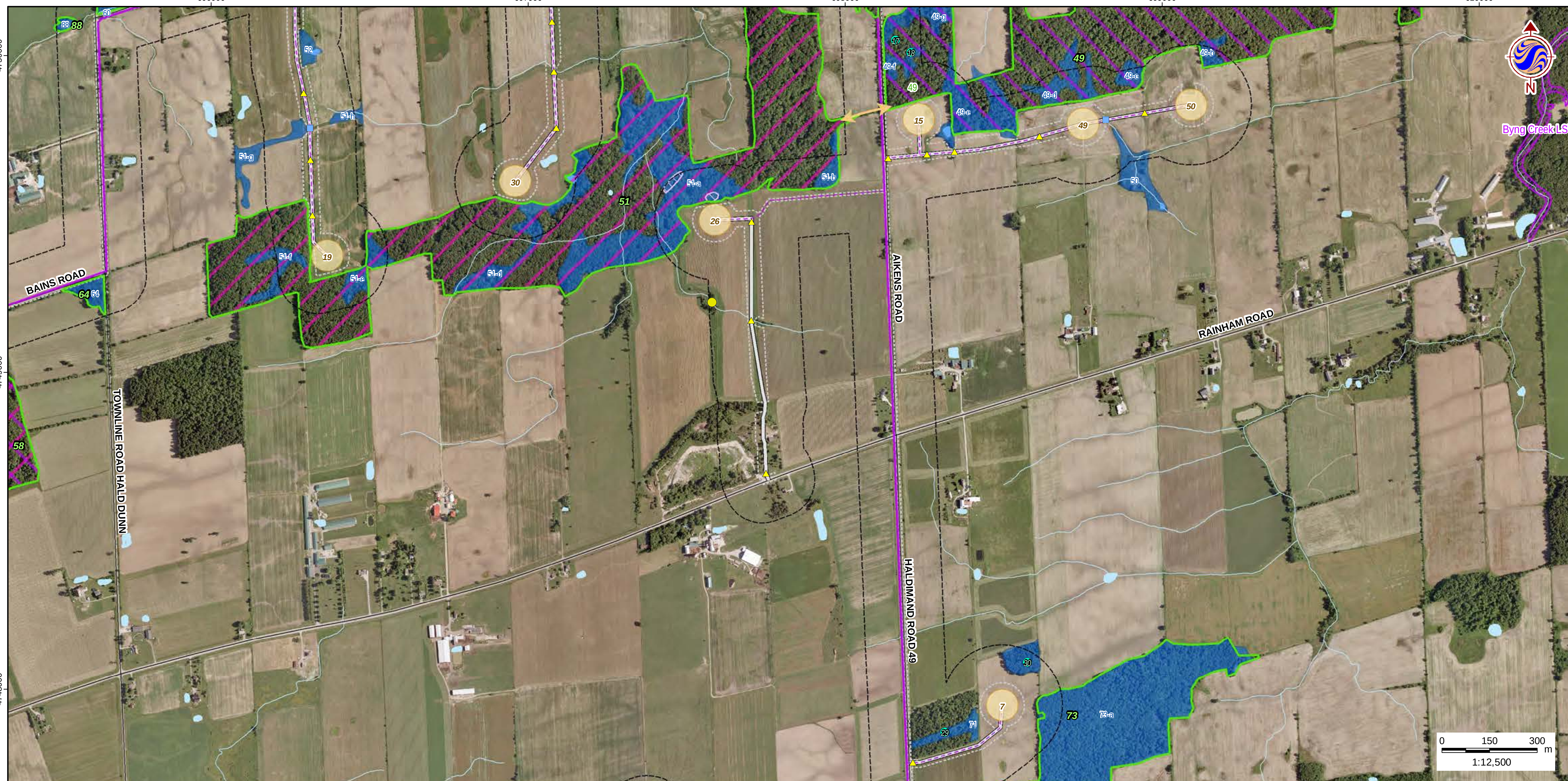


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.13

Title
SIGNIFICANT NATURAL FEATURES - W13



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160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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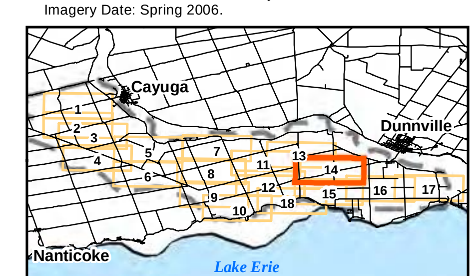


Client/Project

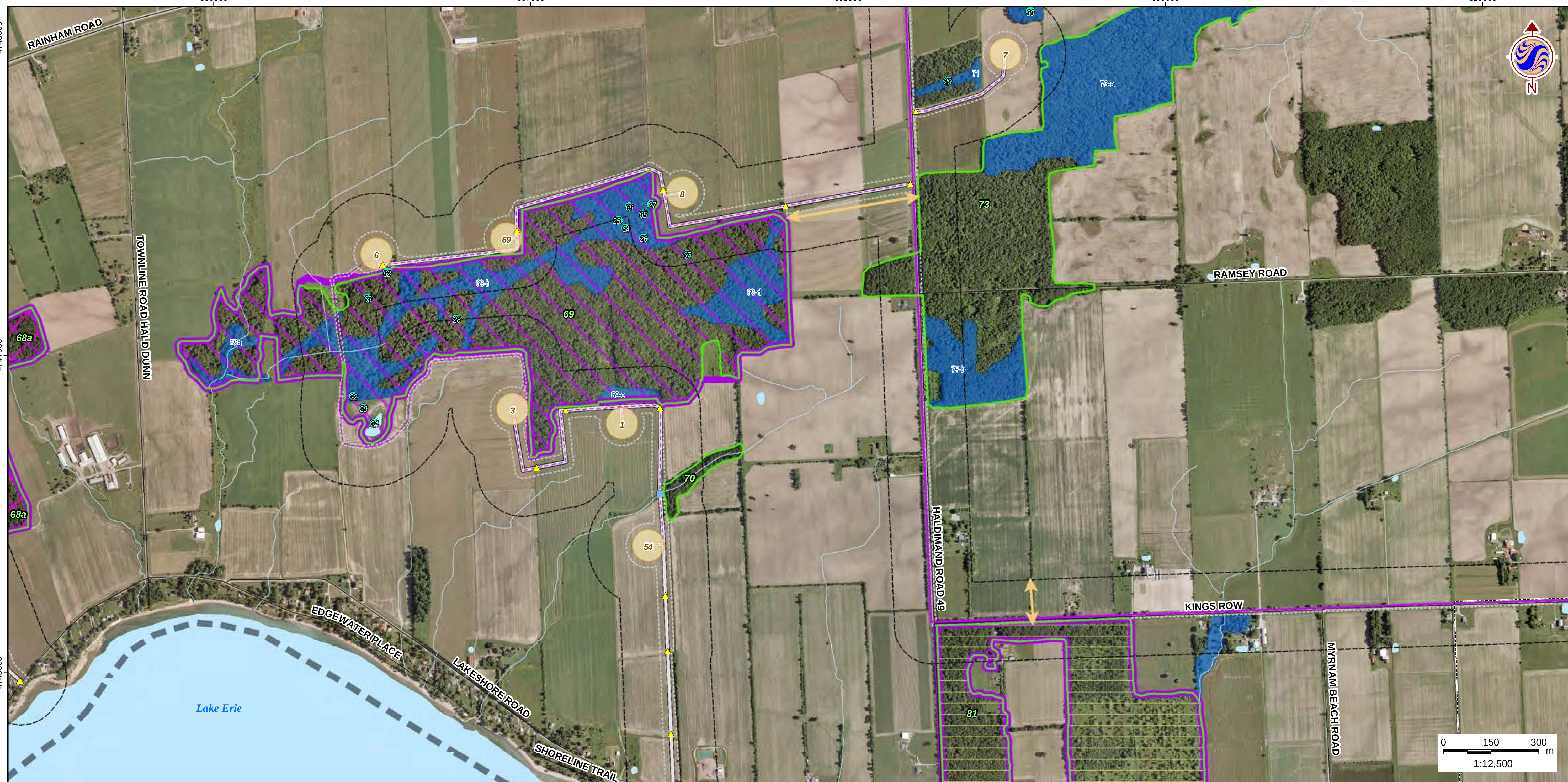
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.14

Title

SIGNIFICANT NATURAL FEATURES - W14



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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location
Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location
Solar Lands

Transmission Line
Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features
Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)
Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features
Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat
Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts
Wildlife & Flow Culvert
Other Culvert

Notes

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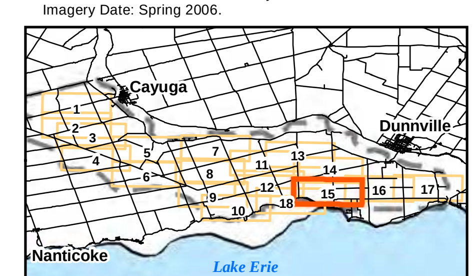

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.15

Title
SIGNIFICANT NATURAL FEATURES - W15

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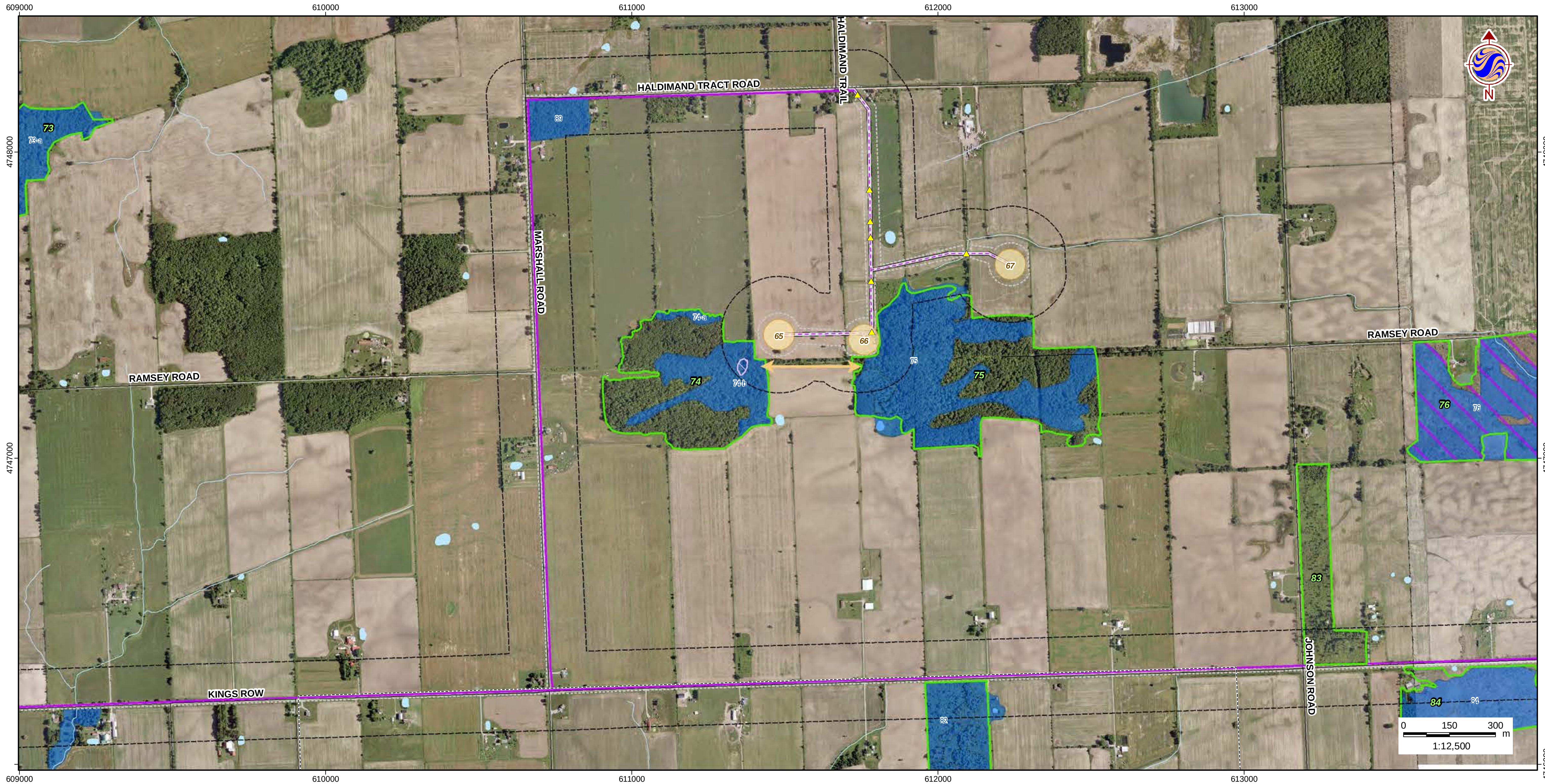

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160960577

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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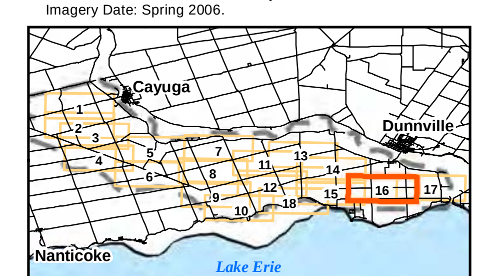
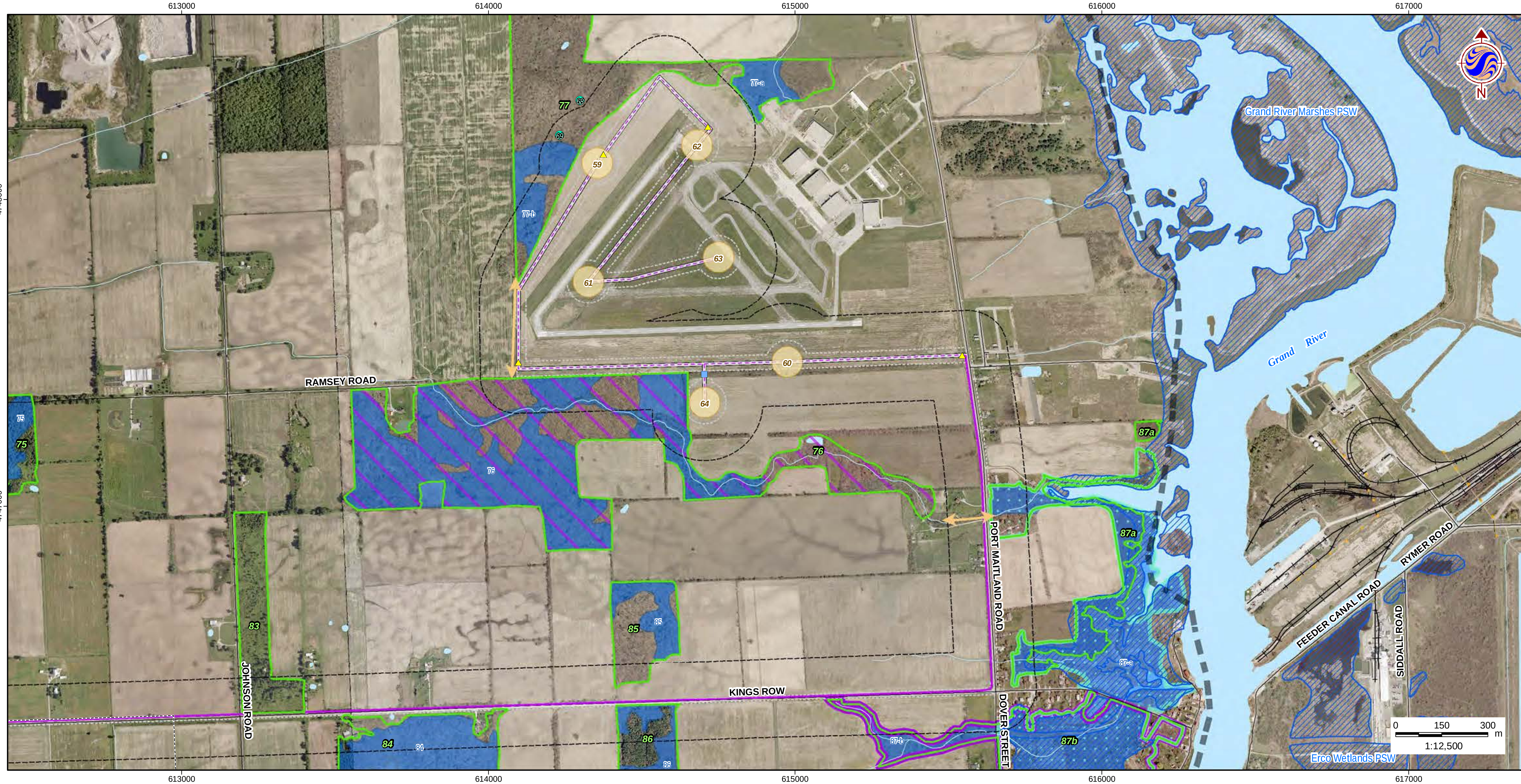


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.16

Title
SIGNIFICANT NATURAL FEATURES - W16



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October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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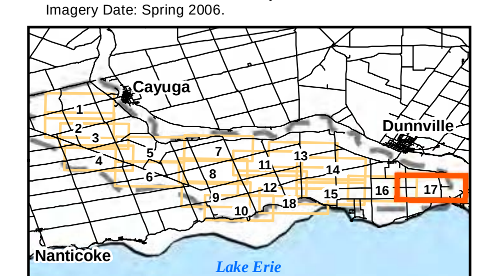
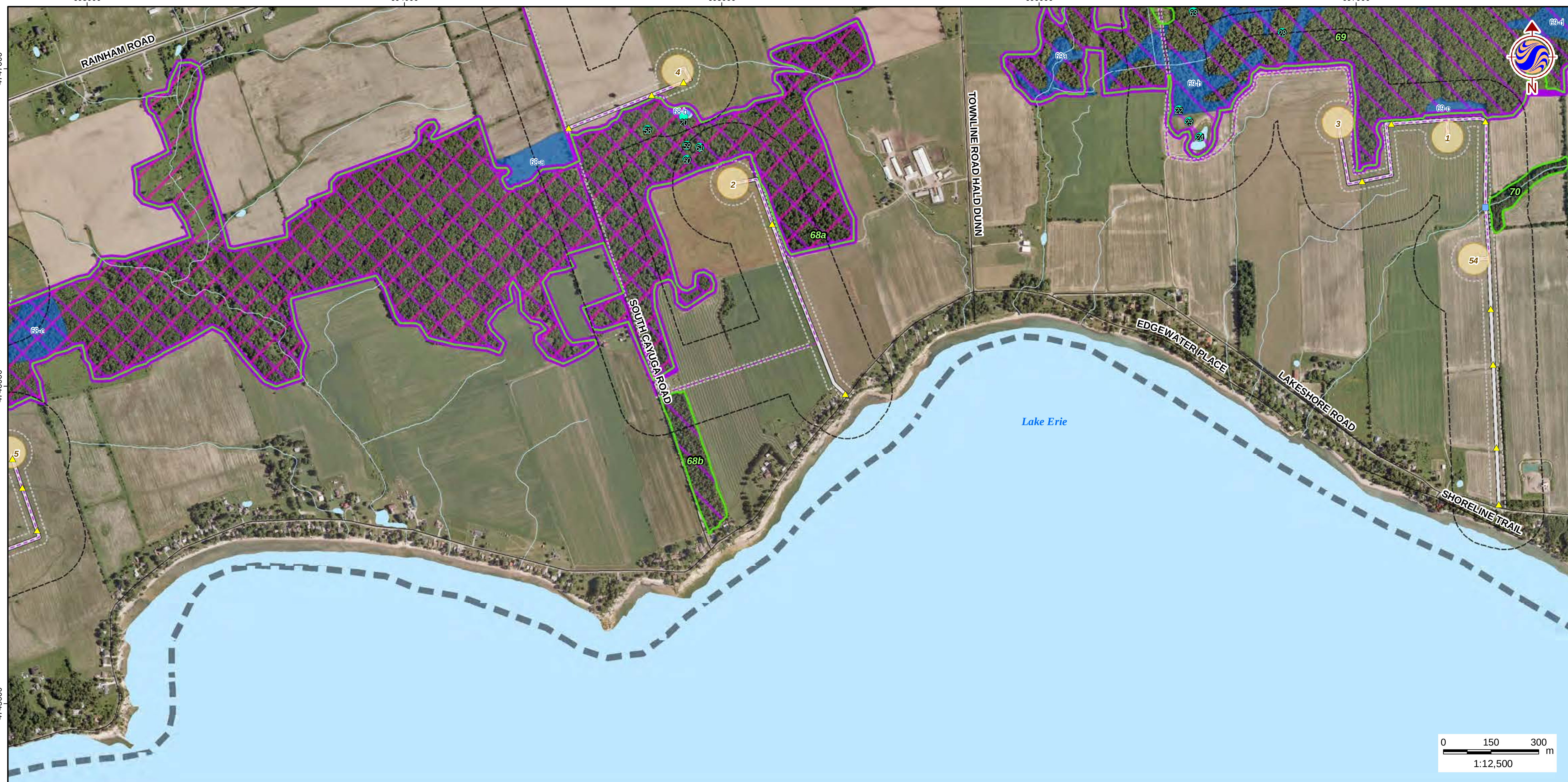


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.17

Title
SIGNIFICANT NATURAL FEATURES - W17



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160960577

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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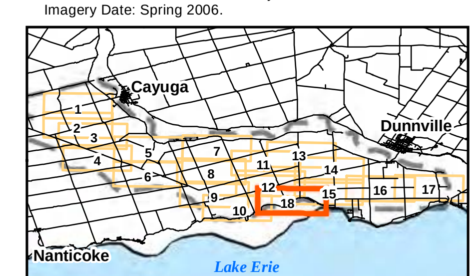


Client/Project

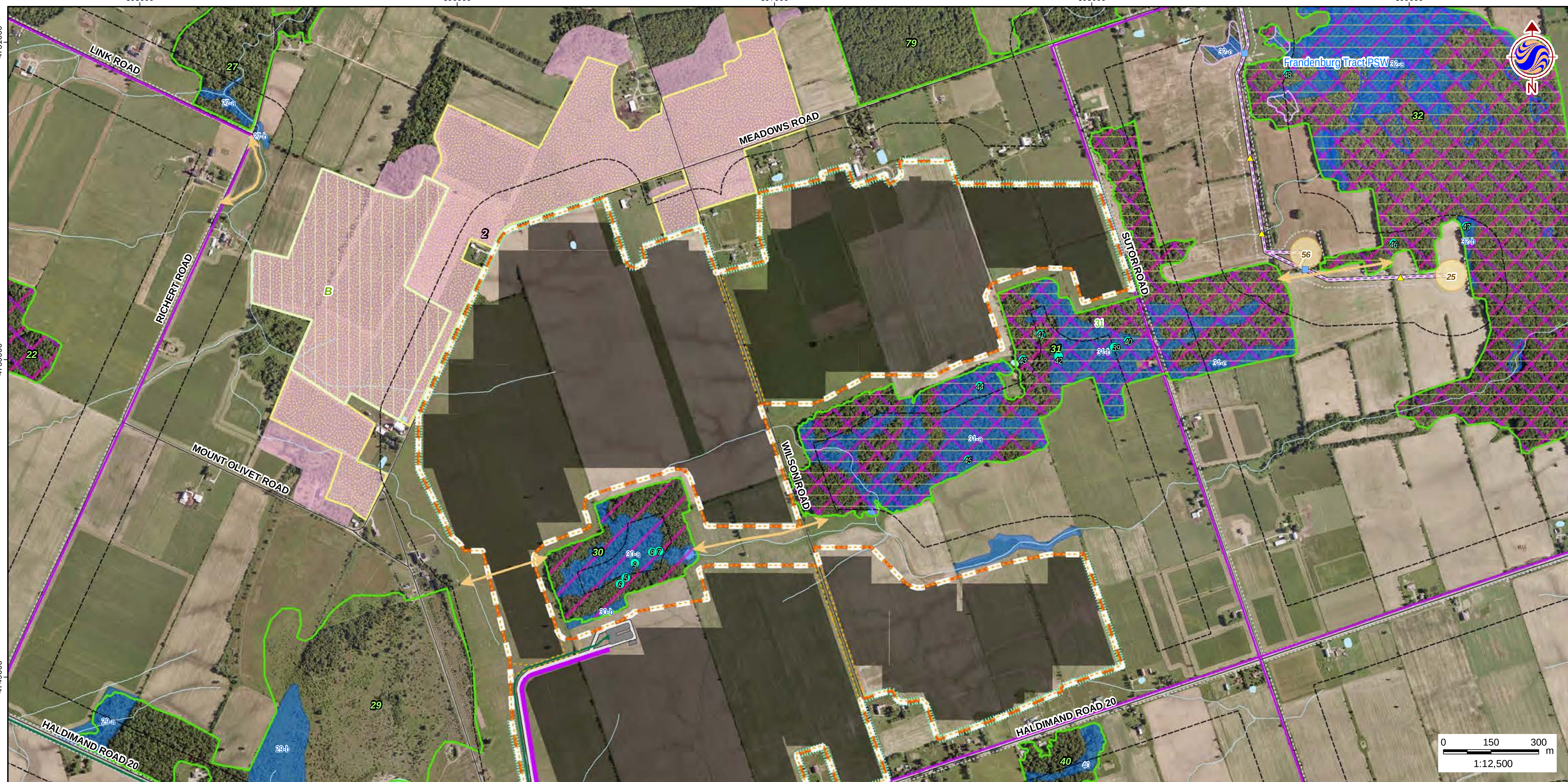
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.18

Title

SIGNIFICANT NATURAL FEATURES - W18



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Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands
Solar Panel Unit
Solar Berm
Solar Fence

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Significant Winter Raptor Feeding & Roosting Habitat
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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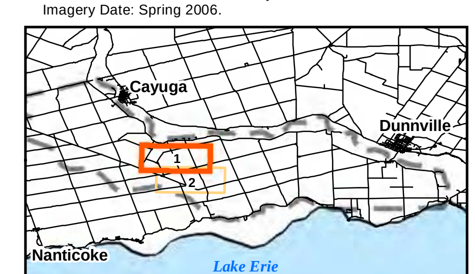

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

4.1

Title

SIGNIFICANT NATURAL FEATURES - S1

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October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands
- Solar Panel Unit
- Solar Berm
- Solar Fence

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Significant Winter Raptor Feeding & Roosting Habitat
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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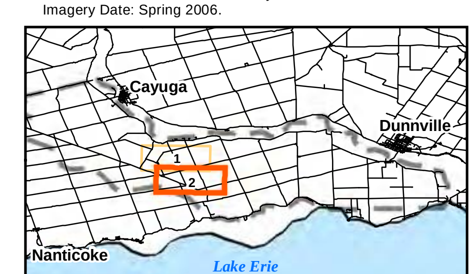

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

4.2

Title

SIGNIFICANT NATURAL FEATURES - S2

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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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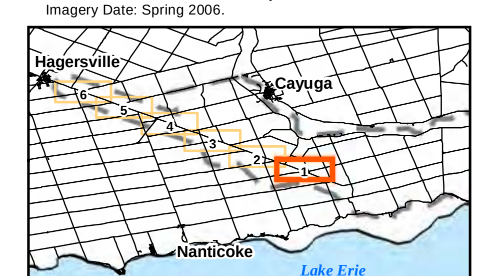

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.1

Title

SIGNIFICANT NATURAL FEATURES - T1

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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location
- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location
- Solar Lands

Transmission Line
- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features
- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)
- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features
- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat
- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts
- Wildlife & Flow Culvert
- Other Culvert

Notes

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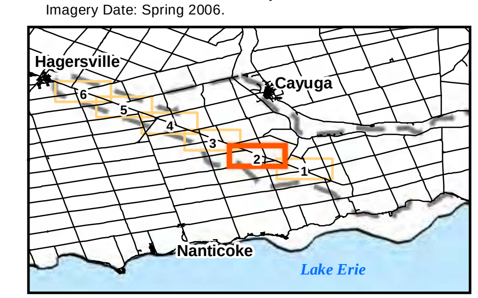

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
5.2

Title

SIGNIFICANT NATURAL FEATURES - T2

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160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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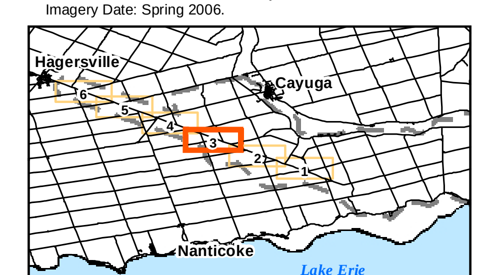

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.3

Title

SIGNIFICANT NATURAL FEATURES - T3

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160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Sensitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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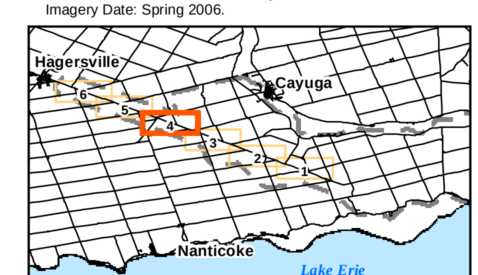

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.4

Title

SIGNIFICANT NATURAL FEATURES - T4

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160960577

Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Sensitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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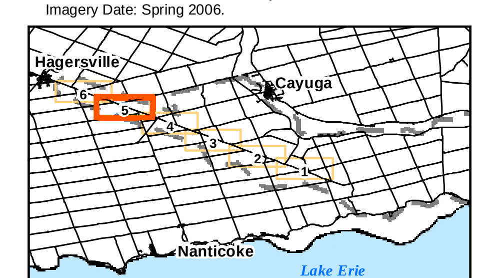

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.5

Title

SIGNIFICANT NATURAL FEATURES - T5

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October 2011
160960577

Stantec

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Sensitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
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Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.6

Title

SIGNIFICANT NATURAL FEATURES - T6

Attachment B

Noise Assessment Report

GRAND RENEWABLE ENERGY PARK

NOISE ASSESSMENT REPORT

Revision 1

For

Stantec

By

J. R. Salmon
C.F. Brothers, P.Eng.
S.J. Corby

2011 July 11

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1 INTRODUCTION

1.1 Purpose

This Noise Assessment Report (NAR) describes the results of a noise impact assessment for Samsung Renewable Energy Inc.'s proposed land-based Grand Renewable Energy Park (GREP).

1.2 Revision 0

Revision 0 was the original Noise Assessment Report.

1.3 Revision 1

This Revision (1) documents a change in the number of project turbines from 69 to 67. Turbines T31 and T32 were removed. It also includes changes to the locations of turbines T9, T16, T19, T20, T21, T56, T57, and T59. No turbine re-numbering has occurred, but there are a number of status changes to receptors/VLSRs/participants due to removal of the two turbines along with relocation of the other turbines. The turbine type (Siemens SWT-2.3-101, nominal) remains the same as described in Revision 0. There is a minor change in the specification of the octave-band source sound power levels for the project transformers.

1.4 Brief Project Description

The Grand Renewable Energy Park is located in Haldimand County on the north shore of Lake Erie. The project features one wind farm cluster of 67 wind turbines with a nominal capacity of 148.2 MW, and one solar array with a nominal capacity of 100 MW. The project is located roughly between the towns of Fisherville to the west and Dunnville to the east.

Figure 1 shows the project location and details.

1.5 Reporting Details

This report has been prepared to meet all reporting requirements related to renewable energy project noise for a *Renewable Energy Approval* (REA) under the *Green Energy and Economy Act* (Ontario).

A noise impact assessment was carried out for this project under Section 55.(3) of O. Reg 359/09 and amendments (O.Reg. 521/10, 2010/12/20). The assessment methodology and calculations conform to the International Standards Organization (ISO) 9613-2 International Standard (*Acoustics — Attenuation of sound during propagation outdoors — Part 2: General Method of Calculation*). Results of the analysis have been interpreted using the Ontario Ministry of Environment's guideline, *'Noise Guidelines for Wind Farms; Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities'* which is dated October 2008. This document generally provides guidelines and clarifications for the application of MoE regulations document *NPC-232 — Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)* — to wind farm projects.

The *Noise Guidelines for Wind Farms (October 2008)* document prescribes receptor noise level limits based on an analysis of typical wind-induced background noise levels, and tabulates these limits as functions of the ambient 6, 7, 8, 9, and 10 ms^{-1} wind speeds measured at 10 m above ground level (a.g.l.). Note that the receptor noise level limits must be met for noise produced by other project hardware such as sub-station transformers in addition to noise produced by the wind turbines.

This report will show that the estimated noise levels generated by the project turbines and other hardware meet the Guidelines' prescribed limits at all qualified receptors.

Figure 1 Project site map.

1.6 Sound Level Limits for Wind Farms

The Ontario MoE document *Noise Guidelines for Wind Farms (October 2008)* lists the sound level limits for wind farms (based on the NPC-205 and NPC-232 publications and a consideration of the background ambient wind-induced sound level) as follows. Note that noise contributions from project switching, transformer, and sub-stations must be included.

Summary of Sound Level Limits for Wind Turbines							
Wind speed (ms^{-1}) at 10 m height	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Wind turbine sound level limits Class 3 Area, dBA	40.0	40.0	40.0	43.0	45.0	49.0	51.0
Wind turbine sound level limits Class 1 Area, dBA	45.0	45.0	45.0	45.0	45.0	49.0	51.0
Reference wind induced background sound level L_{90}, dBA	30.0	31.0	33.0	36.0	38.0	42.0	44.0

2 PROJECT LAYOUT

2.1 Project Site

The Grand Renewable Energy Park is located in Haldimand County. Project details along with typical topographic map features are shown in Figure 1.

Within the project domain, the topography can be characterized as very gently rolling to the point of being almost flat. On the land portion of Figure 1, the contour lines (5 m contour interval) confirm this. Note that the general terrain elevation in the land portion of the project area is about 198 m above sea level (a.s.l). To the south of the project domain lies (the obviously very flat) Lake Erie with its surface located at 175 m a.s.l.

The surface roughness of the project domain is typical of Ontario rural terrain with a heterogeneous mixture of agricultural fields, woodlots, farm buildings, dwellings, rural settlements, and small villages and towns. The primary activity in this area is agriculture.

The GREP site features a population density typical of southern Ontario rural communities — a relatively sparse population in the countryside except for a small number of settlement clusters (villages and towns).

2.2 Project Details

Figure 1 shows the properties that have been optioned for lease to the project proponent (Samsung Renewable Energy Inc.) along with prospective turbine, point of reception (receptor), vacant lot, vacant lot surrogate receptor (VLSR), and participating point of reception (participant) locations. Turbine numbers are designated with the prefix 'T', receptors are designated with 'R', VLSRs with 'V', and participants with 'P'.

As specified by O.Reg 359/09, the Grand Renewable Energy Park is a Class 4 Wind Project.

The GREP will consist of 67 power-de-rated Siemens turbines. There will be 65 SWT 2.221-101 and two SWT 2.126-101 turbines resulting in a project nameplate capacity of 148.3 MW. (Note, for clarity, that these turbines are often referred to as model SWT-2.3-101 — their nominal designation.) In Figure 1, project turbines are numbered T1 to T69. Turbines T31 and T32 are no longer included in the layout.

The project stretches for a distance of about 14 km roughly parallel to the shoreline of Lake Erie. Turbines are located from approximately 0.8 km to 14.3 km from the shoreline. A listing of all GREP turbine locations can be found in Section 12 (Appendix A) of this report.

The Ontario NPC designation for the project properties would generally be Class 3 — Rural. Typical background sound levels for these areas would be generated by residential, agricultural, and small commercial activities, ambient sound from wind, vehicle noise from regional roads, and ambient wave noise at the shoreline of Lake Erie. For the purposes of this report, all areas have been considered to be NPC Class 3.

2.3 Municipal Zoning

Typically, the project area is zoned as Agricultural.

2.4 Adjacent Projects

2.4.1 Summerhaven Wind Energy Centre

Figure 1 shows tentative locations of turbines in the NextEra Energy Canada ULC, Summerhaven Wind Energy Centre (SWEC) project. These turbines are located roughly to the south and west of the GREP project. In Figure 1, Summerhaven project turbines are numbered T201 to T296.

NextEra Energy has informed Samsung Renewable Energy Inc. that the SWEC project will be comprised of 60 power de-rated Siemens SWT-2.221-101 and one power-de-rated Siemens SWT-2.221-93 turbine for a project capacity of approximately 135 MW.

Further details of these turbines are provided further below. All turbines in the SWEC project within 5 km of any receptor of the GREP have been included in the present noise assessment.

2.4.2 Byng Wind Project

Figure 1 shows tentative locations of turbines in the International Power Canada (IPC) Byng Wind Project (BWP). These turbines are located roughly to the south and east of the GREP turbines. In Figure 1, Byng project turbines are numbered T101 to T106.

IPC has informed Samsung Renewable Energy Inc. that the BWP will be comprised of six GE Energy 1.5sle turbines.

Further details of these turbines are provided below. All turbines in the BWP within 5 km of any receptor of the GREP have been included in the noise assessment for the latter project.

2.5 Project Sub-Stations

2.5.1 GREP Sub-Station

The GREP will include a sub-station with two transformers located on the western side of the project as shown in Figure 1. The nearest GREP turbine (T56) is located about 2.4 km to the east of the sub-station.

Noise from the two transformers has been included in all the reported noise calculations.

2.5.2 SWEC Sub-Station

NextEra has two potential locations under consideration for the SWEC project sub-station. The nearest (to the GREP) is located about 9.6 km west of the nearest GREP turbine (T24). There are several SWEC turbines significantly closer to this transformer station than T24.

Due to its remoteness from the GREP, noise from the SWEC transformer has not been included in any of the reported noise calculations.

2.5.3 BWP Switching Station

International Power Canada has reported to Samsung Renewable Energy Inc. that there will be a switching station used for the relatively small Byng Wind Project. Consistent with normal practice, noise from this station has not been included in the present analysis.

3 DESCRIPTION OF RECEPTORS

3.1 Definition

Receptors (non-participating points of reception), vacant lot surrogate receptors (VLSRs) and participants (participating points of reception) are defined in Ontario MoE publications *NPC-232 — Sound Level Limits for Stationary Sources in Class 3 Areas (Rural),* MoE *Noise Guidelines for Wind Farms* (October 2008), and in Ontario O.Reg. 359-09 and proposed amendments (O.Reg. 521-10, 2010/12/20).

3.2 Determination of Receptors and Participants

Receptors and participants were identified through mapping, aerial photographs, and on-site surveys of the area. Typically, for this area, receptors are residential dwellings of individuals and families not associated with the project. Section 12 (Appendix A) lists limited details for all known receptors and participants situated within the project area. Their locations are shown in Figure 1. All receptors within 1.5 km of any GREP turbine have been included and reported in this noise impact analysis. All receptors have been considered to be designated as rural (NPC Class 3).

For the purposes of noise assessment, participants have been defined as dwellings occupied by landowners who receive financial compensation for the placement of project hardware (turbines, wind monitoring stations, cables, roads, sub-stations, *etc*.) on their properties.

3.3 Vacant Lots

The *Noise Guidelines for Wind Farms* (October 2008) document also requires prediction of the noise levels on "...vacant lots that have been zoned by the local municipality to permit residential or similar noise-sensitive uses...". Therefore, all vacant lots within 1.5 km of the GREP were identified as those lots defined by the complete set of cadastral parcel fabric which did not contain a receptor nor a participant dwelling (and were obviously not road rights-of-way, *etc*.). A one-hectare "building envelope within the vacant lot property that would reasonably be expected to contain the use, and that conforms with the municipal zoning by-laws in effect" was also identified for each of the vacant lots by determining a location within the vacant lot where the predicted noise level would be below the allowed maxima. A 'vacant lot surrogate receptor' (VLSR) centred in the one-hectare building envelope and designated with a height of 4.5 m was created for the purpose of noise estimation. The VLSRs are listed in Section 12 (Appendix A).

3.4 Methodology

ISO 9613-2 modelling was carried out for all receptors, participants and VLSRs). It should be noted that the calculated receptor sound pressure level for each 1-storey (height = 1.5 m) receptor was determined as the maximum calculated sound pressure level (SPrL) value at a height of 1.5 m at any point on the circumference of a 30 m circular 'amenity area' around the receptor location. For 2-storey and higher receptors, the SPrLs were determined as the maximum of calculated SPrL values at a height of 1.5 m at all points on the circumference of a 30 m amenity area buffer around the receptor and the calculated SPrL value at the receptor height at the receptor location itself. In the case of 2-storey receptors, the height was set to 4.5 m.

For areas where there is such a high density of receptors that it would be impractical (and tedious for the reader) to include them all, 'surrogate' receptors were designated. These receptors were chosen to represent the cluster of actual receptors in such a way that the surrogate receptors would be subject to the maximum SPrLs from the surrounding turbines. Typically, receptors at all corners and along all boundaries of the cluster of actual receptors were chosen with (generally) a maximum separation of 200 m between surrogate receptors where possible. All surrogate receptors were assigned a height of 4.5 m to ensure that any 2-storey residences within the cluster were represented.

As noted above, participating receptors (referred to herein as participants) have also been surveyed and are shown in Figure 1 and listed in Section 12 (Appendix A). Estimates of SPrLs were made for the participant locations.

It should be noted that the receptors, VLSRs, and participants listed in Section 12 include only those that are closer than or equal to 1,500 m from any project turbine or noise source.

4 DESCRIPTION OF SOURCES

4.1 GREP Wind Turbines

The turbines proposed for the GREP are manufactured by Siemens Wind Systems A/S (www.siemens.com) of Germany. Siemens Wind Power A/S is a relative new-comer to the ranks of wind turbine manufacturers. However, it entered the market by purchasing the long-standing and experienced Bonus turbine manufacturing company. The proposed models are the SWT-2.221-101 and the SWT-2.126-101.

4.1.1 Siemens SWT-2.221-101 Turbine

The following table summarizes this turbine's characteristics.

	Siemens SWT-2.221-101
Type, number of blades, rotor orientation	horizontal-axis, 3-bladed, upwind wind turbine
Rated power	2,221 kW
Rotor diameter; swept area	101.0 m; 8,000 m^2
Operational rotation rate	6.0 to 16.0 rpm; variable speed
Hub height; tower type	99.5 m; steel tubular tower
Power regulation	pitch regulation with variable speed
Cut-in wind speed	4 ms^{-1}
Cut-out wind speed	25 ms^{-1}
Rated wind speed	12-13 ms^{-1}
Gearbox	yes; 3 stage planetary/helical
Generator; speed	asynchronous with squirrel-cage rotor, without slip rings; variable speed
Turbine transformer	internal (within tower)
Braking system	aerodynamic primary brake by full-span feathering of individual blades; mechanical disk brake on high-speed shaft which has two hydraulic calipers
Yaw system	active electric externally geared slewring; passive friction brake

4.1.2 Siemens SWT-2.126-101 Turbine

The following table summarizes this turbine's characteristics.

	Siemens SWT-2.126-101
Type, number of blades, rotor orientation	horizontal-axis, 3-bladed, upwind wind turbine
Rated power	2,126 kW
Rotor diameter; swept area	101.0 m; 8,000 m^2
Operational rotation rate	6.0 to 16.0 rpm; variable speed
Hub height; tower type	99.5 m; steel tubular tower
Power regulation	pitch regulation with variable speed
Cut-in wind speed	4 ms^{-1}
Cut-out wind speed	25 ms^{-1}
Rated wind speed	12-13 ms^{-1}
Gearbox	yes; 3 stage planetary/helical
Generator; speed	asynchronous with squirrel-cage rotor, without slip rings; variable speed
Turbine transformer	internal (within tower)
Braking system	aerodynamic primary brake by full-span feathering of individual blades; mechanical disk brake on high-speed shaft which has two hydraulic calipers
Yaw system	active electric externally geared slewring; passive friction brake

4.2 SWEC Wind Turbines

In addition to the GREP Siemens SWT-2.221-101 and SWT-2.126-101 turbines, there are 60 Siemens SWT-2.221-101 turbines and one Siemens SWT-2.221-93 turbine in the Summerhaven Wind Energy Centre project. Because the Golder (2010) project noise assessment report does not specify which of the Summerhaven wind turbines is the single SWT-2.221-93, and for simplicity of analysis, Zephyr North treated the Summerhaven Wind Project as all 61 Siemens SWT-2.221-101 turbines. This is a conservative simplification as the maximum broadband source sound power level for the SWT-2.221-101 is approximately 0.6 dB higher than that of the SWT-2.221-93.

4.2.1 Siemens SWT-2.221-101 Turbine

A description of the SWT-2.221-101turbine has been provided above. NextEra has not provided any information to Samsung Renewable Energy Inc. nor to Zephyr North to suggest that the SWT-2.221-101 turbines used in the Summerhaven project will be any different from the description in the table above. Note, though, that the proposed hub height for the turbines of the Summerhaven project is 80 m.

Turbine locations and any additionally required information have been taken from the Golder (2010) noise assessment report.

All of these SWT-2.221-101 turbines have been included in the present assessment.

4.3 BWP Wind Turbines

4.3.1 GE Energy 1.5sle Turbine

In addition to the GREP Siemens SWT-2.221-101 and SWT-2.126-101 turbines and the Summerhaven SWT-2.221-101 and SWT-2.221-93 turbines, there are 6 GE Energy 1.5sle turbines proposed for the International Power Canada Byng Wind Project.

Turbine location data have been provided by IPC.

All of the proposed 1.5sle turbines have been included in the present assessment.

The following table describes this turbine model's major characteristics.

	GE Energy 1.5sle
Type, number of blades, rotor orientation	horizontal-axis, 3-bladed, upwind wind turbine
Rated power	1,500 kW
Rotor diameter; swept area	77.0 m; 4,657 m^2
Operational rotation rate	variable speed
Hub height; tower type	80 m; steel tubular tower
Power regulation	active blade pitch controlled with variable speed
Cut-in wind speed	3.5 ms^{-1}
Cut-out wind speed	25 ms^{-1}
Rated wind speed	14 ms^{-1}
Gearbox	yes; 3 stage planetary/helical design
Generator; speed	doubly fed induction-generator with wound rotor and slip rings; 870 rpm-1600rpm
Turbine transformer	unknown
Braking system	electrical individual blade pitch system with a mechanical brake as well
Yaw system	roller bearing, 4 automatic planetary yaw drives

4.4 GREP Sub-Station

4.4.1 Description

The GREP consists not only of a 148.3 MW wind farm but also a 100 MW solar farm. As a consequence, there will be a shared sub-station located as shown in Figure 1. This sub-station will comprise two collocated project transformers. It is understood from Samsung Renewable Energy Inc. that the broadband source sound power level for each of the transformers will be a maximum of 50 dBA at the sound barriers which will be placed around the transformers to reduce the noise impact on neighbouring receptors.

5 NOISE EMISSION RATINGS

5.1 GREP Wind Turbines

5.1.1 Siemens SWT-2.221-101

Siemens SWT-2.221-101 turbine source sound power level octave band and broadband data for hub-height wind speeds of 4 to 12 ms^{-1} were provided in Siemens A/S documentation (Siemens, 2010) supplied by Samsung Renewable Energy Inc. For clarity, note that this turbine is a power-derated Siemens SWT-2.3-101 turbine. (For information, this latter turbine's full broadband source SPoL is cited as 106 dBA while its rated power is 2.3 MW.)

The broadband and octave band noise information was used with the site-specific power law wind shear exponent of 0.45 (see below for derivation) to synthesize/interpolate/extrapolate source octave sound power levels for 10 m a.g.l. wind speeds of 6, 7, 8, 9, and 10 ms^{-1} for use in the ISO 9613-2 estimates of receptor noise levels.

In the Windtest (2005) report on the Siemens 2.3 MW Mk II turbine, the following statement is made in a section titled, "3.4 Tonal and frequency analysis". "In accordance with the technical guideline [IEC61400-11] a tonal analysis has to be carried out. The frequency spectrum of the noise, which is measured on the acoustically hard board, is determined on the basis of a narrow band analysis by means of the FFT-analyser B&K 2144. This analysis was performed after the measurement using the audio signal recorded on a DAT-recorder. The results of the tonal analysis of the Siemens 2.3 MW MkII according to [IEC 61400-11] are given in table 4." The relevant portion of Windtest (2005) "table 4" is repeated below.

Windtest (2005) Table 4: Summary of results [portion]					
wind speed in 10 m height [m/s]	**6**	**7**	**8**	**9**	**10**
tonality, ΔL_k [dB]	-5,58	-4,68	-6,36	-5,43	-5,91
tonal audibility, $\Delta L_{a,k}$ [dB]	-2,58	-1,69	-3,36	-2,43	-3,58
frequency of the most prevalent tone [Hz]	1200	1200	1200	1200	530

Siemens states in an email (Youmans, 2011), "The enclosed noise test report [Windtest, 2005] for the SWT 2.3-93 has been used on other applications to demonstrate the lack of any tonal characteristics. A similar report will be issued for the SWT 2.3-101 in the near future, but in the meantime this report has been accepted for proof of tonality since both units share common gearbox, generator, and converter systems."

Uncertainty in the tonal analysis is mentioned in section 3.6.3 ("Tonality") of the Windtest (2005) report.

No tonal penalty has been applied to this turbine.

The 10 m broadband and octave band source sound power levels for the Siemens SWT-2.221-101 turbine under its power-reduced operation protocol for a hub height of 99.5 m are shown in Table 1. Note that the 'Manufacturer's emission levels' were only provided for 6 and 8 ms^{-1}. For 7-ms^{-1}, octave band SPoLs have been interpolated; the 9 and 10-ms^{-1} SPoLs have been set equal to the 8-ms^{-1} SpoLs.

Table 1 Siemens SWT-2.221-101 — Wind turbine acoustic emissions summary.

Make and Model: Siemens SWT-2.221-101										
Rating: 2,221 kW										
Hub height (m): 99.5										
Wind profile adjustment: summer night-time power-law wind shear coefficient = 0.45										
	Octave band sound power level (dB)									
	Manufacturer's emission levels (10 m a.g.l)					**Adjusted emission levels (10 m a.g.l.)**				
Wind speed (ms^{-1})	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
Frequency (Hz)										
63	108.3	n/a	108.6	n/a	n/a	108.6	108.6	108.6	108.6	108.6
125	109.4	n/a	109.1	n/a	n/a	109.1	109.1	109.1	109.1	109.1
250	105.1	n/a	104.6	n/a	n/a	104.6	104.6	104.6	104.6	104.6
500	102.2	n/a	103.0	n/a	n/a	103.0	103.0	103.0	103.0	103.0
1000	99.1	n/a	100.1	n/a	n/a	100.1	100.1	100.1	100.1	100.1
2000	95.4	n/a	95.3	n/a	n/a	95.3	95.3	95.3	95.3	95.3
4000	87.8	n/a	88.6	n/a	n/a	88.6	88.6	88.6	88.6	88.6
8000	85.5	n/a	86.8	n/a	n/a	86.8	86.8	86.8	86.8	86.8
A-weighted	**104.5**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**

5.1.2 Siemens SWT-2.126-101

Siemens SWT-2.126-101 turbine broadband source sound power level data for 10-m a.g.l. wind speeds of 4 to 12 ms^{-1} and octave band source sound power level data for 10-m a.g.l. wind speeds of 6 and 8 ms^{-1} are listed in Siemens A/S documents

(Siemens, 2010) supplied by Samsung Renewable Energy Inc. For clarity, note that this turbine is a power de-rated version of the Siemens SWT-2.3-101 turbine.

The broadband and octave band noise information was used with the site-specific power law wind shear exponent of 0.45 (see below for derivation) to synthesize/interpolate/extrapolate source octave sound power levels for 10 m a.g.l. wind speeds of 6, 7, 8, 9, and 10 ms^{-1} for use in the ISO 9613-2 estimates of receptor noise levels.

In Windtest (2005), the following statement is made in a section titled, "3.4 Tonal and frequency analysis". "In accordance with the technical guideline [IEC61400-11] a tonal analysis has to be carried out. The frequency spectrum of the noise, which is measured on the acoustically hard board, is determined on the basis of a narrow band analysis by means of the FFT-analyser B&K 2144. This analysis was performed after the measurement using the audio signal recorded on a DAT-recorder. The results of the tonal analysis of the Siemens 2.3 MW MkII according to [IEC 61400-11] are given in table 4." The relevant portion of Windtest (2005) "table 4" is repeated below.

Windtest (2005) Table 4: Summary of results [portion]					
wind speed in 10 m height [m/s]	***6***	***7***	***8***	***9***	***10***
tonality, ΔL_k [dB]	*-5,58*	*-4,68*	*-6,36*	*-5,43*	*-5,91*
tonal audibility, $\Delta L_{a,k}$ [dB]	*-2,58*	*-1,69*	*-3,36*	*-2,43*	*-3,58*
frequency of the most prevalent tone [Hz]	*1200*	*1200*	*1200*	*1200*	*530*

Siemens states in an email (Youmans, 2011), "The enclosed noise test report [Windtest, 2005] for the SWT 2.3-93 has been used on other applications to demonstrate the lack of any tonal characteristics. A similar report will be issued for the SWT 2.3-101 in the near future, but in the meantime this report has been accepted for proof of tonality since both units share common gearbox, generator, and converter systems."

Uncertainty in the tonal analysis is mentioned in section 3.6.3 ("Tonality") of the Windtest (2005) report.

No tonal penalty has been applied to this turbine.

The 10 m broadband and octave band source sound power levels for the Siemens SWT-2.126-101 turbine (under its power-reduced operation protocol for a hub height of 99.5 m) are shown in Table 2. Note that the 'Manufacturer's emission levels' were only provided for 6 and 8 ms^{-1}. For 7-ms^{-1}, octave band SPoLs have been interpolated; the 9 and 10-ms^{-1} SPoLs have been set equal to the 8-ms^{-1} SpoLs.

Table 2 Siemens SWT-2.126-101 — Wind turbine acoustic emissions summary.

Make and Model: Siemens SWT-2.126-101										
Rating: 2,126 kW										
Hub height (m): 99.5										
Wind profile adjustment: summer night-time power-law wind shear coefficient = 0.45										
	Octave band sound power level (dB)									
	Manufacturer's emission levels (10 m a.g.o.)					**Adjusted emission levels (10 m a.g.l.)**				
Wind speed (ms^{-1})	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
Frequency (Hz)										
63	108.8	n/a	108.4	n/a	n/a	108.4	108.4	108.4	108.4	108.4
125	109.7	n/a	108.6	n/a	n/a	108.6	108.6	108.6	108.6	108.6
250	104.7	n/a	103.4	n/a	n/a	103.4	103.4	103.4	103.4	103.4
500	100.5	n/a	101.7	n/a	n/a	101.7	101.7	101.7	101.7	101.7
1000	97.4	n/a	99.1	n/a	n/a	99.1	99.1	99.1	99.1	99.1
2000	94.8	n/a	94.3	n/a	n/a	94.3	94.3	94.3	94.3	94.3
4000	86.9	n/a	88.0	n/a	n/a	88.0	88.0	88.0	88.0	88.0
8000	84.6	n/a	86.2	n/a	n/a	86.2	86.2	86.2	86.2	86.2
A-weighted	**103.5**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**

5.2 SWEC Wind Turbines

5.2.1 Siemens SWT-2.221-101

The 10 m broadband and octave source sound power levels for the Siemens SWT-2.221-101 turbine with a hub height of 80 m are shown in Table 3. These values have been taken directly from the Summerhaven project (draft) Noise Study Report (Golder, 2010). It should be noted that Zephyr North has modified the ' Adjusted' octave band source sound power level values for 6 and 7 ms^{-1} to match the remaining values at 8, 9 and 10 ms^{-1}. It is believed that this will more accurately represent the turbine noise characteristics at the relatively higher hub-height wind speeds corresponding to the 10-m wind speeds which would be driven by the high (0.45) summer night-time wind shear.

Golder (2010) makes no mention of tonality with regard to this turbine. Since this turbine is the same power- derated version of the SWT2.3-101 described for the GREP project, it has been assumed for the purposes of this noise assessment report that there is no tonal noise associated with the Summerhaven turbines. No tonal penalty has been applied.

Golder (2010) reports that a summer night-time vertical wind shear of 0.42 was used for hub-height wind speed adjustments.

Table 3 Summerhaven SWT-2.221-101 wind turbine acoustic emissions summary.

Make and Model: Siemens SWT-2.221-101										
Rating: 2,221 kW										
Hub height (m): 80.0										
Wind profile adjustment: summer night-time power-law wind shear coefficient: 0.42										
	Octave band sound power level (dB)									
	Manufacturer's emission levels (10 m a.g.l.)					**Adjusted emission levels (10 m a.g.l.)**				
Wind speed (ms^{-1})	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
Frequency (Hz)										
63	108.8	n/a	108.6	n/a	n/a	108.6	108.6	108.6	108.6	108.6
125	109.9	n/a	109.1	n/a	n/a	109.1	109.1	109.1	109.1	109.1
250	105.6	n/a	104.6	n/a	n/a	104.6	104.6	104.6	104.6	104.6
500	102.7	n/a	103.0	n/a	n/a	103.0	103.0	103.0	103.0	103.0
1000	99.6	n/a	100.1	n/a	n/a	100.1	100.1	100.1	100.1	100.1
2000	95.9	n/a	95.3	n/a	n/a	95.3	95.3	95.3	95.3	95.3
4000	88.3	n/a	88.6	n/a	n/a	88.6	88.6	88.6	88.6	88.6
8000	86.0	n/a	86.8	n/a	n/a	86.8	86.8	86.8	86.8	86.8
A-weighted	**105.0**	**n/a**	**105.0**	**n/a**	**n/a**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**

5.3 BWP Wind Turbines

5.3.1 GE Energy 1.5sle

The 10 m broadband and octave source sound power levels for the GE Energy 1.5sle turbine with a hub height of 80 m are shown in Table 4. There are no published details (EA or REA assessments, for example) for this project, so Zephyr North has taken noise information from the generally available literature.

Generally available documentation states that, "At the reference measuring point R_0, a ground distance from the turbine base equal to hub height plus half the rotor diameter, the GE 1.5sl/sle turbine has a value for tonality of (ΔL_a) $\leq$ 4 dB, irrespective of wind speed, turbine type, hub height, and grid frequency. R_0 and ΔL_a are defined here according to IEC 61400-11: 2002." No tonal penalty has been applied to this turbine.

A value of 0.34 has been used for the summer night-time vertical wind shear for hub-height wind speed adjustment. This value was determined from four years of wind profile data from IPC's on-site Grant Point 50 m WM wind monitoring station.

Table 4 GE Energy 1.5sle — Wind turbine acoustic emissions summary.

Make and Model: GE Energy 1.5sle										
Rating: 1,500 kW										
Hub height (m): 80.0										
Wind profile adjustment: summer night-time power-law wind shear coefficient: 0.34										
	Octave band sound power level (dB)									
	Manufacturer's emission levels (hub-height)					**Adjusted emission levels (10 m a.g.l.)**				
Wind speed (ms^{-1})	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
Frequency (Hz)										
63	103.9	107.1	110.0	111.3	111.3	111.3	111.3	111.3	111.3	111.3
125	102.7	105.9	108.8	110.1	110.1	110.1	110.1	110.1	110.1	110.1
250	98.4	101.6	104.5	105.8	105.8	105.8	105.8	105.8	105.8	105.8
500	94.4	97.6	100.5	101.8	101.8	101.8	101.8	101.8	101.8	101.8
1000	90.5	93.7	96.6	97.9	97.9	97.9	97.9	97.9	97.9	97.9
2000	85.9	89.1	92.0	93.3	93.3	93.3	93.3	93.3	93.3	93.3
4000	78.9	82.1	85.0	86.3	86.3	86.3	86.3	86.3	86.3	86.3
8000	71.8	75.0	77.9	79.2	79.2	79.2	79.2	79.2	79.2	79.2
A-weighted	**96.6**	**99.8**	**102.7**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**

5.4 Site-Specific Vertical Wind Shear Exponent

The site-specific vertical wind shear exponent was calculated from two project *in situ* wind monitoring stations — Mast1 60 m WM and Mast2 60 m WM (shown in Figure 1) — installed on the GREP site. Both these wind monitoring stations have wind measurements at nominal levels of 30, 45 and 60 m. There is a third wind monitoring mast on the site with a height of approximately 100 m. Unfortunately, there are, as of yet, insufficient summertime data for calculation of summer night-time vertical wind shear.

The vertical wind shear exponent was calculated by Zephyr North from a least-squares fit of a power law profile to period-averaged data at the three available levels of wind speed. The averaged data were filtered to include only summer months (April through September inclusive) and the diurnal hours between 23:00 and 07:00 the following day. That is, the power law wind shear exponent for the 'average summer night time wind speed profile' is reported here — specifically, 0.44 for the Mast1 60 m WM station, and 0.45 for the Mast2 60 m WM station. One full summer of data was used for each station.

To be conservative, a value of 0.45 was used for the vertical wind shear exponent for the purposes of this report.

5.5 GREP Transformer Sub-Station

5.5.1 Noise Emission Rating

As the specific transformer models have not yet been determined for the project, octave band source sound power levels characteristic of a typical power transformer were adjusted to reflect the maximum 50 dBA broadband source sound power level at the exterior of the barrier, as guaranteed by the project proponent. These are listed in Table 5 along with a 5 dB tone penalty assessed to every octave band. The net octave band source sound power levels are also shown, as is the resulting broadband source sound power levels before and after assessment of the penalties.

Table 5 Project transformer station acoustic emissions summary.

Make and Model: Unknown at this time			
Rating: Unknown at this time			
Source height (m): 4.0 m			
	Source sound power level (dB)	**Tonal penalty (dB)**	**Net source sound power level (dB)**
Frequency (Hz)			
63	28.5	5.0	33.5
125	40.6	5.0	45.6
250	43.1	5.0	48.1
500	48.5	5.0	53.5
1000	45.7	5.0	50.7
2000	41.9	5.0	46.9
4000	36.7	5.0	41.7
8000	27.6	5.0	32.6
A-weighted (dBA)	50.0		55.0

6 IMPACT ASSESSMENT

6.1 Methodology

Cumulative turbine sound levels were estimated at each of the receptors using the ISO 9613-2 model as implemented in the Zephyr North WFNoise software program which interacts with the ReSoft WindFarm program (www.resoft.co.uk) to extract turbine data required for the analysis. Receptor, VLSR, and participant data are extracted from a supplementary file.

Wind turbine octave band and A-weighted sound power values, standardized meteorological conditions, turbine locations, receptor/VLSR/participant locations, and characteristics were used to determine the A-weighted sound pressure levels at all receptors.

6.2 Specific Parameters

a)

Analysis was carried out for turbine source sound power levels in eight octave bands (63 to 8,000 Hz) corresponding to 10 m (a.g.l.) ambient wind speeds of 6, 7, 8, 9, and 10 ms^{-1}.

b)

ISO 9613-2 parameters, as prescribed in the MoE *Noise Guidelines for Wind Farms; Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities (October 2008)* were set as follows:

Ambient air temperature: 10 C
Ambient barometric pressure: 101.325 kPa
Ambient humidity: 70 %

Note that barometric pressure (standard, sea-level) is included here as it is required for the ISO 9613-1 Standard calculation of atmospheric sound absorption as described in the following paragraph.

The attenuation due to atmospheric absorption was based on atmospheric attenuation coefficients for 10 C, 70 % relative humidity, and 101.325 kPa barometric pressure. Note that since the numerical model used for the present calculations also includes the ISO 9613-1 Standard (*Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of* *sound by the atmosphere*), the absorption coefficients for 4 and 8 kHz differ slightly from those prescribed in the MoE *Noise Guidelines for Wind Farms October 2008* document. These are shown in the following table.

Atmospheric Absorption Coefficients								
Centre Octave Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Atmospheric Absorption Coefficient (dB/km) from MoE Oct 2008 document	0.1	0.4	1.0	1.9	3.7	9.7	32.8	117.0
Atmospheric Absorption Coefficient (dB/km) from ISO 9613-1 calculation	0.1	0.4	1.0	1.9	3.7	9.7	33.1	118.4

For modelling consistency, the coefficients from the ISO 9613-1 Standard were used. Sensitivity tests have shown that for these high frequencies and the distances typically under consideration in wind farms there is no practical difference in the resultant receptor sound pressure levels.

c)

The ISO 9613-2 term for Ground Attenuation was calculated using the "General" Method (Section 7.3.1 of the Standard). Ground factors were assigned the following values as required by the MoE *Noise Guidelines for Wind Farms (October 2008)* publication.

Source ground factor: 1.0 (soft ground)
Middle ground factor: 0.8 (soft ground)
Receptor ground factor: 0.5 (hard/soft ground)

6.3 Additional parameters and conditions

Sound pressure levels were not calculated for any receptors for which there was no GREP turbine closer than 1,500 m.

For any receptor, turbines further than 5,000 m away were not included in the calculations.

No additional adjustments were made for wind speed or direction since ISO 9613-2 assumes worst-case conditions for these parameters with respect to noise impact.

6.4 Results

Results are reported in Tables 7, 8 and 9 found in Section 7 and the noise level isopleth map of Section 8 .

To briefly summarize, Table 6 is a sorted list of the highest sound pressure levels determined in the analysis for receptors and VLSRs.

Table 6 WFNoise – Highest noise levels at receptors

Receptor ID	SPrL (dBA)	Height (m)	Nearest Turbine	Project or Other Turbine	Distance (m)
R1265	40.0	4.5	T3	P	757
R2885	40.0	4.5	T60	P	640
V3276	40.0	4.5	T20	P	584
R566	40.0	4.5	T233	O	524
V3264	39.9	4.5	T48	P	618
V3716	39.9	4.5	T60	P	801
R1000	39.9	4.5	T49	P	734
R732	39.9	4.5	T21	P	668
V3707	39.9	4.5	T26	P	759
R2956	39.9	4.5	T54	P	783
R694	39.9	4.5	T40	P	683
V3816	39.9	4.5	T8	P	866
R3010	39.8	4.5	T61	P	741
R676	39.8	4.5	T55	P	743
R871	39.8	4.5	T26	P	848
R733	39.8	4.5	T12	P	632
R730	39.8	4.5	T21	P	688
V3827	39.8	4.5	T67	P	684
R869	39.8	4.5	T15	P	678
V3776	39.8	4.5	T13	P	658
R679	39.8	4.5	T53	P	807
V3772	39.7	4.5	T55	P	768
V3836	39.7	4.5	T60	P	657
R990	39.7	4.5	T8	P	934
V3777	39.7	4.5	T12	P	735
R142	39.7	4.5	T28	P	669
WindFarm layout file: GRE10-WFL016.WFL					

7 NOISE LEVEL SUMMARY TABLES

Table 7 Receptor noise level summary table.

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R33	Residence	4.5	1164	T18	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R34	Residence	1.5	1049	T18	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R35	Residence	4.5	891	T18	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R36	Residence	4.5	1017	T18	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R37	Residence	1.5	664	T18	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R38	Residence	1.5	706	T18	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R39	Residence	4.5	612	T18	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R40	Residence	4.5	653	T18	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R43	Residence	1.5	727	T18	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R44	Residence	1.5	629	T18	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R45	Residence	4.5	688	T18	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R46	Residence	1.5	895	T18	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R47	Residence	4.5	883	T18	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R48	Residence	4.5	1056	T18	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R49	Residence	1.5	1082	T18	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R50	Residence	1.5	1181	T18	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R51	Residence	1.5	1067	T34	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R52	Residence	1.5	1023	T34	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R53	Residence	4.5	917	T34	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R54	Residence	1.5	964	T34	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R55	Residence	1.5	992	T34	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R56	Residence	1.5	1024	T34	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R57	Residence	4.5	1041	T34	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R58	Residence	1.5	1107	T34	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R59	Residence	1.5	1088	T34	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R60	Residence	4.5	958	T34	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R61	Residence	4.5	851	T34	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R63	Residence	1.5	815	T34	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R64	Residence	1.5	802	T34	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R65	Residence	1.5	835	T33	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R66	Residence	1.5	708	T34	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R69	Residence	1.5	921	T45	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R70	Residence	4.5	957	T36	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R72	Residence	4.5	820	T36	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R73	Residence	1.5	896	T36	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R74	Residence	4.5	1011	T41	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R75	Residence	1.5	1212	T41	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R76	Residence	1.5	1208	T36	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R77	Residence	4.5	1271	T36	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R78	Residence	1.5	1317	T36	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
R90	Residence	4.5	1385	T41	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R91	Residence	1.5	1310	T41	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
R92	Residence	1.5	1305	T41	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
R93	Residence	1.5	1296	T41	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
R95	Residence	1.5	1131	T41	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R96	Residence	4.5	1234	T41	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R98	Residence	1.5	1316	T28	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R99	Residence	1.5	1259	T28	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R100	Residence	1.5	993	T28	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R101	Residence	1.5	956	T28	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R102	Residence	4.5	1055	T28	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R103	Residence	1.5	901	T28	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R104	Residence	1.5	861	T28	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R105	Residence	1.5	1059	T46	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R106	Residence	4.5	848	T43	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R108	Residence	4.5	697	T43	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R109	Residence	4.5	957	T43	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R110	Residence	4.5	1067	T43	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R111	Residence	1.5	1083	T211	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R112	Residence	1.5	1134	T211	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R113	Residence	4.5	1024	T211	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R115	Residence	1.5	1367	T18	31.4	31.4	31.4	31.4	31.4	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R119	Residence	1.5	826	T43	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R120	Residence	1.5	805	T34	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R121	Residence	1.5	710	T43	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R122	Residence	1.5	672	T43	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R127	Residence	1.5	846	T211	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R128	Residence	1.5	984	T211	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R129	Residence	4.5	1020	T211	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R130	Residence	4.5	1273	T211	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R131	Residence	1.5	987	T43	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R132	Residence	1.5	944	T43	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R133	Residence	1.5	818	T43	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R134	Residence	4.5	793	T43	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R135	Residence	1.5	815	T43	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R136	Residence	4.5	926	T43	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R137	Residence	4.5	1053	T43	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R138	Residence	4.5	1135	T43	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R139	Residence	4.5	884	T46	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R141	Residence	4.5	809	T46	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R142	Residence	4.5	669	T28	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R143	Residence	4.5	643	T28	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R144	Residence	4.5	899	T28	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R145	Residence	4.5	1001	T28	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R146	Residence	4.5	1150	T28	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R147	Residence	4.5	816	T28	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R148	Residence	4.5	842	T28	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R149	Residence	4.5	1151	T28	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R150	Residence	4.5	999	T28	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R152	Residence	1.5	999	T28	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R153	Residence	4.5	1261	T28	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R155	Residence	1.5	1114	T28	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R158	Residence	4.5	1433	T23	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R159	Residence	4.5	1408	T23	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R160	Residence	1.5	1386	T23	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R161	Residence	1.5	1314	T23	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R162	Residence	1.5	1330	T23	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R163	Residence	1.5	1344	T23	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R164	Residence	1.5	1301	T23	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R165	Residence	4.5	1422	T23	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R166	Residence	1.5	1499	T24	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R167	Residence	1.5	1461	T24	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R170	Residence	1.5	1276	T24	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R171	Residence	1.5	1126	T24	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R172	Residence	1.5	1012	T24	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R173	Residence	4.5	871	T24	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R174	Residence	4.5	878	T24	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R175	Residence	4.5	647	T20	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
R176	Residence	1.5	665	T20	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R178	Residence	4.5	597	T20	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R179	Residence	1.5	847	T20	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R180	Residence	1.5	829	T20	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R181	Residence	1.5	856	T20	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R182	Residence	4.5	931	T228	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R184	Residence	4.5	692	T228	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R185	Residence	4.5	633	T228	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R239	Residence	1.5	874	T58	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R243	Residence	1.5	855	T58	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R244	Residence	4.5	802	T58	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R245	Residence	1.5	832	T58	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R246	Residence	4.5	950	T58	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R250	Residence	4.5	1285	T211	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R253	Residence	4.5	1335	T58	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R254	Residence	4.5	668	T58	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R255	Residence	4.5	659	T58	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R256	Residence	4.5	628	T219	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R257	Residence	4.5	765	T219	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R259	Residence	4.5	613	T219	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R260	Residence	1.5	815	T219	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R261	Residence	1.5	897	T219	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R262	Residence	4.5	769	T58	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R263	Residence	1.5	821	T58	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R265	Residence	1.5	946	T58	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R266	Residence	4.5	918	T58	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R267	Residence	1.5	864	T58	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R268	Residence	4.5	838	T58	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R269	Residence	4.5	860	T46	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R270	Residence	4.5	673	T58	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R271	Residence	4.5	572	T46	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R272	Residence	1.5	663	T46	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R273	Residence	1.5	798	T23	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R275	Residence	1.5	795	T23	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R276	Residence	4.5	731	T23	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R277	Residence	4.5	754	T23	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R278	Residence	1.5	648	T23	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R279	Residence	4.5	689	T23	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R280	Residence	1.5	856	T23	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R281	Residence	4.5	909	T23	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R282	Residence	4.5	901	T23	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R283	Residence	1.5	1083	T23	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R284	Residence	4.5	930	T16	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R285	Residence	1.5	837	T10	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R288	Residence	4.5	836	T13	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R289	Residence	4.5	691	T13	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R290	Residence	4.5	569	T13	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R291	Residence	4.5	664	T13	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R292	Residence	1.5	681	T13	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R293	Residence	4.5	575	T13	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R294	Residence	1.5	760	T13	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R295	Residence	4.5	593	T13	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R296	Residence	1.5	674	T13	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R297	Residence	4.5	799	T13	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R300	Residence	4.5	729	T13	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R302	Residence	1.5	705	T10	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R303	Residence	4.5	717	T10	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R304	Residence	1.5	1209	T10	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R305	Residence	1.5	873	T10	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R306	Residence	4.5	1148	T233	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R307	Residence	1.5	628	T300	31.2	31.2	31.2	31.2	31.2	40.0	43.0	45.0	49.0	51.0
R308	Residence	1.5	1178	T13	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R309	Residence	4.5	1437	T13	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
R325	Residence	1.5	1409	T56	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
R327	Residence	4.5	1327	T56	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R336	Residence	1.5	759	T22	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R337	Residence	4.5	640	T22	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R338	Residence	4.5	715	T22	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R339	Residence	4.5	774	T22	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R340	Residence	1.5	754	T22	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R341	Residence	4.5	913	T22	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R342	Residence	1.5	855	T22	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R343	Residence	7.5	1260	T22	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R349	Residence	4.5	1176	T14	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R350	Residence	1.5	1080	T13	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R353	Residence	1.5	592	T13	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R354	Residence	4.5	725	T13	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R355	Residence	4.5	1069	T16	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R356	Residence	1.5	875	T13	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R357	Residence	1.5	1023	T13	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R358	Residence	4.5	1014	T16	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R359	Residence	1.5	740	T16	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R360	Residence	1.5	926	T16	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R361	Residence	1.5	1131	T301	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R362	Residence	1.5	844	T301	31.1	31.1	31.1	31.1	31.1	40.0	43.0	45.0	49.0	51.0
R363	Church	1.5	918	T301	31.4	31.4	31.4	31.4	31.4	40.0	43.0	45.0	49.0	51.0
R364	Residence	7.5	955	T301	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R365	Residence	1.5	1295	T301	30.1	30.1	30.1	30.1	30.1	40.0	43.0	45.0	49.0	51.0
R366	Residence	1.5	1399	T301	29.1	29.1	29.1	29.1	29.1	40.0	43.0	45.0	49.0	51.0
R367	Residence	4.5	1445	T301	30.8	30.8	30.8	30.8	30.8	40.0	43.0	45.0	49.0	51.0
R369	Residence	4.5	1441	T56	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R370	Residence	4.5	1465	T56	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R371	Residence	4.5	1246	T56	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R372	Residence	1.5	911	T56	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R373	Residence	1.5	1088	T56	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R374	Residence	4.5	856	T56	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R378	Residence	1.5	956	T300	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R380	Residence	1.5	1202	T17	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R381	Residence	1.5	1179	T17	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R383	Residence	4.5	977	T17	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R386	Residence	4.5	849	T17	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R387	Residence	1.5	849	T27	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R388	Residence	1.5	859	T27	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R389	Residence	4.5	1037	T27	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R390	Residence	4.5	901	T56	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R391	Residence	4.5	851	T56	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R392	Residence	1.5	642	T56	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R393	Residence	4.5	602	T56	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R394	Residence	4.5	893	T56	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R395	Residence	4.5	787	T56	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R396	Residence	1.5	1163	T56	31.8	31.8	31.8	31.8	31.8	40.0	43.0	45.0	49.0	51.0
R399	Residence	4.5	686	T55	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R401	Residence	1.5	1053	T55	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R402	Residence	4.5	897	T9	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R403	Residence	1.5	778	T9	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R404	Residence	1.5	636	T9	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R405	Residence	4.5	1025	T9	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R406	Residence	4.5	877	T10	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R407	Residence	1.5	871	T10	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R408	Residence	1.5	674	T10	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R409	Residence	1.5	671	T10	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R410	Residence	1.5	750	T10	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R411	Residence	4.5	873	T10	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R412	Residence	1.5	904	T10	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R413	Residence	4.5	876	T10	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R414	Residence	1.5	968	T10	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R415	Residence	4.5	1220	T10	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R416	Residence	4.5	1338	T233	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R455	Residence	4.5	659	T301	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R457	Residence	4.5	698	T301	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R459	Residence	1.5	622	T301	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
R460	Residence	4.5	986	T300	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R461	Residence	1.5	1081	T300	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R462	Residence	4.5	1071	T300	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R464	Residence	1.5	1248	T300	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R465	Residence	4.5	1399	T300	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R466	Residence	4.5	1185	T247	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R467	Residence	1.5	904	T247	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R468	Residence	4.5	1005	T247	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R469	Residence	1.5	959	T17	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R470	Residence	4.5	904	T17	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R471	Residence	4.5	1012	T17	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R501	Residence	1.5	951	T42	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R502	Residence	4.5	1036	T68	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R503	Residence	4.5	856	T68	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R504	Residence	4.5	947	T68	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R505	Residence	4.5	881	T12	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R507	Residence	4.5	762	T12	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R508	Residence	4.5	745	T12	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R509	Residence	4.5	773	T12	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R510	Residence	4.5	846	T12	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R512	Residence	4.5	707	T12	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R513	Residence	1.5	718	T21	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R515	Residence	1.5	761	T21	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R516	Residence	1.5	636	T51	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R517	Residence	1.5	879	T51	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R518	Residence	1.5	881	T51	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R519	Residence	1.5	836	T51	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R520	Residence	1.5	1116	T2	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R521	Residence	1.5	1144	T2	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R523	Residence	1.5	571	T2	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R524	Residence	4.5	630	T4	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R525	Residence	4.5	623	T4	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R527	Residence	1.5	735	T4	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R528	Residence	4.5	821	T11	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R529	Residence	4.5	856	T4	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R530	Residence	1.5	851	T11	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R531	Residence	1.5	734	T11	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R532	Residence	1.5	664	T11	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R533	Residence	1.5	754	T11	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R534	Residence	1.5	811	T11	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R535	Residence	4.5	867	T11	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R536	Residence	1.5	877	T4	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R537	Residence	1.5	881	T4	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R540	Residence	4.5	775	T14	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R541	Residence	1.5	956	T14	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R559	Residence	1.5	1435	T10	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R561	Residence	4.5	1050	T10	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R562	Residence	1.5	550	T10	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R564	Residence	4.5	636	T10	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R565	Residence	1.5	598	T233	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R566	Residence	4.5	524	T233	40.0	40.0	40.0	40.0	40.0	40.0	43.0	45.0	49.0	51.0
R567	Residence	4.5	689	T233	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R568	Residence	4.5	752	T233	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R569	Residence	4.5	951	T233	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R570	Residence	4.5	891	T233	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R571	Residence	1.5	1086	T233	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R572	Residence	4.5	1115	T233	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R573	Residence	4.5	1102	T300	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R574	Residence	4.5	789	T300	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R575	Residence	4.5	627	T300	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R576	Residence	4.5	769	T300	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R577	Residence	4.5	769	T300	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R578	Residence	1.5	1120	T300	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R579	Residence	1.5	1164	T300	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R581	Residence	1.5	1208	T17	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R582	Residence	1.5	1178	T17	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R584	Residence	4.5	1040	T27	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R585	Residence	4.5	1014	T27	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R588	Residence	4.5	889	T44	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R590	Residence	4.5	899	T25	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R591	Residence	4.5	1008	T44	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
R592	Residence	4.5	946	T53	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R593	Residence	4.5	705	T42	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R595	Residence	4.5	718	T42	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R596	Residence	4.5	1134	T42	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R597	Residence	4.5	1100	T68	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R598	Residence	4.5	1111	T38	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R599	CEMETARY	1.5	1005	T38	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R602	Residence	4.5	934	T35	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R603	Residence	4.5	894	T35	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R604	Residence	4.5	913	T35	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R605	Residence	4.5	814	T35	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R606	Residence	4.5	796	T35	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R607	Residence	4.5	809	T35	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R608	Residence	1.5	965	T35	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R609	Residence	4.5	778	T14	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R611	Residence	4.5	603	T47	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R612	Residence	1.5	617	T47	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R613	Residence	4.5	600	T47	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R614	Residence	4.5	754	T47	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R615	Residence	4.5	995	T47	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R616	Residence	4.5	1005	T47	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R617	Residence	4.5	1028	T57	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R619	Residence	1.5	1025	T57	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R621	Residence	4.5	1470	T57	30.1	30.1	30.1	30.1	30.1	40.0	43.0	45.0	49.0	51.0
R622	Residence	1.5	1384	T57	29.0	29.0	29.0	29.0	29.0	40.0	43.0	45.0	49.0	51.0
R623	Residence	4.5	1285	T57	31.0	31.0	31.0	31.0	31.0	40.0	43.0	45.0	49.0	51.0
R624	Residence	4.5	1281	T57	31.0	31.0	31.0	31.0	31.0	40.0	43.0	45.0	49.0	51.0
R625	Residence	1.5	1279	T57	29.6	29.6	29.6	29.6	29.6	40.0	43.0	45.0	49.0	51.0
R626	Residence	1.5	1403	T57	28.7	28.7	28.7	28.7	28.7	40.0	43.0	45.0	49.0	51.0
R627	Residence	1.5	1364	T57	29.0	29.0	29.0	29.0	29.0	40.0	43.0	45.0	49.0	51.0
R628	Residence	4.5	1430	T57	30.1	30.1	30.1	30.1	30.1	40.0	43.0	45.0	49.0	51.0
R676	Residence	4.5	743	T55	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
R679	Residence	4.5	807	T53	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
R681	Residence	4.5	807	T12	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R682	Residence	1.5	688	T12	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R683	Residence	1.5	749	T12	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R686	Residence	4.5	932	T12	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R687	Residence	1.5	861	T68	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R688	Residence	4.5	824	T68	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R693	Residence	4.5	729	T40	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R694	Residence	4.5	683	T40	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
R695	Residence	4.5	1261	T4	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R696	Residence	1.5	1098	T4	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R697	Residence	4.5	748	T4	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R698	Residence	4.5	691	T4	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R699	Residence	4.5	838	T4	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R700	Residence	1.5	740	T4	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R701	Residence	1.5	671	T4	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R702	Residence	1.5	742	T4	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R703	Residence	4.5	717	T4	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R704	Residence	4.5	632	T4	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R705	Residence	4.5	713	T4	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R706	Residence	4.5	714	T4	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R707	Residence	4.5	667	T4	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0
R708	Residence	1.5	656	T4	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R709	Residence	4.5	810	T4	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R710	Residence	1.5	693	T4	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R711	Residence	4.5	791	T4	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R712	Residence	1.5	844	T4	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R713	Residence	1.5	902	T4	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R714	Residence	4.5	908	T11	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R715	Residence	1.5	810	T11	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R716	Residence	1.5	802	T11	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R717	Residence	4.5	899	T11	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R718	Residence	4.5	735	T11	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R719	Residence	1.5	913	T11	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R720	Residence	1.5	968	T11	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R721	Residence	1.5	1020	T11	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R722	Residence	4.5	910	T11	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R723	Residence	1.5	856	T21	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R724	Residence	4.5	650	T21	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R725	Residence	4.5	621	T21	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R726	Residence	7.5	795	T21	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R727	Residence	1.5	550	T21	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R728	Residence	4.5	672	T21	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0
R730	Residence	4.5	688	T21	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R731	Residence	1.5	631	T21	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R732	Residence	4.5	668	T21	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
R733	Residence	4.5	632	T12	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
R734	Residence	4.5	677	T12	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R737	Residence	4.5	693	T12	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R738	Residence	4.5	604	T12	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R739	Residence	1.5	760	T12	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R740	Residence	1.5	913	T55	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R741	Residence	1.5	846	T55	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R742	Residence	4.5	673	T55	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R743	Residence	4.5	684	T55	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R744	Residence	4.5	608	T55	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R745	Residence	4.5	793	T55	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R746	Residence	4.5	1070	T55	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R747	Residence	1.5	1210	T55	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R748	Residence	4.5	1271	T55	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R749	Residence	4.5	1277	T55	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R750	Residence	4.5	1408	T55	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R833	Residence	1.5	656	T47	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R834	Residence	1.5	835	T47	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R835	Residence	4.5	982	T47	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R836	Residence	1.5	915	T19	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R837	Residence	1.5	737	T19	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R838	Residence	1.5	709	T19	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R839	Residence	4.5	1292	T19	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R840	Residence	1.5	1097	T6	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R841	Residence	1.5	1027	T6	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R842	Church/Cmtry	1.5	872	T4	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R843	Residence	1.5	813	T6	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R846	Residence	4.5	914	T2	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R847	Residence	4.5	844	T2	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R850	Residence	1.5	1417	T57	30.5	30.5	30.5	30.5	30.5	40.0	43.0	45.0	49.0	51.0
R851	Residence	1.5	1427	T57	30.6	30.6	30.6	30.6	30.6	40.0	43.0	45.0	49.0	51.0
R852	Residence	1.5	1406	T57	31.2	31.2	31.2	31.2	31.2	40.0	43.0	45.0	49.0	51.0
R853	Residence	4.5	1137	T57	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R854	Residence	1.5	1345	T57	31.8	31.8	31.8	31.8	31.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R855	Residence	1.5	1196	T57	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R856	Residence	4.5	1302	T57	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R857	Residence	1.5	1340	T57	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R858	Residence	1.5	1348	T57	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R859	Residence	1.5	1327	T15	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
R860	Residence	1.5	1287	T15	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R861	Residence	1.5	1237	T15	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R862	Residence	1.5	1182	T15	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R863	Residence	1.5	1269	T15	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R864	Residence	1.5	1115	T15	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R865	Residence	4.5	1133	T15	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R868	Residence	4.5	679	T15	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R869	Residence	4.5	678	T15	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
R871	Residence	4.5	848	T26	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
R872	Residence	1.5	784	T8	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R873	Church/ Cmtry	1.5	926	T19	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R874	Residence	4.5	938	T57	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R875	Residence	1.5	867	T30	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R876	Residence	1.5	741	T57	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R877	Residence	4.5	704	T57	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R878	Residence	1.5	845	T30	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R879	Residence	4.5	705	T30	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R880	Residence	4.5	781	T57	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R882	Residence	4.5	780	T57	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R883	Residence	1.5	860	T57	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R887	Residence	4.5	848	T57	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R888	Residence	4.5	1305	T49	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R889	Residence	1.5	1159	T49	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R890	Residence	4.5	1202	T50	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R891	Residence	1.5	1229	T50	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R892	Residence	4.5	1022	T50	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R893	Residence	1.5	954	T50	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R894	Residence	1.5	906	T50	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R895	Residence	1.5	833	T50	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R896	Residence	1.5	673	T50	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R897	Residence	1.5	709	T50	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R898	Residence	1.5	716	T50	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R899	Residence	1.5	815	T50	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R900	Residence	1.5	819	T50	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R902	Residence	1.5	849	T50	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R903	Residence	1.5	861	T50	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R904	Residence	1.5	753	T50	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R905	Residence	1.5	783	T50	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R906	Residence	1.5	874	T50	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R907	Residence	1.5	890	T50	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R908	Residence	4.5	914	T50	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R910	Residence	1.5	830	T50	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R911	Residence	1.5	860	T50	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R912	Residence	1.5	1036	T50	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R913	Residence	4.5	1091	T50	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R914	Residence	4.5	997	T50	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R916	Residence	1.5	1467	T50	30.1	30.1	30.1	30.1	30.1	40.0	43.0	45.0	49.0	51.0
R917	Residence	1.5	1365	T50	30.8	30.8	30.8	30.8	30.8	40.0	43.0	45.0	49.0	51.0
R918	Residence	1.5	1297	T50	31.2	31.2	31.2	31.2	31.2	40.0	43.0	45.0	49.0	51.0
R919	Residence	1.5	1270	T50	31.3	31.3	31.3	31.3	31.3	40.0	43.0	45.0	49.0	51.0
R920	Residence	1.5	1366	T50	30.6	30.6	30.6	30.6	30.6	40.0	43.0	45.0	49.0	51.0
R921	Residence	1.5	1417	T50	30.3	30.3	30.3	30.3	30.3	40.0	43.0	45.0	49.0	51.0
R922	Residence	1.5	1359	T50	31.1	31.1	31.1	31.1	31.1	40.0	43.0	45.0	49.0	51.0
R923	Residence	1.5	1401	T50	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R924	Residence	4.5	1464	T50	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R925	Residence	1.5	1459	T50	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R926	Residence	1.5	1462	T50	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R927	Residence	4.5	1460	T50	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R928	Residence	4.5	1466	T50	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R929	Residence	4.5	1474	T50	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R930	Residence	1.5	1401	T50	31.7	31.7	31.7	31.7	31.7	40.0	43.0	45.0	49.0	51.0
R931	Residence	1.5	1297	T50	32.2	32.2	32.2	32.2	32.2	40.0	43.0	45.0	49.0	51.0
R932	Residence	1.5	1237	T50	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R969	Residence	1.5	1211	T59	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R970	Residence	4.5	972	T67	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R971	Residence	4.5	1106	T67	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R972	Residence	4.5	1251	T106	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R978	Residence	1.5	1047	T61	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R979	Residence	4.5	910	T6	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R980	Residence	1.5	954	T6	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R981	Residence	4.5	819	T6	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R982	Residence	4.5	1014	T19	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R983	Residence	1.5	1008	T19	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R984	Residence	4.5	1013	T19	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R985	Residence	4.5	1029	T19	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0
R986	Residence	1.5	967	T69	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R987	Residence	1.5	990	T69	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R989	Residence	4.5	905	T19	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
R990	Residence	4.5	934	T8	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R991	Residence	4.5	937	T8	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R992	Residence	4.5	973	T26	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R998	Residence	1.5	844	T49	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R999	Residence	1.5	726	T49	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R1000	Residence	4.5	734	T49	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
R1001	Residence	1.5	796	T50	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1003	Residence	1.5	764	T50	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R1004	Residence	1.5	716	T50	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R1005	Residence	1.5	721	T50	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R1006	Residence	4.5	925	T50	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R1007	Residence	4.5	657	T50	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R1008	Residence	4.5	904	T50	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R1009	Residence	1.5	869	T50	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R1010	Residence	1.5	938	T50	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1011	Residence	1.5	1004	T50	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R1012	Residence	4.5	1083	T50	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R1013	Residence	1.5	1222	T50	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R1014	Residence	1.5	1371	T50	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
R1015	Residence	1.5	1455	T50	31.6	31.6	31.6	31.6	31.6	40.0	43.0	45.0	49.0	51.0
R1030	Residence	1.5	739	T67	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R1031	Residence	4.5	711	T67	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R1032	Residence	4.5	1071	T106	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R1034	Residence	4.5	1013	T66	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R1035	Residence	4.5	964	T105	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R1036	Residence	4.5	746	T104	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
R1037	Residence	1.5	870	T66	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1039	Residence	4.5	788	T104	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R1040	Residence	1.5	818	T104	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R1041	Residence	1.5	965	T102	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R1042	Residence	4.5	877	T102	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R1043	Residence	4.5	910	T102	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
R1054	Residence	4.5	771	T67	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1055	Residence	4.5	790	T65	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1057	Residence	1.5	760	T65	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R1058	Residence	4.5	798	T65	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R1059	Residence	4.5	999	T65	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R1060	Residence	1.5	948	T65	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R1061	Residence	1.5	1127	T65	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R1062	Residence	1.5	972	T65	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R1064	Residence	4.5	1456	T67	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
R1065	Residence	4.5	1020	T67	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R1068	Residence	1.5	1440	T65	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R1069	Residence	1.5	1382	T65	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R1070	Residence	4.5	1082	T65	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R1071	Residence	1.5	1015	T65	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R1072	Residence	1.5	995	T65	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R1073	Residence	4.5	991	T65	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R1074	Residence	1.5	1078	T65	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R1075	Residence	4.5	915	T65	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R1076	Residence	4.5	819	T65	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R1078	Residence	4.5	1254	T65	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R1079	Residence	4.5	1295	T65	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R1080	Residence	1.5	1204	T7	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R1175	Residence	1.5	1143	T9	31.5	31.5	31.5	31.5	31.5	40.0	43.0	45.0	49.0	51.0
R1176	Residence	1.5	982	T9	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R1177	Residence	4.5	852	T9	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1178	Residence	1.5	789	T9	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R1179	Residence	4.5	729	T9	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R1197	Residence	7.5	1080	T9	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R1198	Residence	1.5	1048	T9	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R1199	Residence	1.5	1146	T51	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R1200	Residence	1.5	1020	T51	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R1201	Residence	1.5	972	T51	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R1202	Residence	1.5	914	T9	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R1203	Residence	1.5	878	T51	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R1204	Residence	1.5	899	T51	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1205	Residence	1.5	913	T51	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R1206	Residence	1.5	940	T51	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R1207	Residence	4.5	1043	T51	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R1208	Residence	4.5	986	T51	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R1209	Residence	1.5	908	T51	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R1210	Residence	1.5	704	T51	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R1211	Residence	1.5	801	T51	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R1213	Residence	1.5	731	T51	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R1214	Residence	1.5	772	T51	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R1215	Residence	1.5	717	T51	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R1216	Residence	1.5	788	T51	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R1217	Residence	1.5	740	T51	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R1218	Residence	1.5	680	T51	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R1219	Residence	1.5	637	T51	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1220	Residence	1.5	584	T51	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1221	Residence	1.5	602	T51	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R1222	Residence	1.5	607	T51	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R1223	Residence	1.5	754	T51	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R1224	Residence	1.5	782	T51	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R1225	Residence	1.5	803	T51	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R1226	Residence	1.5	932	T5	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R1227	Residence	1.5	831	T5	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R1228	Residence	1.5	895	T5	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R1229	Residence	1.5	879	T5	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R1230	Residence	4.5	740	T5	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R1231	Residence	4.5	841	T5	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R1232	Residence	1.5	804	T5	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R1235	Residence	4.5	557	T5	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1236	Residence	4.5	561	T5	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1237	Residence	4.5	583	T5	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R1238	Residence	1.5	626	T5	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1239	Residence	4.5	673	T5	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R1240	Residence	4.5	719	T5	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R1241	Residence	1.5	839	T5	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R1242	Residence	1.5	901	T5	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R1243	Residence	4.5	1075	T5	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R1244	Residence	1.5	1273	T5	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R1245	Residence	4.5	1364	T5	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R1246	Residence	1.5	1363	T2	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R1247	Residence	4.5	1297	T2	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R1248	Residence	1.5	1370	T2	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R1249	Residence	1.5	1212	T2	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R1250	Residence	4.5	1191	T2	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R1251	Residence	1.5	1072	T2	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R1252	Residence	1.5	922	T2	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R1254	Residence	4.5	781	T2	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R1255	Residence	1.5	759	T2	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R1256	Residence	1.5	761	T2	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R1257	Residence	1.5	779	T2	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R1258	Residence	1.5	780	T2	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1259	Residence	1.5	793	T2	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1260	Residence	1.5	919	T2	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R1261	Residence	1.5	1051	T2	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1262	Residence	1.5	915	T3	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
R1263	Residence	1.5	865	T3	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R1264	Residence	4.5	829	T3	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
R1265	Residence	4.5	757	T3	40.0	40.0	40.0	40.0	40.0	40.0	43.0	45.0	49.0	51.0
R1266	Residence	1.5	803	T3	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R1268	Residence	1.5	1364	T9	30.6	30.6	30.6	30.6	30.6	40.0	43.0	45.0	49.0	51.0
R1270	Residence	7.5	795	T9	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R1271	Residence	1.5	1060	T51	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R1272	Residence	1.5	877	T51	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1273	Residence	1.5	860	T51	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R1274	Residence	4.5	702	T51	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R1275	Residence	1.5	733	T51	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R1276	Residence	1.5	705	T51	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R1277	Residence	1.5	869	T51	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R1278	Residence	1.5	886	T5	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1280	Residence	1.5	1389	T2	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R1281	Residence	1.5	1471	T50	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
R1284	Residence	4.5	580	T67	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R1287	Residence	4.5	1336	T50	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R1288	Residence	4.5	1265	T50	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R1289	Residence	1.5	942	T8	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R1290	Residence	4.5	984	T26	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1291	Residence	4.5	790	T4	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R1292	Church	1.5	869	T4	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R1293	Residence	1.5	915	T4	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R1294	Residence	1.5	805	T11	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1295	Cemetery	1.5	756	T21	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R1296	Residence	1.5	651	T21	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
R1297	Residence	1.5	692	T21	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R1298	Residence	1.5	781	T12	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1299	Residence	4.5	749	T55	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0
R1300	Residence	1.5	817	T55	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R1301	Residence	4.5	1034	T55	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R1317	Residence	4.5	741	T300	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R1318	Residence	1.5	703	T42	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R1319	Cemetery	1.5	788	T42	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R1320	Residence	1.5	995	T42	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
R1321	Residence	1.5	866	T38	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R1322	Residence	4.5	923	T26	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
R1323	Residence	4.5	1023	T15	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R1324	Residence	1.5	1433	T50	30.8	30.8	30.8	30.8	30.8	40.0	43.0	45.0	49.0	51.0
R1341	Residence	4.5	1352	T13	31.6	31.6	31.6	31.6	31.6	40.0	43.0	45.0	49.0	51.0
R1342	Cemetery	1.5	719	T13	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R1345	Residence	1.5	1286	T36	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R1346	Residence	4.5	714	T33	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1347	Residence	4.5	816	T34	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0
R1348	Residence	1.5	809	T34	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R1349	Residence	1.5	805	T34	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1350	Residence	1.5	857	T34	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R1351	Residence	1.5	1162	T34	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1352	Residence	4.5	1153	T18	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R1353	Residence	1.5	588	T18	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R1355	Residence	1.5	1042	T45	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R1356	Residence	4.5	1426	T41	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R1357	Residence	1.5	1363	T23	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R1358	Church	1.5	1484	T23	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R1359	Residence	4.5	1460	T24	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R1360	Cemetery	1.5	1260	T24	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R1361	Residence	4.5	1168	T24	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R1362	Residence	1.5	1098	T300	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R1363	Residence	4.5	980	T19	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R1365	Residence	4.5	597	T2	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R1366	Residence	1.5	822	T11	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R1367	Residence	4.5	789	T11	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R1368	Residence	4.5	612	T9	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1369	Residence	4.5	1137	T17	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R1373	Cemetery	1.5	785	T20	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R1374	Residence	4.5	784	T20	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
R1375	Residence	1.5	950	T16	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R1377	Residence	4.5	900	T23	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R1378	Residence	1.5	1045	T34	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R2137	Residence	1.5	887	T218	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R2148	Residence	4.5	998	T218	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R2152	Residence	4.5	1087	T58	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R2153	Residence	4.5	983	T58	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R2159	Residence	4.5	910	T58	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R2164	Residence	4.5	1115	T218	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R2165	Residence	4.5	924	T218	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R2170	Residence	1.5	1084	T218	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R2171	Residence	1.5	923	T218	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R2179	Residence	4.5	993	T218	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R2552	Residence	1.5	762	T18	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R2565	Residence	1.5	1252	T33	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R2566	Residence	1.5	1213	T33	31.6	31.6	31.6	31.6	31.6	40.0	43.0	45.0	49.0	51.0
R2567	Residence	4.5	1097	T33	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R2568	Residence	4.5	1096	T36	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R2569	Residence	1.5	1033	T36	32.2	32.2	32.2	32.2	32.2	40.0	43.0	45.0	49.0	51.0
R2575	Residence	1.5	1327	T36	29.6	29.6	29.6	29.6	29.6	40.0	43.0	45.0	49.0	51.0
R2593	Residence	1.5	1128	T34	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R2594	Residence	4.5	1153	T34	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R2595	Residence	4.5	1170	T34	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R2596	Residence	4.5	1206	T33	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R2597	Residence	1.5	1217	T33	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R2598	Residence	1.5	1174	T33	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R2599	Residence	4.5	1159	T33	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R2600	Residence	1.5	1186	T33	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R2601	Residence	1.5	1118	T33	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R2602	Residence	1.5	1079	T33	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R2603	Residence	1.5	1051	T33	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R2604	Residence	1.5	1022	T33	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R2605	Residence	1.5	993	T33	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R2606	Residence	1.5	1041	T33	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R2607	Residence	4.5	1032	T33	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R2608	Residence	1.5	1011	T33	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R2609	Residence	4.5	661	T33	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R2610	Residence	4.5	928	T33	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R2611	Residence	1.5	1030	T33	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R2612	Residence	1.5	852	T36	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R2613	Residence	1.5	1132	T36	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R2614	Residence	1.5	790	T36	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R2615	Residence	1.5	808	T36	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R2616	Residence	1.5	1104	T36	31.8	31.8	31.8	31.8	31.8	40.0	43.0	45.0	49.0	51.0
R2617	Residence	4.5	858	T36	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R2618	Residence	1.5	1033	T36	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
R2684	Residence	1.5	1291	T13	29.0	29.0	29.0	29.0	29.0	40.0	43.0	45.0	49.0	51.0
R2769	Residence	1.5	1477	T22	29.9	29.9	29.9	29.9	29.9	40.0	43.0	45.0	49.0	51.0
R2770	Residence	1.5	1445	T22	30.0	30.0	30.0	30.0	30.0	40.0	43.0	45.0	49.0	51.0
R2853	Residence	4.5	1268	T59	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R2854	Residence	4.5	1220	T59	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R2855	Residence	1.5	1190	T59	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R2856	Residence	4.5	1164	T59	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R2857	Residence	4.5	898	T59	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R2858	Residence	4.5	934	T59	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R2859	Residence	1.5	1349	T59	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R2860	Residence	1.5	1049	T59	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R2861	Residence	4.5	922	T59	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R2862	Residence	1.5	849	T59	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R2863	Residence	4.5	686	T62	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
R2864	Residence	4.5	884	T62	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R2865	Residence	1.5	918	T62	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R2866	Residence	1.5	996	T62	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R2867	Residence	4.5	1060	T62	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R2868	Residence	1.5	1015	T62	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R2869	Residence	1.5	1102	T62	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R2870	Residence	1.5	1158	T62	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R2871	Residence	1.5	1193	T62	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
R2872	Residence	1.5	1226	T62	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R2873	Residence	1.5	1245	T62	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R2874	Residence	1.5	1253	T62	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R2875	Residence	4.5	1260	T62	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R2876	Residence	4.5	1385	T62	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R2877	Residence	1.5	829	T62	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
R2878	Residence	4.5	832	T62	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
R2879	Residence	1.5	888	T62	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R2880	Residence	1.5	745	T62	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
R2881	Residence	1.5	1190	T62	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R2884	Residence	1.5	632	T60	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R2885	Residence	4.5	640	T60	40.0	40.0	40.0	40.0	40.0	40.0	43.0	45.0	49.0	51.0
R2886	Residence	4.5	670	T60	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R2887	Residence	4.5	708	T60	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R2888	Residence	1.5	892	T60	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R2889	Residence	4.5	781	T60	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R2890	Residence	4.5	715	T60	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
R2891	Residence	4.5	886	T60	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R2892	Residence	4.5	739	T60	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
R2893	Residence	4.5	870	T60	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R2894	Residence	1.5	887	T60	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R2895	Residence	4.5	903	T60	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R2896	Residence	1.5	919	T60	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R2897	Residence	1.5	1101	T60	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R2898	Residence	1.5	1126	T60	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R2899	Residence	4.5	1165	T60	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R2900	Residence	1.5	1244	T60	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R2901	Residence	1.5	1283	T60	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R2902	Residence	4.5	1355	T60	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R2903	Residence	1.5	1373	T60	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R2904	Residence	1.5	1388	T60	31.8	31.8	31.8	31.8	31.8	40.0	43.0	45.0	49.0	51.0
R2905	Residence	4.5	1451	T60	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R2906	Residence	1.5	1408	T60	31.7	31.7	31.7	31.7	31.7	40.0	43.0	45.0	49.0	51.0
R2907	Residence	4.5	1371	T60	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R2908	Residence	4.5	1354	T60	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
R2909	Residence	1.5	1344	T60	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R2910	Residence	1.5	1330	T60	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R2935	Residence	4.5	1457	T60	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R2936	Residence	1.5	1454	T60	31.7	31.7	31.7	31.7	31.7	40.0	43.0	45.0	49.0	51.0
R2940	Residence	4.5	1269	T64	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R2941	Residence	4.5	1275	T64	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R2942	Residence	1.5	1391	T64	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R2943	Residence	4.5	1492	T64	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R2944	Residence	4.5	1472	T64	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R2945	Residence	4.5	1462	T64	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R2946	Residence	4.5	1444	T64	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R2947	Residence	4.5	1438	T64	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R2948	Residence	1.5	1404	T64	32.2	32.2	32.2	32.2	32.2	40.0	43.0	45.0	49.0	51.0
R2949	Residence	4.5	1399	T64	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R2950	Residence	1.5	1424	T64	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
R2951	Residence	4.5	1465	T64	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R2956	Residence	4.5	783	T54	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
R2957	Residence	1.5	987	T54	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
R2958	Residence	1.5	1350	T54	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R2962	Residence	1.5	1129	T54	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R2963	Residence	1.5	1157	T54	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R2967	Residence	1.5	1482	T54	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
R2968	Residence	1.5	1451	T54	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R2969	Residence	1.5	1333	T54	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R2970	Residence	1.5	1321	T54	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R2971	Residence	4.5	1301	T54	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R2972	Residence	1.5	1294	T54	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R2973	Residence	1.5	1333	T54	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R2974	Residence	1.5	1301	T54	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R2975	Residence	1.5	1224	T54	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R2976	Residence	1.5	1203	T54	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R2977	Residence	1.5	1174	T54	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R2978	Residence	1.5	1136	T54	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R2979	Residence	1.5	1101	T54	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R2980	Residence	1.5	1070	T54	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R2981	Residence	4.5	1048	T54	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R2982	Residence	1.5	978	T54	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R2983	Residence	1.5	926	T54	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R2984	Residence	1.5	943	T54	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
R2985	Residence	1.5	1008	T54	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R2986	Residence	4.5	1109	T54	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R2987	Residence	1.5	940	T54	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R2988	Residence	1.5	746	T54	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R2989	Residence	4.5	930	T54	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R2990	Residence	4.5	860	T54	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
R2991	Residence	4.5	825	T54	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R2992	Residence	1.5	794	T54	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R2993	Residence	4.5	768	T54	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R2994	Residence	4.5	758	T54	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R2996	Residence	1.5	732	T54	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R2999	Residence	1.5	724	T54	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R3000	Residence	4.5	704	T54	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R3001	Residence	1.5	724	T54	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R3003	Residence	1.5	725	T54	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R3004	Residence	4.5	747	T54	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
R3005	Residence	4.5	797	T54	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
R3006	Residence	1.5	832	T54	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
R3007	Residence	1.5	796	T3	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R3008	Residence	1.5	796	T3	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R3009	Residence	1.5	805	T3	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
R3010	Residence	4.5	741	T61	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
R3011	Residence	1.5	780	T68	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R3013	Residence	4.5	1162	T62	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R3014	Residence	1.5	1281	T62	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R3015	Residence	4.5	1293	T62	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R3016	Residence	1.5	1296	T62	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R3018	Residence	1.5	800	T60	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R3019	Residence	1.5	804	T60	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R3020	Residence	1.5	880	T60	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R3021	Residence	1.5	1363	T60	32.2	32.2	32.2	32.2	32.2	40.0	43.0	45.0	49.0	51.0
R3022	Residence	1.5	1408	T60	31.8	31.8	31.8	31.8	31.8	40.0	43.0	45.0	49.0	51.0
R3023	Residence	1.5	1481	T60	31.4	31.4	31.4	31.4	31.4	40.0	43.0	45.0	49.0	51.0
R3025	Residence	4.5	1341	T60	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R3026	Residence	1.5	1319	T60	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R3027	Residence	4.5	1424	T60	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R3028	Residence	4.5	1397	T60	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R3029	Residence	1.5	1302	T60	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R3030	Residence	4.5	1340	T60	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R3033	Residence	1.5	1296	T54	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R3034	Residence	1.5	1241	T54	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R3035	Residence	1.5	1260	T54	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R3036	Residence	1.5	1209	T54	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
R3037	Residence	1.5	1166	T54	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R3038	Residence	1.5	731	T54	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
R3039	Residence	4.5	727	T54	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
R3052	Residence	1.5	1391	T59	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R3623	Residence	4.5	718	T42	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0

Table 8 Vacant lot surrogate receptor noise level summary table.

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3107	VLSR	4.5	1418	T18	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
V3108	VLSR	4.5	1469	T18	30.3	30.3	30.3	30.3	30.3	40.0	43.0	45.0	49.0	51.0
V3109	VLSR	4.5	1095	T18	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
V3111	VLSR	4.5	1190	T18	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
V3112	VLSR	4.5	875	T18	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
V3113	VLSR	4.5	808	T18	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
V3114	VLSR	4.5	748	T18	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
V3115	VLSR	4.5	686	T18	37.0	37.0	37.0	37.0	37.0	40.0	43.0	45.0	49.0	51.0
V3126	VLSR	4.5	838	T18	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V3127	VLSR	4.5	878	T18	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
V3133	VLSR	4.5	1489	T33	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
V3134	VLSR	4.5	1111	T18	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
V3135	VLSR	4.5	1260	T18	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
V3136	VLSR	4.5	981	T18	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3137	VLSR	4.5	1034	T18	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3138	VLSR	4.5	1137	T18	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3139	VLSR	4.5	1226	T34	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V3140	VLSR	4.5	1149	T34	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
V3141	VLSR	4.5	1153	T34	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
V3142	VLSR	4.5	1201	T34	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3143	VLSR	4.5	1212	T33	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
V3145	VLSR	4.5	1307	T33	31.7	31.7	31.7	31.7	31.7	40.0	43.0	45.0	49.0	51.0
V3146	VLSR	4.5	1090	T33	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
V3147	VLSR	4.5	1137	T33	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
V3148	VLSR	4.5	1172	T34	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
V3149	VLSR	4.5	1013	T34	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
V3150	VLSR	4.5	866	T34	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3151	VLSR	4.5	986	T33	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
V3152	VLSR	4.5	988	T33	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
V3153	VLSR	4.5	1194	T33	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
V3154	VLSR	4.5	1151	T33	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
V3155	VLSR	4.5	657	T33	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
V3159	VLSR	4.5	663	T36	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
V3160	VLSR	4.5	729	T36	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
V3162	VLSR	4.5	862	T36	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3163	VLSR	4.5	1090	T36	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
V3164	VLSR	4.5	1010	T36	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0
V3165	VLSR	4.5	1108	T36	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
V3170	VLSR	4.5	937	T36	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
V3174	VLSR	4.5	1172	T211	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
V3176	VLSR	4.5	630	T18	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
V3177	VLSR	4.5	722	T18	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3178	VLSR	4.5	922	T18	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
V3179	VLSR	4.5	1108	T34	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
V3180	VLSR	4.5	1051	T34	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
V3181	VLSR	4.5	931	T34	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
V3182	VLSR	4.5	827	T34	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3183	VLSR	4.5	1052	T46	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
V3185	VLSR	4.5	1026	T46	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3186	VLSR	4.5	1006	T41	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3187	VLSR	4.5	1037	T41	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
V3188	VLSR	4.5	1161	T41	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
V3219	VLSR	4.5	880	T211	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V3230	VLSR	4.5	1127	T43	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
V3231	VLSR	4.5	1269	T211	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3232	VLSR	4.5	1002	T58	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V3234	VLSR	4.5	815	T28	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3236	VLSR	4.5	650	T23	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
V3237	VLSR	4.5	738	T23	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
V3239	VLSR	4.5	776	T23	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
V3240	VLSR	4.5	1377	T23	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
V3241	VLSR	4.5	1391	T23	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3242	VLSR	4.5	1374	T23	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
V3243	VLSR	4.5	1485	T23	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
V3246	VLSR	4.5	1443	T13	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
V3250	VLSR	4.5	1234	T13	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
V3255	VLSR	4.5	1458	T23	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3257	VLSR	4.5	1391	T24	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
V3258	VLSR	4.5	1246	T24	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
V3259	VLSR	4.5	1179	T24	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V3260	VLSR	4.5	1243	T48	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
V3261	VLSR	4.5	1107	T24	36.2	36.2	36.2	36.2	36.2	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3262	VLSR	4.5	889	T13	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
V3263	VLSR	4.5	818	T13	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
V3264	VLSR	4.5	618	T48	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
V3267	VLSR	4.5	698	T20	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
V3268	VLSR	4.5	895	T24	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V3269	VLSR	4.5	926	T24	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
V3270	VLSR	4.5	896	T24	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V3271	VLSR	4.5	1428	T24	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
V3272	VLSR	4.5	1364	T23	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
V3273	VLSR	4.5	979	T23	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3274	VLSR	4.5	776	T24	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3275	VLSR	4.5	767	T24	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
V3276	VLSR	4.5	584	T20	40.0	40.0	40.0	40.0	40.0	40.0	43.0	45.0	49.0	51.0
V3277	VLSR	4.5	606	T20	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
V3278	VLSR	4.5	735	T23	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
V3279	VLSR	4.5	852	T23	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
V3280	VLSR	4.5	1065	T58	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
V3281	VLSR	4.5	772	T219	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
V3282	VLSR	4.5	943	T219	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
V3283	VLSR	4.5	789	T24	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
V3284	VLSR	4.5	767	T24	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3285	VLSR	4.5	900	T24	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V3286	VLSR	4.5	872	T16	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3287	VLSR	4.5	856	T10	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
V3288	VLSR	4.5	835	T10	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
V3305	VLSR	4.5	1062	T211	35.0	35.0	35.0	35.0	35.0	40.0	43.0	45.0	49.0	51.0
V3306	VLSR	4.5	1044	T58	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
V3307	VLSR	4.5	749	T58	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3308	VLSR	4.5	713	T58	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3309	VLSR	4.5	678	T219	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
V3311	VLSR	4.5	573	T58	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3312	VLSR	4.5	841	T58	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
V3313	VLSR	4.5	829	T58	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
V3336	VLSR	4.5	963	T218	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
V3341	VLSR	4.5	687	T58	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
V3342	VLSR	4.5	651	T219	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
V3347	VLSR	4.5	1184	T233	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3348	VLSR	4.5	895	T233	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V3349	VLSR	4.5	927	T10	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3350	VLSR	4.5	601	T233	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
V3351	VLSR	4.5	753	T10	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
V3352	VLSR	4.5	693	T10	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
V3353	VLSR	4.5	965	T10	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
V3354	VLSR	4.5	766	T20	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3355	VLSR	4.5	804	T228	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
V3410	VLSR	4.5	971	T17	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
V3411	VLSR	4.5	1180	T55	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3477	VLSR	4.5	1377	T9	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
V3478	VLSR	4.5	1086	T9	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
V3479	VLSR	4.5	1183	T9	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
V3480	VLSR	4.5	1274	T9	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
V3481	VLSR	4.5	912	T55	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
V3482	VLSR	4.5	636	T9	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
V3484	VLSR	4.5	680	T55	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3485	VLSR	4.5	560	T55	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
V3486	VLSR	4.5	767	T55	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V3487	VLSR	4.5	791	T55	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
V3488	VLSR	4.5	852	T51	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
V3508	VLSR	4.5	1419	T56	32.2	32.2	32.2	32.2	32.2	40.0	43.0	45.0	49.0	51.0
V3510	VLSR	4.5	1452	T56	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
V3511	VLSR	4.5	1468	T56	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
V3522	VLSR	4.5	1362	T29	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
V3526	VLSR	4.5	579	T22	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
V3527	VLSR	4.5	559	T22	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3528	VLSR	4.5	591	T22	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
V3531	VLSR	4.5	1322	T22	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
V3545	VLSR	4.5	1356	T57	30.5	30.5	30.5	30.5	30.5	40.0	43.0	45.0	49.0	51.0
V3546	VLSR	4.5	1499	T57	29.7	29.7	29.7	29.7	29.7	40.0	43.0	45.0	49.0	51.0
V3559	VLSR	4.5	1377	T15	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3560	VLSR	4.5	1363	T49	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3561	VLSR	4.5	1334	T50	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
V3562	VLSR	4.5	1245	T49	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
V3563	VLSR	4.5	1279	T49	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
V3566	VLSR	4.5	1440	T57	32.2	32.2	32.2	32.2	32.2	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3567	VLSR	4.5	1427	T57	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
V3568	VLSR	4.5	1385	T57	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
V3569	VLSR	4.5	1378	T57	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
V3570	VLSR	4.5	1108	T15	36.3	36.3	36.3	36.3	36.3	40.0	43.0	45.0	49.0	51.0
V3571	VLSR	4.5	1093	T15	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
V3572	VLSR	4.5	1104	T15	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3573	VLSR	4.5	1117	T15	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
V3574	VLSR	4.5	1121	T15	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
V3575	VLSR	4.5	1132	T15	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
V3576	VLSR	4.5	1136	T15	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
V3577	VLSR	4.5	937	T50	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
V3578	VLSR	4.5	876	T50	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
V3579	VLSR	4.5	800	T50	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
V3580	VLSR	4.5	820	T50	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
V3581	VLSR	4.5	874	T50	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3582	VLSR	4.5	1178	T50	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
V3583	VLSR	4.5	1417	T50	32.4	32.4	32.4	32.4	32.4	40.0	43.0	45.0	49.0	51.0
V3584	VLSR	4.5	1496	T50	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
V3585	VLSR	4.5	1458	T57	29.9	29.9	29.9	29.9	29.9	40.0	43.0	45.0	49.0	51.0
V3586	VLSR	4.5	1315	T57	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
V3587	VLSR	4.5	1240	T57	31.3	31.3	31.3	31.3	31.3	40.0	43.0	45.0	49.0	51.0
V3588	VLSR	4.5	1292	T57	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
V3589	VLSR	4.5	1275	T57	31.0	31.0	31.0	31.0	31.0	40.0	43.0	45.0	49.0	51.0
V3590	VLSR	4.5	1337	T57	30.8	30.8	30.8	30.8	30.8	40.0	43.0	45.0	49.0	51.0
V3591	VLSR	4.5	1323	T57	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
V3592	VLSR	4.5	1078	T57	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
V3595	VLSR	4.5	1205	T57	31.5	31.5	31.5	31.5	31.5	40.0	43.0	45.0	49.0	51.0
V3597	VLSR	4.5	876	T57	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
V3604	VLSR	4.5	1366	T22	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
V3605	VLSR	4.5	1208	T22	33.5	33.5	33.5	33.5	33.5	40.0	43.0	45.0	49.0	51.0
V3606	VLSR	4.5	1371	T14	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
V3607	VLSR	4.5	887	T14	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
V3608	VLSR	4.5	761	T14	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
V3610	VLSR	4.5	991	T22	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
V3611	VLSR	4.5	714	T22	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3614	VLSR	4.5	1089	T22	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
V3615	VLSR	4.5	1217	T14	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3616	VLSR	4.5	994	T22	36.9	36.9	36.9	36.9	36.9	40.0	43.0	45.0	49.0	51.0
V3619	VLSR	4.5	986	T38	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3620	VLSR	4.5	1208	T42	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
V3621	VLSR	4.5	927	T42	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
V3622	VLSR	4.5	1265	T29	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
V3628	VLSR	4.5	1239	T29	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
V3634	VLSR	4.5	1345	T56	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
V3637	VLSR	4.5	1105	T29	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
V3638	VLSR	4.5	1117	T29	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
V3642	VLSR	4.5	912	T56	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
V3646	VLSR	4.5	795	T56	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3649	VLSR	4.5	907	T27	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
V3654	VLSR	4.5	1159	T56	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
V3655	VLSR	4.5	1380	T56	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
V3657	VLSR	4.5	1449	T301	31.1	31.1	31.1	31.1	31.1	40.0	43.0	45.0	49.0	51.0
V3658	VLSR	4.5	1458	T13	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
V3659	VLSR	4.5	1285	T301	31.3	31.3	31.3	31.3	31.3	40.0	43.0	45.0	49.0	51.0
V3664	VLSR	4.5	922	T300	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
V3669	VLSR	4.5	878	T17	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
V3671	VLSR	4.5	862	T52	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
V3677	VLSR	4.5	860	T42	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
V3678	VLSR	4.5	783	T42	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3679	VLSR	4.5	723	T42	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
V3682	VLSR	4.5	1021	T53	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3686	VLSR	4.5	825	T35	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
V3689	VLSR	4.5	899	T35	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3693	VLSR	4.5	885	T14	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3697	VLSR	4.5	896	T40	38.4	38.4	38.4	38.4	38.4	40.0	43.0	45.0	49.0	51.0
V3698	VLSR	4.5	817	T19	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3699	VLSR	4.5	673	T47	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3703	VLSR	4.5	813	T30	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
V3704	VLSR	4.5	699	T19	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
V3705	VLSR	4.5	1027	T26	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
V3707	VLSR	4.5	759	T26	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
V3712	VLSR	4.5	1224	T62	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
V3713	VLSR	4.5	927	T59	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
V3714	VLSR	4.5	1142	T59	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3715	VLSR	4.5	815	T62	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
V3716	VLSR	4.5	801	T60	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
V3717	VLSR	4.5	1027	T67	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V3718	VLSR	4.5	908	T67	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
V3719	VLSR	4.5	1163	T67	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
V3722	VLSR	4.5	813	T67	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3747	VLSR	4.5	1490	T50	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
V3749	VLSR	4.5	1427	T50	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
V3750	VLSR	4.5	1406	T50	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
V3751	VLSR	4.5	1311	T65	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3752	VLSR	4.5	1354	T65	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
V3753	VLSR	4.5	860	T65	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3754	VLSR	4.5	888	T50	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3755	VLSR	4.5	783	T50	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3756	VLSR	4.5	815	T49	39.3	39.3	39.3	39.3	39.3	40.0	43.0	45.0	49.0	51.0
V3757	VLSR	4.5	808	T19	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
V3758	VLSR	4.5	1087	T40	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
V3765	VLSR	4.5	685	T12	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
V3766	VLSR	4.5	693	T12	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
V3772	VLSR	4.5	768	T55	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
V3773	VLSR	4.5	812	T55	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
V3774	VLSR	4.5	972	T55	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
V3775	VLSR	4.5	1040	T17	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
V3776	VLSR	4.5	658	T12	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
V3777	VLSR	4.5	735	T12	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
V3778	VLSR	4.5	715	T12	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
V3783	VLSR	4.5	792	T21	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3790	VLSR	4.5	805	T11	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3791	VLSR	4.5	712	T4	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0
V3792	VLSR	4.5	771	T4	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
V3793	VLSR	4.5	809	T4	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3794	VLSR	4.5	829	T4	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3795	VLSR	4.5	838	T4	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3796	VLSR	4.5	855	T4	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3797	VLSR	4.5	864	T4	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3798	VLSR	4.5	764	T4	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
V3799	VLSR	4.5	713	T4	39.1	39.1	39.1	39.1	39.1	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3800	VLSR	4.5	818	T11	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3801	VLSR	4.5	767	T11	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3802	VLSR	4.5	826	T11	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3803	VLSR	4.5	718	T11	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
V3804	VLSR	4.5	693	T11	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
V3805	VLSR	4.5	768	T11	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3806	VLSR	4.5	722	T11	38.9	38.9	38.9	38.9	38.9	40.0	43.0	45.0	49.0	51.0
V3808	VLSR	4.5	651	T4	39.4	39.4	39.4	39.4	39.4	40.0	43.0	45.0	49.0	51.0
V3809	VLSR	4.5	869	T4	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3813	VLSR	4.5	923	T8	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
V3814	VLSR	4.5	884	T26	39.6	39.6	39.6	39.6	39.6	40.0	43.0	45.0	49.0	51.0
V3815	VLSR	4.5	715	T2	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
V3816	VLSR	4.5	866	T8	39.9	39.9	39.9	39.9	39.9	40.0	43.0	45.0	49.0	51.0
V3817	VLSR	4.5	645	T7	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0
V3818	VLSR	4.5	1318	T7	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
V3819	VLSR	4.5	1267	T101	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
V3821	VLSR	4.5	873	T65	37.5	37.5	37.5	37.5	37.5	40.0	43.0	45.0	49.0	51.0
V3822	VLSR	4.5	1026	T65	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
V3823	VLSR	4.5	865	T65	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
V3824	VLSR	4.5	938	T104	38.6	38.6	38.6	38.6	38.6	40.0	43.0	45.0	49.0	51.0
V3825	VLSR	4.5	761	T65	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0
V3826	VLSR	4.5	781	T67	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
V3827	VLSR	4.5	684	T67	39.8	39.8	39.8	39.8	39.8	40.0	43.0	45.0	49.0	51.0
V3828	VLSR	4.5	587	T67	39.5	39.5	39.5	39.5	39.5	40.0	43.0	45.0	49.0	51.0
V3829	VLSR	4.5	913	T67	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
V3831	VLSR	4.5	916	T61	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0
V3834	VLSR	4.5	1103	T64	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
V3835	VLSR	4.5	948	T64	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
V3836	VLSR	4.5	657	T60	39.7	39.7	39.7	39.7	39.7	40.0	43.0	45.0	49.0	51.0
V3842	VLSR	4.5	897	T105	38.5	38.5	38.5	38.5	38.5	40.0	43.0	45.0	49.0	51.0
V3843	VLSR	4.5	942	T105	38.1	38.1	38.1	38.1	38.1	40.0	43.0	45.0	49.0	51.0
V3844	VLSR	4.5	939	T60	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
V3845	VLSR	4.5	1329	T60	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
V3846	VLSR	4.5	1401	T60	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
V3847	VLSR	4.5	1437	T60	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
V3848	VLSR	4.5	787	T60	38.2	38.2	38.2	38.2	38.2	40.0	43.0	45.0	49.0	51.0
V3849	VLSR	4.5	733	T60	38.8	38.8	38.8	38.8	38.8	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3850	VLSR	4.5	743	T48	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V3851	VLSR	4.5	1011	T24	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
V3856	VLSR	4.5	893	T55	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
V3857	VLSR	4.5	958	T65	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
V3858	VLSR	4.5	1087	T48	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
V4000	VLSR	4.5	951	T38	38.7	38.7	38.7	38.7	38.7	40.0	43.0	45.0	49.0	51.0

Table 9 Participant noise level summary table.

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)				
					6.0	7.0	8.0	9.0	10.0
P41	Residence	4.5	581	T18	38.6	38.6	38.6	38.6	38.6
P62	Residence	4.5	705	T34	39.4	39.4	39.4	39.4	39.4
P67	Residence	4.5	724	T34	40.0	40.0	40.0	40.0	40.0
P68	Residence	4.5	895	T45	39.5	39.5	39.5	39.5	39.5
P71	Residence	4.5	812	T36	39.0	39.0	39.0	39.0	39.0
P107	Residence	4.5	559	T43	39.3	39.3	39.3	39.3	39.3
P140	Residence	4.5	795	T46	38.5	38.5	38.5	38.5	38.5
P177	Residence	4.5	486	T20	40.8	40.8	40.8	40.8	40.8
P258	Residence	4.5	439	T219	41.3	41.3	41.3	41.3	41.3
P301	Residence	4.5	755	T16	38.5	38.5	38.5	38.5	38.5
P351	Residence	4.5	481	T13	40.8	40.8	40.8	40.8	40.8
P352	Residence	4.5	519	T48	40.9	40.9	40.9	40.9	40.9
P376	Residence	4.5	1264	T301	31.3	31.3	31.3	31.3	31.3
P377	Residence	4.5	836	T300	33.5	33.5	33.5	33.5	33.5
P522	Residence	4.5	672	T2	38.4	38.4	38.4	38.4	38.4
P538	Residence	1.5	497	T11	40.0	40.0	40.0	40.0	40.0
P563	Residence	4.5	430	T10	40.8	40.8	40.8	40.8	40.8
P580	Residence	4.5	1267	T17	35.4	35.4	35.4	35.4	35.4
P587	Residence	4.5	808	T27	39.3	39.3	39.3	39.3	39.3
P589	Residence	4.5	826	T44	39.8	39.8	39.8	39.8	39.8
P594	Residence	1.5	583	T42	39.1	39.1	39.1	39.1	39.1
P601	Residence	4.5	820	T38	39.5	39.5	39.5	39.5	39.5
P610	Residence	4.5	448	T47	43.2	43.2	43.2	43.2	43.2
P677	Residence	4.5	551	T52	41.5	41.5	41.5	41.5	41.5
P678	Residence	4.5	701	T52	40.7	40.7	40.7	40.7	40.7
P680	Residence	1.5	689	T53	38.7	38.7	38.7	38.7	38.7
P689	Residence	4.5	658	T68	41.4	41.4	41.4	41.4	41.4
P690	Residence	4.5	736	T37	40.8	40.8	40.8	40.8	40.8
P691	Residence	4.5	563	T11	41.7	41.7	41.7	41.7	41.7
P692	Residence	1.5	563	T40	40.7	40.7	40.7	40.7	40.7
P729	Residence	4.5	551	T21	40.5	40.5	40.5	40.5	40.5
P735	Residence	4.5	547	T12	40.3	40.3	40.3	40.3	40.3
P844	Residence	1.5	713	T2	38.4	38.4	38.4	38.4	38.4
P845	Residence	4.5	484	T2	41.6	41.6	41.6	41.6	41.6
P870	Residence	1.5	762	T26	38.9	38.9	38.9	38.9	38.9

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)				
					6.0	7.0	8.0	9.0	10.0
P885	Residence	1.5	879	T57	37.2	37.2	37.2	37.2	37.2
P886	Residence	4.5	632	T57	38.7	38.7	38.7	38.7	38.7
P988	Residence	4.5	883	T69	39.9	39.9	39.9	39.9	39.9
P993	Residence	1.5	711	T26	38.8	38.8	38.8	38.8	38.8
P994	Residence	4.5	879	T26	39.6	39.6	39.6	39.6	39.6
P995	Residence	1.5	846	T15	38.7	38.7	38.7	38.7	38.7
P996	Residence	4.5	718	T7	39.6	39.6	39.6	39.6	39.6
P997	Residence	4.5	674	T49	40.6	40.6	40.6	40.6	40.6
P1002	Residence	4.5	655	T50	40.2	40.2	40.2	40.2	40.2
P1053	Residence	4.5	711	T67	39.6	39.6	39.6	39.6	39.6
P1056	Residence	1.5	770	T65	38.0	38.0	38.0	38.0	38.0
P1180	Residence	4.5	686	T9	36.7	36.7	36.7	36.7	36.7
P1181	Residence	1.5	630	T9	36.5	36.5	36.5	36.5	36.5
P1182	Residence	1.5	567	T9	37.6	37.6	37.6	37.6	37.6
P1183	Residence	1.5	497	T9	38.8	38.8	38.8	38.8	38.8
P1184	Residence	1.5	421	T9	40.5	40.5	40.5	40.5	40.5
P1185	Residence	1.5	365	T9	41.9	41.9	41.9	41.9	41.9
P1186	Residence	1.5	378	T9	41.6	41.6	41.6	41.6	41.6
P1187	Residence	1.5	376	T9	41.6	41.6	41.6	41.6	41.6
P1188	Residence	1.5	418	T9	40.6	40.6	40.6	40.6	40.6
P1189	Residence	1.5	468	T9	39.4	39.4	39.4	39.4	39.4
P1190	Residence	1.5	506	T9	38.7	38.7	38.7	38.7	38.7
P1191	Residence	1.5	562	T9	37.7	37.7	37.7	37.7	37.7
P1192	Residence	1.5	628	T9	36.6	36.6	36.6	36.6	36.6
P1193	Residence	1.5	688	T9	35.8	35.8	35.8	35.8	35.8
P1194	Residence	1.5	725	T9	35.3	35.3	35.3	35.3	35.3
P1195	Residence	1.5	764	T9	34.8	34.8	34.8	34.8	34.8
P1196	Residence	1.5	740	T9	35.1	35.1	35.1	35.1	35.1
P1212	Residence	4.5	678	T51	37.1	37.1	37.1	37.1	37.1
P1233	Residence	4.5	720	T5	37.5	37.5	37.5	37.5	37.5
P1234	Residence	1.5	642	T5	37.3	37.3	37.3	37.3	37.3
P1253	Residence	4.5	850	T2	36.7	36.7	36.7	36.7	36.7
P1269	Residence	1.5	375	T9	41.7	41.7	41.7	41.7	41.7
P1279	Residence	1.5	616	T5	37.7	37.7	37.7	37.7	37.7
P1283	Residence	4.5	536	T67	40.8	40.8	40.8	40.8	40.8
P2882	Residence	1.5	607	T62	40.5	40.5	40.5	40.5	40.5
P2883	Residence	1.5	493	T62	42.6	42.6	42.6	42.6	42.6

Point of Reception ID	Description	Height (m)	Distance to Nearest Project Turbine (m)	Nearest Project Turbine	Calculated Sound Level at Selected Wind Speeds (dBA)				
					6.0	7.0	8.0	9.0	10.0
P2995	Residence	4.5	685	T54	38.9	38.9	38.9	38.9	38.9
P2997	Residence	1.5	678	T54	37.9	37.9	37.9	37.9	37.9
P2998	Residence	1.5	643	T54	38.6	38.6	38.6	38.6	38.6
P3002	Residence	4.5	597	T54	41.0	41.0	41.0	41.0	41.0
P3017	Residence	1.5	642	T63	41.1	41.1	41.1	41.1	41.1
P3017	Residence	1.5	642	T63	41.1	41.1	41.1	41.1	41.1

8 NOISE LEVEL ISOPLETH MAP

Figure 2 is a noise level isopleth map of the turbine-generated SPrLs (dBA) over the region of the project for a 10 m a.g.l. wind speed of 6 ms^{-1}. The noise levels are calculated for receptors with 1.5 m (1 storey) and 4.5 m (2 storeys) heights.

The map displays the specific noise level isopleth relevant to the MoE Guidelines limit for each wind speed as listed here:

Wind Speed	Limiting Noise Isopleth
6 ms^{-1}	40 dBA

Noise level isopleth maps for 8 and 10 ms^{-1} have not been included since the calculated SPrLs are identical to those calculated for the 6 ms^{-1} values.

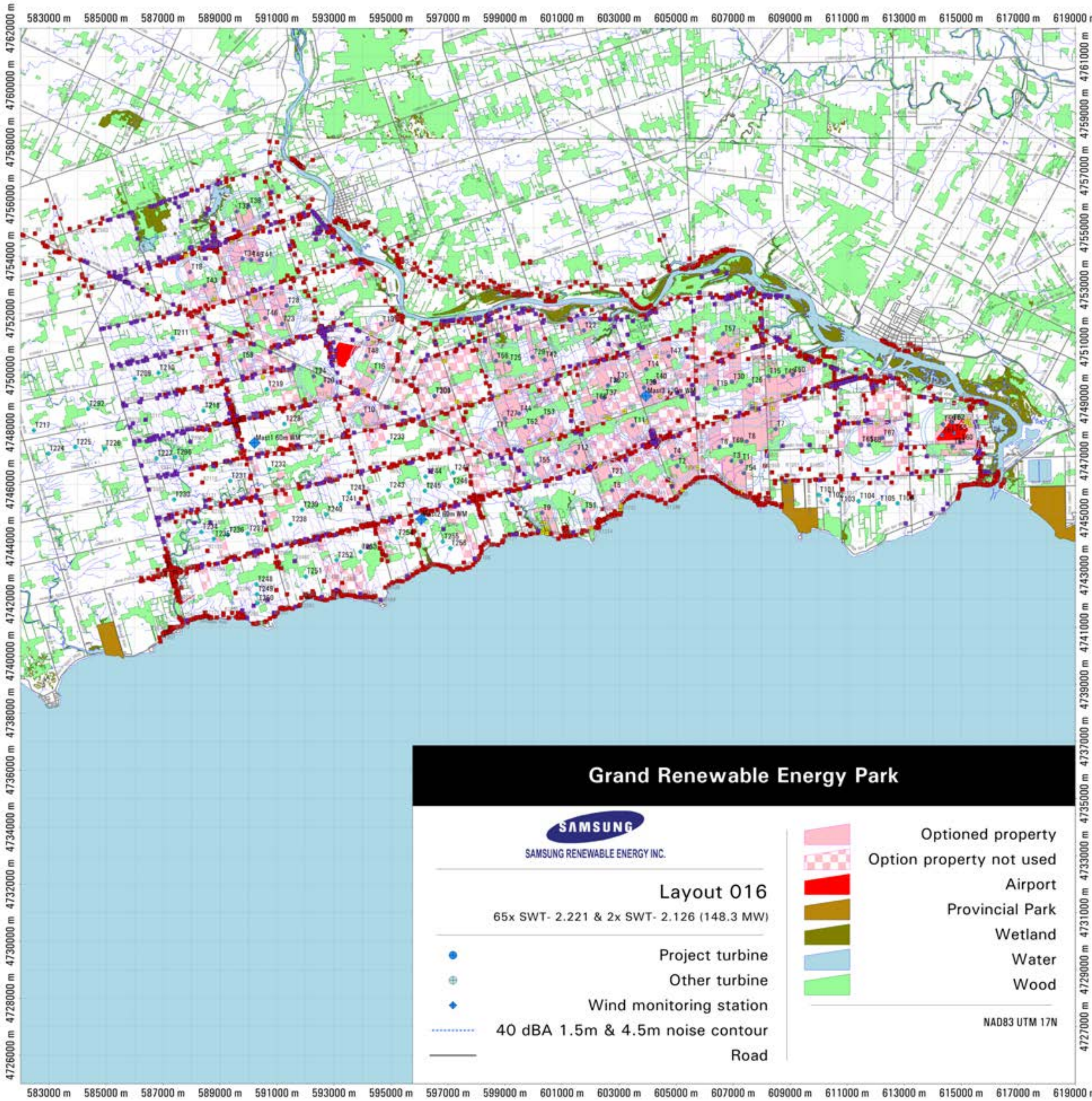

Figure 2 40 dBA noise isopleth map for 6 ms^{-1} (10 m) for 1.5 and 4.5 m receptor heights.

9 EXAMPLE CALCULATION

9.1 Method of Calculation

The calculation of cumulative receptor noise levels from wind turbines uses the methodology of ISO 9613-2, '*Acoustics — Attenuation of sound during propagation outdoors: Part 2: General method of calculation'*. These calculations are effected with Zephyr North's *WFNoise* software. This program has been purpose-written to carry out the ISO 9613-2 calculations by accessing the ReSoft WindFarm software files to obtain (some of) the required data — turbine locations, turbine types, turbine characteristics (including hub-height, and octave band source sound power levels). Additional data which must be input into WFNoise are as follows.

- a file containing the locations, types, and heights of each of the receptors
- ambient air temperature
- ambient barometric pressure
- ambient humidity
- source ground factor
- middle ground factor
- receptor ground factor

The core of WFNoise carries out the equation (5) calculation from ISO 9613-2 shown here:

$$L_{AT}(DW) = 10\log_{10}\left\{\sum_{i=1}^{n}\left[\sum_{j=1}^{8} 10^{0.1\left[L_{fT}(ij)+A_f(j)\right]}\right]\right\}$$

where

$L_{AT}(DW)$ is the equivalent continuous A-weighted downwind sound pressure level at a receptor location,

n is the number of turbines,

$A_f(j)$ is the standard A-weighting for octave band j,

j is an index indicating the eight standard octave-band mid-band frequencies from 63 Hz to 8 kHz,

$L_{fT}(ij) \equiv L_{fT}(DW)$ is the equivalent continuous downwind octave-band sound pressure level at a receptor location for turbine i and octave band j, and is given by

$$L_{ft}(DW) = L_W + D_C - A$$

where

L_W is the octave-band sound power level, in decibels, produced by the point sound source relative to a reference sound power of one picowatt,

D_C is the directivity correction in decibels,

A is the octave-band attenuation, in decibels, that occurs during propagation from the turbine to receptor, and is given by

$$A = A_{\mathrm{div}} + A_{atm} + A_{gr} + A_{\mathrm{bar}} + A_{misc}$$

where

A_{div} is the attenuation due to geometrical divergence,

A_{atm} is the attenuation due to atmospheric absorption,

A_{gr} is the attenuation due to the ground effect,

A_{bar} is the attenuation due to a barrier,

A_{misc} is the attenuation due to miscellaneous other effects,

A_{atm} is given by

$$A = \frac{\alpha d}{1000}$$

where

α is the atmospheric attenuation coefficient, in decibels per kilometre, for each octave band at the midband frequency,

d is the distance from the turbine to the receptor.

Note that α is calculated using ISO 9613-1, and not interpolated from Table 2 of ISO 9613-2. For this reason, the barometric pressure is one of the input parameters to WFNoise. Note also that A_{bar} and A_{misc} are not treated in WFNoise.

9.1 Example

The following sample calculation presents intermediate octave-band results of calculations for A-weighted sound pressure levels corresponding to a 10 m (a.g.l.) wind speed of 6 ms^{-1}. All model parameters are the same as previously tabulated.

Table 10 lists the intermediate sound pressure levels calculated at receptor R733 due to the single turbine T12. Receptor and turbine are separated by 632 m. Note that the resultant A-weighted sound pressure level at R733 due to turbine T12 alone is 39.8 dBA.

Table 10 Sample calculation for receptor and turbine.

Intermediate calculations for receptor R733 and turbine T12						
Octave band	**Mid-band frequency (Hz)**	**L_W (dBA)**	**A_{div} (dB)**	**A_{atm} (dB)**	**A_{gr} (dB)**	**L_{fT}(DW) (dBA)**
1	63	82.4	67.0	0.1	-3.0	18.3
2	125	93.0	67.0	0.3	1.0	24.7
3	250	96.0	67.0	0.7	-0.1	28.4
4	500	99.8	67.0	1.2	-0.7	32.3
5	1000	100.1	67.0	2.3	-0.7	31.5
6	2000	96.5	67.0	6.1	-0.8	24.1
7	4000	89.6	67.0	20.9	-0.8	2.4
8	8000	85.7	67.0	74.8	-0.8	-55.4

In the table:

L_W is the octave-band sound power level, in decibels, produced by the point sound source relative to a reference sound power of one picowatt,

A_{div} is the attenuation due to geometrical divergence,

A_{atm} is the attenuation due to atmospheric absorption,

A_{gr} is the attenuation due to the ground effect,

$L_{fT}(DW)$ is the equivalent continuous downwind octave-band sound pressure level.

Table 11 shows intermediate octave band values of the calculations for the A-weighted sound pressure levels at receptor R733 due to all turbines (from all projects) within 5,000 m of the receptor. The resultant A-weighted sound pressure level at R733 due to all turbines is 39.9 dBA.

Table 11 Sample calculation for single receptor and multiple turbines.

Intermediate calculations for receptor R733 and multiple turbines										
		Turbine L_{ft} contribution (dB) in frequency band (Hz)								
Turbine ID	Distance (m)	63	125	250	500	1000	2000	4000	8000	Turbine L_{AT} (dBA)
T2	3151	30.3	25.7	20.4	16.7	8.4	-15.5	-95.8	-366.4	17.5
T4	3000	30.7	26.2	21.0	17.4	9.3	-13.6	-90.4	-348.1	18.2
T5	1208	38.8	34.8	30.8	28.8	23.8	11.7	-23.2	-128.1	29.4
T6	4681	27.6	21.8	15.6	10.5	-0.5	-33.6	-149.6	-550.8	12.2
T9	2273	33.2	28.9	24.2	21.2	14.4	-4.1	-63.9	-259.7	21.8
T11	2150	33.7	29.4	24.8	22.0	15.3	-2.5	-59.4	-244.6	22.5
T12	632	44.5	40.8	37.0	35.5	31.5	22.9	1.4	-54.3	36.5
T14	3997	28.7	23.4	17.6	13.2	3.3	-25.6	-125.7	-468.6	14.3
T17	3486	29.7	24.7	19.3	15.3	6.3	-19.6	-107.6	-406.6	16.2
T21	875	41.7	37.8	33.9	32.2	27.8	17.7	-9.4	-85.9	33.0
T22	4777	27.5	21.6	15.3	10.2	-1.0	-34.7	-152.9	-562.3	11.9
T25	4562	27.8	22.1	15.9	11.0	0.2	-32.2	-145.5	-536.9	12.5
T27	3342	29.9	25.1	19.7	15.9	7.2	-17.8	-102.6	-389.5	16.7
T29	4293	28.2	22.7	16.7	12.0	1.7	-29.1	-136.1	-504.1	13.4
T35	3186	30.2	25.6	20.3	16.6	8.1	-15.9	-97.0	-370.6	17.4
T37	2486	32.4	28.0	23.2	20.1	12.8	-7.0	-71.7	-285.6	20.7
T38	2934	30.9	26.4	21.3	17.8	9.8	-12.8	-88.0	-340.1	18.5
T39	3415	29.8	24.9	19.5	15.6	6.7	-18.7	-105.2	-398.4	16.5
T40	3804	29.1	23.9	18.2	13.9	4.4	-23.4	-118.9	-445.3	15.0
T42	4041	28.7	23.3	17.5	13.0	3.1	-26.1	-127.2	-473.8	14.2
T44	3031	30.6	26.1	20.9	17.3	9.1	-14.0	-91.5	-351.8	18.0
T47	4812	27.4	21.5	15.2	10.1	-1.2	-35.1	-154.2	-566.6	11.8
T51	1546	36.6	32.5	28.3	26.0	20.4	6.3	-36.5	-170.2	26.6
T52	2582	32.0	27.6	22.7	19.5	12.2	-8.2	-75.2	-297.4	20.2
T53	2347	32.9	28.6	23.8	20.8	13.9	-5.1	-66.7	-268.7	21.4
T55	1749	35.5	31.4	27.0	24.5	18.6	3.2	-44.3	-195.3	25.1
T56	4905	27.3	21.3	15.1	9.9	-1.7	-36.1	-157.4	-572.2	11.5
T68	2296	33.1	28.8	24.1	21.1	14.2	-4.4	-64.8	-262.5	21.7
T246	4814	27.8	21.6	15.3	10.1	-1.1	-35.0	-154.1	-566.7	11.9
T247	4708	28.0	21.8	15.6	10.5	-0.5	-33.8	-150.5	-553.9	12.2

10 CONCLUSIONS

This noise impact assessment for the proposed Grand Renewable Energy Park has determined that the estimated sound pressure levels at receptors and Vacant Lot Surrogate Receptors (VLSRs) in the project area comply with the Ministry of the Environment sound level limits at all qualified points of reception.

11 REFERENCES

Golder Associates, 2010: NextEra Energy Canada, ULC, Summerhaven Wind Energy Centre, Application for a Renewable Energy Approval; Noise Study Report; Version 1 (Draft), Report Number: 10-1151-0035.

Government of Ontario, 1990: *Environmental Assessment Act, R.S.O. 1990, Chapter E.18.* http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e18_e.htm

Government of Ontario, 1990: *Environmental Protection Act, R.S.O. 1990, Chapter E.19.* http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e19_e.htm

Government of Ontario, 2009: Green Energy Act, 2009, http://www.search.e-laws.gov.on.ca/en/isysquery/abaf99f7-8e6f-4ea9-b8a4-d6d8b0435bac/1/doc/?search=browseStatutes&context=#BK7

Government of Ontario, 2009: *Ontario Regulation 359/09, made under the Environmental Protection Act, Renewable Energy Approvals under Part V.0.1 of the Act.* http://www.search.e-laws.gov.on.ca/en/isysquery/e366a7f1-5b0c-4468-b87d-479b33d386b4/1/frame/?search=browseStatutes&context=

International Standards Organization (ISO), 1993: 9613-1 International Standard: Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=17426

International Standards Organization (ISO), 1996: 9613-2 International Standard: Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=20649

Ontario Ministry of the Environment (MoE), 1995: *Sound Level Limits for Stationary Sources in Class 3 Areas (Rural) Publication NPC-232. October 1995.* http://www.ene.gov.on.ca/envision/gp/3405e.pdf

Ontario Ministry of the Environment (MoE), 2008: MoE *Noise Guidelines for Wind Farms; Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities (*October 2008). http://www.ene.gov.on.ca/publications/4709e.pdf. 20 pp.

Siemens Wind Power A/S, 2010: *Acoustic Emission, SWT-2.3-101, Hub-Height 99.5 m*, Document ID: E R WP SP EN-10-0000-0057-00 PE, BSN / 2010.05.03, "Conveyed confidentially as a trade secret". Document provided as file, 'SWT-2.3-101 99.5m 106dB Acoustic Emission max extended version 2010.05.03.pdf'

Windtest, Kaiser-Wilhelm-Kook GmbH, 2005: Report of acoustical emissions of a Siemens wind turbine generator system of the type 2.3 MW Mk II near Hovsore in Denmark. September 2005. Report WT 4498/05.

Youmans, Blair (2011): Email from Blair Youmans (Siemens) to Adam Rosso (Samsung), 2011/01/25.

12 APPENDIX A — TURBINE, RECEPTOR, VACANT LOT AND PARTICIPANT LOCATIONS

This appendix contains lists of turbine, receptor, vacant lot surrogate receptor (VLSR), and participant locations. Coordinates are given in the Universal Transverse Mercator (UTM) Zone 17 North projection. The datum is North American Datum 1983 (NAD83, Canada).

For reference, the project (turbine) layout identifier is GRE10-WFL016.wfl.

Turbines

Project Name: Grand Renewable Energy Park
Datum and Projection: NAD83 (Canada); UTM 17N

Identifier	Equipment Make and Model	X(E,m)	Y(N,m)	Remarks
T1	SWT-2.221-101	607287	4746785	GREP
T2	SWT-2.221-101	605035	4746639	GREP
T3	SWT-2.221-101	606942	4746830	GREP
T4	SWT-2.221-101	604861	4746993	GREP
T5	SWT-2.221-101	602757	4745791	GREP
T6	SWT-2.221-101	606513	4747319	GREP
T7	SWT-2.221-101	608495	4747949	GREP
T8	SWT-2.221-101	607477	4747512	GREP
T9	SWT-2.221-101	600290	4745005	GREP
T10	SWT-2.126-101	593994	4748442	GREP
T11	SWT-2.221-101	603472	4748075	GREP
T12	SWT-2.221-101	601479	4747111	GREP
T13	SWT-2.221-101	594663	4751618	GREP
T14	SWT-2.221-101	603952	4750047	GREP
T15	SWT-2.221-101	608232	4749798	GREP
T16	SWT-2.221-101	594352	4749960	GREP
T17	SWT-2.221-101	598648	4747922	GREP
T18	SWT-2.221-101	587941	4753452	GREP
T19	SWT-2.221-101	606366	4749368	GREP
T20	SWT-2.221-101	592573	4749463	GREP
T21	SWT-2.221-101	602692	4746290	GREP
T22	SWT-2.221-101	601756	4751401	GREP

T23	SWT-2.221-101	591178	4751634	GREP
T24	SWT-2.221-101	592280	4749799	GREP
T25	SWT-2.221-101	599133	4750265	GREP
T26	SWT-2.221-101	607589	4749481	GREP
T27	SWT-2.221-101	598999	4748313	GREP
T28	SWT-2.221-101	591339	4752273	GREP
T29	SWT-2.221-101	599967	4750467	GREP
T30	SWT-2.221-101	606959	4749603	GREP
T33	SWT-2.221-101	589588	4755581	GREP
T34	SWT-2.221-101	589790	4753921	GREP
T35	SWT-2.221-101	602880	4749652	GREP
T36	SWT-2.221-101	590002	4755767	GREP
T37	SWT-2.221-101	602481	4749039	GREP
T38	SWT-2.221-101	602608	4749469	GREP
T39	SWT-2.221-101	603875	4749401	GREP
T40	SWT-2.221-101	604239	4749614	GREP
T41	SWT-2.221-101	590395	4753879	GREP
T42	SWT-2.221-101	600381	4750377	GREP
T43	SWT-2.221-101	588466	4752970	GREP
T44	SWT-2.221-101	599489	4748483	GREP
T45	SWT-2.221-101	590085	4753880	GREP
T46	SWT-2.221-101	590582	4751836	GREP
T47	SWT-2.221-101	604740	4750499	GREP
T48	SWT-2.221-101	594126	4750504	GREP
T49	SWT-2.221-101	608750	4749784	GREP
T50	SWT-2.221-101	609091	4749844	GREP
T51	SWT-2.221-101	601762	4745085	GREP
T52	SWT-2.221-101	599708	4748016	GREP
T53	SWT-2.221-101	600301	4748359	GREP
T54	SWT-2.221-101	607370	4746400	GREP
T55	SWT-2.221-101	600136	4746677	GREP
T56	SWT-2.221-101	598675	4750335	GREP
T57	SWT.2.221-101	606650	4751283	GREP
T58	SWT-2.126-101	589733	4750362	GREP
T59	SWT-2.221-101	614355	4748118	GREP
T60	SWT-2.221-101	614974	4747470	GREP
T61	SWT-2.221-101	614326	4747732	GREP
T62	SWT-2.221-101	614680	4748176	GREP
T63	SWT-2.221-101	614750	4747811	GREP
T64	SWT-2.221-101	614705	4747338	GREP
T65	SWT-2.221-101	611480	4747403	GREP
T66	SWT-2.221-101	611758	4747387	GREP
T67	SWT-2.221-101	612236	4747633	GREP
T68	SWT-2.221-101	602131	4748909	GREP
T69	SWT-2.221-101	606923	4747368	GREP
101	GE 1.5sle	609999	4745635	BWP
102	GE 1.5sle	610296	4745455	BWP
103	GE 1.5sle	610711	4745306	BWP
104	GE 1.5sle	611401	4745418	BWP
105	GE 1.5sle	612115	4745329	BWP
106	GE 1.5sle	612764	4745342	BWP
201	SWT-2.221-101	576124	4749873	SWEC
202	SWT-2.221-101	573651	4747951	SWEC
203	SWT-2.221-101	574742	4748226	SWEC
204	SWT-2.221-101	575685	4748309	SWEC
205	SWT-2.221-101	576990	4748661	SWEC
206	SWT-2.221-101	578518	4748834	SWEC
207	SWT-2.221-101	579869	4749156	SWEC
208	SWT-2.221-101	580947	4749341	SWEC
209	SWT-2.221-101	586015	4749711	SWEC

210	SWT-2.221-101	586837	4749912	SWEC
211	SWT-2.221-101	587326	4751141	SWEC
212	SWT-2.221-101	572316	4746292	SWEC
213	SWT-2.221-101	572920	4746475	SWEC
214	SWT-2.221-101	574224	4746586	SWEC
215	SWT-2.221-101	576150	4746799	SWEC
216	SWT-2.221-101	577821	4747047	SWEC
217	SWT-2.221-101	582468	4747896	SWEC
218	SWT-2.221-101	588422	4748589	SWEC
219	SWT-2.221-101	590644	4749342	SWEC
220	SWT-2.221-101	573903	4745199	SWEC
221	SWT-2.221-101	577726	4746477	SWEC
222	SWT-2.221-101	579685	4746426	SWEC
223	SWT-2.221-101	580952	4746798	SWEC
224	SWT-2.221-101	582973	4747085	SWEC
225	SWT-2.221-101	583914	4747307	SWEC
226	SWT-2.221-101	584940	4747269	SWEC
227	SWT-2.221-101	586764	4746913	SWEC
228	SWT-2.221-101	591259	4748123	SWEC
230	SWT-2.221-101	587383	4745469	SWEC
231	SWT-2.221-101	589357	4746128	SWEC
232	SWT-2.221-101	590737	4746531	SWEC
233	SWT-2.221-101	594906	4747489	SWEC
234	SWT-2.221-101	588348	4744337	SWEC
235	SWT-2.221-101	588779	4744087	SWEC
236	SWT-2.221-101	589271	4744225	SWEC
237	SWT-2.221-101	589975	4744279	SWEC
238	SWT-2.221-101	591475	4744600	SWEC
239	SWT-2.221-101	591880	4745113	SWEC
240	SWT-2.221-101	592721	4744952	SWEC
241	SWT-2.221-101	593224	4745318	SWEC
242	SWT-2.221-101	593522	4745702	SWEC
243	SWT-2.221-101	594899	4745794	SWEC
244	SWT-2.221-101	596210	4746279	SWEC
245	SWT-2.221-101	596181	4745775	SWEC
246	SWT-2.221-101	597119	4745943	SWEC
247	SWT-2.221-101	597181	4746416	SWEC
248	SWT-2.221-101	590280	4742517	SWEC
249	SWT-2.221-101	590293	4742174	SWEC
250	SWT-2.221-101	590314	4741857	SWEC
251	SWT-2.221-101	592008	4742791	SWEC
252	SWT-2.221-101	593087	4743349	SWEC
253	SWT-2.221-101	593930	4743637	SWEC
254	SWT-2.221-101	595213	4744131	SWEC
255	SWT-2.221-101	596817	4743995	SWEC
256	SWT-2.221-101	597076	4743766	SWEC
291	SWT-2.221-101	579024	4749020	SWEC
292	SWT-2.221-101	584373	4748649	SWEC
293	SWT-2.221-101	577118	4747104	SWEC
294	SWT-2.221-101	575430	4745490	SWEC
295	SWT-2.221-101	577924	4745876	SWEC

Transformers

Project Name: Grand Renewable Energy Park
Datum and Projection: NAD83 (Canada); UTM 17N

Identifier	Equipment Make and Model	X(E,m)	Y(N,m)	Remarks
TR300	Transformer	596520	4749103	GREP
TR301	Transformer	596520	4749113	GREP

Points of Reception (Receptors)

Table - Point of Reception Locations
Project Name: Grand Renewable Energy Park
Datum: NAD83 (Canada) Projection: UTM 17N

Point of Reception ID	Description	Height (m)	NPC Class	X(E,m)	Y(N,m)
R33	Residence	4.5	3	586801	4753685
R34	Residence	1.5	3	586915	4753670
R35	Residence	4.5	3	587107	4753766
R36	Residence	4.5	3	586991	4753815
R37	Residence	1.5	3	587384	4753814
R38	Residence	1.5	3	587323	4753794
R39	Residence	4.5	3	587596	4753957
R40	Residence	4.5	3	587786	4754086
R43	Residence	1.5	3	588023	4754174
R44	Residence	1.5	3	588029	4754075
R45	Residence	4.5	3	588090	4754124
R46	Residence	1.5	3	588271	4754284
R47	Residence	4.5	3	588374	4754221
R48	Residence	4.5	3	588590	4754285
R49	Residence	1.5	3	588639	4754279
R50	Residence	1.5	3	588655	4754393
R51	Residence	1.5	3	588786	4754283
R52	Residence	1.5	3	588802	4754188
R53	Residence	4.5	3	588903	4754152
R54	Residence	1.5	3	588886	4754256
R55	Residence	1.5	3	588871	4754295
R56	Residence	1.5	3	588847	4754320
R57	Residence	4.5	3	588857	4754382
R58	Residence	1.5	3	588817	4754448
R59	Residence	1.5	3	588880	4754518
R60	Residence	4.5	3	588963	4754405
R61	Residence	4.5	3	589301	4754618
R63	Residence	1.5	3	589411	4754642
R64	Residence	1.5	3	589533	4754681
R65	Residence	1.5	3	589711	4754755
R66	Residence	1.5	3	589639	4754613
R69	Residence	1.5	3	590194	4754795
R70	Residence	4.5	3	590318	4754864
R72	Residence	4.5	3	590390	4755045
R73	Residence	1.5	3	590490	4755015
R74	Residence	4.5	3	590508	4754884
R75	Residence	1.5	3	590996	4754932
R76	Residence	1.5	3	591066	4755195
R77	Residence	4.5	3	591142	4755206

R78	Residence	1.5	3	591212	4755248
R90	Residence	4.5	3	591238	4754978
R91	Residence	1.5	3	591533	4754527
R92	Residence	1.5	3	591564	4754460
R93	Residence	1.5	3	591601	4754353
R95	Residence	1.5	3	591463	4754250
R96	Residence	4.5	3	591616	4754058
R98	Residence	1.5	3	591702	4753538
R99	Residence	1.5	3	591753	4753462
R100	Residence	1.5	3	591569	4753239
R101	Residence	1.5	3	591492	4753217
R102	Residence	4.5	3	591364	4753328
R103	Residence	1.5	3	591260	4753171
R104	Residence	1.5	3	591138	4753110
R105	Residence	1.5	3	590135	4752796
R106	Residence	4.5	3	589111	4752420
R108	Residence	4.5	3	588499	4752274
R109	Residence	4.5	3	588109	4752082
R110	Residence	4.5	3	587968	4752026
R111	Residence	1.5	3	587790	4752120
R112	Residence	1.5	3	587594	4752243
R113	Residence	4.5	3	587567	4752136
R115	Residence	1.5	3	586866	4752607
R119	Residence	1.5	3	589019	4753583
R120	Residence	1.5	3	589174	4753402
R121	Residence	1.5	3	589129	4753224
R122	Residence	1.5	3	589129	4753079
R127	Residence	1.5	3	587461	4751976
R128	Residence	1.5	3	587885	4751951
R129	Residence	4.5	3	588015	4751893
R130	Residence	4.5	3	588518	4751589
R131	Residence	1.5	3	588177	4752026
R132	Residence	1.5	3	588258	4752049
R133	Residence	1.5	3	588578	4752160
R134	Residence	4.5	3	588762	4752234
R135	Residence	1.5	3	588304	4752171
R136	Residence	4.5	3	589147	4752343
R137	Residence	4.5	3	589359	4752412
R138	Residence	4.5	3	589462	4752426
R139	Residence	4.5	3	589898	4752396
R141	Residence	4.5	3	590557	4752645
R142	Residence	4.5	3	590818	4752693
R143	Residence	4.5	3	591469	4752903
R144	Residence	4.5	3	591585	4753138
R145	Residence	4.5	3	591929	4753082
R146	Residence	4.5	3	591995	4753218
R147	Residence	4.5	3	591985	4752772
R148	Residence	4.5	3	592104	4752624
R149	Residence	4.5	3	592336	4752848
R150	Residence	4.5	3	592321	4752454
R152	Residence	1.5	3	592307	4752025
R153	Residence	4.5	3	592572	4752010
R155	Residence	1.5	3	592336	4751777
R158	Residence	4.5	3	592591	4751396
R159	Residence	4.5	3	592581	4751514
R160	Residence	1.5	3	592562	4751561
R161	Residence	1.5	3	592488	4751533
R162	Residence	1.5	3	592499	4751476
R163	Residence	1.5	3	592498	4751381
R164	Residence	1.5	3	592451	4751364

R165	Residence	4.5	3	592561	4751302
R166	Residence	1.5	3	592665	4751248
R167	Residence	1.5	3	592675	4751206
R170	Residence	1.5	3	592834	4750948
R171	Residence	1.5	3	592806	4750795
R172	Residence	1.5	3	592854	4750632
R173	Residence	4.5	3	592839	4750467
R174	Residence	4.5	3	592959	4750356
R175	Residence	4.5	3	593206	4749595
R176	Residence	1.5	3	593043	4748993
R178	Residence	4.5	3	592332	4748917
R179	Residence	1.5	3	592005	4748835
R180	Residence	1.5	3	592107	4748777
R181	Residence	1.5	3	592062	4748776
R182	Residence	4.5	3	591946	4748752
R184	Residence	4.5	3	591530	4748760
R185	Residence	4.5	3	591579	4748669
R239	Residence	1.5	3	588997	4749890
R243	Residence	1.5	3	588886	4750247
R244	Residence	4.5	3	588931	4750382
R245	Residence	1.5	3	588913	4750503
R246	Residence	4.5	3	588806	4750568
R250	Residence	4.5	3	588611	4751157
R253	Residence	4.5	3	588694	4751201
R254	Residence	4.5	3	589943	4749728
R255	Residence	4.5	3	590130	4749836
R256	Residence	4.5	3	590549	4749963
R257	Residence	4.5	3	590797	4750092
R259	Residence	4.5	3	590819	4749930
R260	Residence	1.5	3	591137	4749991
R261	Residence	1.5	3	591243	4750010
R262	Residence	4.5	3	589331	4751018
R263	Residence	1.5	3	589346	4751086
R265	Residence	1.5	3	589552	4751291
R266	Residence	4.5	3	589618	4751273
R267	Residence	1.5	3	589722	4751226
R268	Residence	4.5	3	589805	4751197
R269	Residence	4.5	3	589953	4751250
R270	Residence	4.5	3	590072	4750943
R271	Residence	4.5	3	590117	4751503
R272	Residence	1.5	3	589961	4751604
R273	Residence	1.5	3	590915	4750881
R275	Residence	1.5	3	591121	4750841
R276	Residence	4.5	3	591293	4750912
R277	Residence	4.5	3	591558	4750983
R278	Residence	1.5	3	591457	4751049
R279	Residence	4.5	3	591686	4751169
R280	Residence	1.5	3	591901	4751175
R281	Residence	4.5	3	591929	4751121
R282	Residence	4.5	3	591963	4751192
R283	Residence	1.5	3	592168	4751194
R284	Residence	4.5	3	593593	4749422
R285	Residence	1.5	3	593644	4749202
R288	Residence	4.5	3	594802	4752442
R289	Residence	4.5	3	595053	4752188
R290	Residence	4.5	3	594993	4752081
R291	Residence	4.5	3	595129	4752091
R292	Residence	1.5	3	595257	4751952
R293	Residence	4.5	3	595180	4751869
R294	Residence	1.5	3	595356	4751931

R295	Residence	4.5	3	595233	4751783
R296	Residence	1.5	3	595312	4751801
R297	Residence	4.5	3	595418	4751879
R300	Residence	4.5	3	595388	4751690
R302	Residence	1.5	3	594197	4749117
R303	Residence	4.5	3	594425	4749015
R304	Residence	1.5	3	595177	4748691
R305	Residence	1.5	3	594821	4748722
R306	Residence	4.5	3	595426	4748513
R307	Residence	1.5	3	596129	4748611
R308	Residence	1.5	3	595830	4751457
R309	Residence	4.5	3	596100	4751651
R325	Residence	1.5	3	598346	4751705
R327	Residence	4.5	3	598214	4751579
R336	Residence	1.5	3	601010	4751539
R337	Residence	4.5	3	601265	4751811
R338	Residence	4.5	3	601684	4752112
R339	Residence	4.5	3	602037	4752122
R340	Residence	1.5	3	602390	4751809
R341	Residence	4.5	3	602498	4751933
R342	Residence	1.5	3	602509	4751807
R343	Residence	7.5	3	602928	4751863
R349	Residence	4.5	3	603144	4750902
R350	Residence	1.5	3	593583	4751606
R353	Residence	1.5	3	594609	4751028
R354	Residence	4.5	3	594938	4750947
R355	Residence	4.5	3	595233	4750565
R356	Residence	1.5	3	595320	4751040
R357	Residence	1.5	3	595471	4750990
R358	Residence	4.5	3	595252	4750428
R359	Residence	1.5	3	595088	4750040
R360	Residence	1.5	3	595216	4749628
R361	Residence	1.5	3	595517	4749636
R362	Residence	1.5	3	595748	4749453
R363	Church	1.5	3	595682	4749487
R364	Residence	7.5	3	595795	4749735
R365	Residence	1.5	3	596064	4750325
R366	Residence	1.5	3	596556	4750512
R367	Residence	4.5	3	596650	4750552
R369	Residence	4.5	3	597292	4750739
R370	Residence	4.5	3	597248	4750668
R371	Residence	4.5	3	597528	4750821
R372	Residence	1.5	3	598092	4751035
R373	Residence	1.5	3	598103	4751260
R374	Residence	4.5	3	598295	4751102
R378	Residence	1.5	3	597392	4748712
R380	Residence	1.5	3	597617	4748539
R381	Residence	1.5	3	597542	4748329
R383	Residence	4.5	3	597832	4747384
R386	Residence	4.5	3	599094	4747199
R387	Residence	1.5	3	598518	4749012
R388	Residence	1.5	3	598470	4748990
R389	Residence	4.5	3	598453	4749195
R390	Residence	4.5	3	598466	4749459
R391	Residence	4.5	3	598331	4749557
R392	Residence	1.5	3	598327	4749796
R393	Residence	4.5	3	598184	4749987
R394	Residence	4.5	3	597860	4750701
R395	Residence	4.5	3	597996	4750732
R396	Residence	1.5	3	597867	4751171

R399	Residence	4.5	3	599457	4746582
R401	Residence	1.5	3	599349	4745978
R402	Residence	4.5	3	599410	4745181
R403	Residence	1.5	3	599512	4744986
R404	Residence	1.5	3	599793	4744608
R405	Residence	4.5	3	599604	4744244
R406	Residence	4.5	3	593184	4748779
R407	Residence	1.5	3	593146	4748642
R408	Residence	1.5	3	593334	4748307
R409	Residence	1.5	3	593350	4748255
R410	Residence	1.5	3	593488	4747888
R411	Residence	4.5	3	593389	4747812
R412	Residence	1.5	3	593406	4747756
R413	Residence	4.5	3	593537	4747695
R414	Residence	1.5	3	593415	4747666
R415	Residence	4.5	3	593579	4747295
R416	Residence	4.5	3	593627	4747096
R455	Residence	4.5	3	595897	4749329
R457	Residence	4.5	3	595844	4749286
R459	Residence	1.5	3	595916	4749261
R460	Residence	4.5	3	596136	4748195
R461	Residence	1.5	3	596099	4748107
R462	Residence	4.5	3	596203	4748080
R464	Residence	1.5	3	596434	4747858
R465	Residence	4.5	3	597146	4747852
R466	Residence	4.5	3	597329	4747592
R467	Residence	1.5	3	597505	4747260
R468	Residence	4.5	3	597960	4747051
R469	Residence	1.5	3	598084	4747146
R470	Residence	4.5	3	598478	4747034
R471	Residence	4.5	3	599198	4747072
R501	Residence	1.5	3	600846	4749547
R502	Residence	4.5	3	601128	4749169
R503	Residence	4.5	3	601337	4748589
R504	Residence	4.5	3	601320	4748421
R505	Residence	4.5	3	601527	4747991
R507	Residence	4.5	3	601382	4747867
R508	Residence	4.5	3	601517	4747855
R509	Residence	4.5	3	601562	4747880
R510	Residence	4.5	3	601704	4747927
R512	Residence	4.5	3	601959	4746592
R513	Residence	1.5	3	602042	4746596
R515	Residence	1.5	3	601962	4746506
R516	Residence	1.5	3	602395	4745144
R517	Residence	1.5	3	602617	4744883
R518	Residence	1.5	3	602615	4744865
R519	Residence	1.5	3	602547	4744797
R520	Residence	1.5	3	604976	4745525
R521	Residence	1.5	3	604946	4745498
R523	Residence	1.5	3	604715	4746166
R524	Residence	4.5	3	604317	4747310
R525	Residence	4.5	3	604363	4747368
R527	Residence	1.5	3	604311	4747481
R528	Residence	4.5	3	604043	4747485
R529	Residence	4.5	3	604185	4747518
R530	Residence	1.5	3	604187	4747613
R531	Residence	1.5	3	604135	4747760
R532	Residence	1.5	3	604106	4747879
R533	Residence	1.5	3	604196	4747866
R534	Residence	1.5	3	604223	4747770

R535	Residence	4.5	3	604253	4747699
R536	Residence	1.5	3	604201	4747571
R537	Residence	1.5	3	604268	4747645
R540	Residence	4.5	3	603293	4750455
R541	Residence	1.5	3	603164	4750588
R559	Residence	1.5	3	592871	4747549
R561	Residence	4.5	3	593296	4747657
R562	Residence	1.5	3	594083	4747899
R564	Residence	4.5	3	594306	4747888
R565	Residence	1.5	3	594675	4748041
R566	Residence	4.5	3	594782	4747998
R567	Residence	4.5	3	595233	4748095
R568	Residence	4.5	3	595348	4748097
R569	Residence	4.5	3	595494	4748236
R570	Residence	4.5	3	595505	4748148
R571	Residence	1.5	3	595663	4748268
R572	Residence	4.5	3	595750	4748218
R573	Residence	4.5	3	595790	4748278
R574	Residence	4.5	3	596487	4748315
R575	Residence	4.5	3	596772	4748529
R576	Residence	4.5	3	596975	4748483
R577	Residence	4.5	3	597145	4748655
R578	Residence	1.5	3	597594	4748786
R579	Residence	1.5	3	597644	4748802
R581	Residence	1.5	3	597786	4748768
R582	Residence	1.5	3	597849	4748787
R584	Residence	4.5	3	598134	4748890
R585	Residence	4.5	3	598242	4748987
R588	Residence	4.5	3	599042	4749252
R590	Residence	4.5	3	599519	4749453
R591	Residence	4.5	3	599784	4749447
R592	Residence	4.5	3	600206	4749300
R593	Residence	4.5	3	600450	4749675
R595	Residence	4.5	3	601044	4750101
R596	Residence	4.5	3	601475	4750077
R597	Residence	4.5	3	601547	4749841
R598	Residence	4.5	3	601768	4750196
R599	Cemetery	1.5	3	601999	4750268
R602	Residence	4.5	3	602253	4750344
R603	Residence	4.5	3	602385	4750396
R604	Residence	4.5	3	602564	4750509
R605	Residence	4.5	3	602542	4750393
R606	Residence	4.5	3	602792	4750443
R607	Residence	4.5	3	602875	4750461
R608	Residence	1.5	3	602944	4750615
R609	Residence	4.5	3	603780	4750806
R611	Residence	4.5	3	604558	4751074
R612	Residence	1.5	3	604708	4751115
R613	Residence	4.5	3	604748	4751099
R614	Residence	4.5	3	605022	4751198
R615	Residence	4.5	3	605161	4751400
R616	Residence	4.5	3	605570	4751066
R617	Residence	4.5	3	605622	4751286
R619	Residence	1.5	3	605642	4751467
R621	Residence	4.5	3	606205	4752684
R622	Residence	1.5	3	606418	4752647
R623	Residence	4.5	3	606526	4752562
R624	Residence	4.5	3	606668	4752564
R625	Residence	1.5	3	606889	4752539
R626	Residence	1.5	3	606949	4752654

R627	Residence	1.5	3	607040	4752590
R628	Residence	4.5	3	607131	4752630
R676	Residence	4.5	3	599597	4747189
R679	Residence	4.5	3	600535	4747587
R681	Residence	4.5	3	600962	4747730
R682	Residence	1.5	3	601115	4747695
R683	Residence	1.5	3	600910	4747598
R686	Residence	4.5	3	601899	4747943
R687	Residence	1.5	3	601721	4748152
R688	Residence	4.5	3	602436	4748143
R693	Residence	4.5	3	604687	4749039
R694	Residence	4.5	3	604785	4749203
R695	Residence	4.5	3	605073	4748236
R696	Residence	1.5	3	605465	4747910
R697	Residence	4.5	3	605079	4747709
R698	Residence	4.5	3	604889	4747683
R699	Residence	4.5	3	604781	4747827
R700	Residence	1.5	3	604762	4747726
R701	Residence	1.5	3	604777	4747659
R702	Residence	1.5	3	604727	4747723
R703	Residence	4.5	3	604680	4747687
R704	Residence	4.5	3	604716	4747608
R705	Residence	4.5	3	604662	4747678
R706	Residence	4.5	3	604628	4747668
R707	Residence	4.5	3	604584	4747600
R708	Residence	1.5	3	604561	4747576
R709	Residence	4.5	3	604450	4747691
R710	Residence	1.5	3	604390	4747501
R711	Residence	4.5	3	604219	4747455
R712	Residence	1.5	3	604126	4747408
R713	Residence	1.5	3	604036	4747357
R714	Residence	4.5	3	603986	4747326
R715	Residence	1.5	3	603916	4747397
R716	Residence	1.5	3	603851	4747368
R717	Residence	4.5	3	603931	4747302
R718	Residence	4.5	3	603543	4747343
R719	Residence	1.5	3	603581	4747169
R720	Residence	1.5	3	603447	4747107
R721	Residence	1.5	3	603384	4747059
R722	Residence	4.5	3	603309	4747180
R723	Residence	1.5	3	603190	4746986
R724	Residence	4.5	3	602983	4746871
R725	Residence	4.5	3	602922	4746867
R726	Residence	7.5	3	602867	4747065
R727	Residence	1.5	3	602749	4746837
R728	Residence	4.5	3	602487	4746930
R730	Residence	4.5	3	602148	4746712
R731	Residence	1.5	3	602164	4746635
R732	Residence	4.5	3	602109	4746616
R733	Residence	4.5	3	601884	4746626
R734	Residence	4.5	3	601880	4746566
R737	Residence	4.5	3	601549	4746422
R738	Residence	4.5	3	601384	4746515
R739	Residence	1.5	3	601285	4746376
R740	Residence	1.5	3	600942	4746249
R741	Residence	1.5	3	600841	4746210
R742	Residence	4.5	3	600631	4746221
R743	Residence	4.5	3	600540	4746125
R744	Residence	4.5	3	600394	4746127
R745	Residence	4.5	3	599866	4745931

R746	Residence	4.5	3	599466	4745843
R747	Residence	1.5	3	599327	4745777
R748	Residence	4.5	3	599226	4745790
R749	Residence	4.5	3	599190	4745819
R750	Residence	4.5	3	599035	4745799
R833	Residence	1.5	3	605343	4750757
R834	Residence	1.5	3	605575	4750473
R835	Residence	4.5	3	605720	4750430
R836	Residence	1.5	3	605696	4749991
R837	Residence	1.5	3	605690	4749662
R838	Residence	1.5	3	605703	4749620
R839	Residence	4.5	3	605643	4748297
R840	Residence	1.5	3	605764	4748120
R841	Residence	1.5	3	605750	4748007
R842	Church/Cemetery	1.5	3	605627	4747409
R843	Residence	1.5	3	605704	4747241
R846	Residence	4.5	3	605935	4746482
R847	Residence	4.5	3	605775	4746233
R850	Residence	1.5	3	607958	4751829
R851	Residence	1.5	3	607982	4751795
R852	Residence	1.5	3	608009	4751642
R853	Residence	4.5	3	607759	4751532
R854	Residence	1.5	3	607971	4751536
R855	Residence	1.5	3	607839	4751413
R856	Residence	4.5	3	607952	4751294
R857	Residence	1.5	3	607987	4751201
R858	Residence	1.5	3	607993	4751164
R859	Residence	1.5	3	608019	4751108
R860	Residence	1.5	3	608012	4751066
R861	Residence	1.5	3	608020	4751017
R862	Residence	1.5	3	608022	4750961
R863	Residence	1.5	3	608127	4751063
R864	Residence	1.5	3	607949	4750876
R865	Residence	4.5	3	607822	4750854
R868	Residence	4.5	3	608046	4750451
R869	Residence	4.5	3	608262	4750475
R871	Residence	4.5	3	608129	4748827
R872	Residence	1.5	3	608178	4747161
R873	Church/Cemetery	1.5	3	605932	4750186
R874	Residence	4.5	3	606274	4750424
R875	Residence	1.5	3	606470	4750319
R876	Residence	1.5	3	606392	4750588
R877	Residence	4.5	3	606532	4750589
R878	Residence	1.5	3	606614	4750374
R879	Residence	4.5	3	606655	4750239
R880	Residence	4.5	3	606868	4750533
R882	Residence	4.5	3	606964	4750569
R883	Residence	1.5	3	606945	4750475
R887	Residence	4.5	3	607477	4751095
R888	Residence	4.5	3	608625	4751083
R889	Residence	1.5	3	608648	4750939
R890	Residence	4.5	3	608874	4751026
R891	Residence	1.5	3	608719	4751015
R892	Residence	4.5	3	608867	4750841
R893	Residence	1.5	3	608936	4750785
R894	Residence	1.5	3	609171	4750746
R895	Residence	1.5	3	609351	4750635
R896	Residence	1.5	3	609266	4750494
R897	Residence	1.5	3	609365	4750498
R898	Residence	1.5	3	609524	4750414

R899	Residence	1.5	3	609517	4750539
R900	Residence	1.5	3	609554	4750520
R902	Residence	1.5	3	609624	4750505
R903	Residence	1.5	3	609656	4750494
R904	Residence	1.5	3	609612	4750387
R905	Residence	1.5	3	609654	4750388
R906	Residence	1.5	3	609692	4750478
R907	Residence	1.5	3	609720	4750473
R908	Residence	4.5	3	609780	4750444
R910	Residence	1.5	3	609777	4750312
R911	Residence	1.5	3	609830	4750284
R912	Residence	1.5	3	609968	4750396
R913	Residence	4.5	3	610062	4750341
R914	Residence	4.5	3	609991	4750273
R916	Residence	1.5	3	610412	4750483
R917	Residence	1.5	3	610294	4750489
R918	Residence	1.5	3	610213	4750494
R919	Residence	1.5	3	610160	4750530
R920	Residence	1.5	3	610169	4750683
R921	Residence	1.5	3	610195	4750732
R922	Residence	1.5	3	610420	4750126
R923	Residence	1.5	3	610467	4750108
R924	Residence	4.5	3	610547	4749998
R925	Residence	1.5	3	610547	4749938
R926	Residence	1.5	3	610553	4749870
R927	Residence	4.5	3	610550	4749791
R928	Residence	4.5	3	610552	4749729
R929	Residence	4.5	3	610548	4749621
R930	Residence	1.5	3	610461	4749553
R931	Residence	1.5	3	610344	4749510
R932	Residence	1.5	3	610271	4749473
R969	Residence	1.5	3	613187	4748438
R970	Residence	4.5	3	613194	4747795
R971	Residence	4.5	3	613199	4747089
R972	Residence	4.5	3	613121	4746541
R978	Residence	1.5	3	613371	4747303
R979	Residence	4.5	3	605950	4748034
R980	Residence	1.5	3	606095	4748176
R981	Residence	4.5	3	606306	4748111
R982	Residence	4.5	3	606361	4748354
R983	Residence	1.5	3	606476	4748366
R984	Residence	4.5	3	606560	4748374
R985	Residence	4.5	3	606619	4748371
R986	Residence	1.5	3	606668	4748301
R987	Residence	1.5	3	606714	4748336
R989	Residence	4.5	3	606762	4748554
R990	Residence	4.5	3	607080	4748357
R991	Residence	4.5	3	607125	4748380
R992	Residence	4.5	3	607502	4748512
R998	Residence	1.5	3	608830	4748944
R999	Residence	1.5	3	608952	4749087
R1000	Residence	4.5	3	608998	4749093
R1001	Residence	1.5	3	609162	4749051
R1003	Residence	1.5	3	609297	4749108
R1004	Residence	1.5	3	609463	4749232
R1005	Residence	1.5	3	609493	4749245
R1006	Residence	4.5	3	609512	4749020
R1007	Residence	4.5	3	609528	4749353
R1008	Residence	4.5	3	609764	4749241
R1009	Residence	1.5	3	609792	4749331

R1010	Residence	1.5	3	609897	4749365
R1011	Residence	1.5	3	610003	4749425
R1012	Residence	4.5	3	609989	4749239
R1013	Residence	1.5	3	610252	4749464
R1014	Residence	1.5	3	610399	4749434
R1015	Residence	1.5	3	610498	4749473
R1030	Residence	1.5	3	612873	4747259
R1031	Residence	4.5	3	612903	4747387
R1032	Residence	4.5	3	612591	4746399
R1034	Residence	4.5	3	612134	4746446
R1035	Residence	4.5	3	612390	4746253
R1036	Residence	4.5	3	611789	4746055
R1037	Residence	1.5	3	611689	4746520
R1039	Residence	4.5	3	611370	4746205
R1040	Residence	1.5	3	611203	4746212
R1041	Residence	1.5	3	610774	4746293
R1042	Residence	4.5	3	610778	4746188
R1043	Residence	4.5	3	610706	4746267
R1054	Residence	4.5	3	611697	4748184
R1055	Residence	4.5	3	611653	4748174
R1057	Residence	1.5	3	611375	4748156
R1058	Residence	4.5	3	611223	4748159
R1059	Residence	4.5	3	610900	4748217
R1060	Residence	1.5	3	610879	4748136
R1061	Residence	1.5	3	610694	4748210
R1062	Residence	1.5	3	610713	4748000
R1064	Residence	4.5	3	611651	4748966
R1065	Residence	4.5	3	611693	4748496
R1068	Residence	1.5	3	610785	4748664
R1069	Residence	1.5	3	610600	4748469
R1070	Residence	4.5	3	610603	4748036
R1071	Residence	1.5	3	610632	4747961
R1072	Residence	1.5	3	610632	4747923
R1073	Residence	4.5	3	610618	4747891
R1074	Residence	1.5	3	610440	4747686
R1075	Residence	4.5	3	610646	4747026
R1076	Residence	4.5	3	610724	4747088
R1078	Residence	4.5	3	610243	4747195
R1079	Residence	4.5	3	610188	4747321
R1080	Residence	1.5	3	609418	4747176
R1175	Residence	1.5	3	599409	4744277
R1176	Residence	1.5	3	599716	4744208
R1177	Residence	4.5	3	599876	4744260
R1178	Residence	1.5	3	599962	4744287
R1179	Residence	4.5	3	600138	4744292
R1197	Residence	7.5	3	600875	4744097
R1198	Residence	1.5	3	600965	4744203
R1199	Residence	1.5	3	601078	4744166
R1200	Residence	1.5	3	601100	4744309
R1201	Residence	1.5	3	601067	4744406
R1202	Residence	1.5	3	601044	4744488
R1203	Residence	1.5	3	601113	4744493
R1204	Residence	1.5	3	601127	4744449
R1205	Residence	1.5	3	601136	4744420
R1206	Residence	1.5	3	601188	4744341
R1207	Residence	4.5	3	601241	4744182
R1208	Residence	4.5	3	601327	4744200
R1209	Residence	1.5	3	601484	4744221
R1210	Residence	1.5	3	601710	4744383
R1211	Residence	1.5	3	601690	4744287

R1213	Residence	1.5	3	601857	4744360
R1214	Residence	1.5	3	602243	4744481
R1215	Residence	1.5	3	602178	4744501
R1216	Residence	1.5	3	602296	4744506
R1217	Residence	1.5	3	602277	4744553
R1218	Residence	1.5	3	602260	4744622
R1219	Residence	1.5	3	602244	4744669
R1220	Residence	1.5	3	602226	4744731
R1221	Residence	1.5	3	602263	4744752
R1222	Residence	1.5	3	602289	4744783
R1223	Residence	1.5	3	602438	4744752
R1224	Residence	1.5	3	602483	4744783
R1225	Residence	1.5	3	602514	4744802
R1226	Residence	1.5	3	602668	4744863
R1227	Residence	1.5	3	602729	4744960
R1228	Residence	1.5	3	602766	4744896
R1229	Residence	1.5	3	602871	4744919
R1230	Residence	4.5	3	602844	4745056
R1231	Residence	4.5	3	602969	4744977
R1232	Residence	1.5	3	603058	4745045
R1235	Residence	4.5	3	603158	4745404
R1236	Residence	4.5	3	603098	4745346
R1237	Residence	4.5	3	603254	4745487
R1238	Residence	1.5	3	603322	4745521
R1239	Residence	4.5	3	603387	4745554
R1240	Residence	4.5	3	603454	4745613
R1241	Residence	1.5	3	603574	4745600
R1242	Residence	1.5	3	603655	4745715
R1243	Residence	4.5	3	603819	4745627
R1244	Residence	1.5	3	604015	4745594
R1245	Residence	4.5	3	604102	4745564
R1246	Residence	1.5	3	604234	4745536
R1247	Residence	4.5	3	604481	4745466
R1248	Residence	1.5	3	604624	4745332
R1249	Residence	1.5	3	604802	4745450
R1250	Residence	4.5	3	604848	4745463
R1251	Residence	1.5	3	605026	4745567
R1252	Residence	1.5	3	605147	4745724
R1254	Residence	4.5	3	605312	4745909
R1255	Residence	1.5	3	605350	4745949
R1256	Residence	1.5	3	605478	4746020
R1257	Residence	1.5	3	605596	4746099
R1258	Residence	1.5	3	605657	4746168
R1259	Residence	1.5	3	605705	4746214
R1260	Residence	1.5	3	605865	4746245
R1261	Residence	1.5	3	606016	4746262
R1262	Residence	1.5	3	606225	4746262
R1263	Residence	1.5	3	606300	4746250
R1264	Residence	4.5	3	606405	4746198
R1265	Residence	4.5	3	606410	4746292
R1266	Residence	1.5	3	606477	4746175
R1268	Residence	1.5	3	599155	4744249
R1270	Residence	7.5	3	600618	4744281
R1271	Residence	1.5	3	601121	4744241
R1272	Residence	1.5	3	601162	4744445
R1273	Residence	1.5	3	601149	4744482
R1274	Residence	4.5	3	601765	4744383
R1275	Residence	1.5	3	602403	4744730
R1276	Residence	1.5	3	602348	4744693
R1277	Residence	1.5	3	602591	4744824

R1278	Residence	1.5	3	603032	4744949
R1280	Residence	1.5	3	604339	4745437
R1281	Residence	1.5	3	610543	4750080
R1284	Residence	4.5	3	612396	4748190
R1287	Residence	4.5	3	610389	4749526
R1288	Residence	4.5	3	610307	4749494
R1289	Residence	1.5	3	607360	4748447
R1290	Residence	4.5	3	607465	4748505
R1291	Residence	4.5	3	604283	4747531
R1292	Church	1.5	3	604071	4747354
R1293	Residence	1.5	3	604013	4747337
R1294	Residence	1.5	3	603883	4747383
R1295	Cemetery	1.5	3	603036	4746963
R1296	Residence	1.5	3	602136	4746629
R1297	Residence	1.5	3	602077	4746608
R1298	Residence	1.5	3	601257	4746362
R1299	Residence	4.5	3	600884	4746644
R1300	Residence	1.5	3	599816	4745925
R1301	Residence	4.5	3	599520	4745846
R1317	Residence	4.5	3	596911	4748474
R1318	Residence	1.5	3	600507	4749685
R1319	Cemetery	1.5	3	600949	4749831
R1320	Residence	1.5	3	601254	4749900
R1321	Residence	1.5	3	602258	4750261
R1322	Residence	4.5	3	607521	4750401
R1323	Residence	4.5	3	608448	4750798
R1324	Residence	1.5	3	610503	4750088
R1341	Residence	4.5	3	595975	4751290
R1342	Cemetery	1.5	3	595363	4751782
R1345	Residence	1.5	3	591163	4755213
R1346	Residence	4.5	3	589647	4754869
R1347	Residence	4.5	3	589576	4754708
R1348	Residence	1.5	3	589652	4754718
R1349	Residence	1.5	3	589456	4754653
R1350	Residence	1.5	3	589245	4754583
R1351	Residence	1.5	3	588735	4754408
R1352	Residence	4.5	3	588699	4754321
R1353	Residence	1.5	3	587667	4753972
R1355	Residence	1.5	3	590165	4752841
R1356	Residence	4.5	3	591819	4753796
R1357	Residence	1.5	3	592526	4751432
R1358	Church	1.5	3	592623	4751296
R1359	Residence	4.5	3	592604	4751223
R1360	Cemetery	1.5	3	592721	4750979
R1361	Residence	4.5	3	592713	4750884
R1362	Residence	1.5	3	596041	4748115
R1363	Residence	4.5	3	605436	4749676
R1365	Residence	4.5	3	604691	4746151
R1366	Residence	1.5	3	604172	4747645
R1367	Residence	4.5	3	604214	4747808
R1368	Residence	4.5	3	599891	4744541
R1369	Residence	4.5	3	597557	4748243
R1373	Cemetery	1.5	3	593234	4749040
R1374	Residence	4.5	3	591967	4748965
R1375	Residence	1.5	3	595224	4750337
R1377	Residence	4.5	3	590824	4750807
R1378	Residence	1.5	3	588798	4754249
R2137	Residence	1.5	3	588682	4749437
R2148	Residence	4.5	3	588903	4749463
R2152	Residence	4.5	3	589043	4749522

R2153	Residence	4.5	3	589092	4749617
R2159	Residence	4.5	3	589173	4749645
R2164	Residence	4.5	3	589226	4749361
R2165	Residence	4.5	3	589246	4749008
R2170	Residence	1.5	3	589274	4749259
R2171	Residence	1.5	3	589275	4748942
R2179	Residence	4.5	3	589339	4748971
R2552	Residence	1.5	3	587708	4752727
R2565	Residence	1.5	3	588941	4756653
R2566	Residence	1.5	3	589212	4756734
R2567	Residence	4.5	3	589214	4756612
R2568	Residence	4.5	3	589438	4756707
R2569	Residence	1.5	3	590273	4756764
R2575	Residence	1.5	3	590669	4756914
R2593	Residence	1.5	3	588815	4754488
R2594	Residence	4.5	3	588810	4754529
R2595	Residence	4.5	3	588804	4754551
R2596	Residence	4.5	3	588812	4754658
R2597	Residence	1.5	3	588740	4754708
R2598	Residence	1.5	3	588806	4754705
R2599	Residence	4.5	3	588802	4754729
R2600	Residence	1.5	3	588742	4754750
R2601	Residence	1.5	3	588810	4754778
R2602	Residence	1.5	3	588798	4754846
R2603	Residence	1.5	3	588798	4754888
R2604	Residence	1.5	3	588794	4754938
R2605	Residence	1.5	3	588807	4754968
R2606	Residence	1.5	3	588727	4754995
R2607	Residence	4.5	3	588721	4755021
R2608	Residence	1.5	3	588723	4755058
R2609	Residence	4.5	3	589079	4755160
R2610	Residence	4.5	3	588746	4755190
R2611	Residence	1.5	3	588563	4755681
R2612	Residence	1.5	3	590660	4755225
R2613	Residence	1.5	3	591118	4755577
R2614	Residence	1.5	3	590790	4755825
R2615	Residence	1.5	3	590763	4756039
R2616	Residence	1.5	3	591052	4756107
R2617	Residence	4.5	3	590733	4756216
R2618	Residence	1.5	3	590584	4756621
R2684	Residence	1.5	3	595503	4752598
R2769	Residence	1.5	3	600698	4752432
R2770	Residence	1.5	3	600746	4752435
R2853	Residence	4.5	3	613529	4749080
R2854	Residence	4.5	3	613588	4749067
R2855	Residence	1.5	3	613637	4749067
R2856	Residence	4.5	3	613678	4749065
R2857	Residence	4.5	3	613945	4748917
R2858	Residence	4.5	3	614063	4749005
R2859	Residence	1.5	3	613872	4749378
R2860	Residence	1.5	3	614031	4749116
R2861	Residence	4.5	3	614103	4749005
R2862	Residence	1.5	3	614273	4748963
R2863	Residence	4.5	3	614749	4748859
R2864	Residence	4.5	3	614999	4749000
R2865	Residence	1.5	3	615167	4748954
R2866	Residence	1.5	3	615288	4748965
R2867	Residence	4.5	3	615377	4748975
R2868	Residence	1.5	3	615424	4748867
R2869	Residence	1.5	3	615505	4748906

R2870	Residence	1.5	3	615561	4748928
R2871	Residence	1.5	3	615617	4748915
R2872	Residence	1.5	3	615664	4748908
R2873	Residence	1.5	3	615684	4748912
R2874	Residence	1.5	3	615695	4748911
R2875	Residence	4.5	3	615710	4748901
R2876	Residence	4.5	3	615895	4748840
R2877	Residence	1.5	3	615297	4748729
R2878	Residence	4.5	3	615337	4748686
R2879	Residence	1.5	3	615393	4748706
R2880	Residence	1.5	3	615299	4748591
R2881	Residence	1.5	3	615856	4748359
R2884	Residence	1.5	3	615606	4747479
R2885	Residence	4.5	3	615610	4747398
R2886	Residence	4.5	3	615621	4747295
R2887	Residence	4.5	3	615643	4747237
R2888	Residence	1.5	3	615774	4747076
R2889	Residence	4.5	3	615656	4747090
R2890	Residence	4.5	3	615529	4747019
R2891	Residence	4.5	3	615689	4746946
R2892	Residence	4.5	3	615464	4746917
R2893	Residence	4.5	3	615600	4746866
R2894	Residence	1.5	3	615600	4746842
R2895	Residence	4.5	3	615601	4746820
R2896	Residence	1.5	3	615596	4746793
R2897	Residence	1.5	3	615702	4746644
R2898	Residence	1.5	3	615664	4746580
R2899	Residence	4.5	3	615667	4746533
R2900	Residence	1.5	3	615687	4746450
R2901	Residence	1.5	3	615733	4746435
R2902	Residence	4.5	3	615835	4746424
R2903	Residence	1.5	3	615865	4746425
R2904	Residence	1.5	3	615888	4746426
R2905	Residence	4.5	3	615923	4746373
R2906	Residence	1.5	3	615855	4746372
R2907	Residence	4.5	3	615793	4746370
R2908	Residence	4.5	3	615760	4746367
R2909	Residence	1.5	3	615672	4746322
R2910	Residence	1.5	3	615671	4746337
R2935	Residence	4.5	3	615678	4746194
R2936	Residence	1.5	3	615587	4746151
R2940	Residence	4.5	3	613986	4746292
R2941	Residence	4.5	3	613795	4746445
R2942	Residence	1.5	3	614963	4745971
R2943	Residence	4.5	3	615452	4746047
R2944	Residence	4.5	3	615317	4745999
R2945	Residence	4.5	3	615270	4745990
R2946	Residence	4.5	3	615201	4745982
R2947	Residence	4.5	3	615163	4745975
R2948	Residence	1.5	3	615119	4745996
R2949	Residence	4.5	3	615096	4745995
R2950	Residence	1.5	3	615048	4745956
R2951	Residence	4.5	3	614948	4745893
R2956	Residence	4.5	3	608109	4746658
R2957	Residence	1.5	3	608357	4746426
R2958	Residence	1.5	3	608707	4746214
R2962	Residence	1.5	3	608466	4746128
R2963	Residence	1.5	3	608468	4746035
R2967	Residence	1.5	3	608397	4745331
R2968	Residence	1.5	3	608356	4745336

R2969	Residence	1.5	3	608246	4745395
R2970	Residence	1.5	3	608217	4745386
R2971	Residence	4.5	3	608188	4745388
R2972	Residence	1.5	3	608153	4745370
R2973	Residence	1.5	3	608115	4745295
R2974	Residence	1.5	3	608037	4745283
R2975	Residence	1.5	3	607980	4745339
R2976	Residence	1.5	3	607928	4745334
R2977	Residence	1.5	3	607872	4745339
R2978	Residence	1.5	3	607883	4745386
R2979	Residence	1.5	3	607840	4745404
R2980	Residence	1.5	3	607820	4745429
R2981	Residence	4.5	3	607764	4745429
R2982	Residence	1.5	3	607770	4745508
R2983	Residence	1.5	3	607746	4745554
R2984	Residence	1.5	3	607808	4745565
R2985	Residence	1.5	3	607910	4745549
R2986	Residence	4.5	3	608224	4745693
R2987	Residence	1.5	3	607921	4745639
R2988	Residence	1.5	3	607591	4745688
R2989	Residence	4.5	3	607682	4745524
R2990	Residence	4.5	3	607517	4745553
R2991	Residence	4.5	3	607451	4745579
R2992	Residence	1.5	3	607395	4745606
R2993	Residence	4.5	3	607326	4745633
R2994	Residence	4.5	3	607299	4745645
R2996	Residence	1.5	3	607205	4745687
R2999	Residence	1.5	3	607008	4745773
R3000	Residence	4.5	3	606972	4745819
R3001	Residence	1.5	3	606899	4745850
R3003	Residence	1.5	3	606820	4745928
R3004	Residence	4.5	3	606775	4745949
R3005	Residence	4.5	3	606662	4746033
R3006	Residence	1.5	3	606613	4746055
R3007	Residence	1.5	3	606553	4746136
R3008	Residence	1.5	3	606535	4746146
R3009	Residence	1.5	3	606506	4746153
R3010	Residence	4.5	3	613716	4747311
R3011	Residence	1.5	3	601417	4749222
R3013	Residence	4.5	3	615577	4748915
R3014	Residence	1.5	3	615728	4748912
R3015	Residence	4.5	3	615753	4748897
R3016	Residence	1.5	3	615773	4748872
R3018	Residence	1.5	3	615756	4747640
R3019	Residence	1.5	3	615777	4747519
R3020	Residence	1.5	3	615852	4747405
R3021	Residence	1.5	3	615672	4746299
R3022	Residence	1.5	3	615760	4746302
R3023	Residence	1.5	3	615682	4746169
R3025	Residence	4.5	3	615736	4746367
R3026	Residence	1.5	3	615688	4746361
R3027	Residence	4.5	3	615886	4746376
R3028	Residence	4.5	3	615835	4746370
R3029	Residence	1.5	3	615766	4746436
R3030	Residence	4.5	3	615719	4746356
R3033	Residence	1.5	3	608170	4745381
R3034	Residence	1.5	3	607908	4745282
R3035	Residence	1.5	3	608261	4745509
R3036	Residence	1.5	3	608196	4745517
R3037	Residence	1.5	3	608143	4745527

R3038	Residence	1.5	3	607059	4745739
R3039	Residence	4.5	3	607166	4745702
R3052	Residence	1.5	3	613935	4749444
R3623	Residence	4.5	3	600397	4751095

Vacant Lot Surrogate Receptors

Table - Vacant Lot Surrogate Receptor Locations

Project Name: Grand Renewable Energy Park
Datum: NAD83 (Canada) Projection: UTM 17N

Point of Reception ID	Description	Height (m)	NPC Class	X(E,m)	Y(N,m)
V3107	VLSR	4.5	3	586528	4753574
V3108	VLSR	4.5	3	586490	4753681
V3109	VLSR	4.5	3	586905	4753806
V3111	VLSR	4.5	3	586864	4753959
V3112	VLSR	4.5	3	587194	4753907
V3113	VLSR	4.5	3	587295	4753938
V3114	VLSR	4.5	3	587402	4753970
V3115	VLSR	4.5	3	587547	4754014
V3126	VLSR	4.5	3	587943	4754290
V3127	VLSR	4.5	3	587999	4754328
V3133	VLSR	4.5	3	588144	4755218
V3134	VLSR	4.5	3	588380	4754473
V3135	VLSR	4.5	3	588540	4754561
V3136	VLSR	4.5	3	588424	4754306
V3137	VLSR	4.5	3	588486	4754331
V3138	VLSR	4.5	3	588609	4754372
V3139	VLSR	4.5	3	588713	4754507
V3140	VLSR	4.5	3	588774	4754457
V3141	VLSR	4.5	3	588779	4754475
V3142	VLSR	4.5	3	588773	4754560
V3143	VLSR	4.5	3	588764	4754692
V3145	VLSR	4.5	3	588589	4756423
V3146	VLSR	4.5	3	588501	4755505
V3147	VLSR	4.5	3	588802	4754759
V3148	VLSR	4.5	3	588817	4754575
V3149	VLSR	4.5	3	588949	4754485
V3150	VLSR	4.5	3	589216	4754570
V3151	VLSR	4.5	3	588787	4755006
V3152	VLSR	4.5	3	588601	4755632
V3153	VLSR	4.5	3	588890	4756550
V3154	VLSR	4.5	3	589013	4756578
V3155	VLSR	4.5	3	589489	4754932
V3159	VLSR	4.5	3	590559	4755408
V3160	VLSR	4.5	3	590679	4755497
V3162	VLSR	4.5	3	590361	4754983
V3163	VLSR	4.5	3	589843	4756845
V3164	VLSR	4.5	3	590780	4755123
V3165	VLSR	4.5	3	590953	4755198
V3170	VLSR	4.5	3	590802	4756254
V3174	VLSR	4.5	3	587356	4752313
V3176	VLSR	4.5	3	587510	4753911
V3177	VLSR	4.5	3	588482	4753930
V3178	VLSR	4.5	3	588444	4754225
V3179	VLSR	4.5	3	588762	4754335

V3180	VLSR	4.5	3	588834	4754358
V3181	VLSR	4.5	3	589005	4754421
V3182	VLSR	4.5	3	589184	4754484
V3183	VLSR	4.5	3	589977	4752697
V3185	VLSR	4.5	3	590234	4752801
V3186	VLSR	4.5	3	590423	4752873
V3187	VLSR	4.5	3	590747	4754854
V3188	VLSR	4.5	3	591441	4754382
V3219	VLSR	4.5	3	587528	4751998
V3230	VLSR	4.5	3	588430	4751844
V3231	VLSR	4.5	3	588546	4751492
V3232	VLSR	4.5	3	589505	4751338
V3234	VLSR	4.5	3	590825	4752906
V3236	VLSR	4.5	3	591353	4751008
V3237	VLSR	4.5	3	591067	4750904
V3239	VLSR	4.5	3	591812	4751187
V3240	VLSR	4.5	3	592532	4751382
V3241	VLSR	4.5	3	592561	4751482
V3242	VLSR	4.5	3	592547	4751521
V3243	VLSR	4.5	3	592647	4751419
V3246	VLSR	4.5	3	593273	4752004
V3250	VLSR	4.5	3	593429	4751603
V3255	VLSR	4.5	3	592610	4751361
V3257	VLSR	4.5	3	592682	4751131
V3258	VLSR	4.5	3	592731	4750960
V3259	VLSR	4.5	3	592896	4750804
V3260	VLSR	4.5	3	592979	4750982
V3261	VLSR	4.5	3	592884	4750727
V3262	VLSR	4.5	3	593797	4751418
V3263	VLSR	4.5	3	593882	4751374
V3264	VLSR	4.5	3	594180	4751120
V3267	VLSR	4.5	3	593105	4749915
V3268	VLSR	4.5	3	592940	4750403
V3269	VLSR	4.5	3	592907	4750480
V3270	VLSR	4.5	3	592921	4750425
V3271	VLSR	4.5	3	592612	4751188
V3272	VLSR	4.5	3	592506	4751324
V3273	VLSR	4.5	3	592025	4751144
V3274	VLSR	4.5	3	592896	4750271
V3275	VLSR	4.5	3	592947	4750177
V3276	VLSR	4.5	3	593143	4749588
V3277	VLSR	4.5	3	593067	4749112
V3278	VLSR	4.5	3	591409	4750936
V3279	VLSR	4.5	3	591004	4750800
V3280	VLSR	4.5	3	590762	4750637
V3281	VLSR	4.5	3	590994	4750030
V3282	VLSR	4.5	3	591214	4750093
V3283	VLSR	4.5	3	591585	4750172
V3284	VLSR	4.5	3	591563	4750071
V3285	VLSR	4.5	3	591409	4750027
V3286	VLSR	4.5	3	593767	4749313
V3287	VLSR	4.5	3	593827	4749282
V3288	VLSR	4.5	3	593723	4749232
V3305	VLSR	4.5	3	588322	4750772
V3306	VLSR	4.5	3	588828	4750882
V3307	VLSR	4.5	3	589400	4751033
V3308	VLSR	4.5	3	590186	4750913
V3309	VLSR	4.5	3	590218	4749870
V3311	VLSR	4.5	3	589781	4749791
V3312	VLSR	4.5	3	589262	4749665

V3313	VLSR	4.5	3	588916	4750219
V3336	VLSR	4.5	3	589201	4749155
V3341	VLSR	4.5	3	589817	4749680
V3342	VLSR	4.5	3	590138	4749752
V3347	VLSR	4.5	3	595482	4748523
V3348	VLSR	4.5	3	595413	4748227
V3349	VLSR	4.5	3	594881	4748711
V3350	VLSR	4.5	3	594752	4748070
V3351	VLSR	4.5	3	593844	4749180
V3352	VLSR	4.5	3	593699	4747815
V3353	VLSR	4.5	3	593319	4747753
V3354	VLSR	4.5	3	592175	4748809
V3355	VLSR	4.5	3	591807	4748711
V3410	VLSR	4.5	3	598492	4746964
V3411	VLSR	4.5	3	598957	4746731
V3477	VLSR	4.5	3	599117	4745727
V3478	VLSR	4.5	3	599243	4745293
V3479	VLSR	4.5	3	599377	4744253
V3480	VLSR	4.5	3	599267	4744245
V3481	VLSR	4.5	3	599699	4745877
V3482	VLSR	4.5	3	600167	4744381
V3484	VLSR	4.5	3	599482	4746490
V3485	VLSR	4.5	3	599668	4746369
V3486	VLSR	4.5	3	599788	4745994
V3487	VLSR	4.5	3	600450	4745951
V3488	VLSR	4.5	3	601393	4744317
V3508	VLSR	4.5	3	598386	4751724
V3510	VLSR	4.5	3	598481	4751774
V3511	VLSR	4.5	3	598503	4751793
V3522	VLSR	4.5	3	600363	4751770
V3526	VLSR	4.5	3	601301	4751759
V3527	VLSR	4.5	3	601528	4751911
V3528	VLSR	4.5	3	601754	4751992
V3531	VLSR	4.5	3	602763	4752257
V3545	VLSR	4.5	3	606828	4752627
V3546	VLSR	4.5	3	607120	4752706
V3559	VLSR	4.5	3	608478	4751153
V3560	VLSR	4.5	3	608563	4751134
V3561	VLSR	4.5	3	608968	4751172
V3562	VLSR	4.5	3	608682	4751027
V3563	VLSR	4.5	3	608544	4751046
V3566	VLSR	4.5	3	608010	4751757
V3567	VLSR	4.5	3	608016	4751697
V3568	VLSR	4.5	3	608019	4751493
V3569	VLSR	4.5	3	608028	4751269
V3570	VLSR	4.5	3	608054	4750892
V3571	VLSR	4.5	3	608019	4750870
V3572	VLSR	4.5	3	607874	4750842
V3573	VLSR	4.5	3	607797	4750827
V3574	VLSR	4.5	3	607763	4750816
V3575	VLSR	4.5	3	607716	4750805
V3576	VLSR	4.5	3	607681	4750791
V3577	VLSR	4.5	3	608968	4750773
V3578	VLSR	4.5	3	609060	4750719
V3579	VLSR	4.5	3	609685	4750380
V3580	VLSR	4.5	3	609723	4750367
V3581	VLSR	4.5	3	609798	4750358
V3582	VLSR	4.5	3	610216	4750194
V3583	VLSR	4.5	3	610485	4750096
V3584	VLSR	4.5	3	610570	4750069

V3585	VLSR	4.5	3	607203	4752632
V3586	VLSR	4.5	3	606974	4752557
V3587	VLSR	4.5	3	606826	4752510
V3588	VLSR	4.5	3	606804	4752566
V3589	VLSR	4.5	3	606747	4752554
V3590	VLSR	4.5	3	606273	4752566
V3591	VLSR	4.5	3	605600	4752088
V3592	VLSR	4.5	3	606358	4752321
V3595	VLSR	4.5	3	606744	4752484
V3597	VLSR	4.5	3	606999	4750479
V3604	VLSR	4.5	3	603069	4751777
V3605	VLSR	4.5	3	602897	4751799
V3606	VLSR	4.5	3	603299	4751252
V3607	VLSR	4.5	3	603689	4750894
V3608	VLSR	4.5	3	603833	4750799
V3610	VLSR	4.5	3	602673	4751777
V3611	VLSR	4.5	3	602337	4751816
V3614	VLSR	4.5	3	602837	4751535
V3615	VLSR	4.5	3	603063	4750878
V3616	VLSR	4.5	3	602628	4750924
V3619	VLSR	4.5	3	602082	4750303
V3620	VLSR	4.5	3	601576	4750202
V3621	VLSR	4.5	3	601278	4750142
V3622	VLSR	4.5	3	600325	4751680
V3628	VLSR	4.5	3	599373	4751554
V3634	VLSR	4.5	3	598156	4751576
V3637	VLSR	4.5	3	599530	4751482
V3638	VLSR	4.5	3	599407	4751434
V3642	VLSR	4.5	3	598741	4751245
V3646	VLSR	4.5	3	598290	4751031
V3649	VLSR	4.5	3	598552	4749102
V3654	VLSR	4.5	3	597727	4751001
V3655	VLSR	4.5	3	597416	4750900
V3657	VLSR	4.5	3	596284	4750543
V3658	VLSR	4.5	3	595743	4750638
V3659	VLSR	4.5	3	596215	4750361
V3664	VLSR	4.5	3	595963	4748368
V3669	VLSR	4.5	3	598736	4747048
V3671	VLSR	4.5	3	599327	4747243
V3677	VLSR	4.5	3	600421	4749518
V3678	VLSR	4.5	3	600786	4749707
V3679	VLSR	4.5	3	600853	4749829
V3682	VLSR	4.5	3	601314	4748230
V3686	VLSR	4.5	3	602464	4750365
V3689	VLSR	4.5	3	603036	4750537
V3693	VLSR	4.5	3	603282	4750625
V3697	VLSR	4.5	3	605042	4749217
V3698	VLSR	4.5	3	605558	4749487
V3699	VLSR	4.5	3	605413	4750474
V3703	VLSR	4.5	3	606570	4750317
V3704	VLSR	4.5	3	605759	4749022
V3705	VLSR	4.5	3	607230	4748519
V3707	VLSR	4.5	3	607664	4748726
V3712	VLSR	4.5	3	615711	4748835
V3713	VLSR	4.5	3	614127	4749017
V3714	VLSR	4.5	3	613703	4749055
V3715	VLSR	4.5	3	615494	4748209
V3716	VLSR	4.5	3	615547	4748029
V3717	VLSR	4.5	3	613165	4748071
V3718	VLSR	4.5	3	613096	4747923

V3719	VLSR	4.5	3	613046	4748467
V3722	VLSR	4.5	3	611722	4748263
V3747	VLSR	4.5	3	610542	4749505
V3749	VLSR	4.5	3	610468	4749471
V3750	VLSR	4.5	3	610443	4749458
V3751	VLSR	4.5	3	610697	4748454
V3752	VLSR	4.5	3	610597	4748429
V3753	VLSR	4.5	3	611628	4748250
V3754	VLSR	4.5	3	609830	4749352
V3755	VLSR	4.5	3	609355	4749107
V3756	VLSR	4.5	3	608972	4749000
V3757	VLSR	4.5	3	605583	4749168
V3758	VLSR	4.5	3	605193	4749093
V3765	VLSR	4.5	3	601678	4747766
V3766	VLSR	4.5	3	601471	4747804
V3772	VLSR	4.5	3	599566	4747191
V3773	VLSR	4.5	3	599494	4747174
V3774	VLSR	4.5	3	599198	4746930
V3775	VLSR	4.5	3	598890	4746911
V3776	VLSR	4.5	3	601943	4746644
V3777	VLSR	4.5	3	602018	4746611
V3778	VLSR	4.5	3	601757	4746452
V3783	VLSR	4.5	3	603235	4746867
V3790	VLSR	4.5	3	603819	4747349
V3791	VLSR	4.5	3	604361	4747500
V3792	VLSR	4.5	3	604339	4747561
V3793	VLSR	4.5	3	604247	4747520
V3794	VLSR	4.5	3	604215	4747512
V3795	VLSR	4.5	3	604189	4747493
V3796	VLSR	4.5	3	604165	4747489
V3797	VLSR	4.5	3	604141	4747471
V3798	VLSR	4.5	3	604256	4747460
V3799	VLSR	4.5	3	604281	4747407
V3800	VLSR	4.5	3	604182	4747668
V3801	VLSR	4.5	3	604148	4747713
V3802	VLSR	4.5	3	604223	4747732
V3803	VLSR	4.5	3	604132	4747793
V3804	VLSR	4.5	3	604121	4747833
V3805	VLSR	4.5	3	604200	4747831
V3806	VLSR	4.5	3	604171	4747896
V3808	VLSR	4.5	3	604918	4747642
V3809	VLSR	4.5	3	605158	4747810
V3813	VLSR	4.5	3	607175	4748384
V3814	VLSR	4.5	3	607901	4748654
V3815	VLSR	4.5	3	604855	4745947
V3816	VLSR	4.5	3	608181	4747007
V3817	VLSR	4.5	3	608731	4747349
V3818	VLSR	4.5	3	609687	4747387
V3819	VLSR	4.5	3	608825	4746111
V3821	VLSR	4.5	3	610649	4747136
V3822	VLSR	4.5	3	610737	4748110
V3823	VLSR	4.5	3	611020	4748135
V3824	VLSR	4.5	3	611246	4746343
V3825	VLSR	4.5	3	611400	4748160
V3826	VLSR	4.5	3	611677	4748178
V3827	VLSR	4.5	3	611823	4748178
V3828	VLSR	4.5	3	612453	4748178
V3829	VLSR	4.5	3	613088	4747304
V3831	VLSR	4.5	3	613793	4746987
V3834	VLSR	4.5	3	614056	4746446

V3835	VLSR	4.5	3	614301	4746480
V3836	VLSR	4.5	3	615540	4747137
V3842	VLSR	4.5	3	612088	4746226
V3843	VLSR	4.5	3	612337	4746244
V3844	VLSR	4.5	3	615603	4746773
V3845	VLSR	4.5	3	615807	4746435
V3846	VLSR	4.5	3	615917	4746434
V3847	VLSR	4.5	3	615968	4746432
V3848	VLSR	4.5	3	615645	4747059
V3849	VLSR	4.5	3	615653	4747194
V3850	VLSR	4.5	3	593651	4751075
V3851	VLSR	4.5	3	593009	4750499
V3856	VLSR	4.5	3	600909	4746229
V3857	VLSR	4.5	3	610626	4747837
V3858	VLSR	4.5	3	593057	4750701
V4000	VLSR	4.5	3	602203	4750330

Participating Receptors (Participants)

Table - Participating Receptor Locations

Project Name: Grand Renewable Energy Park
Datum: NAD83 (Canada) Projection: UTM 17N

Point of Reception ID	Description	Height (m)	NPC Class	X(E,m)	Y(N,m)
P41	Residence	4.5	3	587809	4754018
P62	Residence	4.5	3	589406	4754512
P67	Residence	4.5	3	589703	4754640
P68	Residence	4.5	3	590093	4754775
P71	Residence	4.5	3	590228	4754987
P107	Residence	4.5	3	588797	4752519
P140	Residence	4.5	3	590219	4752543
P177	Residence	4.5	3	592802	4749034
P258	Residence	4.5	3	590506	4749759
P301	Residence	4.5	3	594036	4749274
P351	Residence	4.5	3	594307	4751294
P352	Residence	4.5	3	594361	4750967
P376	Residence	4.5	3	596873	4750327
P377	Residence	4.5	3	597330	4748897
P522	Residence	4.5	3	604828	4746000
P538	Residence	1.5	3	603953	4748202
P563	Residence	4.5	3	594172	4748051
P580	Residence	4.5	3	597798	4748861
P587	Residence	4.5	3	598739	4749078
P589	Residence	4.5	3	599146	4749234
P594	Residence	1.5	3	600698	4749888
P601	Residence	4.5	3	602230	4750197
P610	Residence	4.5	3	604293	4750474
P677	Residence	4.5	3	599842	4747482
P678	Residence	4.5	3	600242	4747562
P680	Residence	1.5	3	600650	4747765
P689	Residence	4.5	3	602523	4748381
P690	Residence	4.5	3	602653	4748323
P691	Residence	4.5	3	603196	4748566
P692	Residence	1.5	3	604432	4749085

P729	Residence	4.5	3	602344	4746717
P735	Residence	4.5	3	601768	4746647
P844	Residence	1.5	3	605746	4746587
P845	Residence	4.5	3	605516	4746586
P870	Residence	1.5	3	608117	4748931
P885	Residence	1.5	3	607043	4750497
P886	Residence	4.5	3	607150	4750896
P988	Residence	4.5	3	606772	4748238
P993	Residence	1.5	3	607761	4748791
P994	Residence	4.5	3	607806	4748629
P995	Residence	1.5	3	608348	4748960
P996	Residence	4.5	3	608372	4748656
P997	Residence	4.5	3	608758	4749110
P1002	Residence	4.5	3	609157	4749192
P1053	Residence	4.5	3	611791	4748187
P1056	Residence	1.5	3	611536	4748171
P1180	Residence	4.5	3	600306	4744319
P1181	Residence	1.5	3	600391	4744383
P1182	Residence	1.5	3	600369	4744444
P1183	Residence	1.5	3	600349	4744512
P1184	Residence	1.5	3	600326	4744586
P1185	Residence	1.5	3	600311	4744641
P1186	Residence	1.5	3	600349	4744632
P1187	Residence	1.5	3	600382	4744640
P1188	Residence	1.5	3	600428	4744610
P1189	Residence	1.5	3	600442	4744562
P1190	Residence	1.5	3	600447	4744524
P1191	Residence	1.5	3	600462	4744470
P1192	Residence	1.5	3	600482	4744407
P1193	Residence	1.5	3	600501	4744350
P1194	Residence	1.5	3	600512	4744315
P1195	Residence	1.5	3	600511	4744274
P1196	Residence	1.5	3	600465	4744286
P1212	Residence	4.5	3	602018	4744457
P1233	Residence	4.5	3	603052	4745134
P1234	Residence	1.5	3	603057	4745223
P1253	Residence	4.5	3	605221	4745810
P1269	Residence	1.5	3	600416	4744652
P1279	Residence	1.5	3	603059	4745254
P1283	Residence	4.5	3	612059	4748139
P2882	Residence	1.5	3	615276	4748290
P2883	Residence	1.5	3	615173	4748187
P2995	Residence	4.5	3	607255	4745725
P2997	Residence	1.5	3	607154	4745757
P2998	Residence	1.5	3	607068	4745832
P3002	Residence	4.5	3	606893	4746041
P3017	Residence	1.5	3	615328	4748090

13 APPENDIX B — ADDITIONAL DOCUMENTATION

The Siemens Wind Power A/S document describing the source sound power levels for the Siemens SWT-2.221-101 and its power/noise-reduced variants (Siemens, 2010) is marked as "Conveyed confidentially as a trade secret". It is not included here at this time.

END

Attachment C

Environmental Effects Monitoring Plan for Wildlife and Wildlife Habitat

GRAND RENEWABLE ENERGY PARK
ENVIRONMENTAL EFFECTS MONITORING PLAN FOR WILDLIFE AND WILDLIFE HABITAT

File No. 161010624/161010646
June 2011

Prepared for:

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1.0 Introduction

Samsung C&T (Samsung), Korea Power Electric Corporation (KEPCO), and Pattern Energy (Pattern) plan to build and operate the world's largest renewable energy cluster in Southern Ontario (Ontario Alternative Energy Cluster). Stantec Consulting Ltd. (Stantec) was retained by Samsung, Pattern and KEPCO (herein referred to as "SPK") to prepare a Natural Heritage Assessment (NHA) and Environmental Impact Study (EIS) for the proposed Grand Renewable Energy Park (the Project) (Stantec, 2011).

This Environmental Effects Monitoring Program for Wildlife and Wildlife Habitats has been prepared to outline the detailed post-construction monitoring program as it relates to direct and indirect (disturbance) effects to wildlife and wildlife habitat during construction and operation of the Project. This document also outlines performance objectives and contingency measures for adaptive management related to wildlife and wildlife habitats.

The potential environmental effects to wildlife and wildlife habitat and recommended mitigation measures, based upon this dataset, ornithological advice, and professional opinion, are set out in Section 6 of the NHA/EIS. Additionally, wildlife and wildlife habitat post-construction monitoring commitments are summarized in Tables 6.1 and 6.2, Appendix B of the NHA/EIS and are elaborated on in this document.

The purpose of this EEMP is to assess the effectiveness of the proposed mitigation measures in consideration of applicable provincial regulations and guidelines. The EEMP also provides a response and contingency plan if these criteria and standards are not met. The monitoring plan summarized in this EEMP provides details on the post-construction wildlife monitoring program for:

1. mortality of breeding birds, migratory land birds, migratory raptors (fall) and bats; and
2. the effects of disturbance on breeding birds, migratory landbirds and woodland and wetland hydrology.

Monitoring will confirm the accuracy of the impact assessments summarized in the NHA/EIS and will provide a factual foundation and basis for the implementation of the response and contingency plan described in this EEMP.

1.1 PURPOSE AND TIMING

The purpose of the wildlife post-construction monitoring program is to identify performance objectives, assess the effectiveness of the proposed mitigation measures and to identify contingency measures that will be implemented if performance objectives cannot be met. Furthermore, any unanticipated potentially significant adverse environmental effects discovered during the post-construction monitoring program will be mitigated as described in **Section 2.2** and **3.2**. Post-construction monitoring for wildlife and wildlife habitat includes the following:

1.1.1 Mortality Monitoring

Details with respect to mortality monitoring are described in **Section 2.0**, but generally include:

- *mortality monitoring (Wind Project):* Twice weekly (3-4 day intervals) mortality monitoring of birds and bats at 30% (21 of 67) of the wind turbines from May 1 to October 31, and weekly monitoring for raptors during November, for a period of three years. Searcher efficiency and scavenger trials will be conducted each year according to current guidance documents. All turbines will be monitored once per month during the period May-November for evidence of raptor fatalities.

1.1.2 Disturbance Monitoring

Details with respect to disturbance monitoring are described in **Section 3.0**, but generally include:

- *potential disturbance effects to woodland breeding birds survey (Wind, Solar, Transmission Projects):* Point counts will be established within 120 m of the wind, solar and transmission project locations and monitored twice in June, annually for three years (one year pre-construction, two years post-construction). Breeding pair density is a standard measure that can be compared among years or between control/impact sites.
- *potential disturbance effects to migratory birds survey (Wind Project):* Surveys will be conducted to assess use of the Project area by spring and fall migrating landbirds. The number of species and the number of individual migratory landbirds will be monitored across a transect through a variety of habitats and compared to pre-construction conditions, two days per week from early April through end of May and from mid-August through end of October, for a period of three years (one year pre-construction, two years post-construction).
- *potential disturbance effects to wetland and woodland hydrology (Wind, Solar, Transmission Projects):* During construction, surveys will be conducted weekly in and adjacent to work areas to visually assess hydrological conditions. Hydrological conditions will be monitored once seasonally in each of spring and summer during the first year of post-construction.

2.0 Mortality Monitoring

The information contained within this Section is intended to address the requirements of s. 23 of O. Reg. 359/09 with respect to bird and bat mortality monitoring.

2.1 PRIMARY DATA COLLECTION

Data collection will be conducted by field personnel skilled at identifying birds by song and sight and bats by sight. To the extent possible, the same field personnel who carried out the pre-construction baseline studies will carry out the post-construction monitoring works to assist in standardizing the datasets.

The detailed monitoring methods, including duration, frequency and survey locations are discussed below.

2.1.1 Bird Mortality Monitoring

Background

Draft *Bird and Bird Habitats: Guidelines for Wind Power Projects* were released by the MNR in October, 2010, and have been considered during the preparation of this monitoring plan (MNR, 2010a).

Monitoring

Mortality monitoring within minimally-vegetated portions (i.e., Visibility Classes 1 and 2 [MNR, 2010a]) of a 50 m search area radius from the base of 30% (21 of 67) wind turbines will be conducted twice-weekly (3-4 day intervals) between May 1 and October 31. Weekly mortality surveys will be conducted at 21 turbines in November to assess raptor mortality. Additionally, all turbines will be monitored once each month between May and November for evidence of raptor fatalities.

Although all reasonable efforts will be made to conduct surveys as scheduled, surveys will not be conducted if weather (e.g. lightning, severe fog) presents safety concerns. Weather conditions will be noted when surveys were not conducted as scheduled, and every attempt will be made to complete the missed survey(s) as soon as possible.

Searcher efficiency and scavenger trials will be conducted in accordance with current MNR guidelines. Searcher efficiency trials will typically be conducted once in each of spring, summer and fall, but will be repeated if searchers change during the year. Searcher efficiency trials are designed to correct for carcasses that may be overlooked by surveyors during the survey periods. Searcher efficiency trials involve a “tester” that places bird and bat carcasses under turbines prior to the standard carcass searches to test the searcher’s detection rate. Trial carcasses will be discreetly marked so they can be identified as study carcasses. Each trial will consist of a minimum of 10 carcasses per searcher per visibility class (20 test carcasses per searcher). Searcher efficiency (Se) is calculated for each searcher as follows:

$$Se = \frac{\text{number of test carcasses found}}{\text{number of test carcasses placed} - \text{number of test carcasses scavenged}}$$

Scavenger trials will be conducted once a month (May-Oct) and will involve 20 carcasses of bird and bat turbine fatalities, if available, or dark-coloured poultry chicks. If available, at least one raptor carcass will be used for some trials. Carcasses will be discreetly marked so they can be identified as study carcasses. Scavenger trials are designed to correct for carcasses that are removed by predators before the search period. These trials involve the distribution of carcasses in habitat types being searched, at known locations at each wind turbine generator, followed by periodic checking (every 3 to 4 days) to determine the rate of removal. The species used for these trials, location, site conditions (i.e. visibility class) and weather conditions during the carcass surveys will be recorded. Proportions of carcasses remaining after each search interval are pooled to calculate the overall scavenger correction factors:

$$Sc = \frac{n_{visit1} + n_{visit2} + n_{visit3} + n_{visit4}}{n_{visit0} + n_{visit1} + n_{visit2} + n_{visit3}}$$ where

Sc is the proportion of carcasses not removed by scavengers over the search period

$\mathbf{n_{visit0}}$ is the total number of carcasses placed

$\mathbf{n_{visit1} - n_{visit4}}$ are the numbers of carcasses remaining on visits 1 through 4

There are numerous published and unpublished approaches to incorporating these corrective factors into an overall assessment of total bird and bat mortality. The estimated mortality will be calculated as follows:

C = c / (Se x Sc x Ps), where

C is the corrected number of bird or bat fatalities

c is the number of carcasses found

Se is the proportion of carcasses expected to be found by searchers (searcher efficiency)

Sc is the proportion of carcasses not removed by scavengers over the search period

Ps is the percent of the area searched.

Most birds and bats will fall within 50 m of the turbine base (MNR, 2010a). This value will be used to determine the percent of area searched (Ps). When the entire 50 m radius search area is searched, Ps will equal 100%. If portions of the 50 m radius search area are impossible or futile to search due to site conditions such as standing water or dense vegetation, Ps will be adjusted accordingly based on the searchers' ongoing estimates of the proportion of the search area that was physically searched. An alternative option is to use a GPS to delineate the search area and calculate the Ps.

The area searched will be determined for each turbine by mapping searchable areas on a grid (by visibility class) and counting the number of searched grid cells within 50 m. Maps of the varying search areas will be made available to review agencies. The summed area of those cells will be divided by the total area within a 50 m radius circle to determine the percent area searched for that turbine (Ps_x, where x is the turbine number).

$$Ps_x = \frac{\text{area searched within 50 m radius circle}}{7854 \text{ m}^2}$$

The overall Ps for the facility will be calculated as the average of Ps_1 through Ps_{21}.

Observed fatalities will be photographed, and the species, GPS coordinates, substrate, carcass conditions (i.e. injuries), sex (where feasible) and distance and direction to the nearest turbine will be recorded along with the date, time and searcher. This approach to mortality monitoring will facilitate any potential correlation between mortality occurrences, turbine location, habitat/land use features, and season.

Bird carcasses in good condition may be collected and stored in a freezer for future use in searcher efficiency and/or scavenger removal trials. Persons handling bird carcasses will take reasonable precautions (e.g. gloves, tools etc.) to protect their personal health. Bird carcasses will be placed in heavy-duty plastic bags and transported that day to a freezer, where they will be stored until required for the trials. Carcasses of any species covered under the *Endangered Species Act, 2007* ("ESA") or the federal *Species at Risk Act* ("SARA") will be collected in a manner consistent with the conditions of applicable permits (see below). All other bird carcasses will be left in place and noted to avoid double-counting during future searches.

As of 30 June 2008, species that are extirpated, endangered, or threatened are protected under the ESA. Consequently, unless otherwise authorized, possession and transport of species at risk is prohibited under the ESA. Therefore, in order to carry out the various activities contemplated in this Plan, a permit under clause 17(2)b of the ESA is necessary to allow SPK and its agents to collect, possess, and transport species at risk as obtained from the Project Location. Any conditions attached to the permit relating to handling of injured birds, including raptors and species at risk, will be adhered to.

Additionally, in support of the activities contemplated in this Plan, SPK or its agents will apply for a scientific collector's permit under the *Fish and Wildlife Conservation Act* ("FWCA") from the MNR that would allow SPK and its agents to possess and transport a species protected by this legislation.

Finally, SPK or its agents will apply to Environment Canada (Canadian Wildlife Service) for a scientific collector's permit under the *Migratory Bird Convention Act, 1994* ("MBCA") that would allow SPK and its agents to collect, possess, and to utilize for scientific research purposes, deceased specimens of migratory birds obtained from the Project Location.

Other permits, approvals, and authorizations are not likely to be required from the MNR or Environment Canada to permit the monitoring activities contemplated in this Plan.

2.1.2 Bat Mortality Monitoring

Background

Bat mortality has been documented at wind power facilities in a variety of habitats across North America. Nearly every monitored wind power facility in the United States and Canada has reported bat mortality with minimum annual mortality varying from < 1 to 50 bat fatalities/ turbine/year (MNR, 2006). The majority of bat fatalities at wind power facilities occur in the late summer and fall, and the long-distance migratory bats (i.e., hoary bat, eastern red bat, silver-haired bat) appear to be most vulnerable to collisions with moving turbine blades. Specific factors causing bat mortality and affecting species vulnerability to wind turbine mortality remain unclear, although recent evidence from Alberta suggests that air pressure differences in the blade vortices may contribute to bat mortality. Ontario specific data is relatively sparse at this time.

Monitoring

Bat mortality monitoring will be conducted according to MNR's *Bats and Bat Habitats: Guidelines for Wind Power Projects* (2010b). In general, the mortality monitoring requirements for bats will be captured in conjunction with bird mortality monitoring (described above).

- Bat mortality monitoring will be conducted twice-weekly (3-4 day intervals) within minimally-vegetated portions (i.e., Visibility Classes 1 and 2 [MNR, 2010b]) of a 50 m search area radius from the base of 30% (21 of 67) wind turbines between May 1 and September 30 for a three-year period in accordance with MNR guidelines. This time period includes the core season when resident and migratory bats are active. Bat mortality monitoring will be conducted in conjunction with other monitoring activities (birds) for efficiency.
- Searcher efficiency trials will be conducted seasonally and carcass removal trials will be conducted monthly between May 1 and September 30. Searcher efficiency and carcass removal rates are known to be more variable for bats than for birds throughout the year and depending on habitat (in part due to the relative size of the species).

As with birds, trial carcasses will be discreetly marked so they can be identified as study carcasses. Each trial will consist of a minimum of 10 carcasses per searcher per visibility class (for searcher efficiency trials) or 20 carcasses per trial (for scavenger removal trials). When available, at least one-third of the trial carcasses should be bats.

Bat carcasses in good condition may be collected and stored in a freezer for future use in searcher efficiency and/or scavenger removal trials. Persons handling bat carcasses will take reasonable precautions (e.g., gloves, tools etc.) to protect their personal health. Biological material will be disposed of in a way to ensure that it does not pose a public or environmental health risk and in accordance with any applicable federal, provincial, and municipal laws.

2.2 ADAPTIVE MANAGEMENT PROGRAM

The adaptive management program described in this section outlines performance objectives, and contingency measures that will be implemented should the performance objectives not be met. Contingency measures may include an adaptive management approach that allows mitigation measures to be implemented in the event that unanticipated potentially significant adverse environmental effects are observed. Potentially significant adverse effects will be assessed through review of the annual report.

The following sections describe the procedures for notifications, reporting, and adaptive management for mortality monitoring.

All bird and bat mortality will be reported in the annual report submission. Mortality rate is expressed as the number of fatalities per turbine per year (e.g. from May 1 to November 30). Mortality of priority species in Bird Conservation Region ("BCR") 13 and mortality of all species of conservation concern, such as raptors and declining grassland/agricultural species, will be highlighted in the annual post-construction monitoring reports. A threshold approach will be used to identify and mitigate potential negative effects resulting from the operation of wind turbines.

2.2.1 Birds

Post-construction mitigation, including operational controls, will be considered if annual mortality of birds exceeds the following thresholds defined by the MNR (2010a):

- 18 birds/ turbine/year at individual turbines or turbine groups;
- 0.2 raptors or vultures/turbine/year or 0.1 raptors of provincial conservation concern/turbine/year across the wind power project

Or if bird mortality during a single mortality monitoring survey exceeds:

- 10 or more birds at any one turbine; or
- 33 or more birds (including raptors) at multiple turbines

Any and all mortality of species at risk (i.e., a species listed as Endangered, Threatened or Special Concern under Schedule 1 of the federal Species at Risk Act or a species listed on the Species at Risk in Ontario list as Extirpated, Endangered, Threatened, or Special Concern under the provincial Endangered Species Act, 2007) that occurs will be reported immediately to the MNR.

If with due consideration of seasonal abundance and species composition, annual mortality levels exceed the thresholds noted above, the MNR will be engaged to initiate an appropriate response plan as set out in the MNR's Bird Guidelines (2010a), which may include some or all of the following mitigation measures (or alternate plan reasonably agreed to between SPK and the MNR[1]):

- Increased reporting frequency to identify potential threshold exceedance in a timely way
- Additional behavioural studies to determine factors affecting mortality rates
- Periodic shut-down of select turbines (MNR, 2010a)
- Blade feathering at specific times of year (MNR, 2010a)

Subsequent post-construction mortality and effects monitoring should be conducted for two years at individual turbines (and unmonitored turbines in near proximity) where significant bird or raptor annual mortality is identified (MNR, 2010a). Effectiveness monitoring at individual turbines should be conducted for three years where mitigation has been implemented (MNR, 2010a).

2.2.2 Bats

Operational mitigation is required where annual post-construction mortality monitoring exceeds 10 bats per turbine per year (MNR, 2010b).

Operational mitigation to be implemented includes increasing cut-in speed to 5.5 m/s or feathering wind turbine blades when wind speeds are below 5.5 m/s between sunset and sunrise, from July 15 to September 30, as set out in the MNR's Bat Guidelines (2010b).

Where a post-construction monitoring annual report indicates the annual bat mortality threshold of 10 bats per turbine per year has been exceeded, operational monitoring will be implemented from sunset to sunrise, from July 15 to September 30 for the duration of the project (MNR, 2010b).

[1] An alternate plan maintains flexibility within the Plan to consider alternative response ideas that may arise over the course of the Plan (e.g., changes in technology).

2.3 REPORTING AND REVIEW OF RESULTS

Annual post-construction monitoring reports will summarize and analyze the results of all wildlife surveys. Reports will be submitted to the MOE within three months of the conclusion of the October mortality monitoring. All pre- and post-construction data, collected in accordance with MNR guidance and reported to MOE, will be made available for entry into the joint Canadian Wildlife Service – Canadian Wind Energy Association – Bird Studies Canada – Ontario Ministry of Natural Resources Wind Power and Birds Monitoring Database.

The monitoring program will be reassessed by MNR and SPK at the end of each monitoring year. Pending the reassessment results, the program methods, frequencies, and duration may be reasonably modified to better reflect the findings.

2.4 BEST MANAGEMENT PRACTICES

SPK will include the following best management practices as part of the post-construction monitoring program (as outlined in MNR, 2010b).

2.4.1 White-nose Syndrome

Carcasses of the following species found during bat mortality searches may be sent to the Canadian Cooperative Wildlife Health Centre for analysis of White-nose Syndrome and should not be used in carcass removal or searcher efficiency trials.

- Myotis septentrionalis
- Myotis lucifugus
- Myotis leibii
- Perimyotis subflavus
- Eptesicus fuscus

2.4.2 Bat Tissue Samples

Tissue samples from bat carcasses may be used in a number of DNA analyses to provide insight into population size and structure, as well as the geographic origin migrants. SPK will contact the local MNR office prior to disposing bat carcasses, to determine if this type of research is occurring in the area.

3.0 Disturbance Monitoring

The information contained within this Section is intended to address the requirements of s. 38 of O. Reg. 359/09 with respect to disturbance effects on wildlife, wildlife habitat and wetland and woodland hydrology as outlined in Section 6.4 of the Natural Heritage Assessment and Environmental Impact Study.

3.1 PRIMARY DATA COLLECTION

Data collection will be conducted by field personnel skilled at identifying birds by song and sight. To the extent possible, the same field personnel who carried out the pre-construction baseline studies will carry out the post-construction monitoring works to assist in standardizing the datasets.

The detailed monitoring methods, including duration, frequency and survey locations are discussed below.

3.1.1 Woodland Breeding Birds

Background

Wooded habitats located in, and adjacent to, the Wind, Solar and Transmission Project Locations support ten area-sensitive breeding forest bird species (Hairy Woodpecker, White-breasted Nuthatch, Veery, Ovenbird, Scarlet Tanager, Sharp-shinned Hawk, American Redstart, Cooper’s Hawk, Pileated Woodpecker and Least Flycatcher) and four breeding forest bird species (Northern Flicker, Eastern Wood-Pewee, Wood Thrush, Rose-breasted Grosbeak) that have been identified as priority species by Ontario Partners in Flight (PIF) (NHA/EIS, Section 4.3.4.3, 4.4.4.3, 4.5.4.3).

Turbine 53 and its associated access road and collector line are proposed within significant habitat for declining woodland bird species (Feature 42). As such, a post-construction point count-based study will be implemented to identify and assess any actual disturbance effects to the declining woodland species in this Feature during breeding.

Monitoring

Post-construction point count surveys will be completed at the same locations within Feature 42 as were completed during pre-construction monitoring in 2010, providing technical and statistical validity to assess disturbance effects.

Each of the surveys will include a ten-minute point count at each location and each point will be surveyed twice in June, during the peak of the breeding season, for a minimum of three years (one year pre-construction, two years post-construction). Surveys will be conducted at the times of day and under the weather conditions outlined in the MNR's guidance document (2010a).

The number of woodland species of conservation concern observed will be compared to pre-construction conditions. Particular attention will be paid to dominant species or those species identified as priority species that breed consistently or in high numbers on the site. For individual species, breeding pair density is a standard measure that will be used to compare among years.

MNR, along with the proponent and other relevant agencies, will collectively review the results of the post-construction monitoring to determine if an ecologically significant disturbance/avoidance effect is occurring, and whether such an effect is attributable to the Wind, Solar or Transmission Projects and not external factors. These discussions will determine if and when contingency measures will be undertaken. The best available science and information should be considered when determining appropriate mitigation.

3.1.2 Migratory Landbird Surveys

Background

Woodlands adjacent to the Great Lakes shoreline can serve as important stopover locations for migrating landbirds. In consideration of the proximity of various woodlands to the shoreline of Lake Erie, it was determined that the site supports significant wildlife habitat in the form of seasonal concentration areas (migratory landbird stopover areas) (NHA/EIS, Section 5.2.5.1). Pre-construction and post-construction transect surveys will be implemented to assess any actual disturbance effects to migratory landbirds.

Monitoring

A minimum of 6 transect survey routes for migrating landbirds will be conducted within the 4 significant migratory bird stopover areas located within 120 m of a wind turbine, including Features 42, 66, 68 and 69. The route locations and survey methods will be the same as during pre- and post-construction, providing technical and statistical validity to assess disturbance effects. Surveys begin half an hour after sunrise and continue for approximately two hours. The number of individuals of each species observed on the surveys is recorded and the results will be compared to pre-construction data. The surveys will be conducted on two days per week in spring (early April through end of May) and fall (mid-August through end of October) for a minimum of three years (1 year pre-construction and 2 years post-construction).

MNR, along with the proponent and other relevant agencies, will be asked to collectively review the results of the post-construction monitoring to determine if an ecologically significant disturbance/avoidance effect is occurring, and whether such an effect is attributable to the wind turbines and not external factors. These discussions will determine if and when the contingency plan will be implemented and if any additional measures are warranted. The best available science and information will be considered when determining appropriate mitigation.

3.1.3 Wetland and Woodland Hydrology

Background - Wetlands

All components of the Wind Project are sited outside wetland boundaries; therefore there will be no direct loss of wetland habitat or function. Potential indirect effects may arise through changes to wetland hydrology during or after construction.

Indirect impacts resulting from construction activities, such as disturbance to wildlife, dust generation, sedimentation and erosion, are expected to be short term, temporary in duration and mitigable through the use of standard site control measures. During construction, there will be increased traffic and the potential for accidental spills.

Background - Woodlands

Where components of the Wind Project are sited outside significant woodlands, there will be no direct loss or fragmentation of habitat or habitat function. Potential indirect effects may arise through changes to hydrology during or after construction. Where components are sited inside a significant woodland, hydrologic function may be adversely affected.

Indirect and direct impacts resulting from construction activities, such as disturbance to wildlife, dust generation, sedimentation and erosion, are expected to be short term, temporary in duration and mitigable through the use of standard site control measures. During construction, there will be increased traffic and the potential for accidental spills.

Monitoring

Any changes to hydrological conditions in wetlands and significant woodlands located within 120 m of the Project Location will be determined through weekly visual inspection during construction, and once seasonally in spring and summer the first year post-construction.

3.2 ADAPTIVE MANAGEMENT PROGRAM

The adaptive management program described in this section outlines performance objectives, and contingency measures that will be implemented should the performance objectives not be met. Contingency measures may include an adaptive management approach that allows mitigation measures to be implemented in the event that unanticipated potentially significant adverse environmental effects are observed. Potentially significant adverse effects will be assessed through review of the annual report.

The following sections describe the procedures for notifications, reporting, and adaptive management disturbance effects monitoring.

All disturbance to bird use and impacts on wetland and woodland hydrology will be reported in the annual report submission. Disturbance is expressed as a change in the species diversity and abundance observed using the habitats adjacent the project components each year. Disturbance to priority species in Bird Conservation Region ("BCR") 13 and disturbance of all species of conservation concern, such as declining woodland species, will be highlighted in the annual post-construction monitoring reports. A threshold approach will be used to identify and mitigate potential negative effects resulting from the operation of wind turbines.

3.2.1 Wildlife

SPK and the MNR will review the post-construction monitoring results to determine if an ecologically significant effect on breeding birds is occurring, and whether such effect is attributed to the wind turbines and not external factors.

Should the performance objectives not be met, there are a number of contingency measures that may be implemented:

- Compare declines to population trends noted through province or continent-wide breeding bird surveys
- Develop additional paired point count study and/or control/impact study to confirm that decline is due to turbine disturbance, and determine extent of disturbance effect
- Investigate habitat management means to increase breeding density
- Additional post-construction monitoring and/or mitigation may be required where post-construction monitoring identifies ecologically significant disturbance effects.

Discussions will determine whether mitigation is required to replace the habitat lost through displacement, and could include, for example:

- Expanding survey to adjacent areas (e.g., to determine if the effects are localized)
- Mitigation banking, land donation, or conservation easements may be considered
- A reasonable financial contribution from SPK to an independent, qualified third party (e.g., university) to further expand the knowledge base related to bird conservation through research
- Operational controls, such as periodic turbine shut-down and/or blade feathering

The best available science and information should be considered when determining appropriate mitigation.

3.2.2 Wildlife Habitat

The purpose of the hydrological monitoring is to avoid significant ponding or drying of wetland and/or woodland habitat. Should such changes be observed, contingency measures will be developed on a site-specific basis, and may include installation of additional culverts to preserve pre-construction flow patterns.

3.3 REPORTING AND REVIEW OF RESULTS

Annual post-construction monitoring reports will summarize and analyze the results of all wildlife and wildlife habitat surveys. Reports will be submitted to the MOE within three months of the conclusion of the October mortality monitoring. All pre- and post-construction data, collected in accordance with MNR guidance and reported to MOE, will be made available for entry into the joint Canadian Wildlife Service – Canadian Wind Energy Association – Bird Studies Canada – Ontario Ministry of Natural Resources Wind Power and Birds Monitoring Database.

The monitoring program will be reassessed by MNR and SPK at the end of each monitoring year. Pending the reassessment results, the program methods, frequencies, and duration may be reasonably modified to better reflect the findings.

4.0 References

Bird Studies Canada. 1994. Marsh Monitoring Program Protocol.

Environment Canada. 2007. Wind Turbines and Birds - A Guidance Document for Environmental Assessment. 46 pp.

Ontario Ministry of Natural Resources. 2006. Wind Turbines and Bats: Bat Ecology Background Information and Literature Review of Impacts. December 2006.

Ontario Ministry of Natural Resources. 2007. Guideline to Assist in the Review of Wind Power Proposals: Potential Impacts to Bats and Bat Habitats (Working Draft). 28 pp.

Ontario Ministry of Natural Resources. 2010a. Birds and Bird Habitats: Guidelines for Wind Power Projects. 32 pp.

Ontario Ministry of Natural Resources. 2010b. Bats and Bat Habitats: Guidelines for Wind Power Projects. 25 pp.

Penna, M., H. Pottstock and N. Velasquez. 2005. Effect of natural and synthetic noise on evoked vocal responses in a frog of the temperate austral forest. Animal Behaviour 70: 639-651.

Stantec Consulting Ltd. 2011. Grand Renewable Energy Park: Natural Heritage Assessment and Environmental Impact Study. Prepared for Samsung Renewable Energy Inc.

Attachment D

Property Line Setback Assessment

GRAND RENEWABLE ENERGY PARK
PROPERTY LINE SETBACK ASSESSMENT REPORT

File No. 160960577
October 2011

Prepared for:

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Executive Summary

Samsung C&T (Samsung), Korea Power Electric Corporation (KEPCO) and Pattern Energy (Pattern) are proposing to develop, construct, and operate the Grand Renewable Energy Park (the "Project") in response to the Government of Ontario's initiative to promote the development of renewable electricity in the Province. Together, these companies (referred to herein as "SPK") will be involved in the development of the first phase of the energy cluster development.

The Project is proposed within the County of Haldimand and is generally bounded by Townline Road to the north, Haldimand Road 20 to the west, the Grand River to the east and Lake Erie to the south. It consists of a 151.1 MW (nameplate capacity) wind project, a 100 MW (nameplate capacity) solar project located on privately owned and Ontario Realty Corporation (ORC) managed lands and a transmission line to convey electricity to the existing power grid.

The basic components of the Project include 67 wind turbines, approximately 425,000 photovoltaic (PV) solar panels installed on fixed ground-mounted racking structures organized into 100-1 MW solar modules, a collector sub-station, interconnect station and Operations and Maintenance building, temporary storage and staging areas, approximately 20 km of 230 kV transmission lines along Haldimand Road 20, approximately 82 km of new overhead and/or underground 34.5 kV collector lines along public roads, approximately 48 km of new underground collector lines along turbine access roads, approximately 45 km of turbine access roads and 40 km of solar panel maintenance roads.

SPK has retained Stantec Consulting Ltd. (Stantec) to prepare a Renewable Energy Approval (REA) application, as required under Ontario Regulation 359/09 - Renewable Energy Approvals under Part V.0.1 of the Act of the Environmental Protection Act (O. Reg. 359/09). According to subsection 6(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. This Property Line Setback Assessment Report is one component of the REA application for the Project, and has been prepared in accordance with O. Reg. 359/09, the Ontario Ministry of Natural Resources' (MNR's) Approval and Permitting Requirements Document for Renewable Energy Projects (September 2009).

The following table summarizes the documentation requirements as specified under O. Reg. 359/09.

Table E.1: Property Line Setback Assessment Report Requirements: O. Reg. 359/09

Requirements	Completed	Section Reference
As part of an application for the issues of a renewable energy approval or a certificate of approval in respect of the construction, installation or expansion of the wind turbine, the person who is constructing, installing or expanding the wind turbine submits a written assessment,		
1. Demonstrating that the proposed location of the wind turbine will not result in adverse impacts on nearby business, infrastructure, properties or land use activities, and	✓	Section 2.0, Attachment B
2. Describing any preventative measures that are required to be implemented to address the possibility of any adverse impacts.	✓	Section 2.0, Attachment B

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1.0 Introduction

1.1 PROJECT OVERVIEW

Samsung C&T (Samsung), Korea Power Electric Corporation (KEPCO) and Pattern Energy (Pattern) are proposing to develop, construct, and operate the Grand Renewable Energy Park (the "Project") in response to the Government of Ontario's initiative to promote the development of renewable electricity in the Province. Together, these companies (referred to herein as "SPK") will be involved in the development of the first phase of the energy cluster development.

The Project is proposed within the County of Haldimand and is generally bounded by Townline Road to the north, Haldimand Road 20 to the west, the Grand River to the east and Lake Erie to the south. It consists of a 151.1 MW (nameplate capacity) wind project, a 100 MW (nameplate capacity) solar project located on privately owned and Ontario Realty Corporation (ORC) managed lands and a transmission line to convey electricity to the existing power grid.

The basic components of the Project include 67 wind turbines, approximately 425,000 photovoltaic (PV) solar panels installed on fixed ground-mounted racking structures organized into 100-1 MW solar modules, a collector sub-station, interconnect station and Operations and Maintenance building, temporary storage and staging areas, approximately 20 km of 230 kV transmission lines along Haldimand Road 20, approximately 82 km of new overhead and/or underground 34.5 kV collector lines along public roads, approximately 48 km of new underground collector lines along turbine access roads, approximately 45 km of turbine access roads and 40 km of solar panel maintenance roads.

SPK has retained Stantec Consulting Ltd. (Stantec) to prepare a Renewable Energy Approval (REA) application, as required under Ontario Regulation 359/09 - Renewable Energy Approvals under Part V.0.1 of the Act of the Environmental Protection Act (O. Reg. 359/09). According to subsection 6(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. This Property Line Setback Assessment Report is one component of the REA application for the Project, and has been prepared in accordance with O. Reg. 359/09, the Ontario Ministry of Natural Resources' (MNR's) Approval and Permitting Requirements Document (APRD) for Renewable Energy Projects (September 2009).

1.2 REPORT REQUIREMENTS

The purpose of the Property Line Setback Assessment Report is to provide a review of potential adverse impacts and preventative measures for wind turbines located within the prescribed setback from non-participating parcels of land.

Of the 67 potential turbine sites being assessed for the Project all of the proposed turbine sites meet the minimum setback requirement of at least 550 metres from the nearest noise receptor. None of the proposed turbine sites are located less than the length of the turbine blades plus 10 metres (i.e. 59 metres) from a non-participating property line. However 21 are located closer to a non-participating property line than the height of the turbine (100 metres).

For those 21 turbines, in accordance with Section 53 of O.Reg 359/09, this report has been prepared to:

- Demonstrate that the proposed location of the wind turbine will not result in adverse impacts on nearby business, infrastructure, properties or land use activities; and
- Describe any preventative measures that are required to be implemented to address the possibility of any adverse impacts.

2.0 Summary of Property Line Setback Analysis

This section summarizes the features over which Project turbine locations overlap the 100 m setback, potential adverse impacts on those features, and preventative measures to address potential adverse impacts. Mapping of each potential turbine location analyzed is provided in Attachment A.

The detailed analysis for each turbine, including the distance of each potential turbine site from the non-participating property line, and the distance of overlap, is provided in Attachment B.

2.1 INFRASTRUCTURE

Description of Features within Overlap

No structures such as barns, storage units, or receptors are present. Turbine 15 overlaps with the right-of-way associated with Aikens Road (an unimproved road), however the overlap does not extend over the actual road and only the right-of-way. Details regarding the distance of overlap are provided in Attachment B.

Potential Adverse Impacts

In the unlikely event of complete turbine collapse in the direction of the road, the turbine may land within the road right-of-way.

Preventative Measures

Turbine 15 meets the setback distance from public road right-of-ways, 59 m, as prescribed in s. 53 of O. Reg. 359/09. In addition, the turbine would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain automatic shutdown mechanisms in instances such as extreme weather or malfunction. All of these measures are standard best practices detailed in the REA documents, and no additional preventative measures are required.

2.2 LAND USE AND BUSINESSES

Description of Features within Overlap

Sixteen turbines have setback overlaps with agricultural cash crop land. Details regarding the specific turbines, and the overlap distance, are provided in Attachment B.

Potential Adverse Impacts

Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse.

Preventative Measures

The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain automatic shutdown mechanisms in instances such as extreme weather. All of these measures are standard best practices detailed in the REA documents. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by the Project owner for any crop damage, and measures are outlined in the Renewable Energy Application documents (i.e. Construction Plan Report) to mitigate soil compaction. Given the above measures, no additional preventative measures are required.

2.3 HEDGEROWS

Description of Features within Overlap

Eleven turbines have setback overlaps with hedgerows. Details regarding the specific turbines, and the overlap distance, are provided in Attachment B.

Potential Adverse Impacts

Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife, may occur in the unlikely event of turbine collapse.

Preventative Measures

The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain automatic shutdown mechanisms in instances such as extreme weather. All of these measures are standard best practices detailed in the REA documents. Additional mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents. Given the above measures, no additional preventative measures are required for the changes in setback.

2.4 WOODLOTS

Description of Features within Overlap

Nine turbines have setback overlaps with woodlots. Details regarding the specific turbines, and the overlap distance, are provided in Attachment B.

Potential Adverse Impacts

Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.

Preventative Measures

The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain automatic shutdown mechanisms in instances such as extreme weather. All of these measures are standard best practices detailed in the REA documents. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents. Given the above measures, no additional preventative measures are required for the changes in setback.

2.5 WATERCOURSES

Description of Features within Overlap

No turbine setbacks overlap with a watercourse.

Potential Adverse Impacts

There are no potential adverse impacts.

Preventative Measures

No preventative measures are required.

3.0 Closure

This report has been prepared by Stantec for the sole benefit of SPK, and may not be used by any third party without the express written consent of SPK. The data presented in this report are in accordance with Stantec's understanding of the Project as it was presented at the time of reporting.

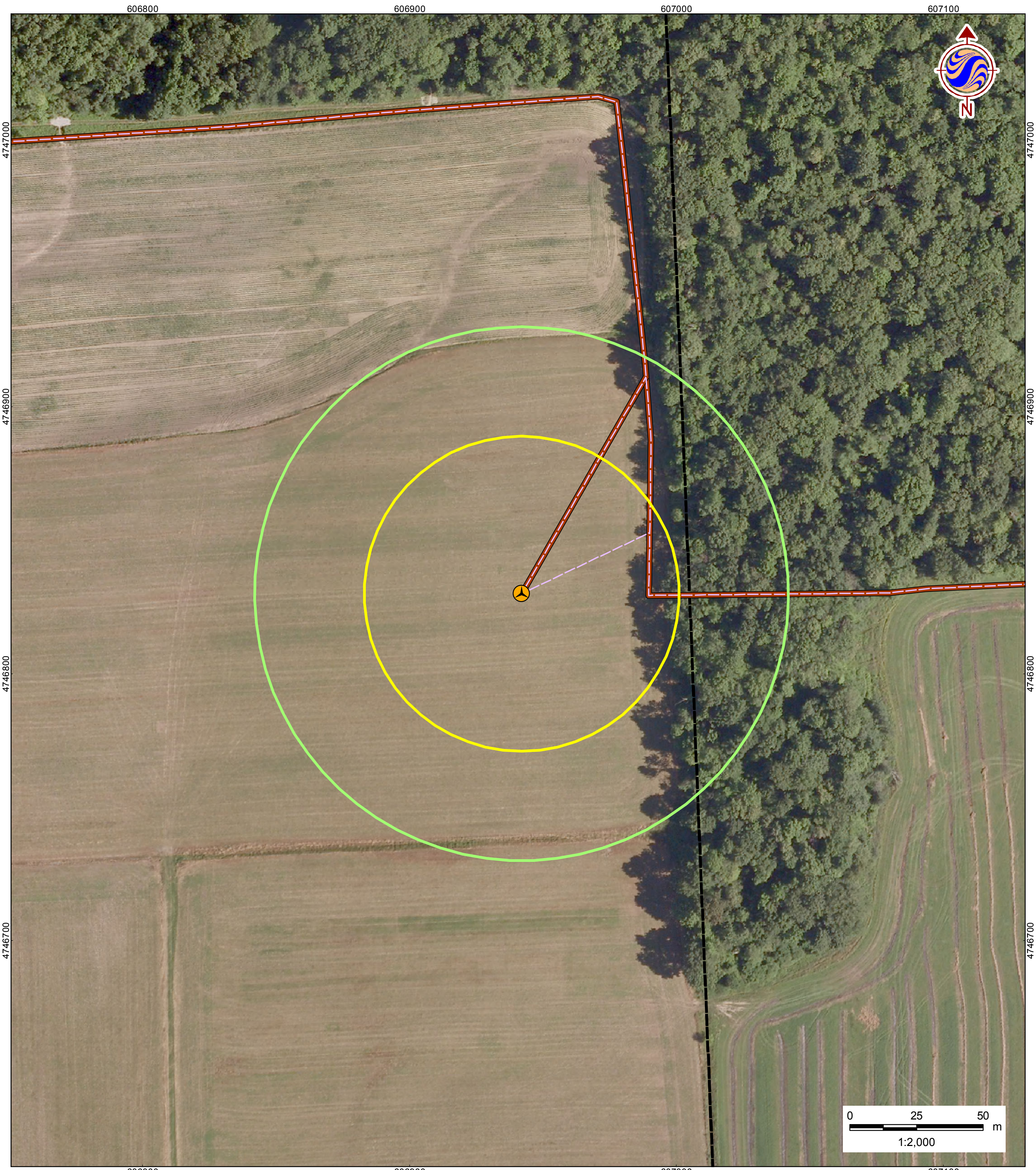
STANTEC CONSULTING LTD.

Rob Nadolny, B.Sc. Hons., CPT
Senior Project Manager

Mark Kozak, B.E.S., Dipl. EA
Project Manager

Attachment A

Figures: Individual Turbine Locations and Property Line Setbacks



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160960577

Legend

- Proposed Turbine Location
- Turbine 59m Buffer
- Turbine 100m Buffer
- Access Road
- Underground Collector Line
- Property Line

Notes

1. Coordinate System: UTM NAD 83 - Zone 17.
2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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Figure No.
T3

Title
PROPERTY LINE ASSESSMENT

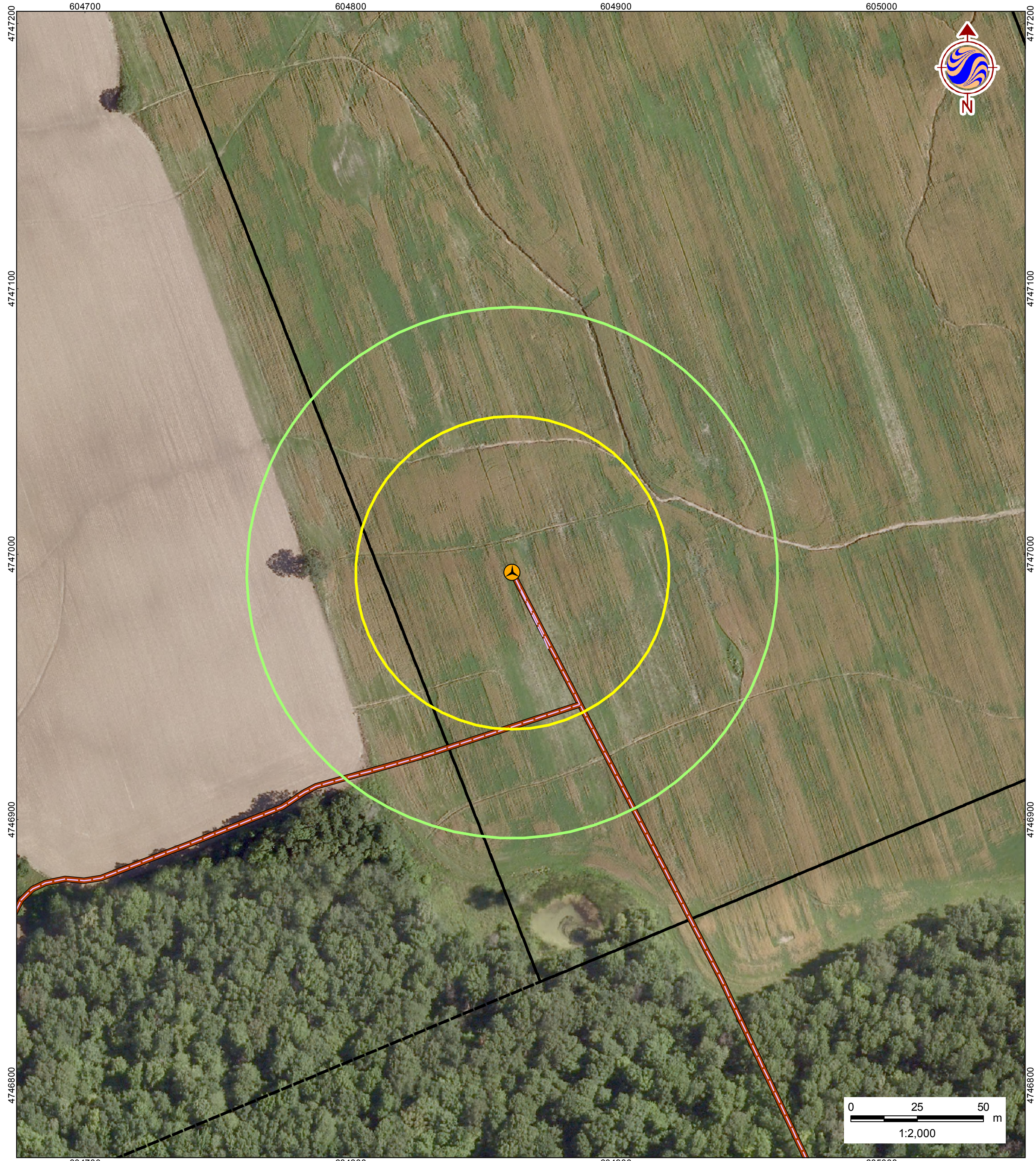

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Figure No.
T4

Title
PROPERTY LINE ASSESSMENT

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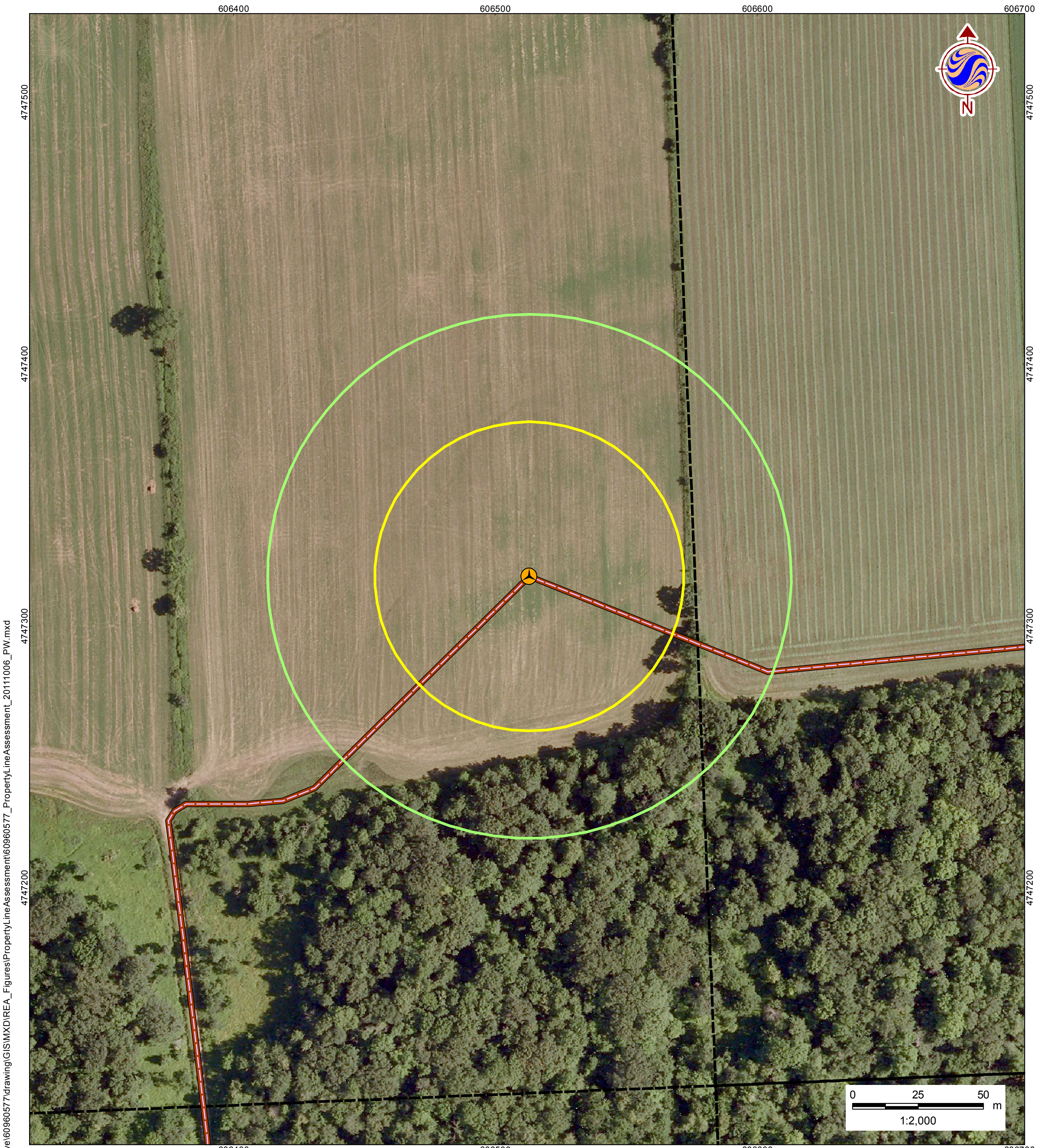

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Figure No.
T6

Title
PROPERTY LINE ASSESSMENT

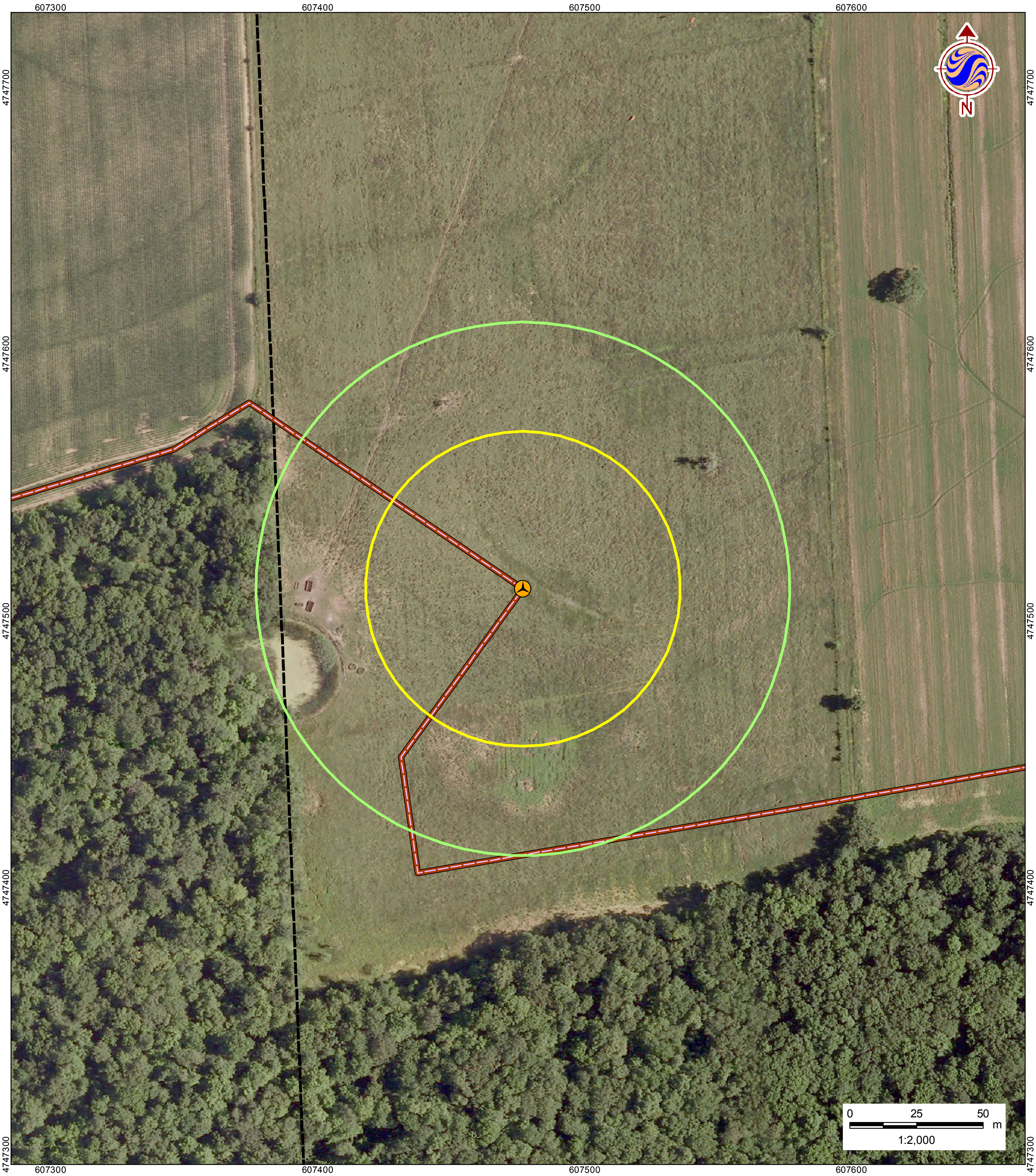

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Figure No.
T8

Title
PROPERTY LINE ASSESSMENT

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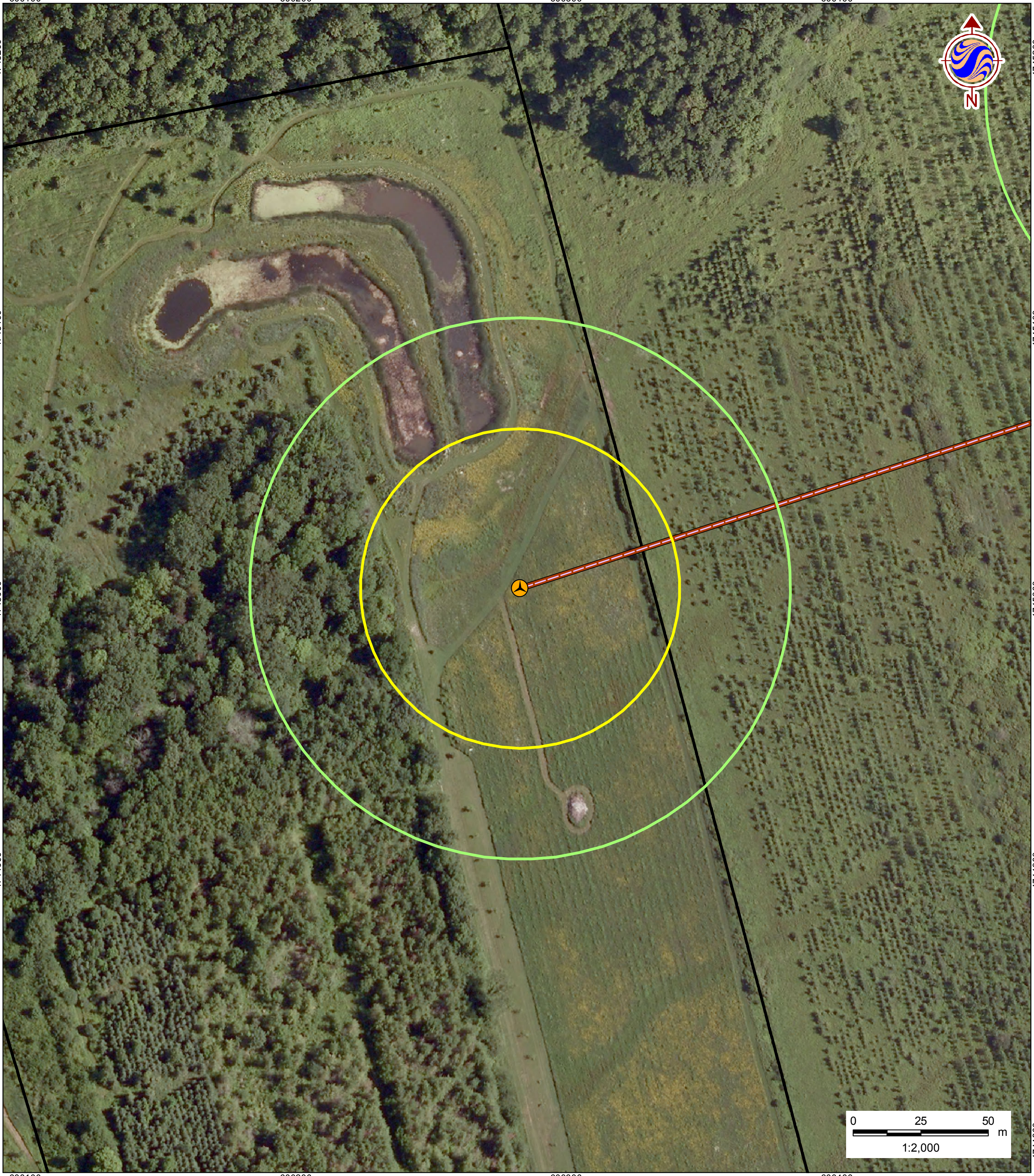

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Figure No.
T9

Title
PROPERTY LINE ASSESSMENT

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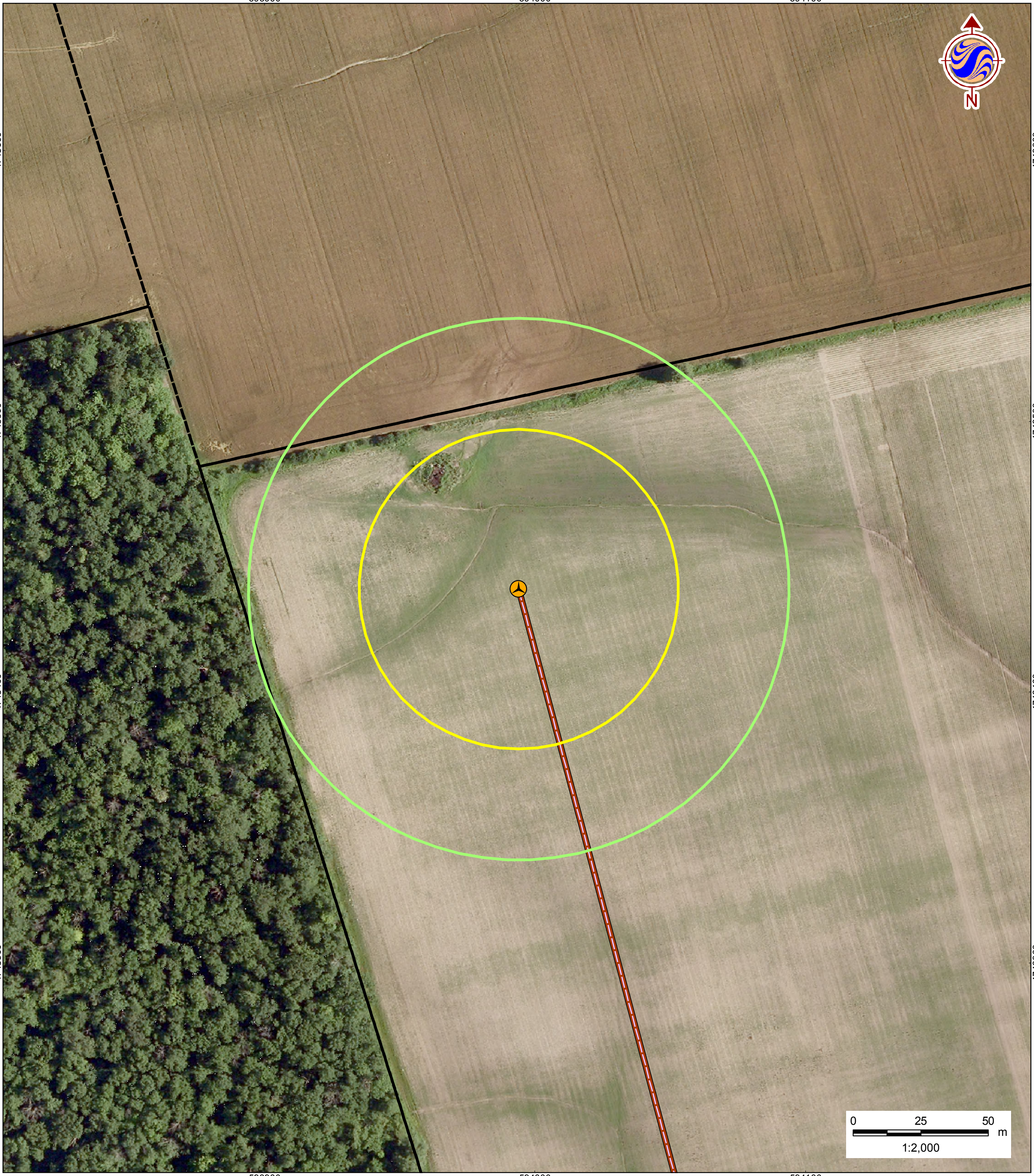

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Figure No.
T10

Title
PROPERTY LINE ASSESSMENT

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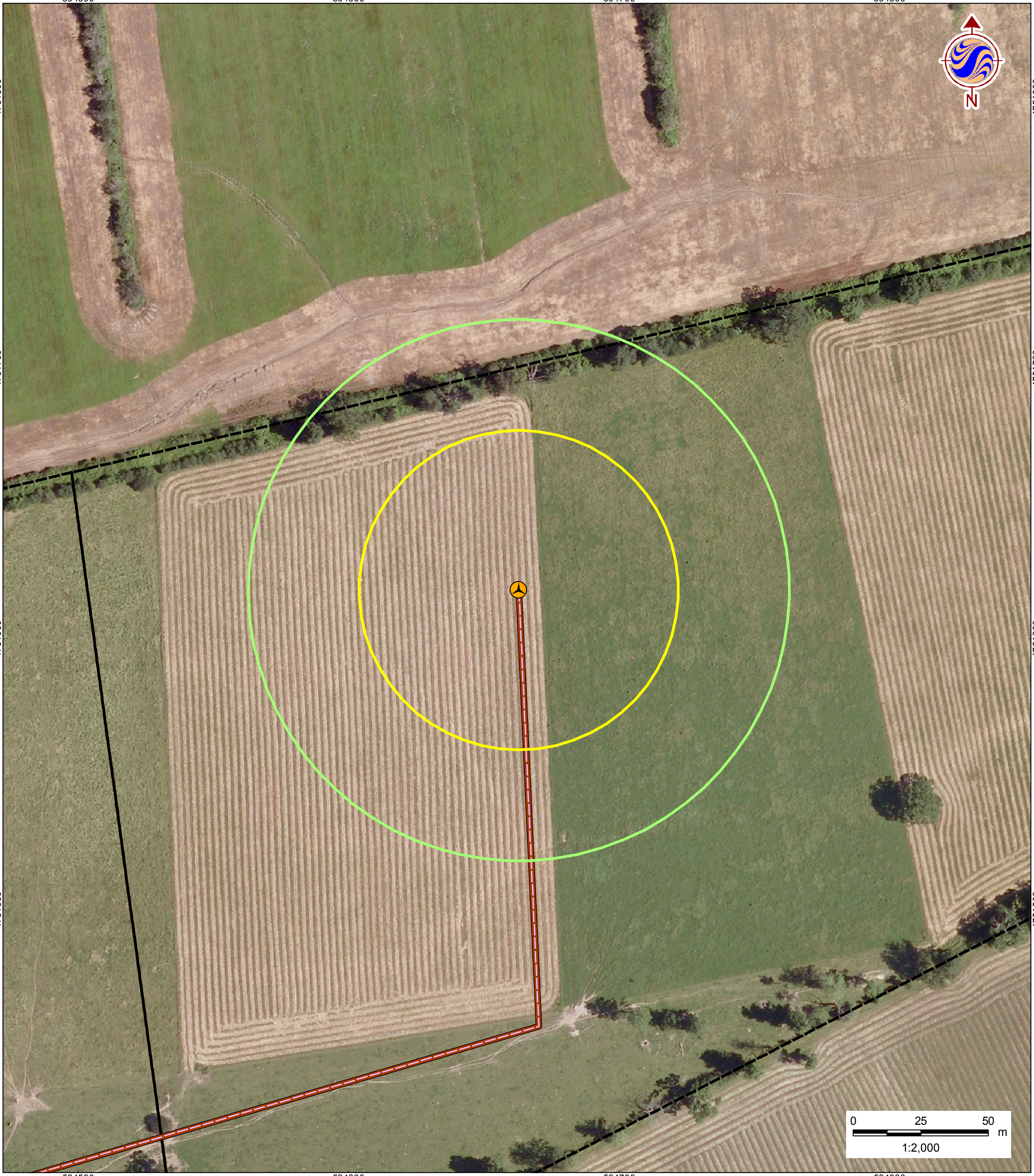

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Figure No.
T13

Title
PROPERTY LINE ASSESSMENT

Stantec

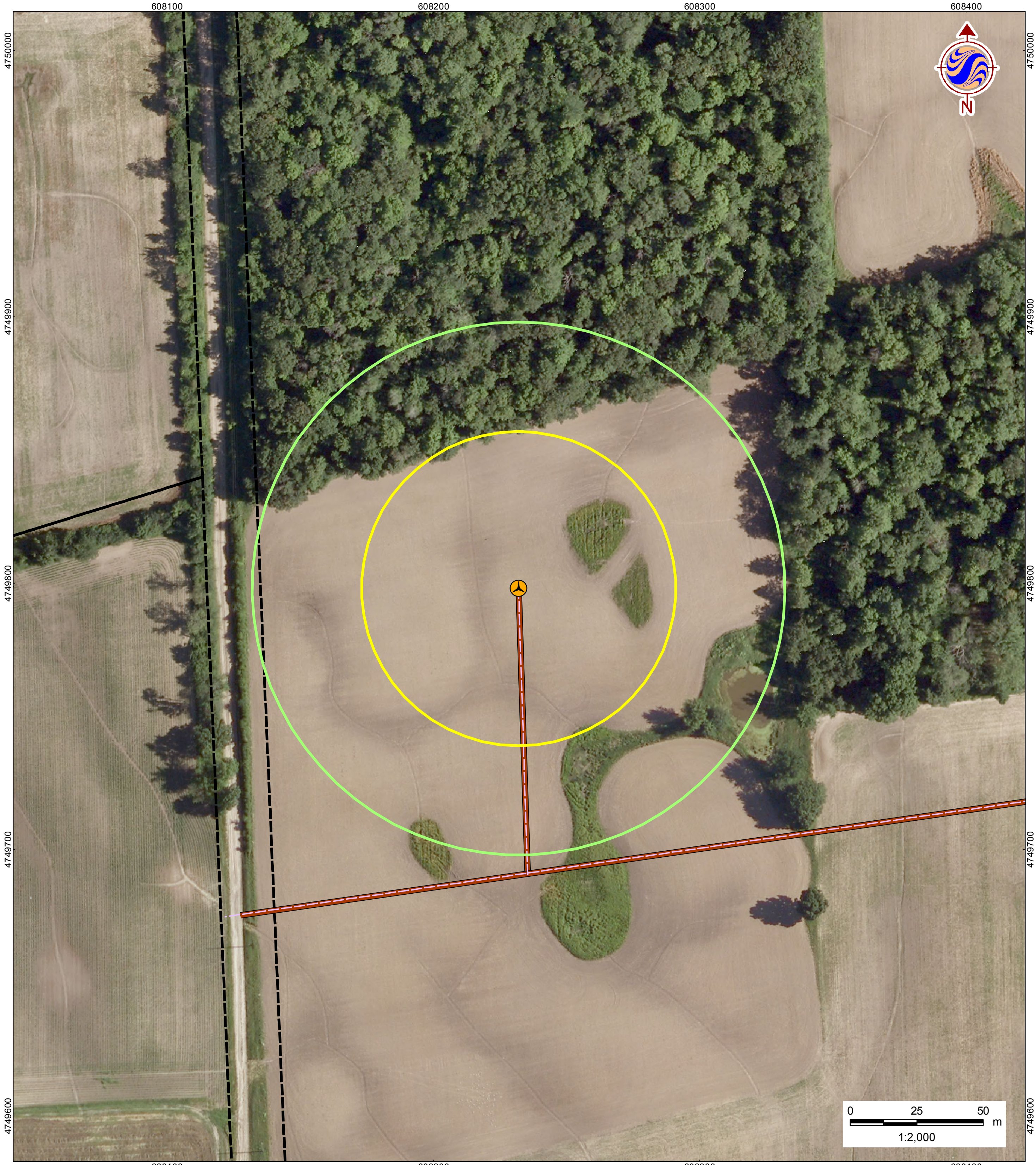

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Figure No.
T15

Title
PROPERTY LINE ASSESSMENT

Stantec

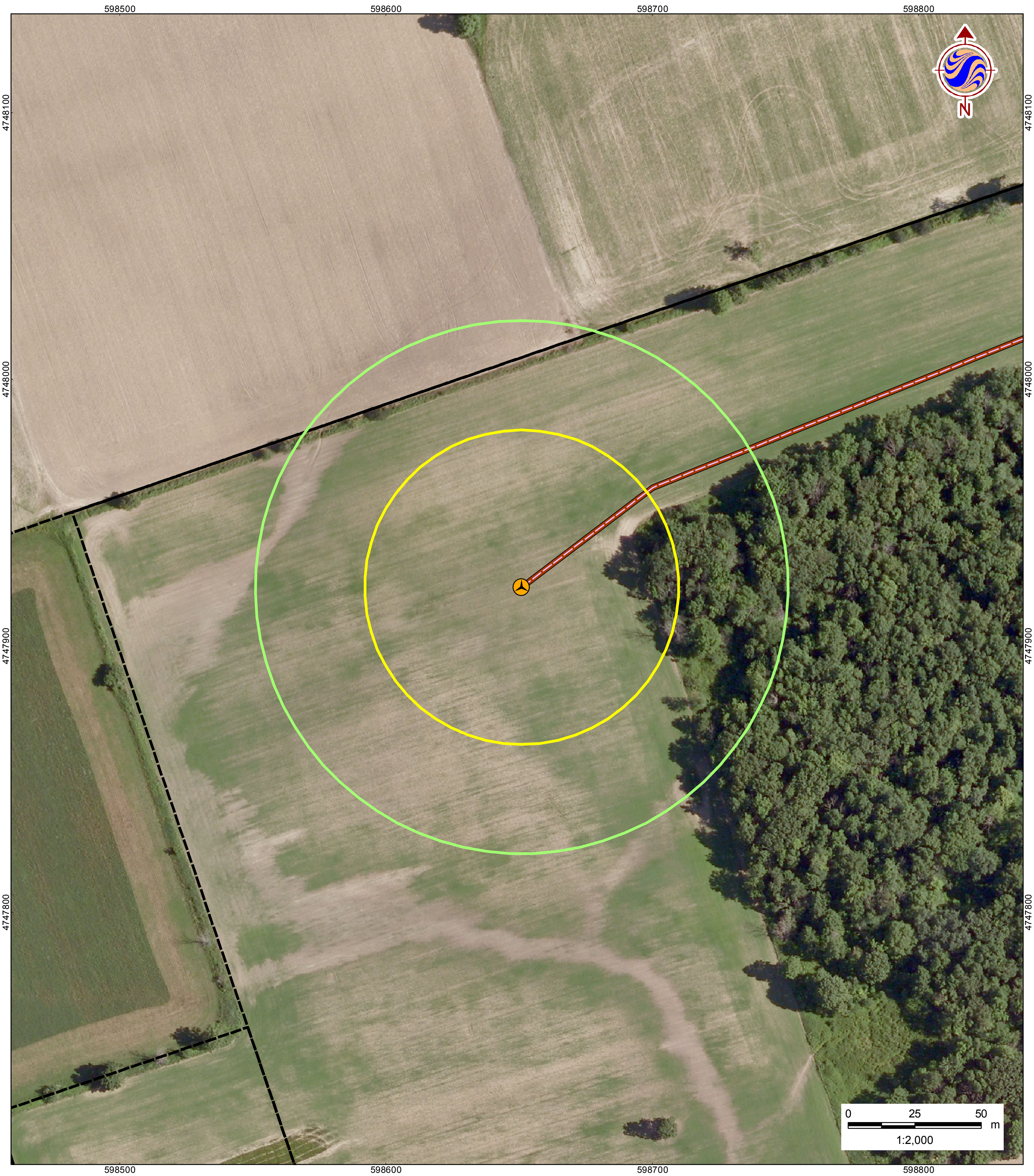

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Figure No.
T17

Title
PROPERTY LINE ASSESSMENT

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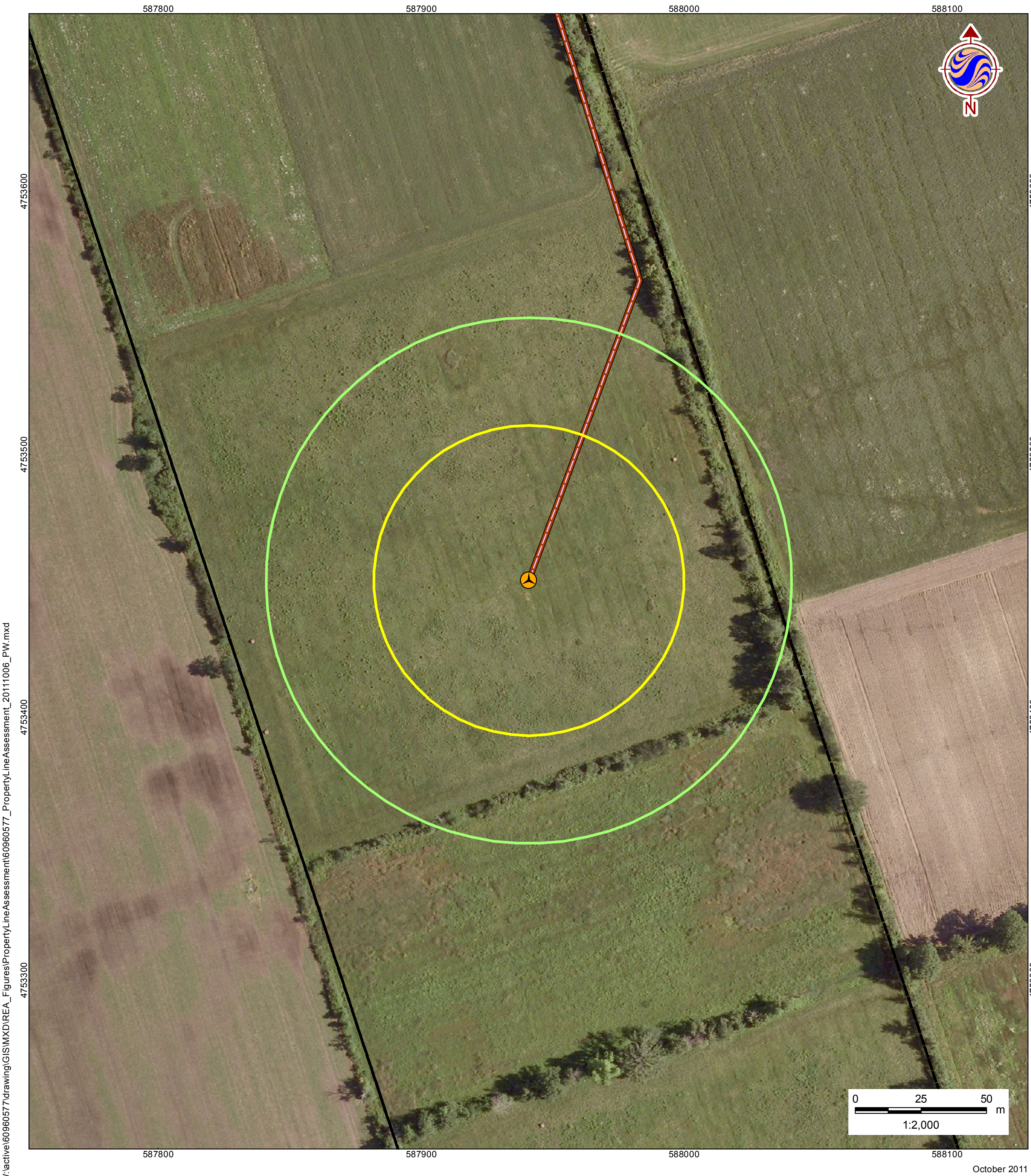

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Figure No.

T18

Title

PROPERTY LINE ASSESSMENT

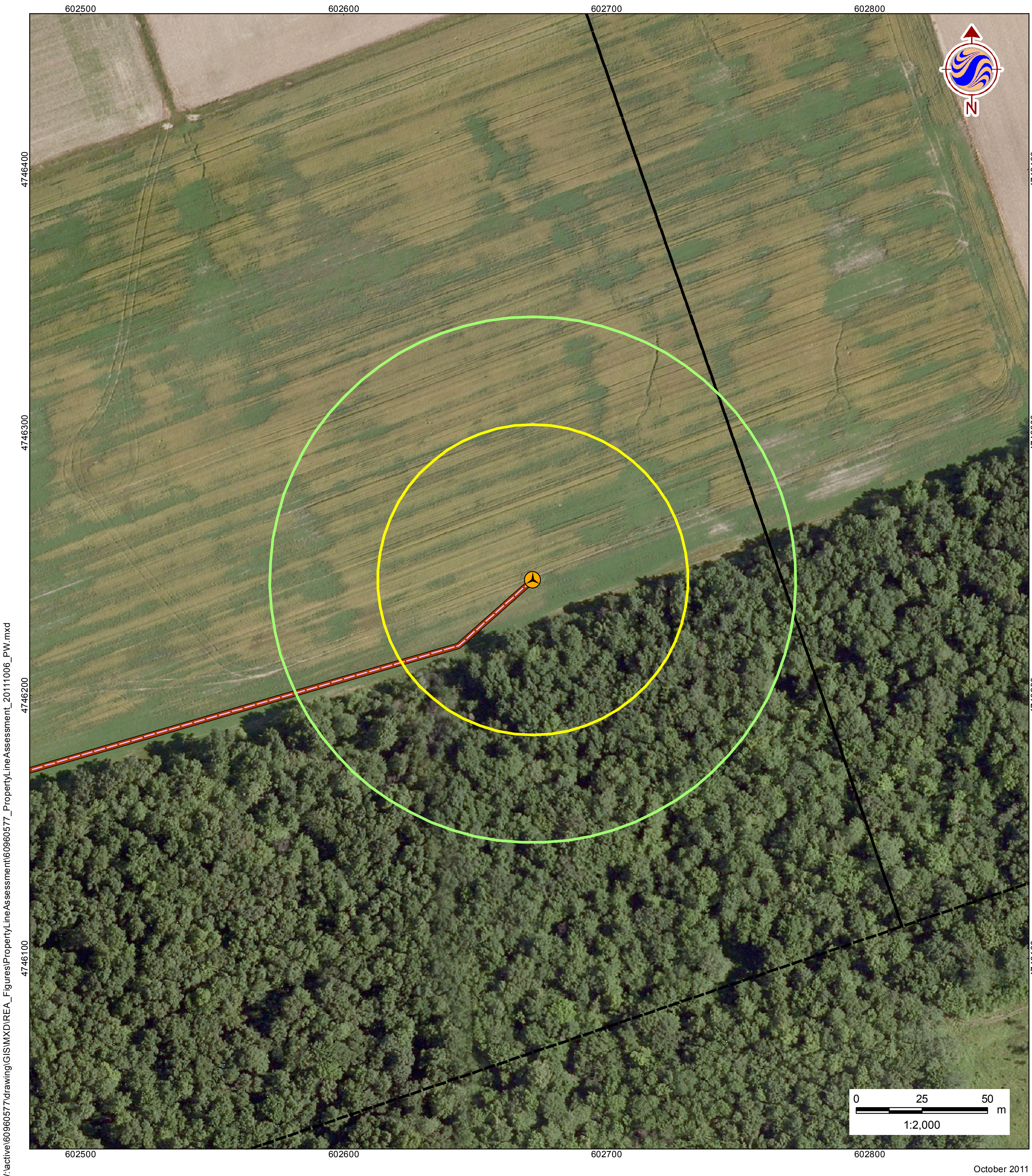

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Figure No.
T21

Title
PROPERTY LINE ASSESSMENT

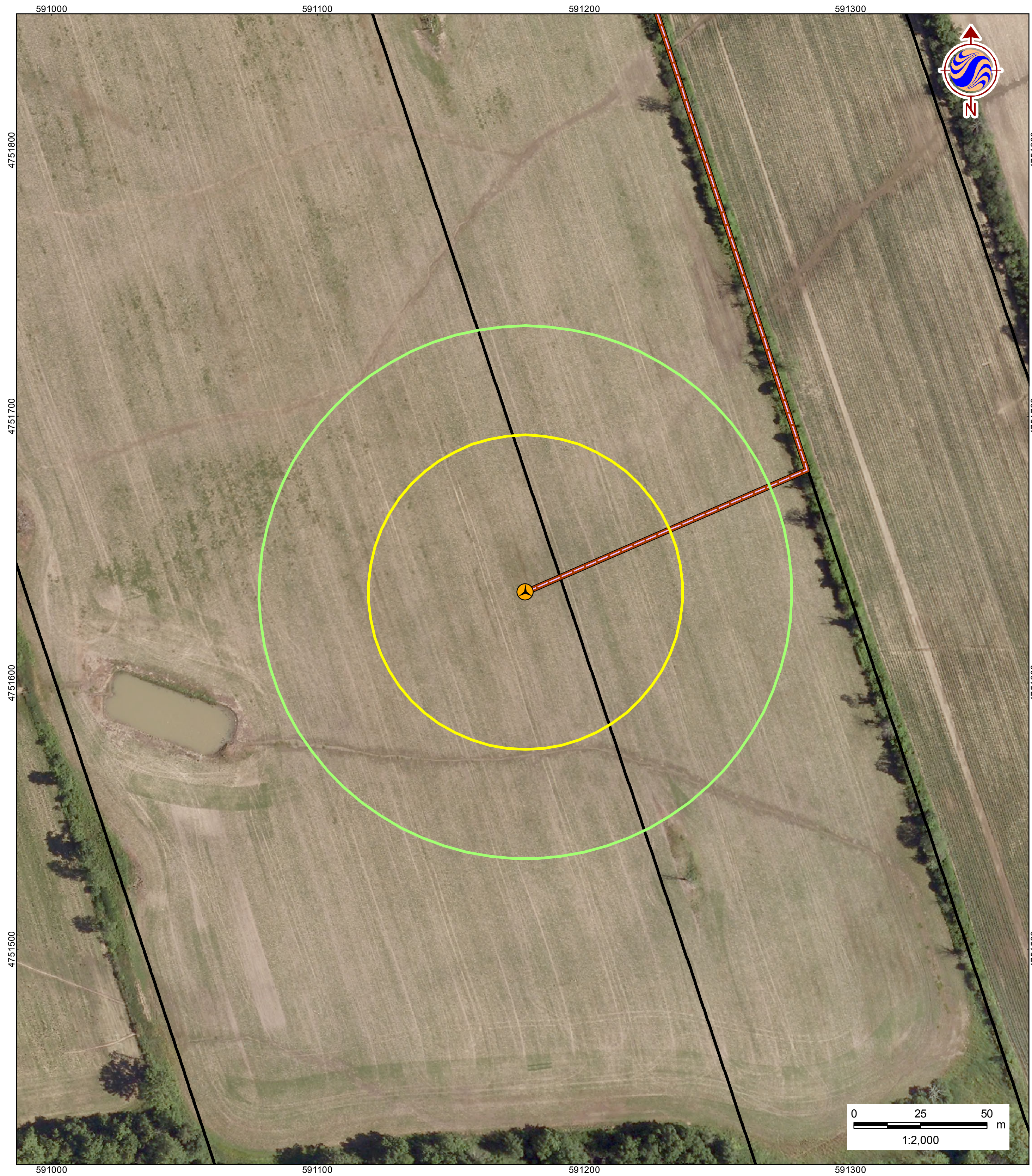

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Figure No.
T23

Title
PROPERTY LINE ASSESSMENT

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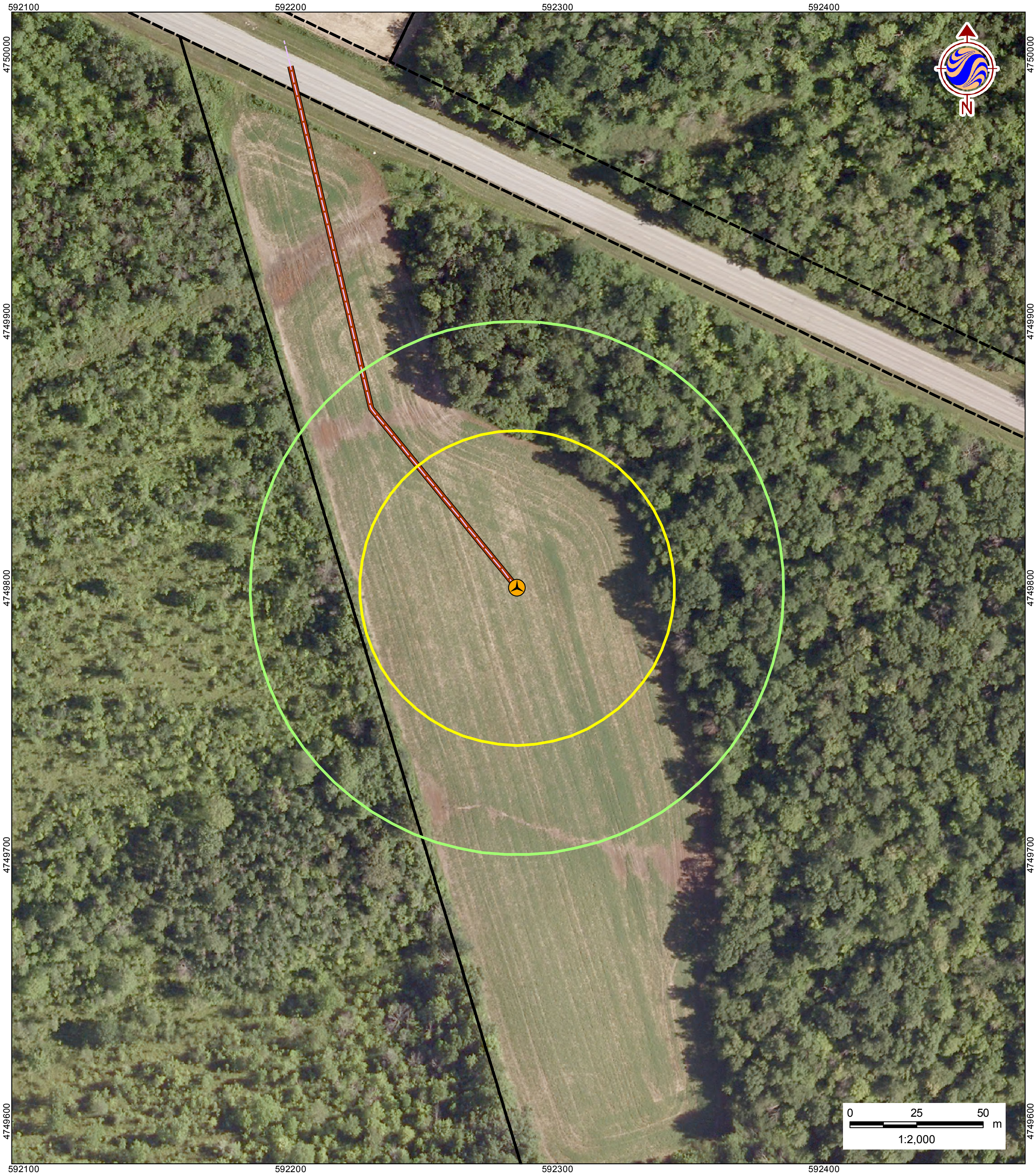

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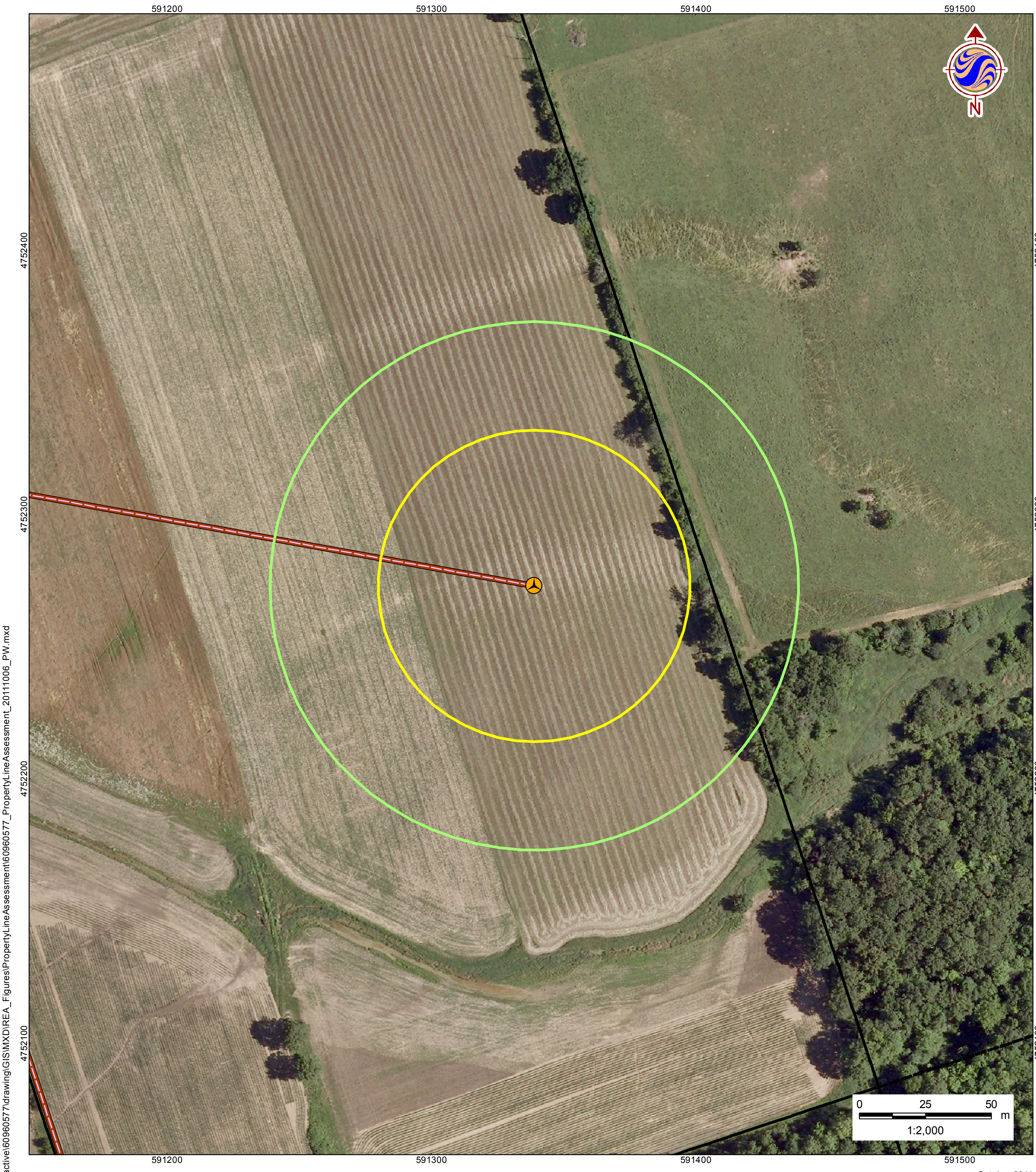
Figure No.
T24

Title
PROPERTY LINE ASSESSMENT



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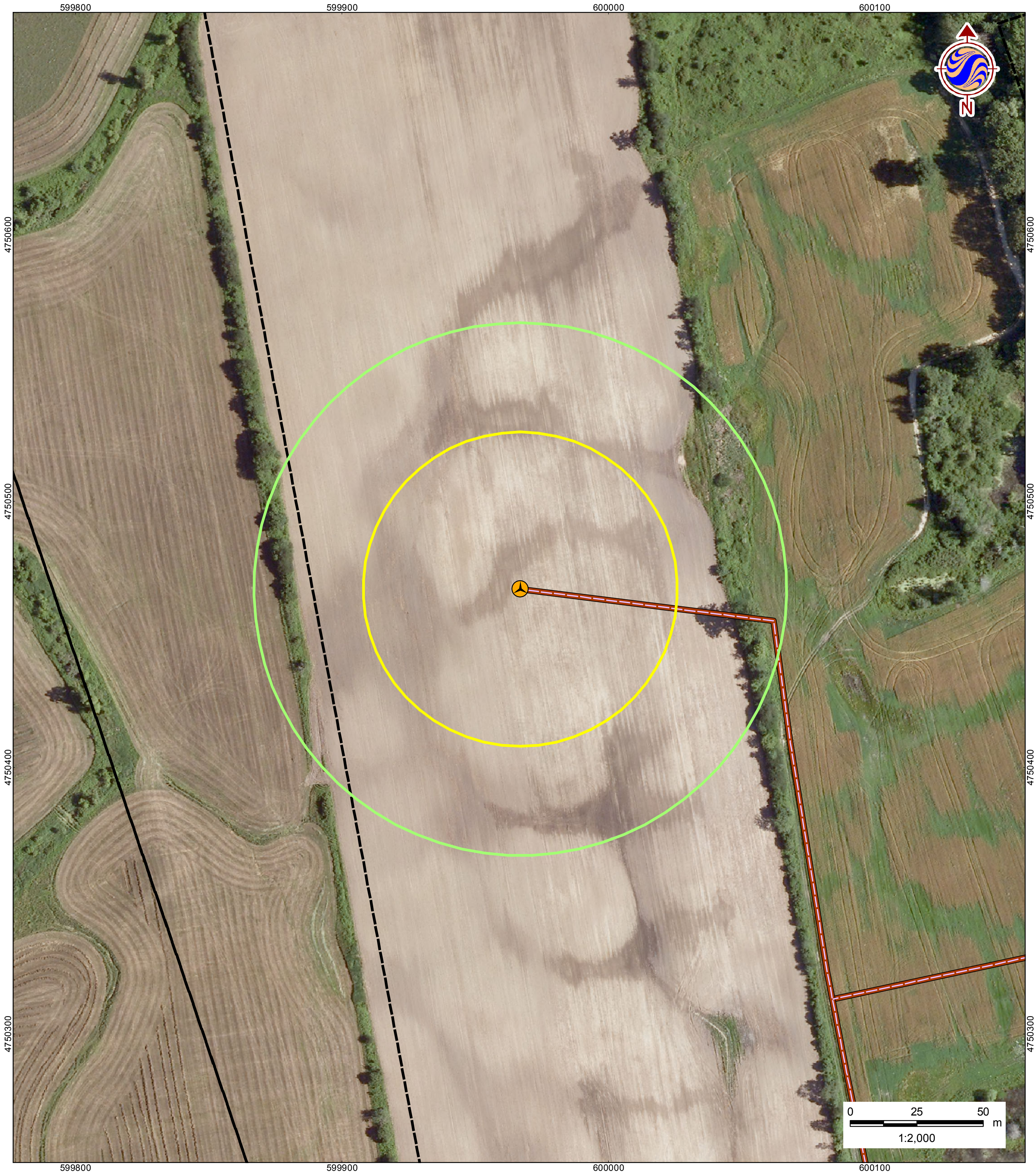
GRAND RENEWABLE ENERGY PARK

Figure No.
T28

Title
PROPERTY LINE ASSESSMENT



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Legend

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Figure No.
T29

Title
PROPERTY LINE ASSESSMENT

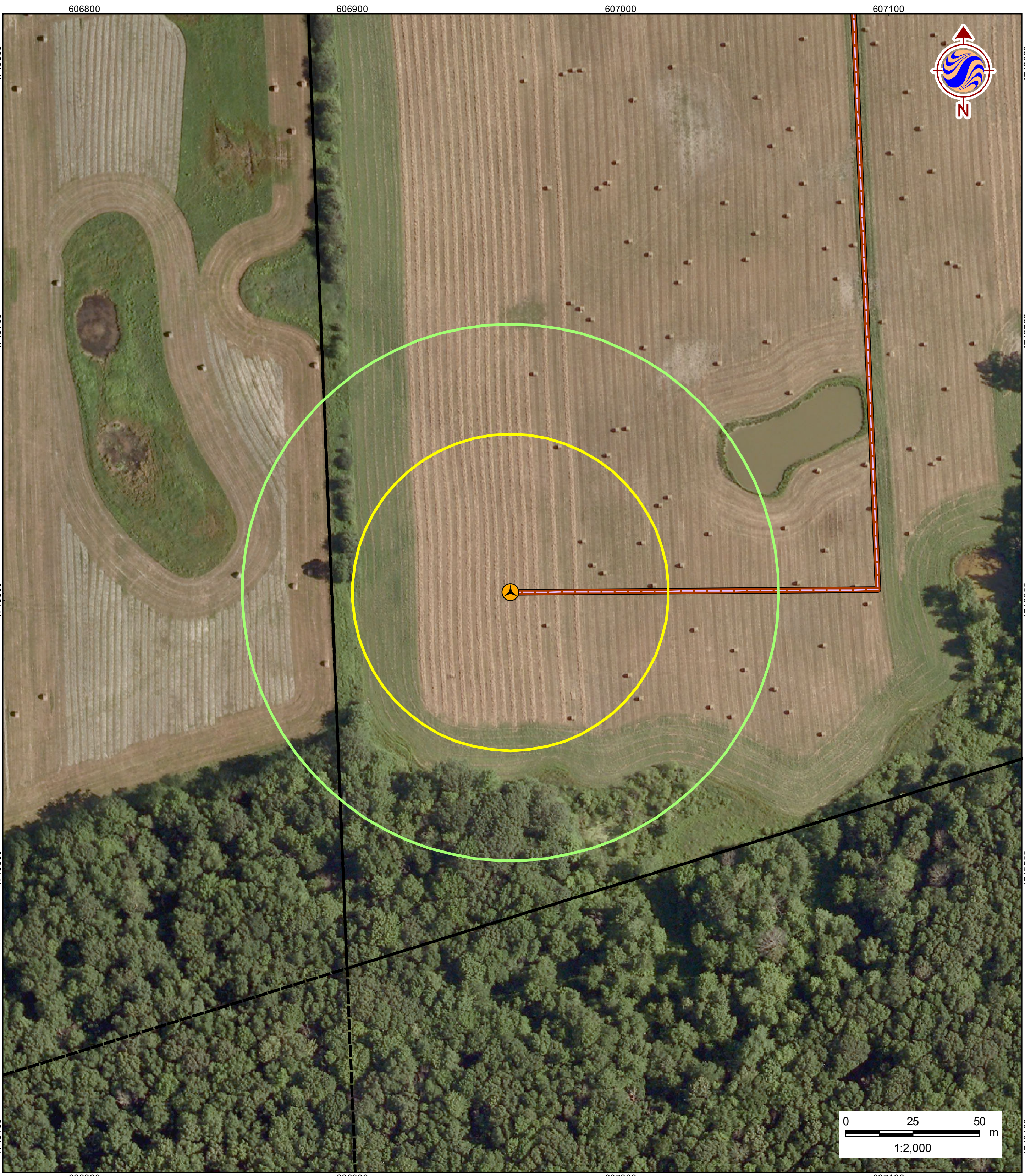

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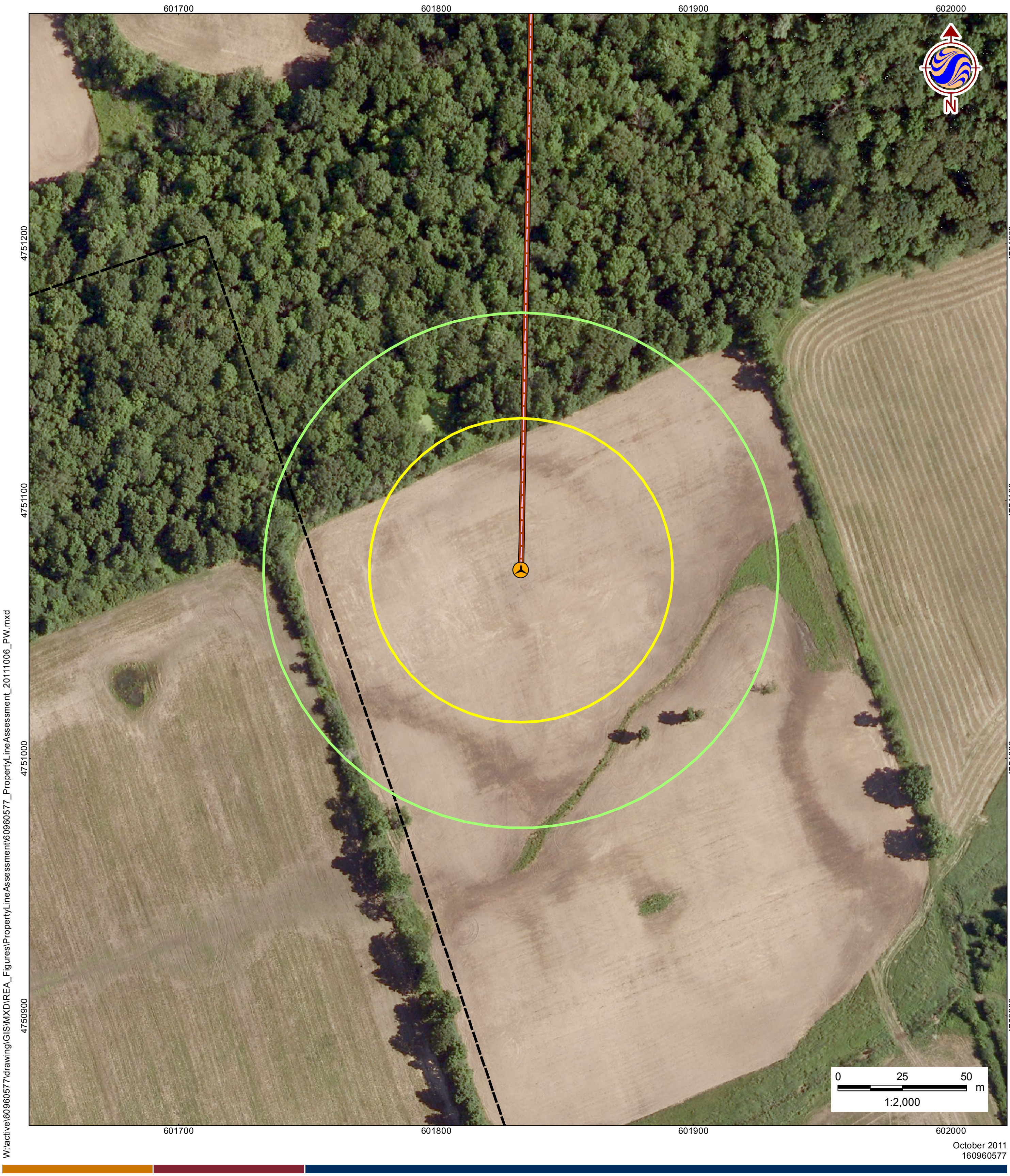
Figure No.
T30

Title
PROPERTY LINE ASSESSMENT



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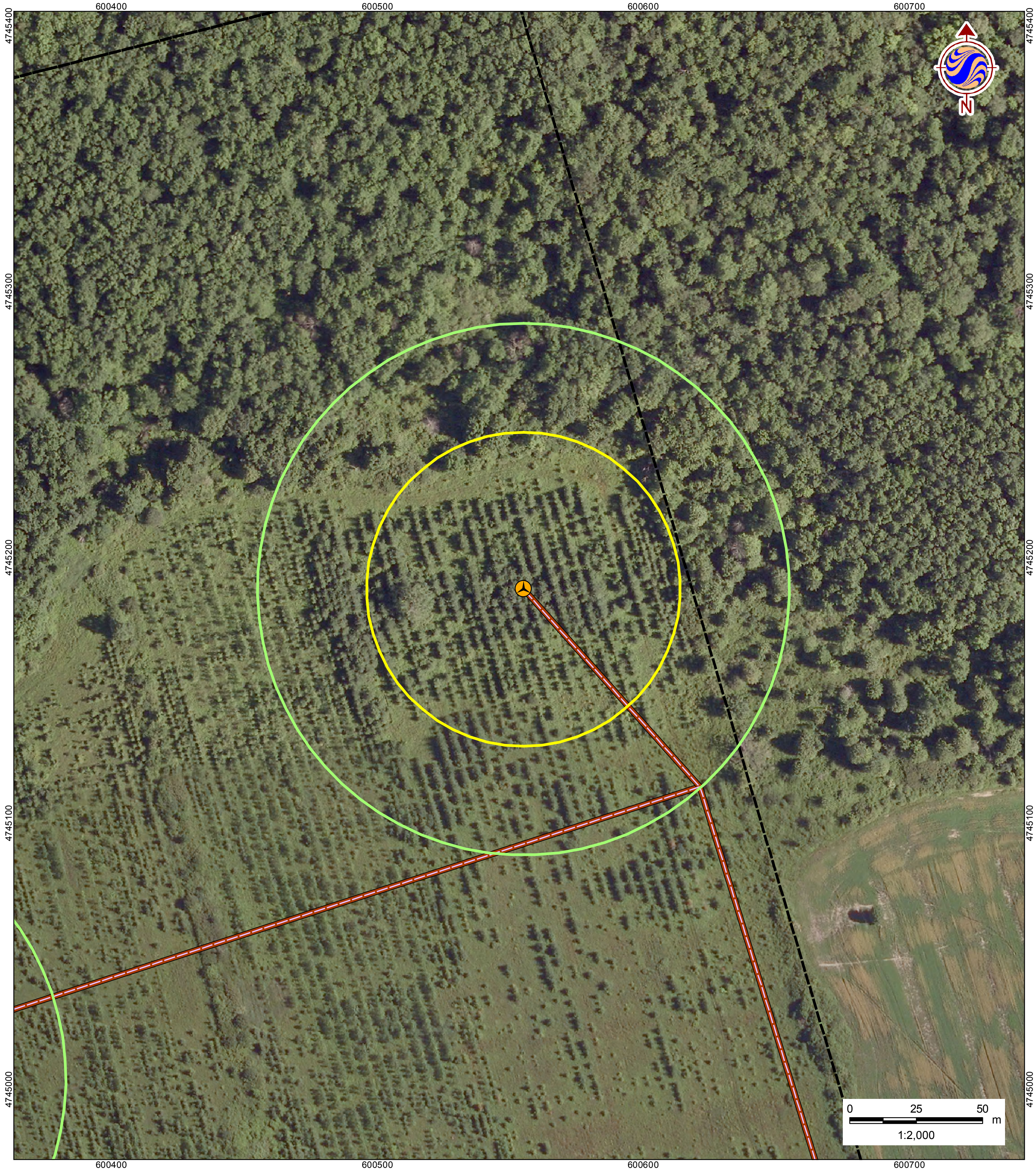
GRAND RENEWABLE ENERGY PARK

Figure No.
T31

Title
PROPERTY LINE ASSESSMENT



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GRAND RENEWABLE ENERGY PARK

Figure No.
T32

Title
PROPERTY LINE ASSESSMENT

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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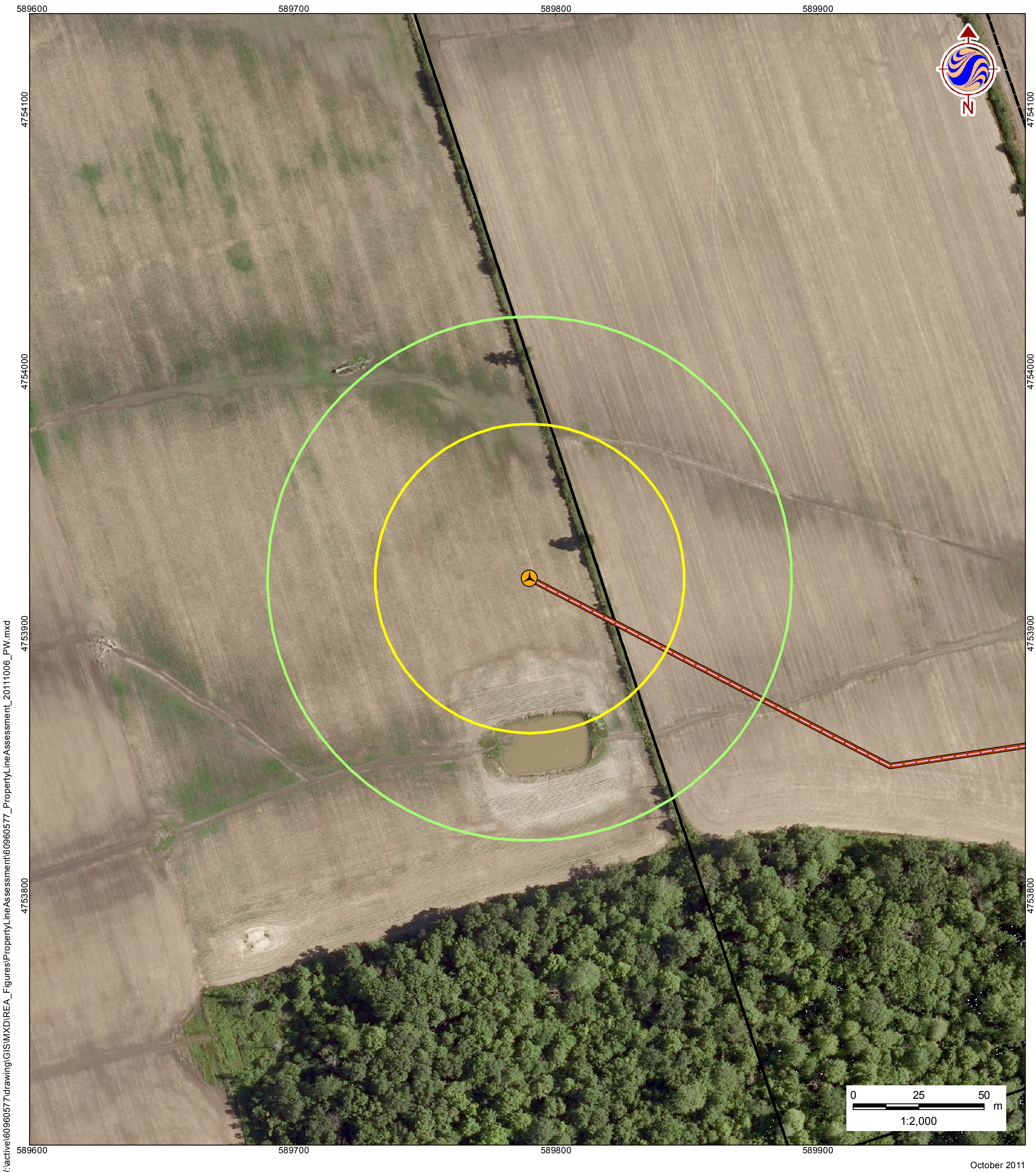
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T33

Title
PROPERTY LINE ASSESSMENT

Stantec



October 2011
160960577

Legend

- Proposed Turbine Location
- Turbine 59m Buffer
- Turbine 100m Buffer
- Access Road
- Underground Collector Line
- Property Line

Notes

1. Coordinate System: UTM NAD 83 - Zone 17.
2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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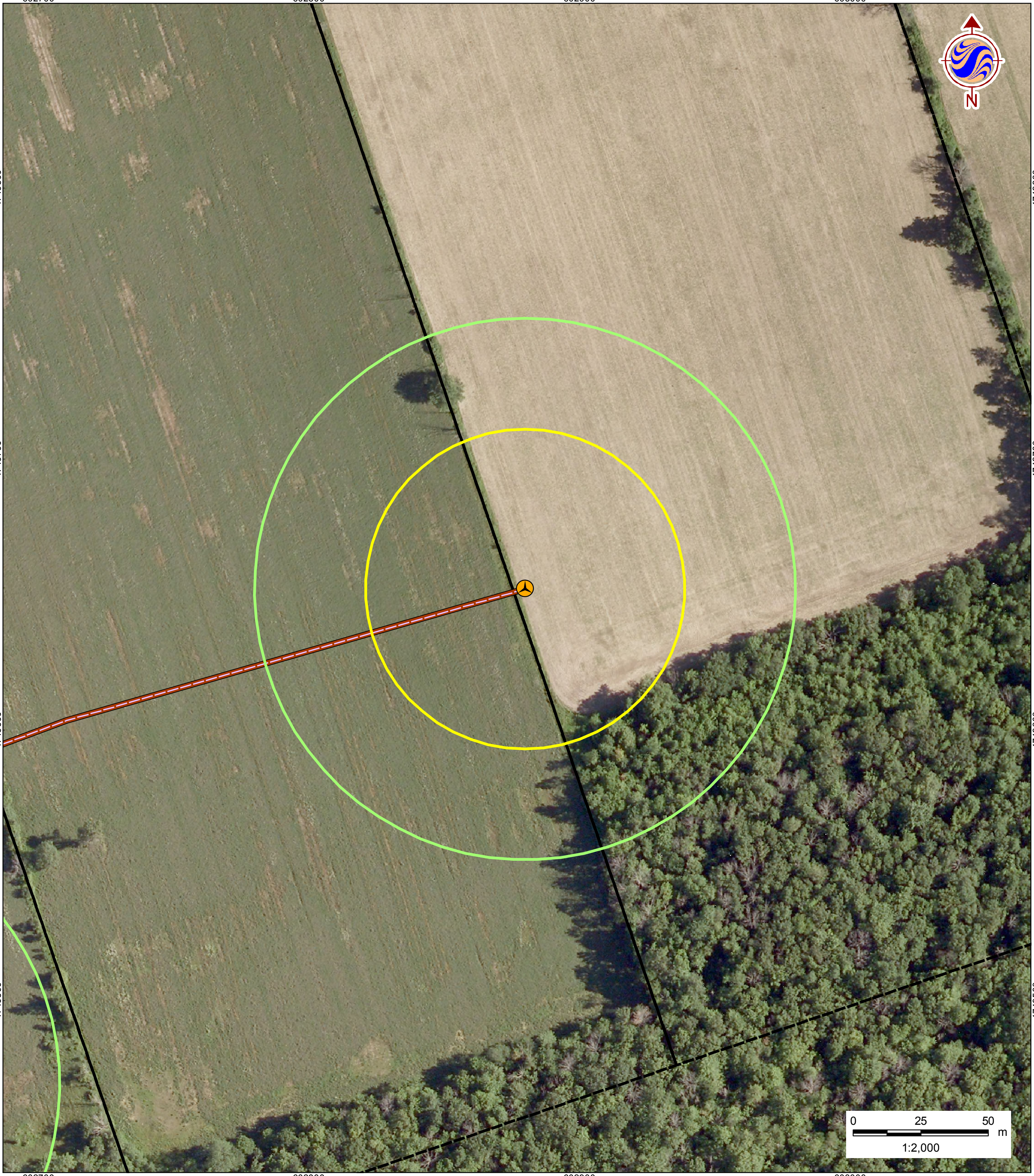
Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T34

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
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- Property Line

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Notes

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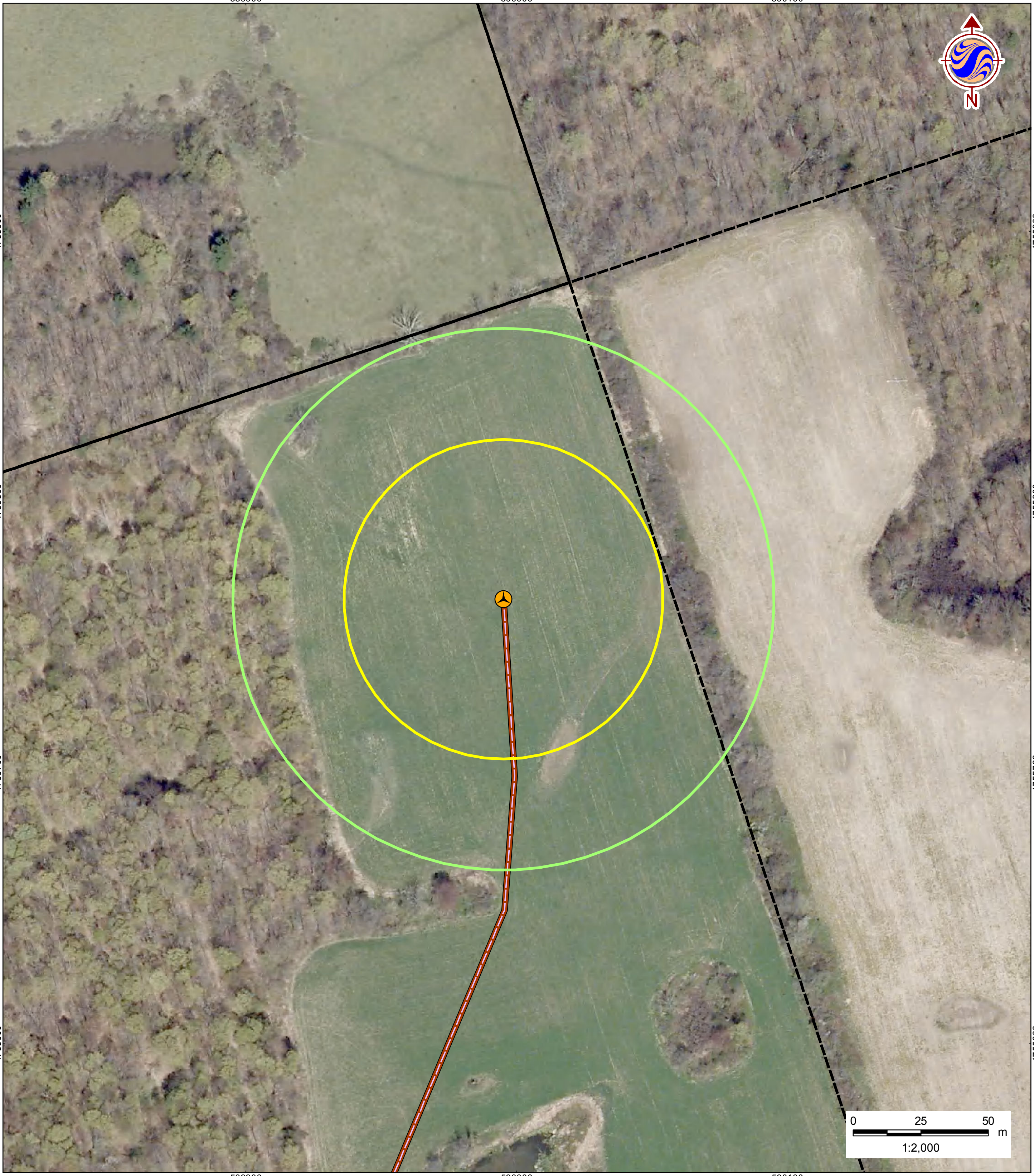
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T35

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
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- Property Line

Notes

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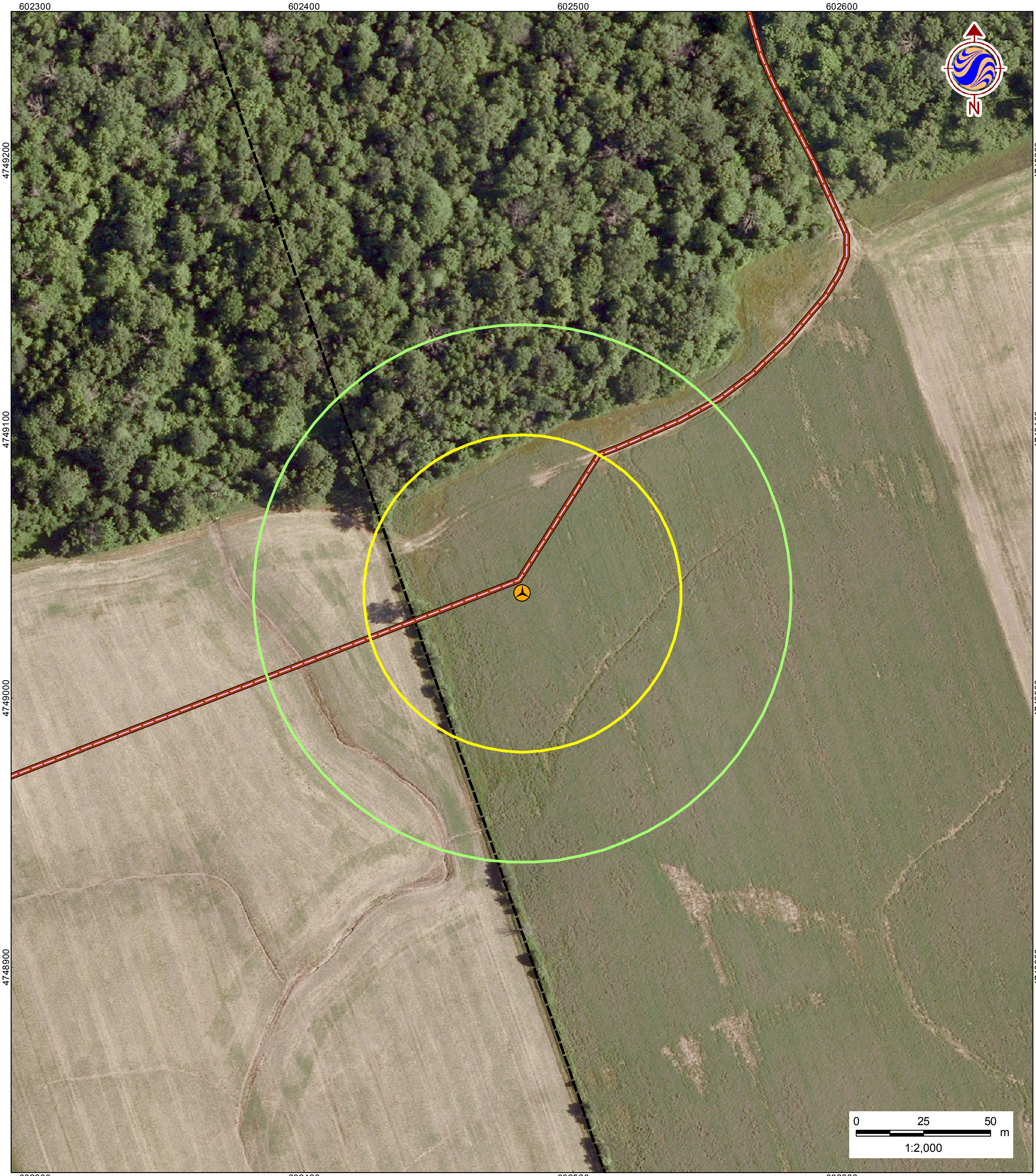
2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T36

Title
PROPERTY LINE ASSESSMENT

Stantec



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October 2011
160960577

Legend

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Notes

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2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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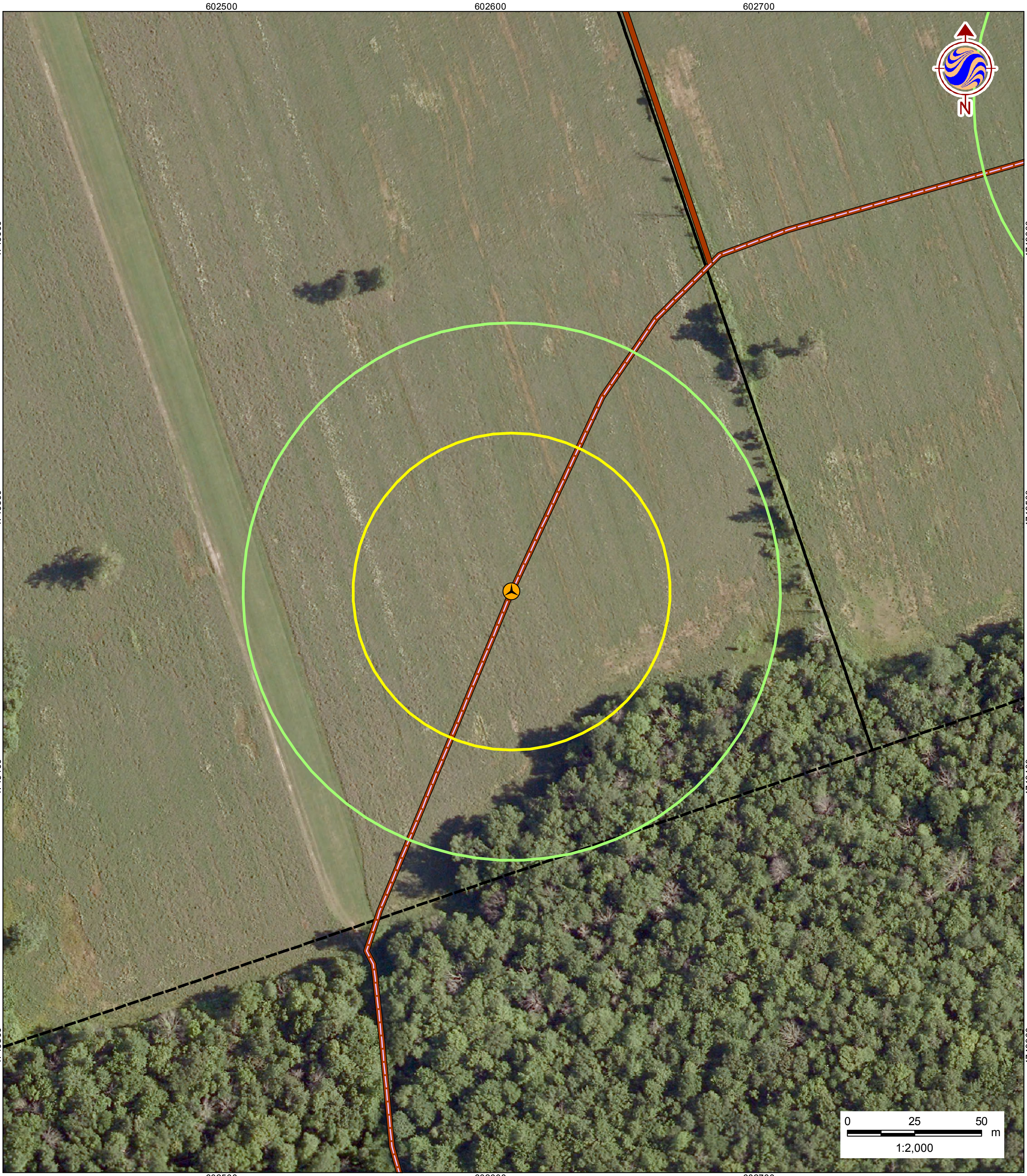
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T37

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
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Notes

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2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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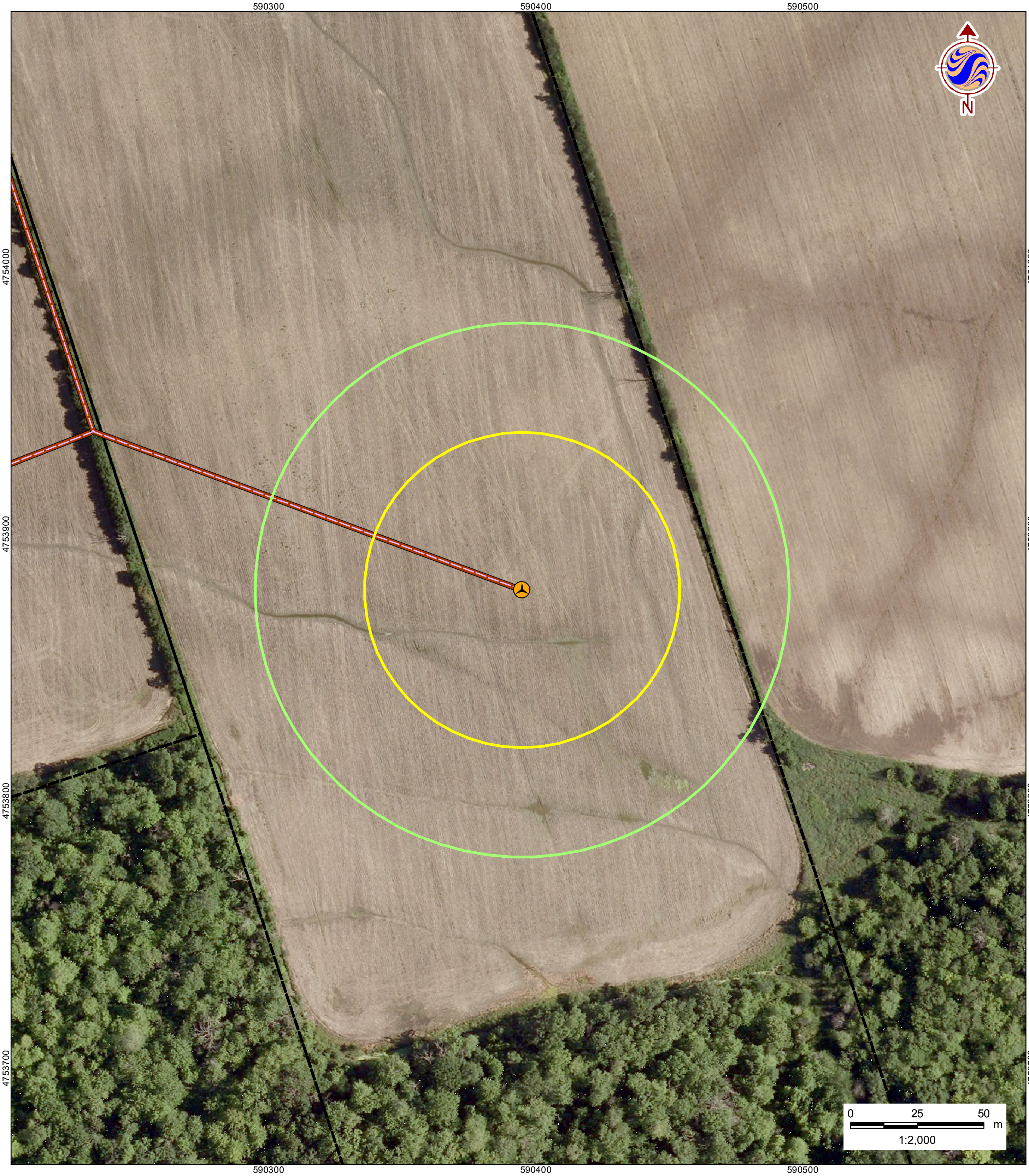
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T38

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
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- Access Road
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Notes

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2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T41

Title
PROPERTY LINE ASSESSMENT

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October 2011
160960577

Legend

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Notes

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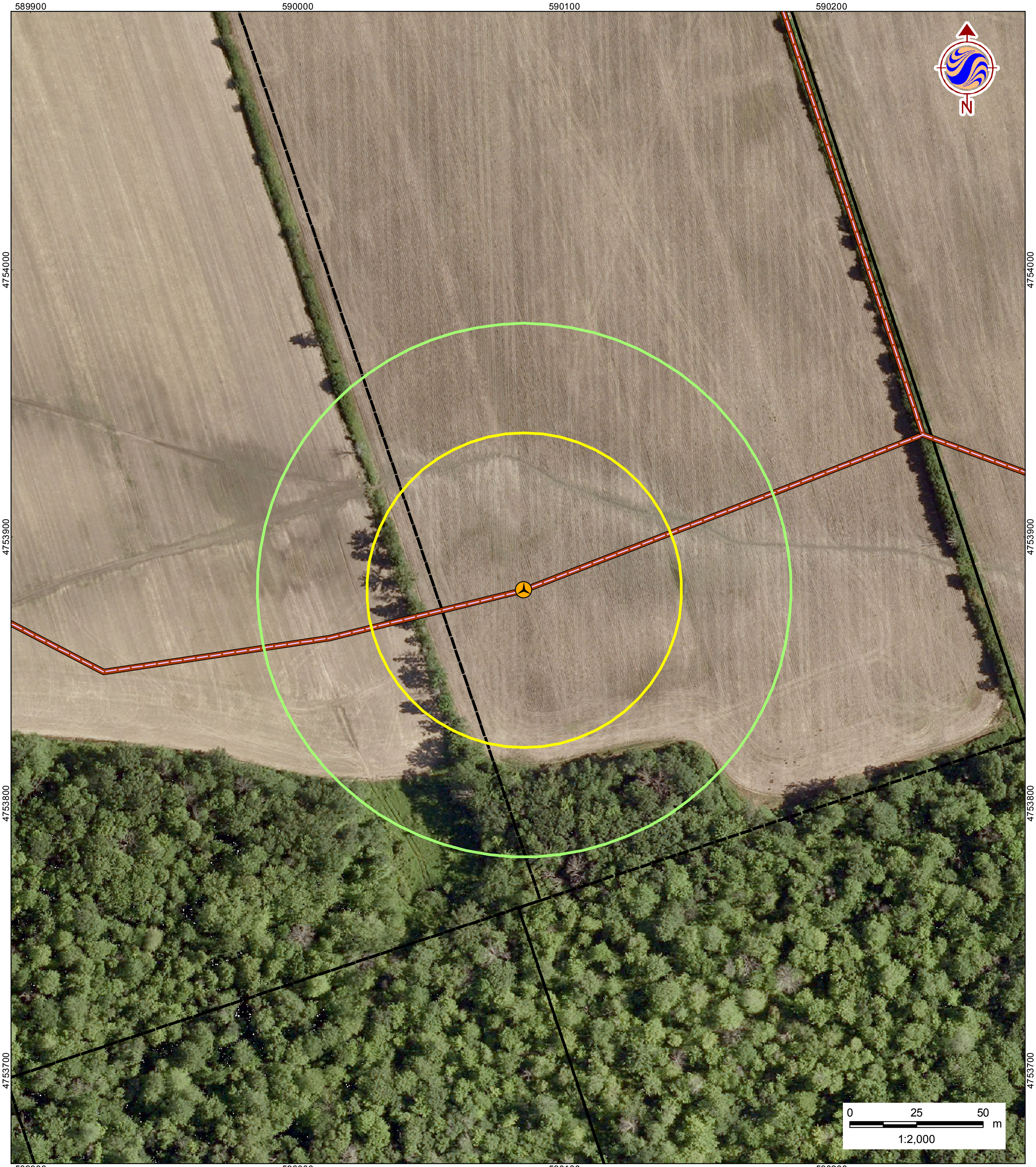
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T43

Title
PROPERTY LINE ASSESSMENT

Stantec



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October 2011
160960577

Legend

- Proposed Turbine Location
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- Turbine 100m Buffer
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- Underground Collector Line
- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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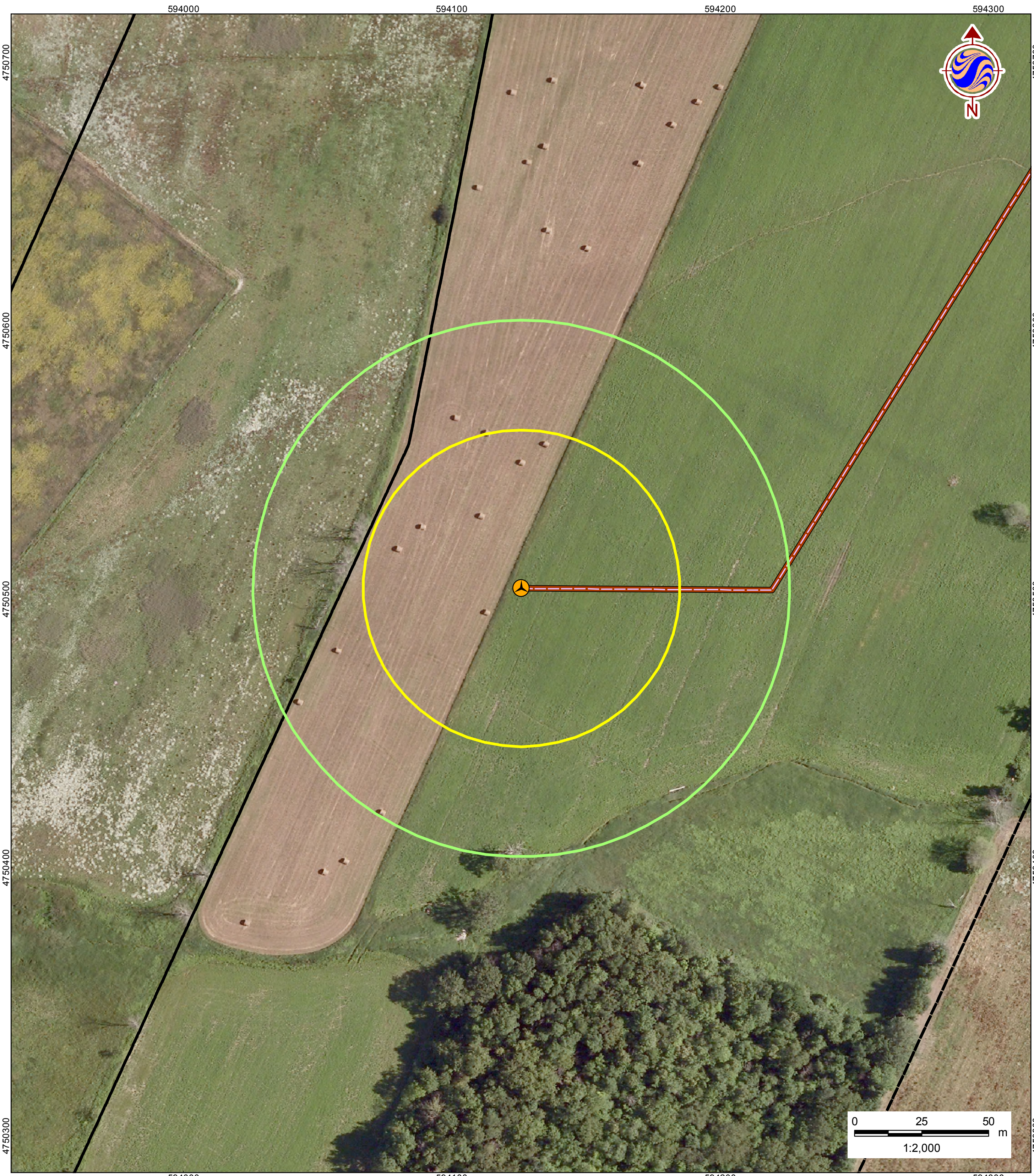
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T45

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
- Turbine 59m Buffer
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- Underground Collector Line
- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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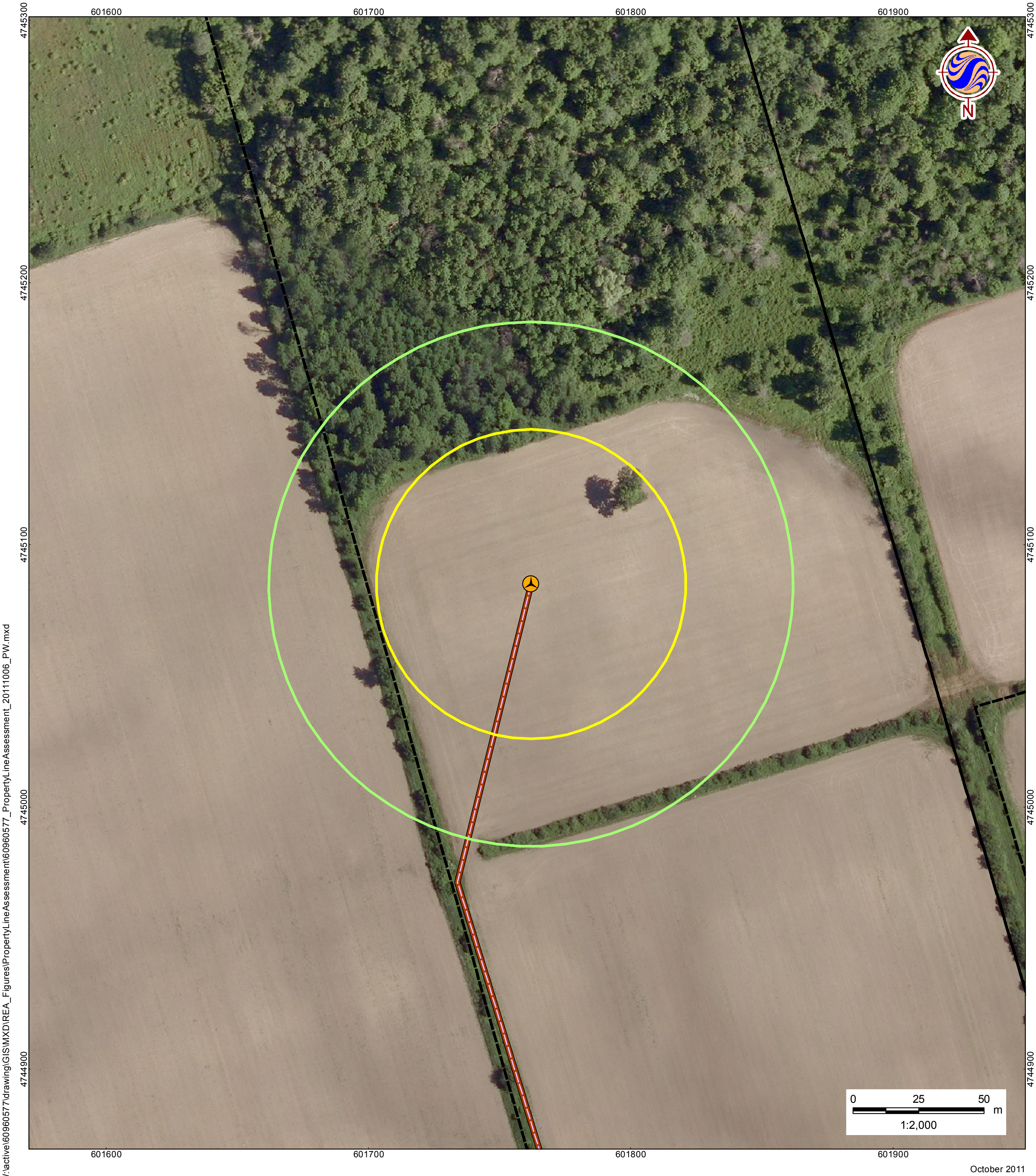
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T48

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
- Turbine 59m Buffer
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- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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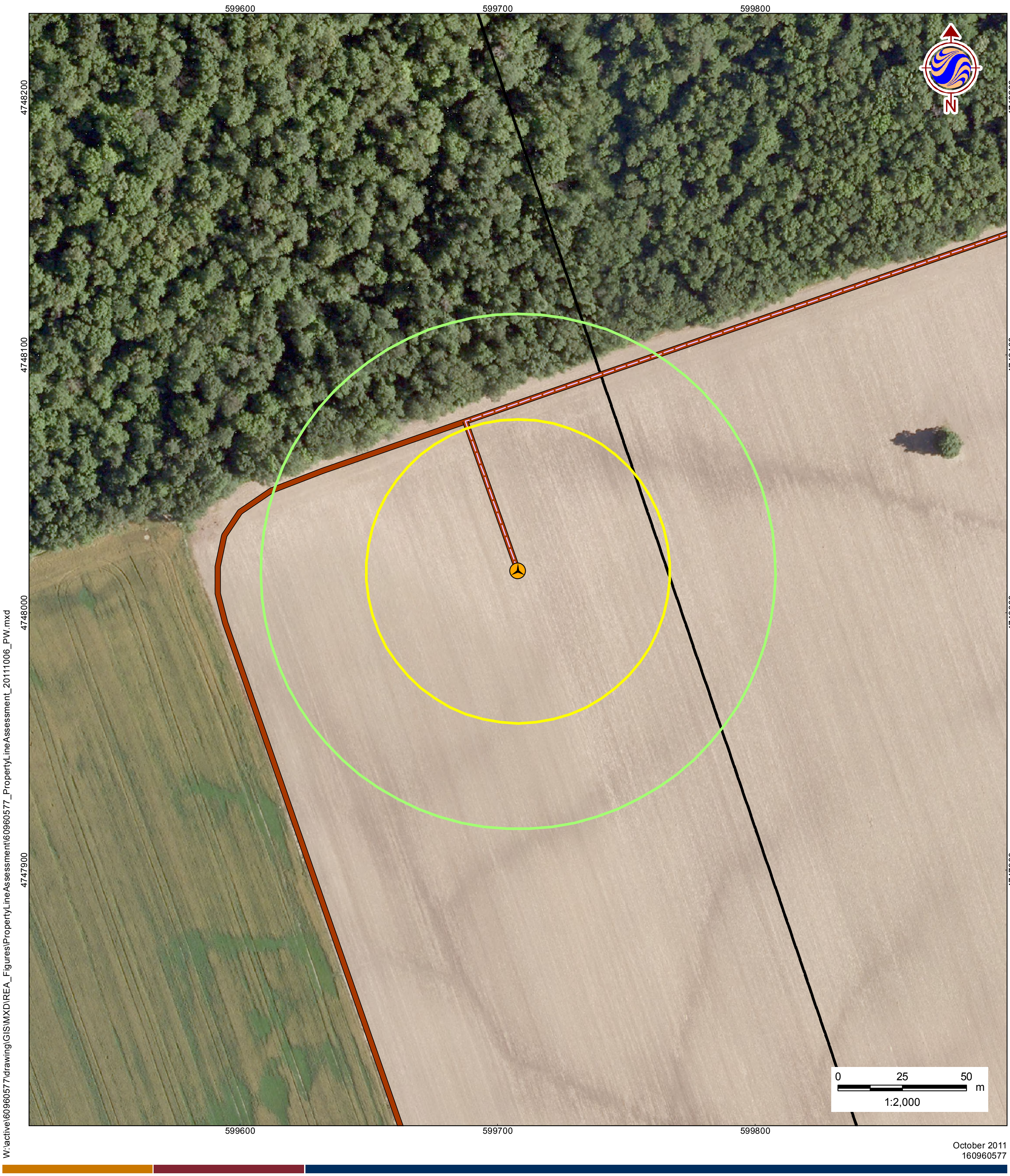
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T51

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

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- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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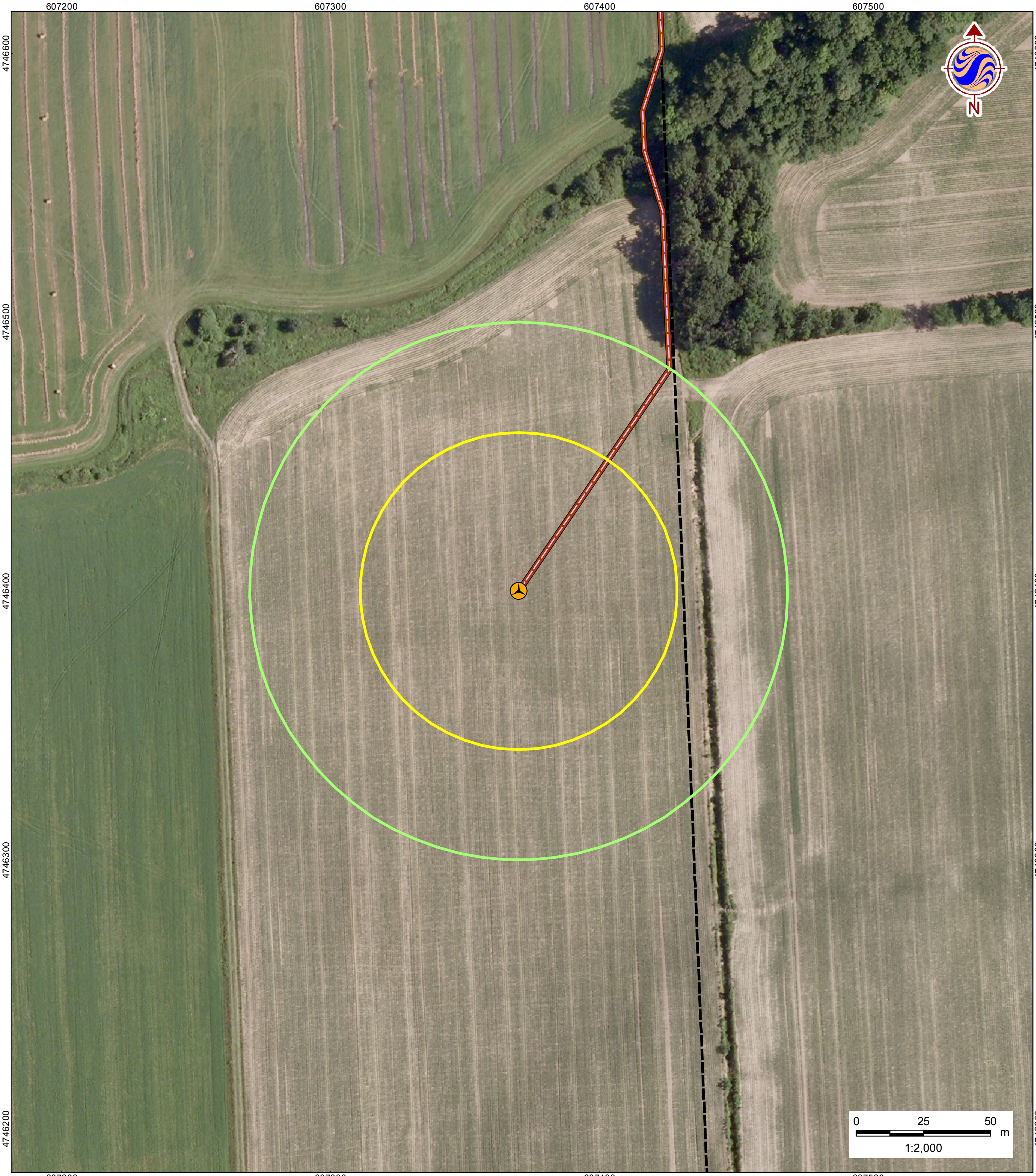
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T52

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

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- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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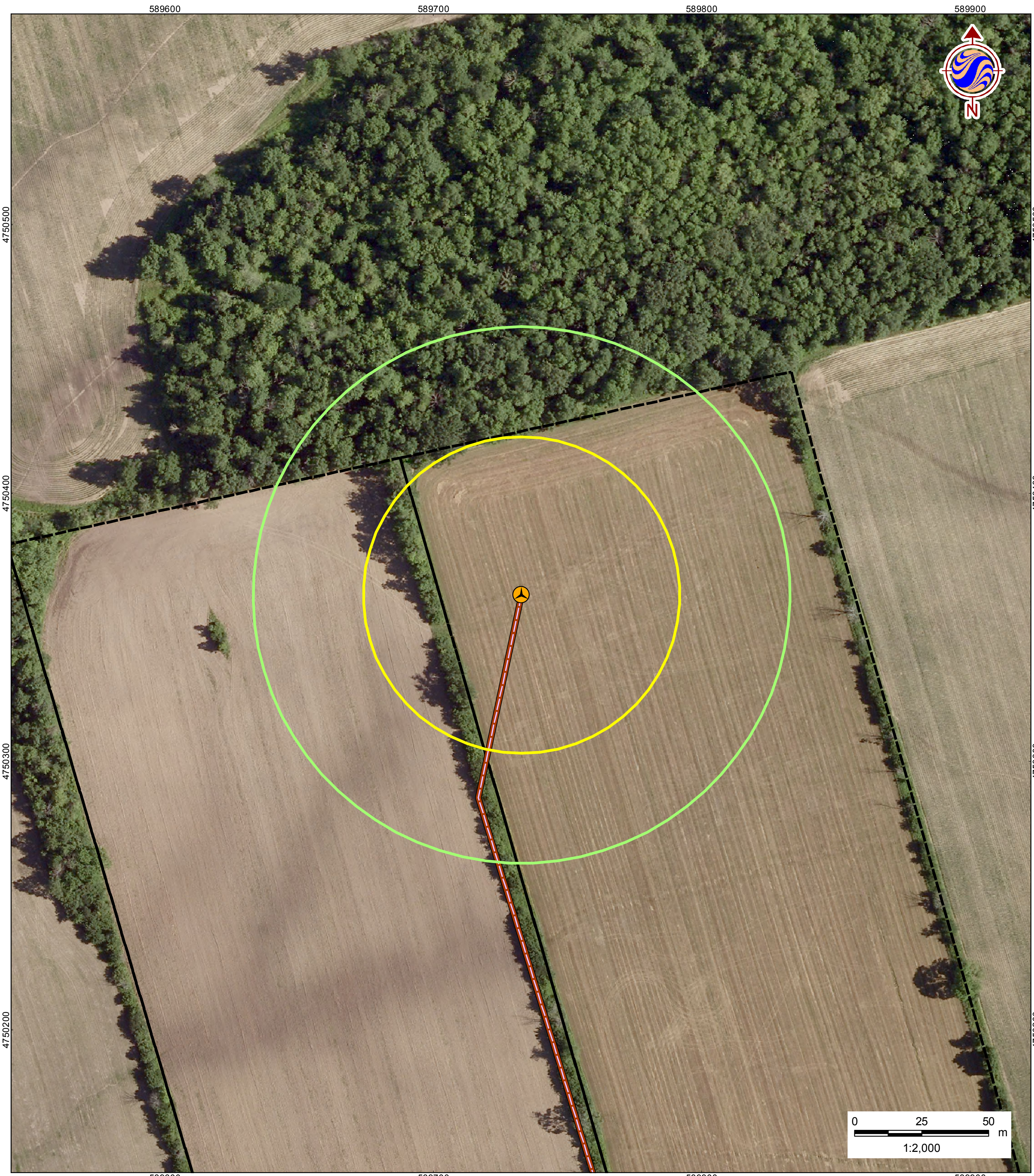
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T54

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

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- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

Client/Project
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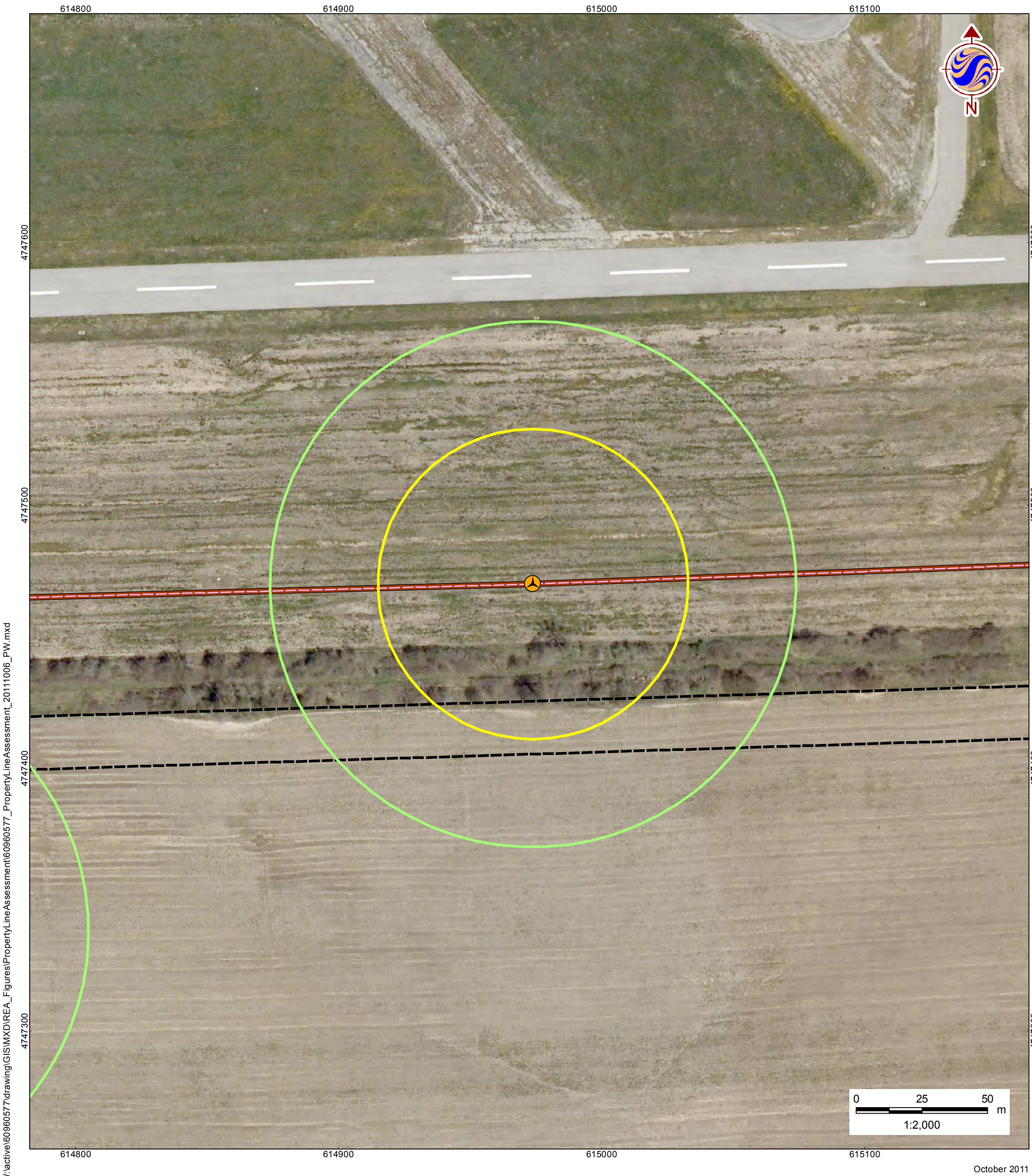
GRAND RENEWABLE ENERGY PARK

Figure No.
T58

Title
PROPERTY LINE ASSESSMENT

Stantec



October 2011
160960577

Legend

- Proposed Turbine Location
- Turbine 59m Buffer
- Turbine 100m Buffer
- Access Road
- Underground Collector Line
- Property Line

Notes

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2. Data Source: Ontario Ministry of Natural Resources © Queens Printer Ontario, 2009.
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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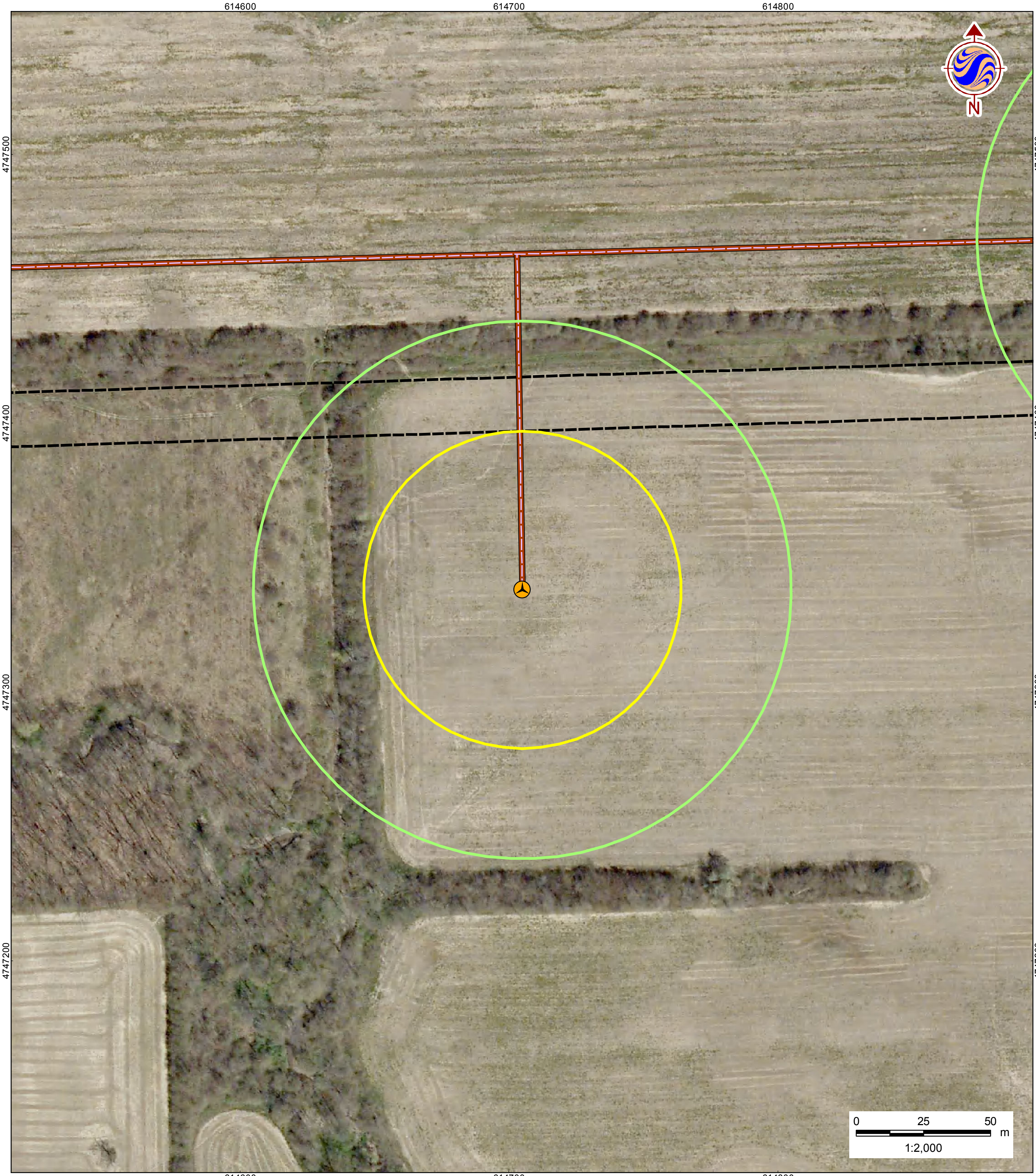
Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T60

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

- Proposed Turbine Location
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- Turbine 100m Buffer
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- Property Line

Notes

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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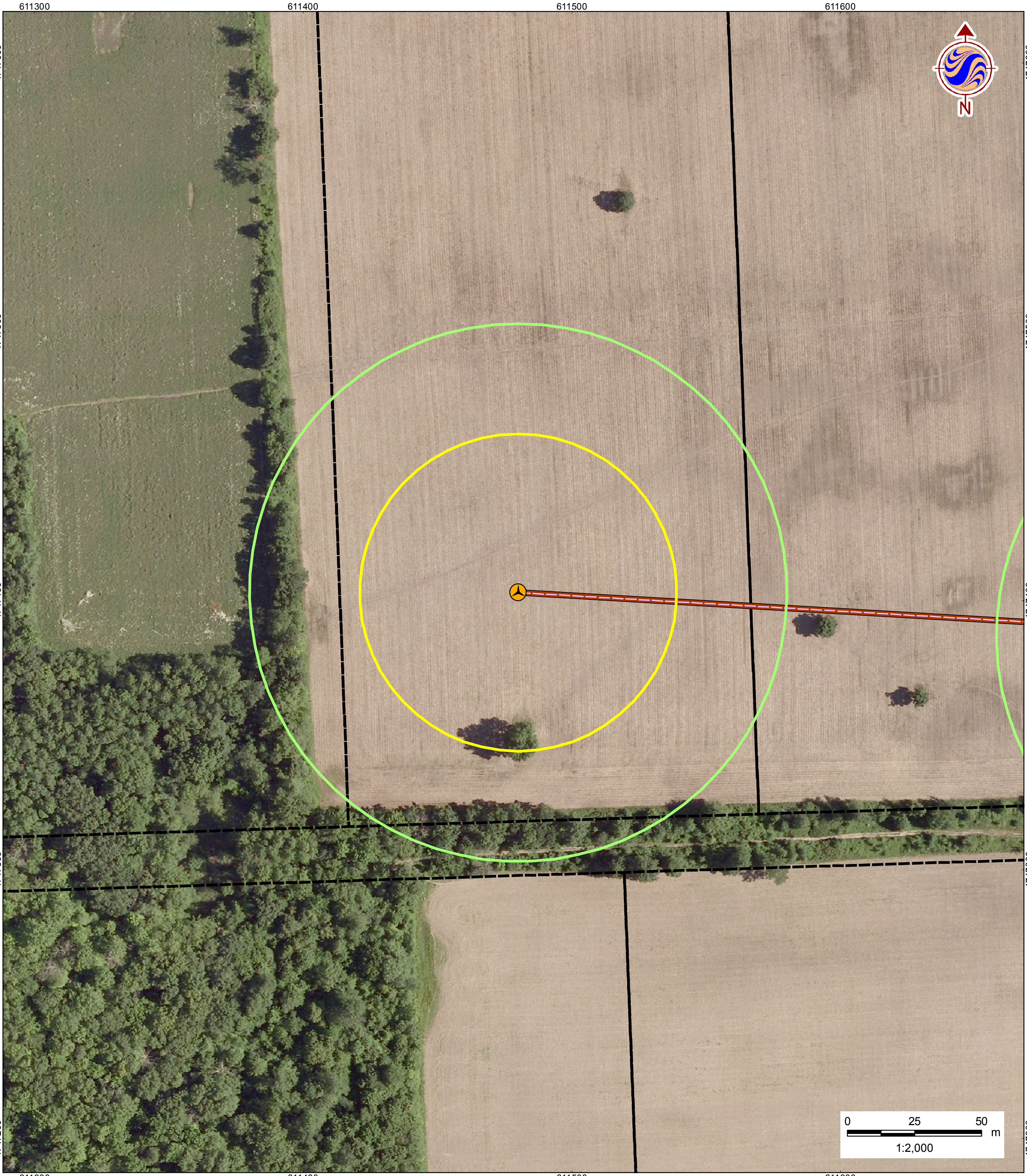
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T64

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T65

Title
PROPERTY LINE ASSESSMENT

October 2011
160960577

Legend

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- Turbine 59m Buffer
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- Access Road
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- Property Line

Notes

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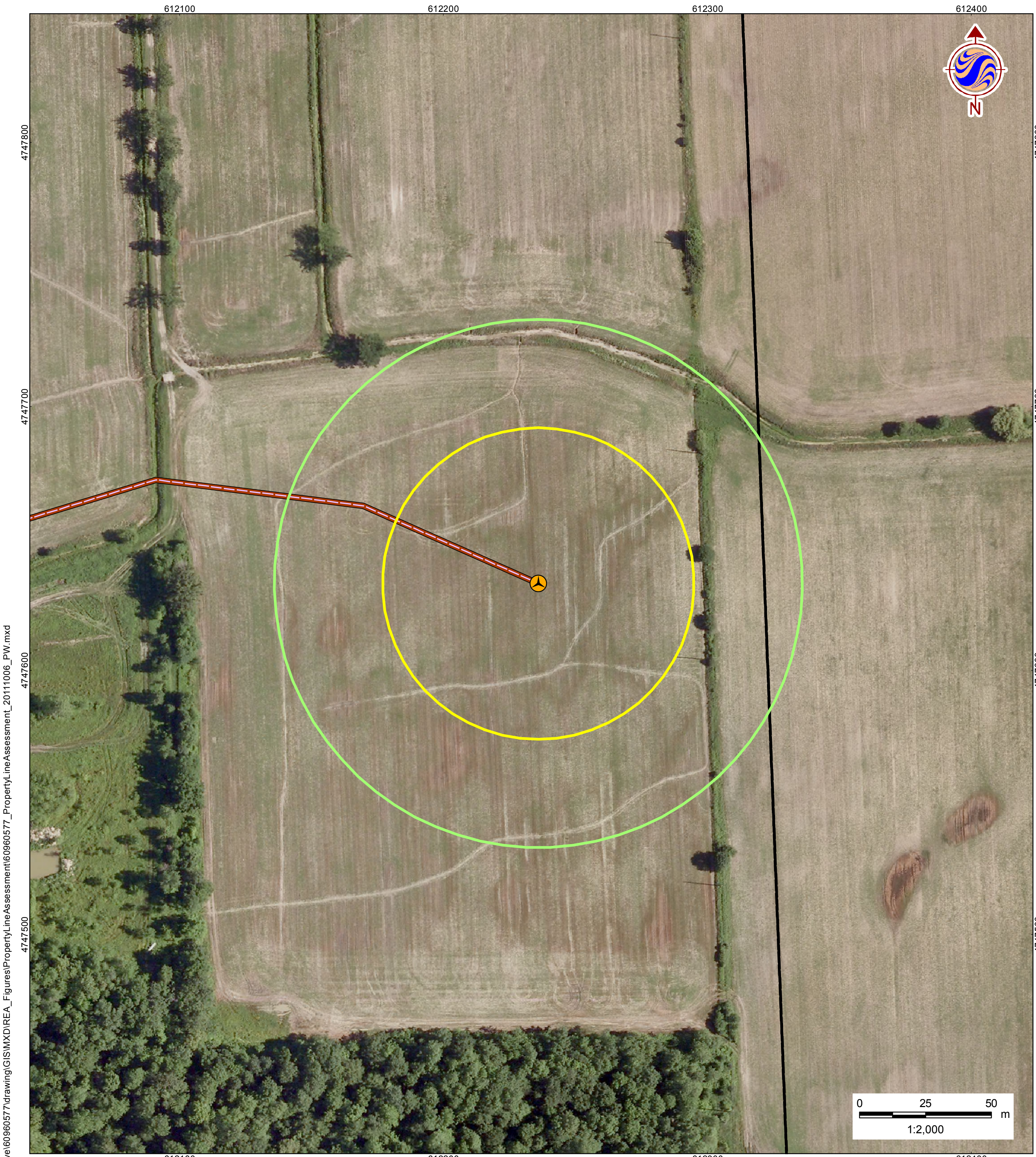
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T66

Title
PROPERTY LINE ASSESSMENT

Stantec



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October 2011
160960577

Legend

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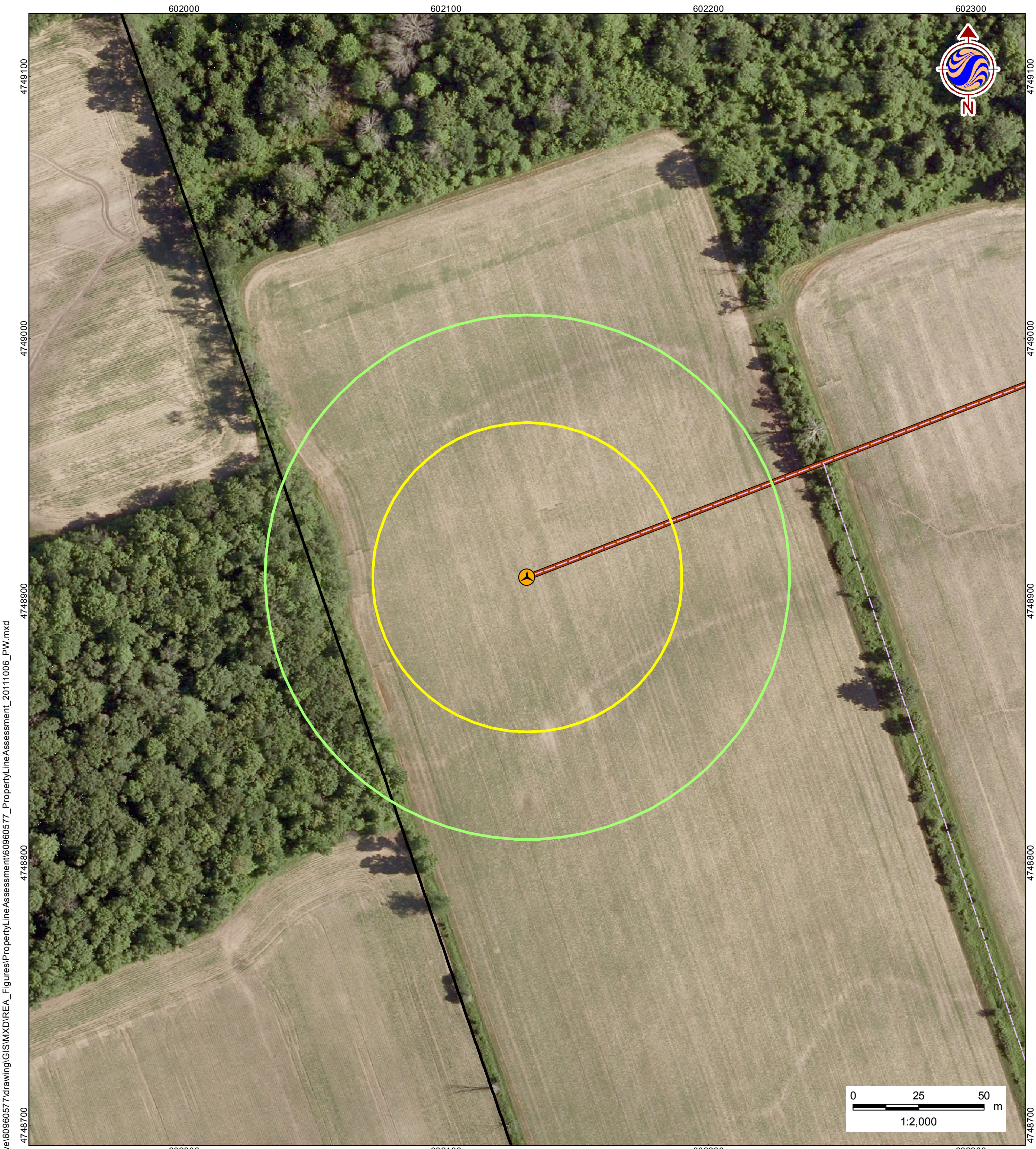
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T67

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

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Notes

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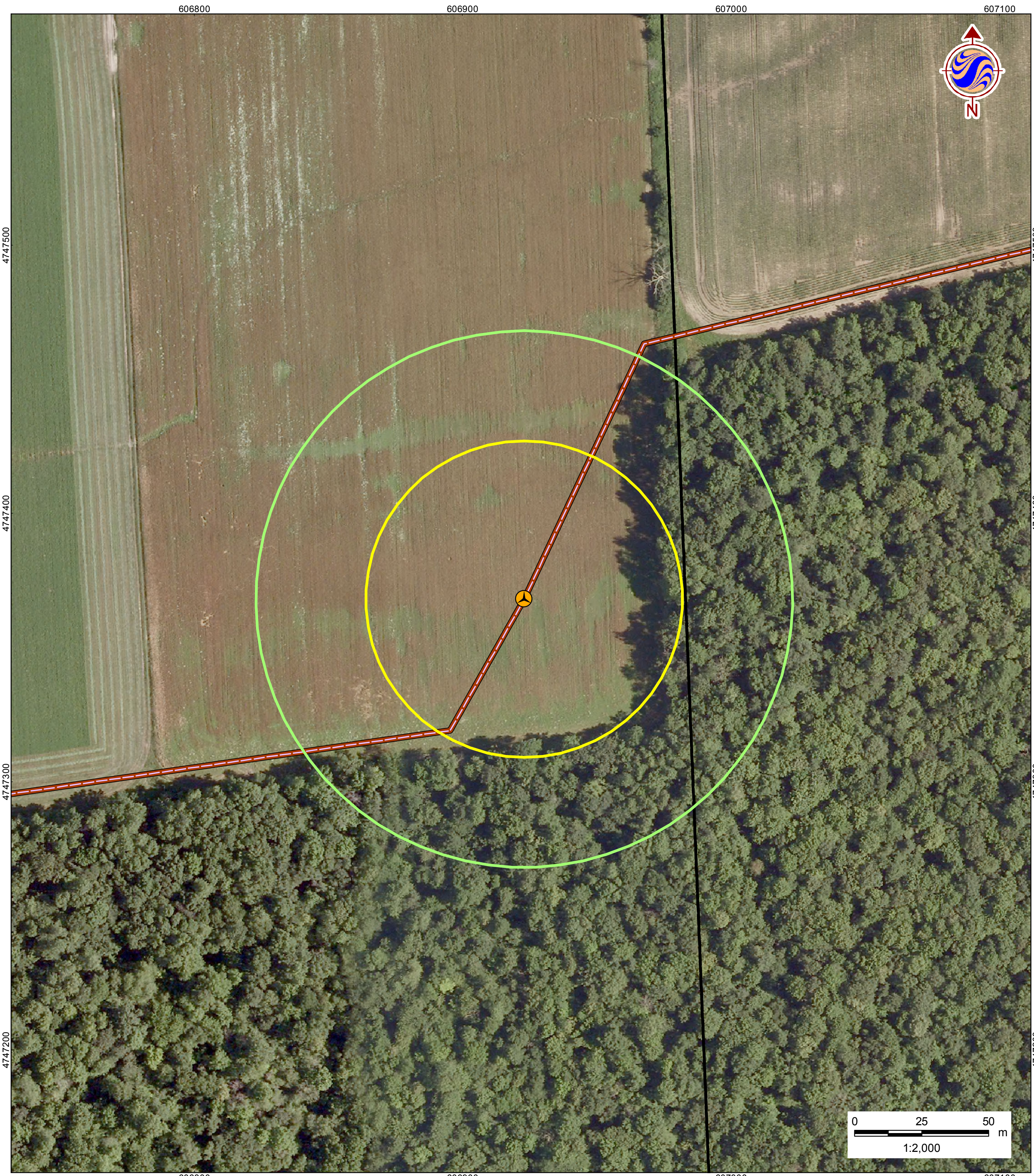
3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

Stantec

Client/Project
SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T68

Title
PROPERTY LINE ASSESSMENT



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October 2011
160960577

Legend

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3. Image Source: Image Source: © Terrapoint, 2009 - Imagery Date: July 2009; © Grand River Conservation Authority, 2010 - Imagery Date: Spring 2006.

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SAMSUNG C&T
GRAND RENEWABLE ENERGY PARK

Figure No.
T69

Title
PROPERTY LINE ASSESSMENT

Attachment B

Individual Property Line Setback Assessments

Attachment B: Property Line Assessment Summary

Turbine ID	Distance to Property Line (m)	Distance of Overlap (m)	Features Within Overlap	Potential Adverse Impacts	Preventative Measures
10	69	31	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☐ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction.
10	99	1	Infrastructure: ☐ Land Use and Businesses ☐ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
13	80	20	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
15	97	3	Infrastructure: ☒ Land Use and Businesses ☐ Hedgerows: ☐ Woodlots: ☐ Watercourses: ☐	In the unlikely event of complete turbine collapse In the direction of the road, the turbine may land within the road right-of-way.	The turbine meets the setback distance from public road rights of way, 59 metres, as prescribed in s.53 of O. Reg. 359/09. The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction.
17	82	18	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☐ Woodlots: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction.

Attachment B: Property Line Assessment Summary

Turbine ID	Distance to Property Line (m)	Distance of Overlap (m)	Features Within Overlap	Potential Adverse Impacts	Preventative Measures
			Watercourses: ☐		
18	87	13	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse or malfunction. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
21	90	10	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
24	61	39	Infrastructure: ☐ Land Use and Businesses ☐ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
28	64	36	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.

Attachment B: Property Line Assessment Summary

Turbine ID	Distance to Property Line (m)	Distance of Overlap (m)	Features Within Overlap	Potential Adverse Impacts	Preventative Measures
29	77	23	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
30	67	33	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
36	59	41	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
41	71	29	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.

Attachment B: Property Line Assessment Summary

Turbine ID	Distance to Property Line (m)	Distance of Overlap (m)	Features Within Overlap	Potential Adverse Impacts	Preventative Measures
43	59	41	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☒ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse. Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
48	61	39	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
51	60	40	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
54	61	39	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction.

Attachment B: Property Line Assessment Summary

Turbine ID	Distance to Property Line (m)	Distance of Overlap (m)	Features Within Overlap	Potential Adverse Impacts	Preventative Measures
			Watercourses: ☐		Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents.
58	60	40	Infrastructure: ☐ Land Use and Businesses ☐ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
65	66	34	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☒ Woodlots: ☒ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse. Adverse impacts to hedgerows, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse. Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction. Mitigation measures for vegetation, including damage and disturbance to related wildlife habitat, are outlined in the REA documents. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
66	81	19	Infrastructure: ☐ Land Use and Businesses ☐ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.
67	86	14	Infrastructure: ☐ Land Use and Businesses ☒ Hedgerows: ☐ Woodlots: ☐ Watercourses: ☐	Adverse impacts to agricultural land, including crop damage and soil compaction, may occur in the unlikely event of turbine collapse.	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme weather or malfunction. In the unlikely event of damage to agricultural land due to turbine collapse, landowners would be compensated by Samsung for any crop damage, and measures are outlined in the REA documents to mitigate soil compaction.
68	76	24	Infrastructure: ☐	Adverse impacts to woodlots, including vegetation damage and disturbance to related wildlife habitat, may	The turbines would be constructed and designed by professional engineers, undergo regular maintenance and monitoring by operational staff, and contain shutdown mechanisms in instances such as extreme

Attachment B: Property Line Assessment Summary

Turbine ID	Distance to Property Line (m)	Distance of Overlap (m)	Features Within Overlap	Potential Adverse Impacts	Preventative Measures
			Land Use and Businesses ☐ Hedgerows: ☐ Woodlots: ☒ Watercourses: ☐	occur in the unlikely event of turbine collapse.	weather or malfunction. Additional mitigation measures for woodlots, including vegetation damage and disturbance to related wildlife habitat, are outlined in the REA documents.

Attachment E

Stormwater Management Plan

GRAND RENEWABLE ENERGY PARK
STORMWATER MANAGEMENT REPORT

File No. 160960577
September 2011

Prepared for:

Samsung Renewable Energy Inc.
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Mississauga, ON L5R 4B2

Prepared by:

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Appendix A

1.0 Introduction

Stantec Consulting Ltd. (Stantec) has been retained to complete the design of the stormwater management (SWM) works associated with two components of the Grand Renewable Energy Park, namely the substation and operation and maintenance facilities within the solar project. The facilities are generally located east of Mount Olivet Road / Bains Road and north and south of Haldimand Road 20, respectively, as shown on Figure 1.

This report documents the SWM strategy and designs developed to mitigate against potential off-site water quality and quantity impacts associated with the development of the subject facilities, both during- and after-construction.

The SWM design approach involved the following study components:

- Complete hydrologic models for the existing and proposed conditions to determine potential negative impacts of project development, if left uncontrolled
- Finalize the SWM designs to control the site runoff in a manner consistent with current requirements (water quality and water quantity)
- Define an erosion and sediment control plan to minimize the potential for erosion and off-site transfer of sediment during construction
- Define a post-development monitoring program to confirm that implemented measures achieve the design level of treatment / control
- Outline an anticipated operation and maintenance program to be implemented by the Owners
- Summarize the study by identifying conclusions and recommendations

The primary guidance document referenced in the completion of the proposed SWM design is the Stormwater Management Planning and Design (SWMPD) Manual, Ministry of the Environment, 2003. The Natural Heritage Assessment Report (Stantec, January 2011) documented site-specific background information relating, in particular, to the characteristics of the receiving systems that was utilized in the establishment of appropriate SWM control criteria and considered in the siting of associated infrastructure.

2.0 Existing Conditions

The existing conditions of the substation and operations and maintenance (O&M) sites are similar, given the geographic proximity. As delineated on Figures 2.0 and 6.0, the drainage catchments for both facilities are relatively small and comprise primarily agricultural land use under existing conditions. The total catchment areas analyzed for the purposes of comparing with proposed development runoff conditions include 34.1 ha and 24.9 ha for the substation and O&M facilities, respectively.

The existing topography of the site is relatively flat, with slopes in the range of 0.5%, and the majority of at-surface soils comprised of a combination of Haldimand and Lincoln clays, as identified on mapping OMAFRA / MNR. Runoff curve numbers, as defined by the US Soil Conservation Service (SCS) and other hydrologic parameters were calculated for each existing catchment based on land use and soil type and are provided in Appendices B and C.

Drainage from both sites is conveyed to a tributary of Wardells Creek, though the O&M facility is more immediately adjacent to the receiver, whereas drainage from the substation facility area will be conveyed along roadside ditches and/or intermittent tributaries prior to its confluence with the more significant tributary system.

The locations of the substation and O&M facilities and/or their associated access roads receive drainage from upstream, external contributing lands that is proposed for diversion around the infrastructure area using grassed swales similar in characteristic to the existing drainage systems. Diversion of such flows minimizes the potential for unnecessary mixing of runoff from the subject sites and/or compromising the effectiveness of the proposed treatment systems. Additional discussion in this regard is provided within Section 4.

3.0 Stormwater Management Objectives / Criteria

The primary stormwater management philosophies, or fundamental principles, developed within the SWMP generally mimic those promoted by the SWMP Planning and Design Manual and reflect current standards of practice. The general approach incorporates a Best Management Practice (BMP), multi-component 'treatment train' approach and includes emphasis on at-source, conveyance, and end-of-pipe treatment controls. The following general objectives guided the development of the site SWM designs:

- Minimize the impact of post development conditions on downstream areas
- Maintain, protect, and enhance the existing watercourse function
- Maintain and preserve the quality of runoff discharge to the receiving waters

Lacking a formally established subwatershed management plan, the SWM criteria were based on an assessment of the characteristics of the receiving systems to define appropriate level of quality control, as well as typical standards of drainage and riparian rights law to define the approach to water quantity control. In this regard, the criteria proposed for implementation include:

- Provide peak flow control of runoff for the return-period events to ensure that pre-development release rates area achieved or reduced to minimize the potential for peak flow related impacts on downstream landowners
- Provide an Enhanced (formerly Level 1) degree of water quality control that aims to reduce effluent total suspended solids (TSS) concentrations by 80% through use of engineered treatment systems. While the reduction of TSS loads is also considered to achieve corresponding reductions in other contaminants, given their adsorption to the suspended particulates, consideration of spills potential at the subject facilities should also be incorporated to minimize the potential off-site of oils, greases, etc.

4.0 Proposed Conditions

The relative size and impervious coverage characteristics of the proposed collector substation and operations and maintenance (O&M) facilities, as well as their associated access roads, are such that negative impacts on stormwater quality and quantity could occur if not mitigated through the use of SWM detention/treatment systems.

4.1 SUBSTATION

The collector substation will be built to accumulate the power circuits from the wind and solar generation equipment. The substation will be located near Haldimand Road 20 and Mt. Olivet Road within the solar lands of the Project Location.

The collector substation will consist of a gravel pad area containing associated infrastructure that is 85 m by 85 m in size with an approximately 1 km long access road entering from Haldimand Rd 20. The gravel surface, traveled portion of the access road is approximately 8 m wide and is of rural cross-section, with grassed swale drainage ditches on either side. For the purposes of proposed conditions hydrologic modeling, the gravel surfaces of substation pad and access road are considered to be 100% impervious.

The delineation of the proposed drainage catchments is provided on Figure 3.0 and is summarized as follows:

- Catchment 201 – 10.62 ha of solar module fields draining to a proposed diversion swale immediately east of the access road discharging to the existing drainage ditch along Haldimand Road 20
- Catchment 202 – 18.25 ha of predominantly agricultural land (1 solar module) draining to a proposed drainage swale on the west side of the access road discharging to the existing drainage ditch along Haldimand Road 20
- Catchment 203 – 2.53 ha of the proposed substation block, proposed access road right-of-way (including grassed swale drainage ditches), and the 0.5 ha SWM block. All major and minor flows are to be conveyed to the proposed SWM facility
- Catchment 204 – 3.20 ha of external lands which are to be diverted along the east side of the proposed SWM facility to the existing drainage ditch located along Haldimand Road 20

SCS curve numbers (CNs) and hydrologic parameters were calculated for each catchment based on land use and soil type and are provided in Appendix B.

4.2 OPERATIONS & MAINTENANCE FACILITY PROPOSED CONDITIONS

The operations and maintenance facility is proposed on the south side of Haldimand Road 20 opposite the solar farm land area, just east of Mount Olivet Road / Bains Road. The building will be a prefabricated engineered structure measuring 24 m wide by 85 m long by 7 m high. It will be founded on concrete foundations that are extended below grade to below the frost line. The access road and equipment/material storage area surrounding the buildings are to be gravel-surfaced and assumed, for the purposes of hydrologic modeling herein, to be 100% impervious coverage.

A 10 m wide gravel-surfaced access road servicing the O&M facility will intersect with Haldimand Road 20 northeast of the facility, just east of a woodlot, and proceed due south and west to the building parking area. Grassed swale drainage ditches on either side will convey road runoff to the SWM facility.

The delineation of the proposed conditions drainage catchments is provided on Figure 7.0 and is summarized as follows:

- Catchment 201a – 10.9 ha of solar module field / agricultural area east of the site draining to a grassed diversion swale immediately east of the access road, discharging to the existing receiver south of the O&M facility
- Catchment 201b – 0.2 ha catchment containing the northerly 1/3 of access road (~100 m) and associated grassed swale drainage ditches
- Catchment 202a – 6.3 ha of solar module field / agricultural area east of the site draining to a grassed diversion swale immediately east of the access road, discharging to the existing receiver south of the O&M facility
- Catchment 202b - 5.8 ha containing the proposed O&M facility, the southerly 2/3 of proposed access road (including grassed swale drainage ditches), and the SWM block. All major and minor flows are to be conveyed to the proposed SWM facility
- Catchment 202c – 1.7 ha of solar module field east of the site draining to a grassed diversion swale immediately east of the O&M facility and associated SWM, discharging to the existing receiver south of the O&M facility

SCS curve numbers (CNs) and hydrologic parameters were calculated for each catchment based on land use and soil type and are provided in Appendix C.

5.0 Proposed Stormwater Management System

The proposed SWM systems include a ‘treatment train’ approach to mitigate potential impacts from the proposed land use changes in accordance with the MOE recommended hierarchy of SWM approaches, ranging in preference from lot level controls, to conveyance controls, to end-of-pipe controls. The SWM designs for both the substation and operations and maintenance facilities utilize a rural cross-section for the access roads, complete with shallow-slope grassed swale drainage ditches, and end-of-pipe detention basins. Details of all aspects of the proposed SWM systems are outlined in the following sections, with additional design information and modeling included within the Appendices. Summary tables outlining the most important design and operating characteristics for each of the SWM Facilities are provided within the following sections.

5.1 HYDROLOGIC MODELING

Hydrologic models were prepared to simulate proposed drainage conditions for the subject developments using the Stormwater Management Hydrologic Model (SWMHYMO) software. The models predicted flows for the existing and proposed development conditions and assessed the design of SWM systems within the collector substation and O&M Management Facility to ensure that the previously discussed stormwater criteria are achieved.

To assess the proposed SWM designs ability to mimic existing conditions hydrology, the

2-100 year, 3-hour Chicago storms derived using the Haldimand County IDF parameters were analyzed. The parameters used to define the design storm events are summarized on Table 1, below:

Table 1: Rainfall Events – 3-hour Chicago Storm Event Depths (Haldimand County)

Storm	Depth (mm)
1:2-year	32.7
1:5-year	47.0
1:10-year	56.5
1:25-year	68.7
1:50-year	76.9
1:100-year	86.1

Schematics of the SWMHYMO models, as well as input and output files, are appended.

5.2 SUBSTATION FACILITY

Drainage generated within this site is conveyed along approximately 1000 m of shallow-slope (~0.5%) grassed swale drainage ditches and temporarily detained within a dry end-of-pipe SWM facility before discharging to a road drainage ditch along Haldimand Road 20. Contributory drainage generated with the catchments upstream of and surrounding of the proposed substation and SWM facility will bypass the developing portions of the site as well as the SWM conveyance / treatment systems via vegetated diversion swales. All discharge (diverted or treated) is to the north ditch of Haldimand Road 20, in a manner consistent with that which occurs under existing conditions. Drainage from this system ultimately contributes to a tributary of Wardells Creek.

An impervious coverage value of 100% has been assumed for the substation pad and the 8 m wide access roads; the grassed swale drainage ditches represent an additional 2.5 m wide pervious zone paralleling either side of the access road along its entirety. Given the typically 'dry' character of the SWM facility, this area (0.5 ha) is also considered to be pervious for the purposes of the hydrologic assessment.

Additional details regarding the drainage area characteristics and SWM designs for the substation facility are provided in Appendix B.

5.2.1 Water Quality Control

The drainage outlet for the substation facility and access road is a roadside ditch along Haldimand Road 20, which eventually discharges to a tributary of Wardells Creek. In recognition of the wetland associated with the tributary downstream (near the O&M facility discharge location), the proposed grassed swale drainage ditch / dry end-of-pipe detention facility treatment train has been designed to achieve an Enhanced (formerly Level 1) degree of water quality protection, as identified within Section 3.

Scientific literature documenting the pollutant removal capabilities of grassed swales indicates widely variable results, dependent to a large extent on the design characteristics of the systems. Critical design aspects to be considered in the improvement of performance include the maximization of bottom width and swale length, and minimization of longitudinal slope, all of which improve runoff / vegetation contact and minimize flow velocities. These aspects have been incorporated into the subject design through incorporation of very long flow length (~1000 m), broad trapezoidal cross-section relative to the predicted flow rates, and shallow longitudinal slope (~0.5%) mimicking the existing topography. It can reasonably be expected that the swales will provide at least 60-70% TSS reduction.

As per the MOE design guidelines, the TSS reduction capabilities of dry, end-of-pipe SWM facilities are generally limited to approximately 60%, primarily achieved through the temporary detention of flows giving sediments an opportunity to settle out and be captured. Performance in this regard has been maximized within the subject facility design through the use of the smallest permitted quality control orifice (50 mm diameter), maximizing the detention time.

Extended detention drawdown control has been incorporated within the design to achieve the 24-hour drawdown of the 213 m3/ha volume specified by the MOE SWMPD Manual. In order to meet these criteria with such a limited contributing drainage area, the low-flow quality control orifice has been sized at 50 mm diameter (minimum permitted), providing an approximate 29-hour drawdown of the 433 m3 water quality volume.

The vegetated characteristic of dry facilities also provides sediment removal and nutrient uptake benefits. A planting strategy utilizing careful selection of plant species tolerant of a range of moisture conditions, and their strategic location in and around the basin will stabilize banks, mitigate temperature increases, deter waterfowl from nesting within the area, improve performance, and provide aesthetic and safety benefits.

Table 2: Substation Facility SWM System Water Quality Design Characteristics

General Parameters	Basin Value
Total Contributing Area to SWM Facility (ha)	2.53
Total Area to SWM Facility requiring quality control (ha)[1]	2.03
Imperviousness of Contributing Area (%)	60
Total Area of SWM Block (ha)	0.50
SWM Basin Water Quality Parameters	
Water Quality Unit Volume Requirements as per SWMPD Manual (m^3/ha)	213
Total Required Water Quality / Extended Detention Volume (m^3)	433
Extended Detention Volume Provided (m^3)	509
Peak Release Rate for MOE Extended Detention (m^3/s)	0.044
Extended Detention Drawdown Time Required (hrs)	24
Extended Detention Drawdown Time Provided (hrs)	30

Notes:
1 Drainage Area for Quality control represents total drainage area to SWMF less the area of the SWM Block itself.

5.2.2 Water Quantity Control

As outlined in Section 3.0, water quantity controls within the proposed development are required to minimize the potential for peak flow related impacts on receiving systems and downstream landowners. A dual-stage outlet structure is proposed for implementation at the dry SWM facility, as detailed on Figure 5.0. In addition to the water quality control described above, this system includes a second orifice, also contained within the perforated CSP riser structure. A detailed stage-storage-discharge analysis for the facility is provided within Appendix B. Target peak flow values and proposed post-development controlled values for the 2-100 year return-period rainfall events are provided in Table 3.

In the event of an extreme rainfall event (>1:100-year return-period) or blockage of the SWM facility outlet, flows would spill southerly to the Haldimand Road 20 ditch via a proposed rip-rap lined emergency overflow weir.

Table 3: Substation Facility SWM Quantity Control Design Characteristics

Table 3: Substation Facility SWM Quantity Control Design Characteristics

	Return-Period Event (yrs)				
	2	**5**	**10**	**25**	**100**
Existing Conditions Peak Discharge (m^3/s) [1]	0.47	0.86	1.15	1.54	2.14
Proposed Conditions Peak Discharge (m^3/s) [1]	0.43	0.80	1.07	1.43	1.98
Proposed SWM Facility Discharge (m^3/s)	0.03	0.07	0.09	0.11	0.13
Maximum Ponding Elevation (m)	199.82	199.89	199.94	199.99	200.06
Maximum Storage Volume Used (m^3)	430	620	750	940	1,240

Notes:

1 The comparison point of existing and proposed conditions peak discharge values is at the Haldimand Road 20 ditch and includes all areas for which runoff is being detained, treated, or diverted, as illustrated on Figures 2 and 3.

5.2.3 Stormwater Management Facility Design

The design of the end-of-pipe SWM facility adheres to standard principles and characteristics recommended or required by the SWMP Design Manual (MOE, 2003). The following list of design characteristics, read in conjunction with Figures 4.0 and 5.0, outlines all significant design aspects and rationales:

- The SWM basin has been designed as a dry, extended detention facility with sufficient active storage volumes to achieve a Basic (formerly Level 3) degree of protection
- Water quantity controls will be implemented to limit peak discharge rates for the return-period rainfall events (2-100 year) to existing conditions rates, as determined within the current work
- Given the proximity of access for maintenance around the entire facility, the shallow depth to pond invert, and the ‘dry’ nature of the pond bottom, generally making maintenance tasks a simpler procedure than with a ‘wet’ facility, an access road has not been incorporated into the design
- Internal side slopes of 3:1 are proposed as the safety concerns normally associated with a ‘dry’ facility are not a concern given the shallow, ‘dry’ nature of the proposed design

- The design of the required outlet structures incorporates a dual-stage configuration for control across the range of rainfall-runoff events, as outlined on Tables 3 and 4
- Operation, maintenance, and monitoring (OMM) of the stormwater management facility will be the responsibility of the Owners. Additional detailed discussion pertaining to the anticipated OMM program is provided within Section 8 of this report

Table 4: Substation Facility SWM Pond Outlet Structure Characteristics

Outlet Structure Parameter	
Water Quality Orifice Plate Diameter (within CSP Riser)(mm)	50
Extended Detention Orifice Plate Invert (m)	199.45
Quantity Control Orifice Diameter (within CSP Riser)(mm)	350
Quantity Control Orifice Invert (m)	199.65
Trapezoidal Overflow Spillway Elevation (m)	200.10
Trapezoidal Overflow Spillway Bottom Width (m)	3
Trapezoidal Overflow Spillway Side Slopes	3

5.3 O&M STORMWATER MANAGEMENT FACILITY

Drainage generated within this site is conveyed via shallow-sloped (~0.5%) grassed swale drainage ditches and temporarily detained within a constructed wetland end-of-pipe SWM facility. Contributory drainage generated with the catchments upstream of and surrounding of the proposed O&M facility and SWM facility will bypass the developing portions of the site as well as the SWM conveyance / treatment systems via vegetated diversion swales. All discharge (diverted or treated) is to an existing drainage draw that conveys flows to a tributary of Wardells Creek, in a manner consistent with that which occurs under existing conditions.

An impervious coverage value of 100% has been assumed for the O&M building/parking area and the 10 m wide access road; the grassed swale drainage ditches represent an additional 5 m wide pervious zone paralleling either side of the access road along its entirety. Given the permanent pool proposed within the wetland SWM facility, this block is assumed to be 50% ‘impervious’ for the purpose of assessing hydrologic characteristics.

Additional details regarding the drainage area characteristics and SWM designs for the O&M facility are provided in Appendix C.

5.3.1 Water Quality Control

The O&M SWM facility has been designed as a constructed wetland with an average permanent pool depth of 0.3 m within the wetland component of the facility. Constructed wetlands offer the dual benefits of dilution and settling of sediment within the forebay and the wetland components of the facility, with the added benefit of biological removal of pollutants (i.e., nutrient uptake) via the wetland plantings. Careful selection of plant species and their location in and around each basin helps stabilize banks, mitigate temperature increases, deter waterfowl from nesting within the area, improve performance, and provide aesthetic and safety benefits.

A sediment forebay has been provided at the inlet to the O&M facility and is designed with a maximum depth of 1.5 m. The design depth is that anticipated immediately following construction and after sediment clean-out operations. The minimum design operating depth of 1.0 m is that which follows a period of sediment collection to 0.5 m depth, and coincides with the point immediately prior to the required clean-out operations. Maintenance of at least 1.0 m of permanent pool in the forebay at all points in the sediment accumulation / clean-out cycle minimizes the potential for scour and re-suspension of previously settled sediments.

It is noted that the proposed forebay area exceeds the MOE recommended design criterion of

≤ 20% of the total permanent pool surface area. The primary rationale for that design criterion, however, reflects the fact that the volumetric sizing criteria for constructed wetland-type facilities relies on the wetland vegetation component of the facility to provide the majority of the water quality treatment functions. In other words, it is contrary to the design sizing guidance to utilize deep water areas, such as those in forebays, to achieve the volumetric storage requirements established as appropriate for constructed wetland facilities. Within the current design, the permanent pool volumetric sizing requirements, as defined by the SWM Planning and Design Manual (MOE, 2003), are achieved within the wetland component of the facility without accounting for the storage volume provided within the forebay. It is concluded, therefore, that the proposed facilities achieve the target of the MOE in this regard.

Specifics of the SWM facility design characteristics pertaining to the provision of water quality treatment are summarized on Table 5.

Table 5: O&M SWM Facility Water Quality Design Characteristics	
General Parameters	
Total Contributing Area to SWM Facility (ha)	6.0
Imperviousness of Contributing Area (%)	50%
Surface area of Permanent Pool (ha)	2,813
SWM Basin Water Quality Parameters	
Forebay Invert Elevation (m)	195.80
Water Quality Volume Requirements as per SWMPD Manual (m^3/ha)	99
Total Required Water Quality Volume (m^3)	594
Required Extended Detention Volume (m^3)	240
Extended Detention Volume Provided (m^3)[2]	289
Required Permanent Pool Volume (m^3)	353
Permanent Pool Volume Provided (Total – above sediment storage) (m^3)[2]	1,078
Permanent Pool Volume Provided within wetland component alone (m^3)[2]	546
Peak Release Rate for Extended Detention (Quality Control) (m^3/s)	0.003

Table 5: O&M SWM Facility Water Quality Design Characteristics	
Extended Detention Drawdown Time (Quality Control) (hrs)	27
Forebay Parameters	
Required Forebay Length (m)	6
Actual Forebay Length (m)	30
Sediment Storage Volume Provided (m^3)	90
Clean-Out Frequency (yrs)	12

5.3.2 Water Quantity Control

As outlined in Section 3.0, water quantity controls within the proposed development are required to minimize the potential for peak flow related impacts on receiving systems and downstream landowners. A dual-stage outlet structure is proposed for implementation at the SWM facility, as detailed on Figure 9.0. In addition to the water quality control described above, this system includes a second orifice, also contained within the perforated CSP riser structure. A detailed stage-storage-discharge analysis for the facility is provided within Appendix C. Target peak flow values and proposed post-development controlled values for the 2-100 year return-period rainfall events are provided in Table 6.

In the event of an extreme rainfall event (>1:100-year return-period) or blockage of the SWM facility outlet, flows would spill to the receiving drainage system via a proposed rip-rap lined emergency overflow weir.

Table 6: O&M SWM Facility Quantity Control Design Characteristics					
	Return-Period Event (yrs)				
	2	**5**	**10**	**25**	**100**
Existing Conditions Peak Discharge (m^3/s) [1]	0.41	0.76	1.03	1.39	1.94
Proposed Conditions Peak Discharge (m^3/s) [1]	0.32	0.63	0.85	1.15	1.60
Proposed SWM Facility Discharge (m^3/s)	0.03	0.08	0.10	0.12	0.15
Maximum Ponding Elevation (m)	197.65	197.78	197.88	198.01	198.20
Maximum Storage Volume Used (m^3)	1,090	1,550	1,900	2,400	3,160

5.3.3 Stormwater Management Facility Design

The design of the end-of-pipe SWM facility adheres to standard principles and characteristics recommended or required by the SWMP Design Manual (MOE, 2003). The following list of design characteristics, read in conjunction with Figures 8.0 and 9.0, outlines all significant design aspects and rationales:

- The facility has been designed as a constructed wetland with sufficient permanent and active storage volumes to achieve an Enhanced (formerly Level 1) degree of protection, in recognition of the Provincially Significant Wetland (assumed) present within the valley of the receiving watercourse

- Water quantity controls have been incorporated to provide extended detention for erosion control and to limit peak discharge rates for the return-period rainfall events (2- to 100-year) to existing conditions flow values

- Anticipated clean-out frequencies for the facility's forebay, as summarized in Table 5, is 12 years

- The design of the outlet structure incorporates a dual-stage configuration for flow control across the range of rainfall-runoff events, as outlined on Table 7

- Design permanent water depths within the forebays are set at 1.5 m and are anticipated to be present immediately after construction and following future sediment clean-out procedures. The provision of 1.5 m depth within the forebay allows for 0.5 m sediment accumulation prior to recommended clean-out while maintaining 1.0 m of permanent pool storage, thereby minimizing the risk of scour and re-suspension of previously settled sediments throughout the deposition / clean-out cycle

- Operation, maintenance, and monitoring (OMM) of the stormwater management facilities will be the responsibility of the Owners. Additional detailed discussion pertaining to the anticipated OMM program is provided within Section 8.0 of this report.

Table 7: O&M SWM Facility Outlet Structure Characteristics

Outlet Structure Parameter	
Water Quality Orifice Plate # 1 Diameter (within CSP Riser)(mm)	75
Water Quality Orifice Plate # 1 Invert (m)	197.30
Quantity Control Orifice Plate # 2 Diameter (within CSP Riser)(mm)	300
Quantity Control Orifice Plate # 2 Invert (m)	197.50
Trapezoidal Overflow Spillway Elevation (m)	198.20
Trapezoidal Overflow Spillway Bottom Width (m)	5
Trapezoidal Overflow Spillway Side Slopes	5

6.0 Erosion and Sediment Control

In order to control erosion and transportation of sediment off-site, an Erosion and Sediment Control Plan (ESC) has been developed and will be implemented during the construction process. The plan focuses on the protection of downstream receivers, namely the adjacent wetland units and receiving watercourses.

The Greater Golden Horseshoe Conservation Authorities Erosion and Sediment Control Guideline for Urban Construction (2006) document was used to determine the erosion potential of the site. Those factors affecting the erosion potential of a given site considered in the assessment include slope gradient, slope length, and soil texture. The relative magnitude of erosion potential guides the development of an appropriate erosion control strategy.

Existing conditions gradients on the subject lands can be summarized as generally gentle

(< 2%) with predominantly long slope lengths (greater than 30 m). Site soils are comprised primarily of Haldimand and Lincoln clays, which are considered to represent a low erodibility potential. Finally, the potential for negative impact on the receiving systems should sediment be transported off-site during construction, should be considered. In the case of the subject lands, the potential for impact on the receiving natural systems is high. In consideration of all of the evaluation parameters described above, the overall erosion potential for the site is considered to be “moderate”.

Most of the various construction activities will result in the disturbance of at-surface soils to various extents, ranging from construction traffic to topsoil stripping and/or grading activities involving cutting or filling, all of which expose the underlying earth to potential erosion and sediment transport to off-site locations. In all instances where the potential for erosion is identified a series of control measures will be implemented including, but not limited to:

- Erect silt fence before grading begins on the downstream side of the area to be graded to protect the downstream lands from potential sediment transport that may be entrained in overland flows.
- Provide a construction entrance feature (“mud mat”) at all site entrances to minimize the transport of sediment on construction vehicle tires
- Direct runoff via swales and erosion control berms (where necessary) to sediment control measures to ensure that no untreated runoff is discharged from the site.
- Utilize the proposed end-of-pipe SWM facilities as temporary sediment control measures.

- Install temporary rock check dams in swales where appropriate to help attenuate flows, reduce erosive velocities, and encourage sediment deposition
- Immediately stabilize all disturbed areas not subject to construction activities within 30 days, according to OPSS 572.
- In order to ensure the effectiveness of the various erosion and sediment control measures, an appropriate inspection and maintenance program is necessary. The inspection activities will include:
- Inspection of the erosion and sediment controls after each significant rainfall event or weekly, whichever is more frequent
- Inspections should include all silt fence installations, rock-check dams, the sediment control facility, outlets and vegetation
- Submission of regular monitoring results to the LPRCA during active construction periods

7.0 Monitoring Program

The proposed monitoring program includes detailed monitoring requirements for the during-construction and post-construction stages of development. Within each stage of the program, monitoring requirements with respect to water quality and quantity have been detailed.

7.1 DURING-CONSTRUCTION MONITORING

Grading and servicing activities constitute the during-construction monitoring stage within which the minimization of potential stormwater impacts is primarily concerned with the control of erosion and off-site transport of sediment.

In addition to the erosion and sediment control inspections discussed in Section 6, the following elements will be monitored and documented during the construction period:

i. The general condition of the discharge point from the SWM facilities

ii. The stability of the SWM facilities embankment slopes and the condition of plantings

iii. The performance and sedimentation levels within the SWM facilities

An annual report will be submitted to the LPRCA summarizing the monitoring results and will make appropriate recommendations for future monitoring if necessary.

7.2 POST-CONSTRUCTION MONITORING

Implementation of a post-construction monitoring program provides the data necessary to assess that the SWM system is functioning as designed and achieves the target control values for treatment. Within the current study, the post-construction period is defined as the two-year period after construction and stabilization of the associated infrastructure (substation, O&M facility, and associated access roads).

The monitoring of SWM facility performance will represent a key component of the post-construction period program, with an objective of confirming the operational characteristics predicted as part of the design process, identifying any discrepancies, and implementing remediative approaches in the event that such are required. Operational inspections will focus on the surface water quantity and quality characteristics of the facilities. Monitoring of inflow and outflow conditions during and immediately after rainfall events, combined with observations of water level fluctuations, will confirm hydrologic characteristics of the contributing catchment area and SWM facility response to the associated runoff. Laboratory testing of grab samples obtained at the inlet and outlet of the SWM facilities on a quarterly basis will confirm pollutant removal characteristics. Water quality parameters to be tested include TSS, TP, DO and E.coli.

Concurrent with the grab sampling / laboratory analysis testing program, in situ air and water temperatures will also be recorded.

Further to the operational characteristics, inspections and monitoring of the general condition of stormwater management infrastructure is discussed in detail in the following section, dealing with operations and maintenance.

Annual reports will be submitted to the LPRCA summarizing the monitoring results and will make appropriate recommendations for future monitoring if necessary.

8.0 Operations and Maintenance Program

The ability of any SWM practice to continue functioning as designed relies on the development and implementation of an operations and maintenance program. While the following sections outline the details of the program components anticipated at the time of design, the adoption of a broader adaptive management philosophy acknowledges the potential for refinement of the program to reflect actual field observations recorded as part of the monitoring program, described in the previous section.

The various components of the stormwater systems proposed for implementation within the Grand Renewable Energy Park are typical of standard practice and represent straightforward activities. Typical SWM measures incorporated within the proposed strategy include the use of grassed swale (ditch) conveyance systems as well as dry and constructed wetland end-of-pipe quality / quantity control facilities.

8.1 GRASSED SWALE (DITCH) CONVEYANCE SYSTEMS

Grassed swale (ditch) conveyance systems represent a familiar, passive, and simple type of stormwater management practice, with operational and maintenance requirements to match. Generally speaking, the treatment benefits of a grassed swale are the result of the contact between the flows being conveyed and the vegetation within the swale. Given this, inspection, operational, and maintenance activities can be generally limited to:

- Routine observations as to the presence of trash/debris within the swale that could be conveyed downstream and/or affect the conveyance capacity of the system and removal of same as needed.

- For the first two years following construction, a semi-annual walking inspection should be completed to identify areas of bare soil and/or the formation of erosive gullies (annually thereafter). Remediative efforts would typically involve re-grading the area and/or re-vegetating with sod or appropriate seed mix, with fertilizer and water applied as necessary to ensure germination and stabilization.

- Concurrent with the walking inspections, a visual assessment of any areas of isolated ponding or sediment build-up should be identified. Minor areas of ponding can be resolved with re-grading / re-stabilization, if the magnitude of associated nuisance warrants such action. From a stormwater management perspective, there are no functional concerns associated with ponding and, therefore, remediation is not strictly required. Excessive sedimentation is an issue requiring attention if it remains in a non-vegetated condition and is, therefore, prone to re-suspension and transport downstream, if it creates an isolated ponding area as described above, or if it occurs to an extent that it impacts on the conveyance capacity of the swale. If any such condition occurs, the sediment should be removed and the area re-stabilized.

- Vegetation management is not a strict requirement in that excess growth will serve to improve water quality treatment benefits. If the density of vegetation reaches a level where conveyance capacity is impacted, a cutting operation should be undertaken. A minimum vegetation height of 0.15 m (6”) should be maintained.

8.2 END-OF-PIPE STORMWATER MANAGEMENT FACILITIES

Long-term operation and maintenance responsibilities at end-of-pipe SWM facilities include regular facility inspections and the implementation of associated remediative actions. For the first two years following construction, inspections should be undertaken following each significant rainfall event (averaging approximately 4 inspections / year) to gain confidence that the facilities are functioning as designed. Following this period, the frequency of inspections can be reduced to an annual or as-needed basis.

The types of information that operations staff should be recording and rectifying, if required, include questions such as:

- Are the regular pond levels above the permanent pool elevation after the predicted extended detention drawdown times outlined herein? This situation could be indicative of outlet blockage by trash or sediment; visual inspection should be completed to confirm.

- Within a ‘wet’ SWM facility, such as the constructed wetland SWM facility proposed as part of the O&M infrastructure design, pond levels should be assessed to determine if they are lower than the normal permanent pool elevation. Such a condition could be indicative of a blockage of the inlet or leakage through the pond’s invert; visual inspection of inlet should be completed to confirm clear passage. Given the predominantly clay characteristic of on-site soils at location of the subject facility, significant leakage is not anticipated. Weather conditions in the days and weeks leading up to the inspection should also be considered as evaporative losses during a hot, dry spell could be significant.

- Is there damage to facility structures including headwalls, pipes, berms, maintenance accesses, etc.? Maintenance requirements in this regard should be performed on an as required basis.

- What are the visual characteristics of water in the facilities (i.e., oily sheen, frothy, colour, etc.)? Issues in this regard could be indicative of an upstream spill and the need for cleanup.

- Is the vegetation around the facilities unhealthy or dying? Are there areas around the ponds with easy access to open water? Deficiencies in this regard could be indicative of either poor species selection at design, or any number of chronic causes. Lack of vegetation, particularly around the water’s edge, increase attractiveness and use by waterfowl, often leading to degradation in effluent water quality (i.e., increased bacteria loadings). Replanting should be undertaken to ensure sufficient vegetation densities.

- Sediment depth and oil accumulation within the forebay or main cell. Within a 'wet' facility, sediment depth can be measured with a graduated pole at a standardized location (can be identified with a marker that is left in the facilities). Sediment should be removed when the permanent pool depth is reduced to 1.0 m within the forebay areas. Owing to the increased sediment loadings anticipated during construction, the clean-out frequencies estimated during the design process might be reduced during the interval prior to complete stabilization of the upstream contributing drainage areas. In any event, the removal and disposal of sediment from all facilities should be completed by a qualified party and/or licensed contractor.
- Erosion around outlet structures or downstream areas requiring stabilization work. All noticeable erosion and damage within and immediately outside the basin should be repaired and stabilized as quickly as possible.
- Draining of the O&M SWM facility will be accomplished through pumping when maintenance is required.

9.0 Conclusions

Based on the preceding report, it is concluded that the proposed SWM strategies for the substation and operations and maintenance facility sites are appropriate for the provision of required water quality and quantity control. Stormwater management approaches including diversion swales designed to route flows from external drainage areas around the proposed facilities, grassed swale drainage ditch conveyance systems, and end-of-pipe stormwater management basins (dry and constructed wetland type for the substation and O&M facilities, respectively) provide:

- Enhanced (formerly Level 1) degree of water quality protection
- Water quantity controls to ensure that discharge to the proposed conditions peak flow discharge rates to the receiving systems are at or below those predicted for the same rainfall events under existing conditions

Site topography, native soils, slope lengths, and the relative sensitivity of adjacent areas and downstream receivers are such that the site is considered to represent a 'moderate' erosion potential. In recognition of such conditions, an ESC strategy that utilizes a multi-component approach aimed at minimizing erosion potential across the graded site and providing a series of sediment control measures to maximize on-site capture of any eroded material has been developed.

During-Construction and Post-Construction Monitoring Programs will be implemented to record data to ensure that they are functioning as designed and achieving the required levels of control. Following an adaptive management approach, the monitoring work programs will continue to evolve, as necessary, in consultation with the respective agencies (LPRCA, MOE), as information is compiled.

All of which is respectfully submitted.

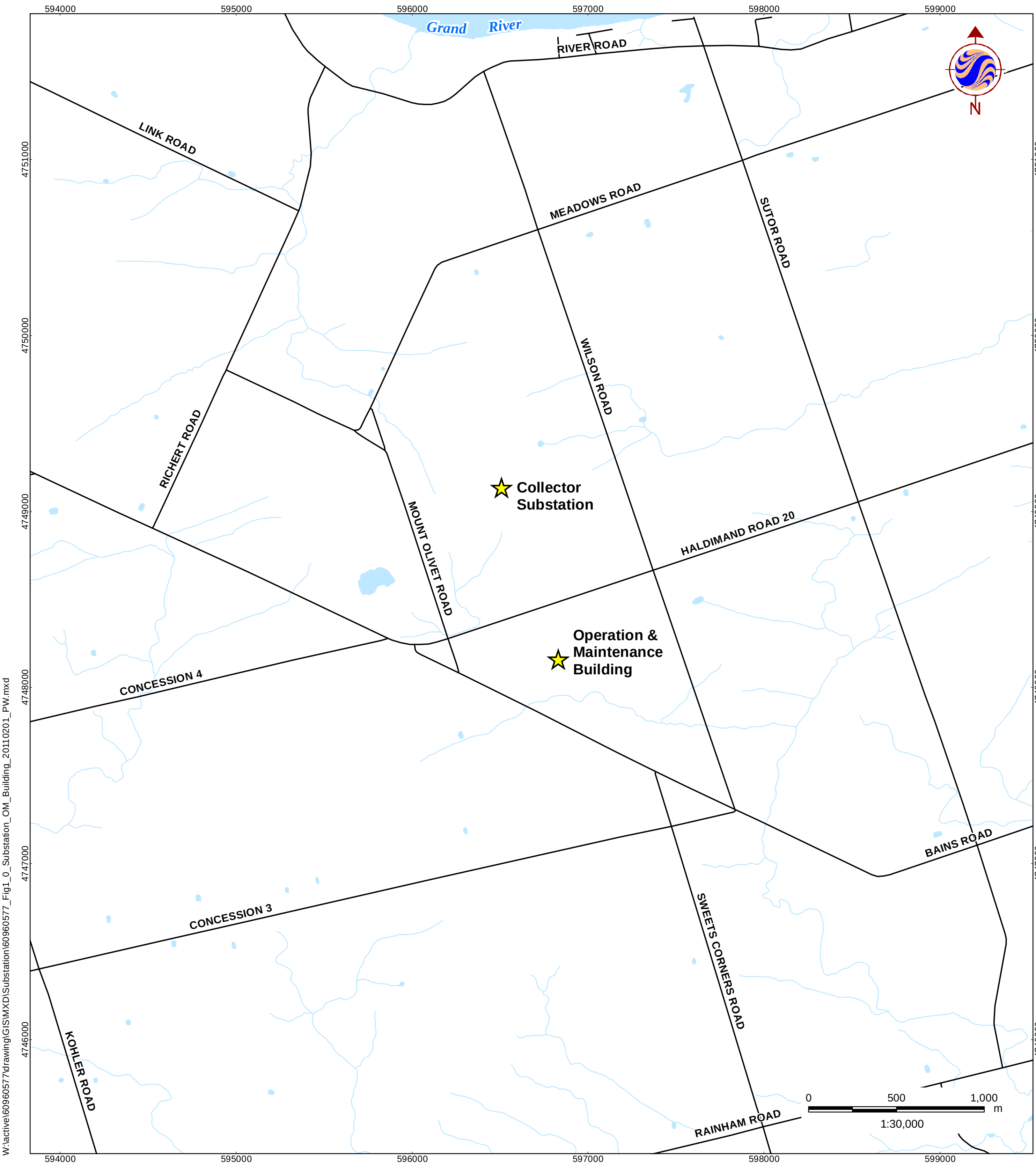
STANTEC CONSULTING LTD.

LICENSED PROFESSIONAL ENGINEER
S. A. ROBERTSON
30. SEPT. 2011
PROVINCE OF ONTARIO

Scott Robertson, P.Eng.
Associate, Water Resources Project Manager

APPENDIX A

FIGURES



February 2011
160960577

Legend

- ★ Electrical Transmission Component
- Road
- Watercourse
- Waterbody

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queens Printer Ontario, 2011; © Samsung, 2011.
3. Image Source: © Terrapoint, 2011 - Imagery Date: July 2009; Grand River Conservation Authority © First Base Solutions, 2011 - Imagery Date: Spring 2006.

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

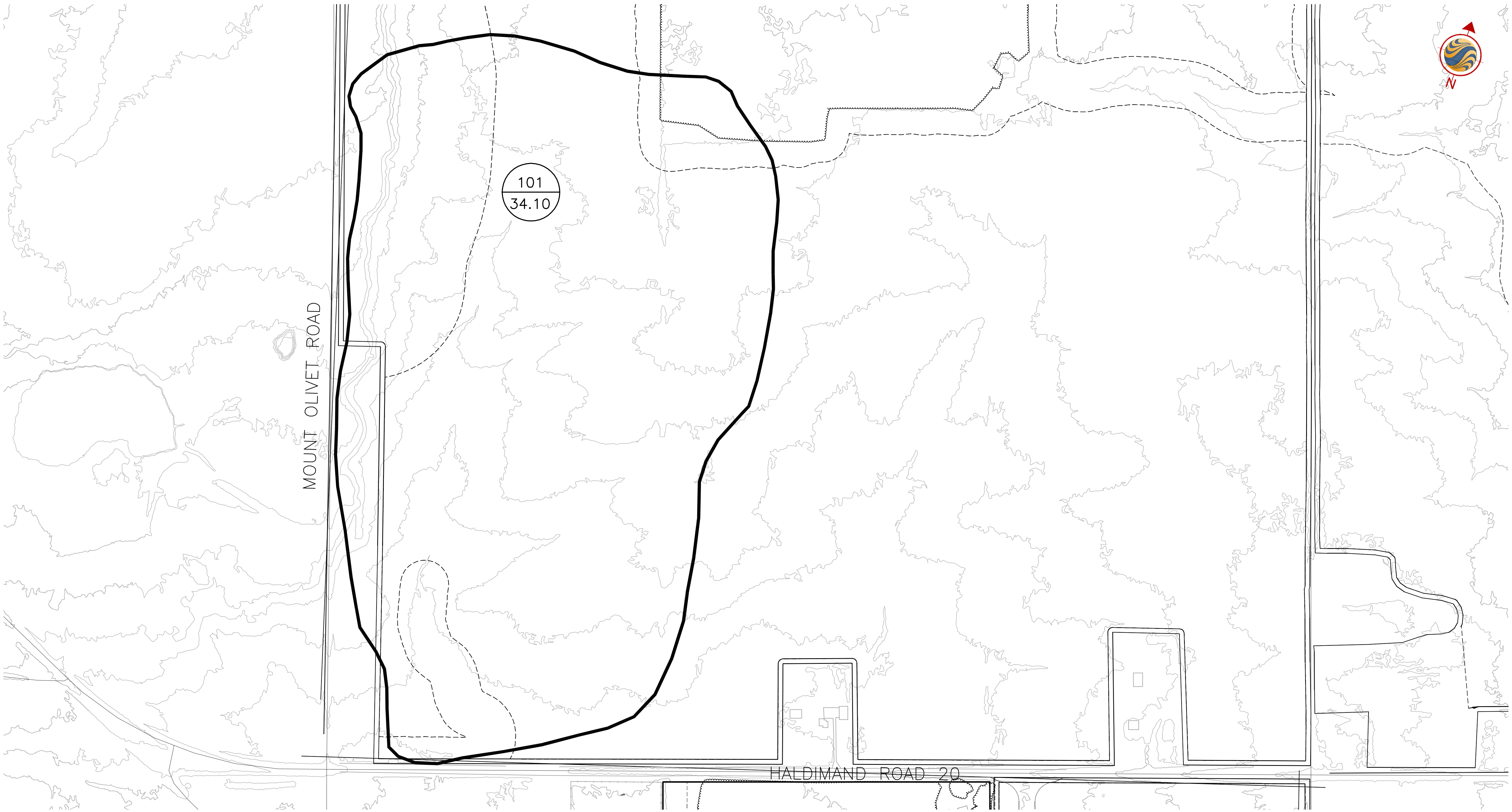
Figure No.

1.0

Title

LOCATION MAP

Stantec



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Legend

101 DRAINAGE CATCHMENT NUMBER

34.10 CONTRIBUTING AREA (ha)

DRAINAGE CATCHMENT BOUNDARY

1:5000 — 0, 50, 150, 250m

Client/Project
SAMSUNG RENEWABLE ENERGY INC.
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
2.0

Title
EXISTING CONDITIONS DRAINAGE PLAN - SUBSTATION FACILITY

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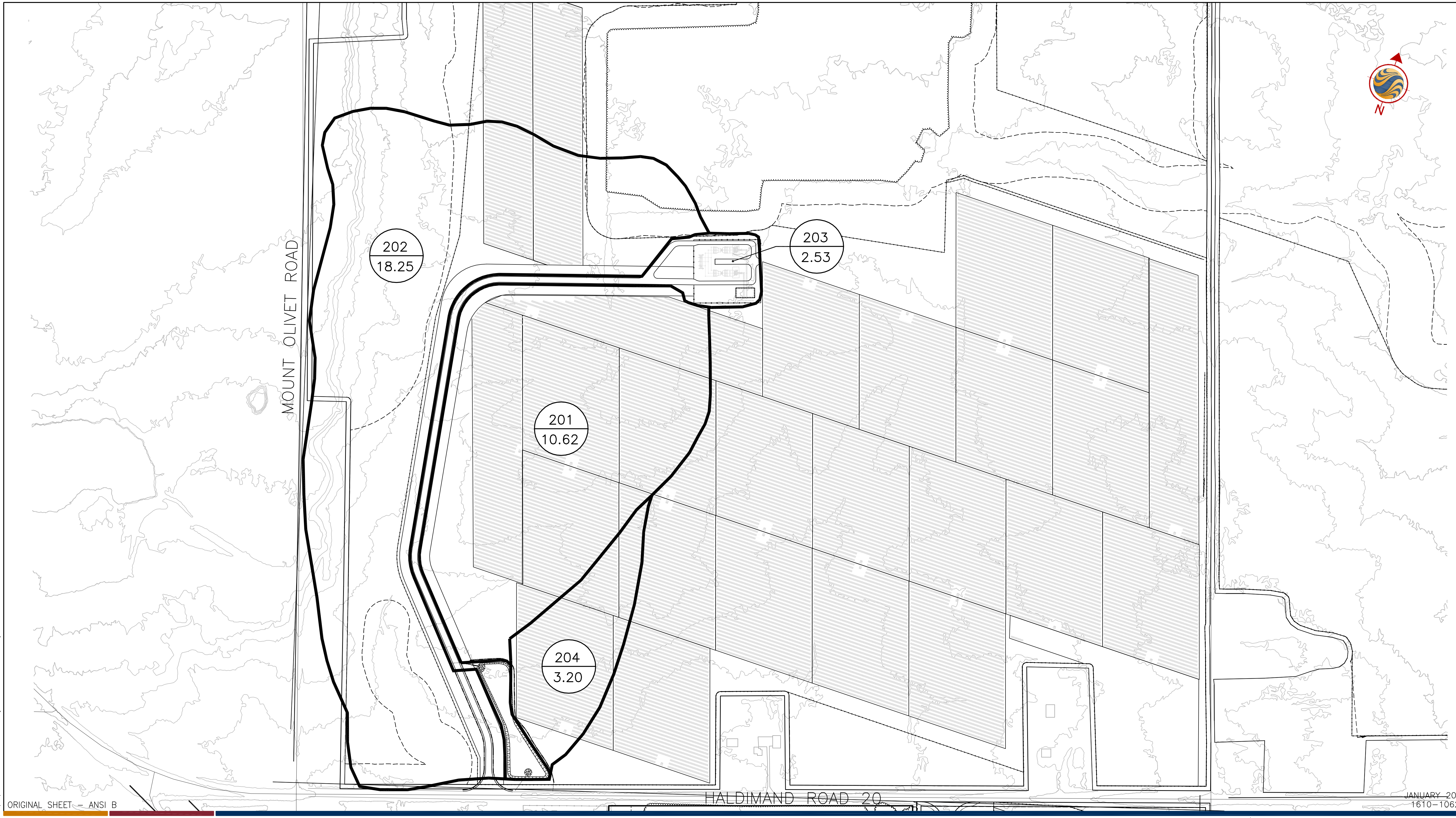

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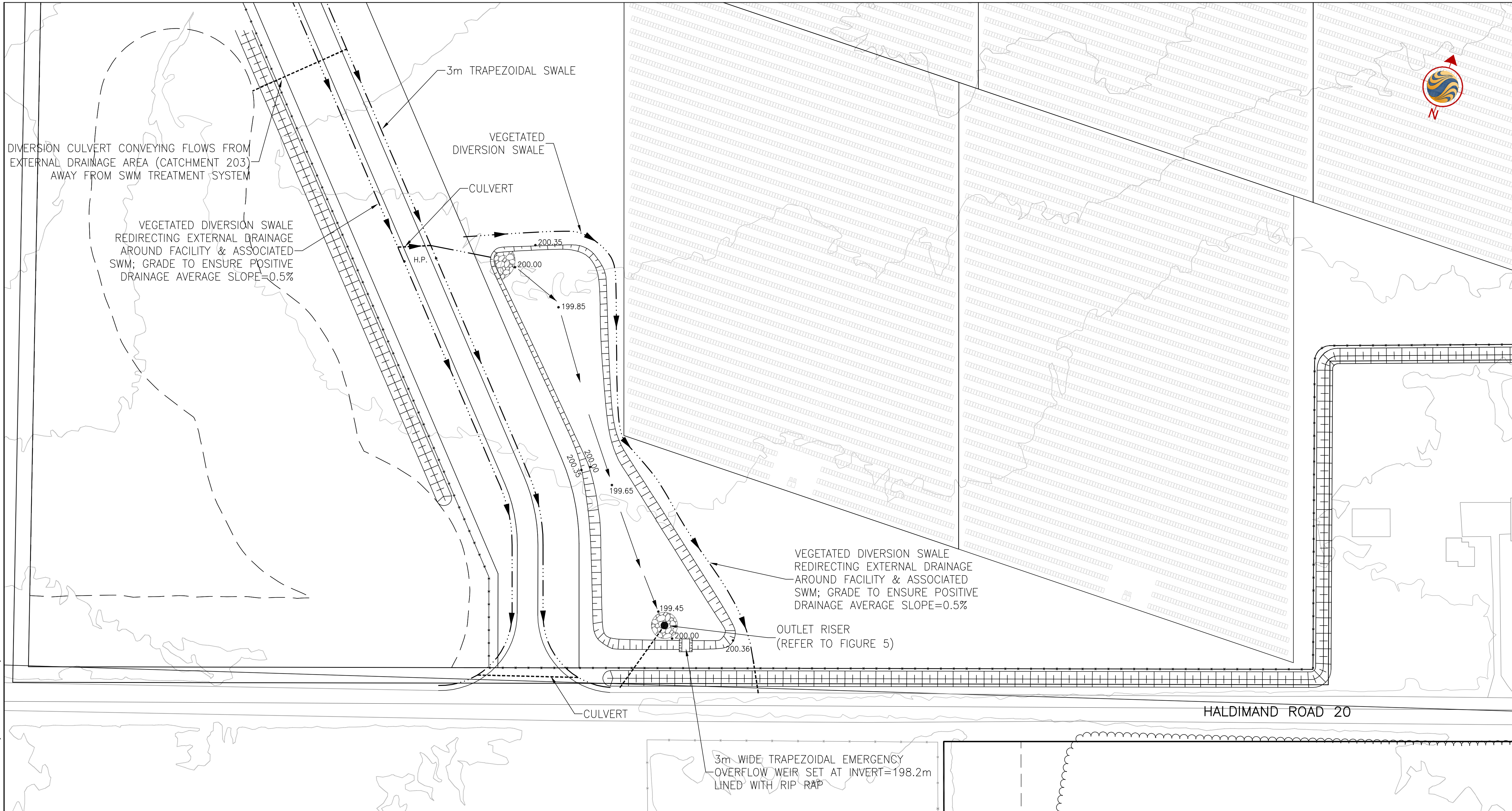
201	DRAINAGE CATCHMENT NUMBER
10.62	CONTRIBUTING AREA (ha)
(line)	DRAINAGE CATCHMENT BOUNDARY

0 50 150 250m
1:5000

Client/Project
SAMSUNG RENEWABLE ENERGY INC.
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
3.0

Title
PROPOSED CONDITIONS DRAINAGE PLAN - SUBSTATION FACILITY



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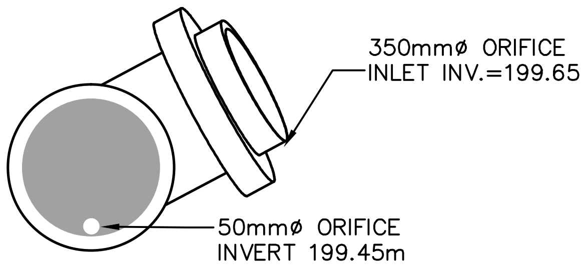
SLOPE (3:1 UNLESS NOTED OTHERWISE)
200.00 ELEVATION
200.0 CONTOUR
SWALE

1:1500 0 15 45 75m

Client/Project
SAMSUNG RENEWABLE ENERGY INC.
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
4.0

Title
SUBSTATION SWM FACILITY - PLAN VIEW



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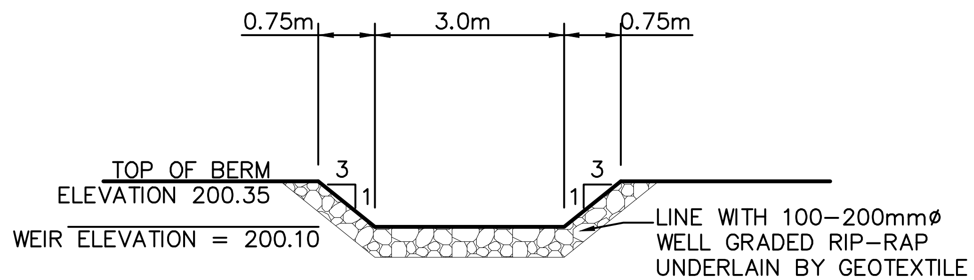

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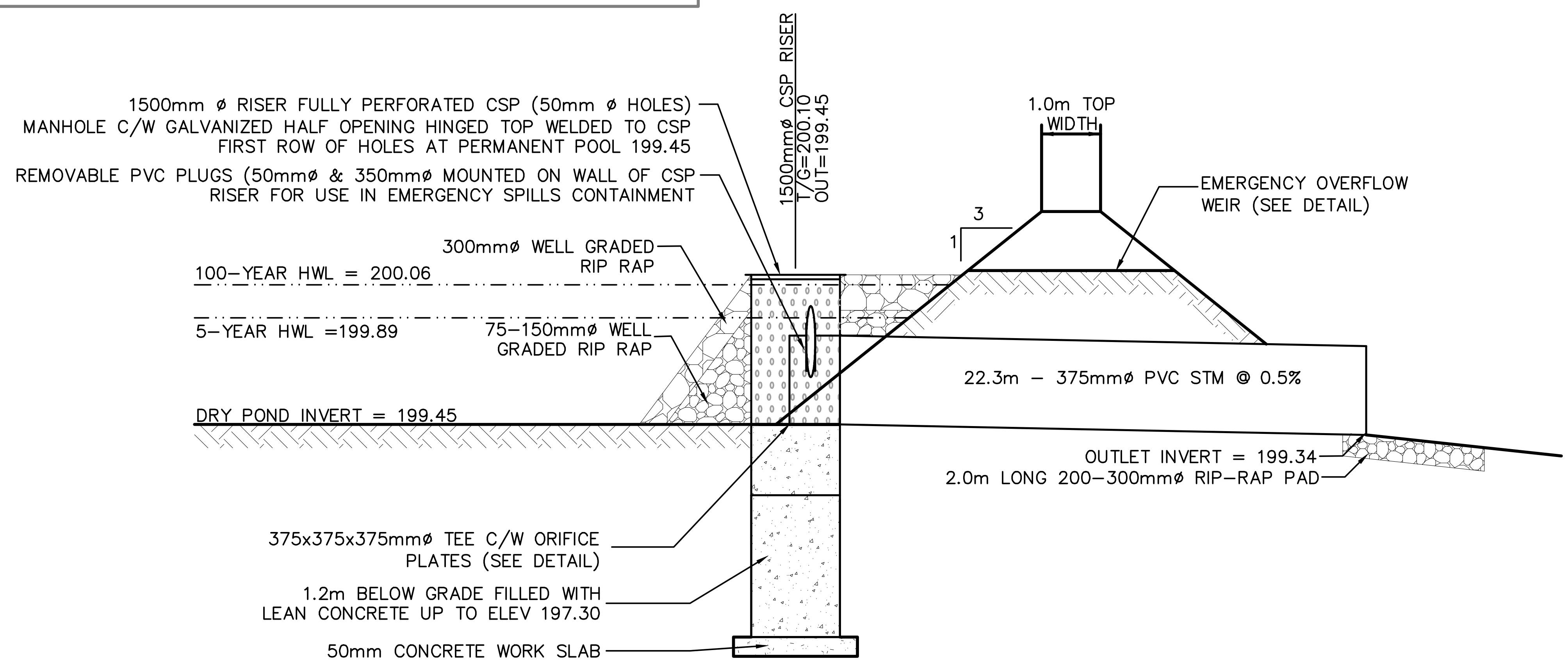

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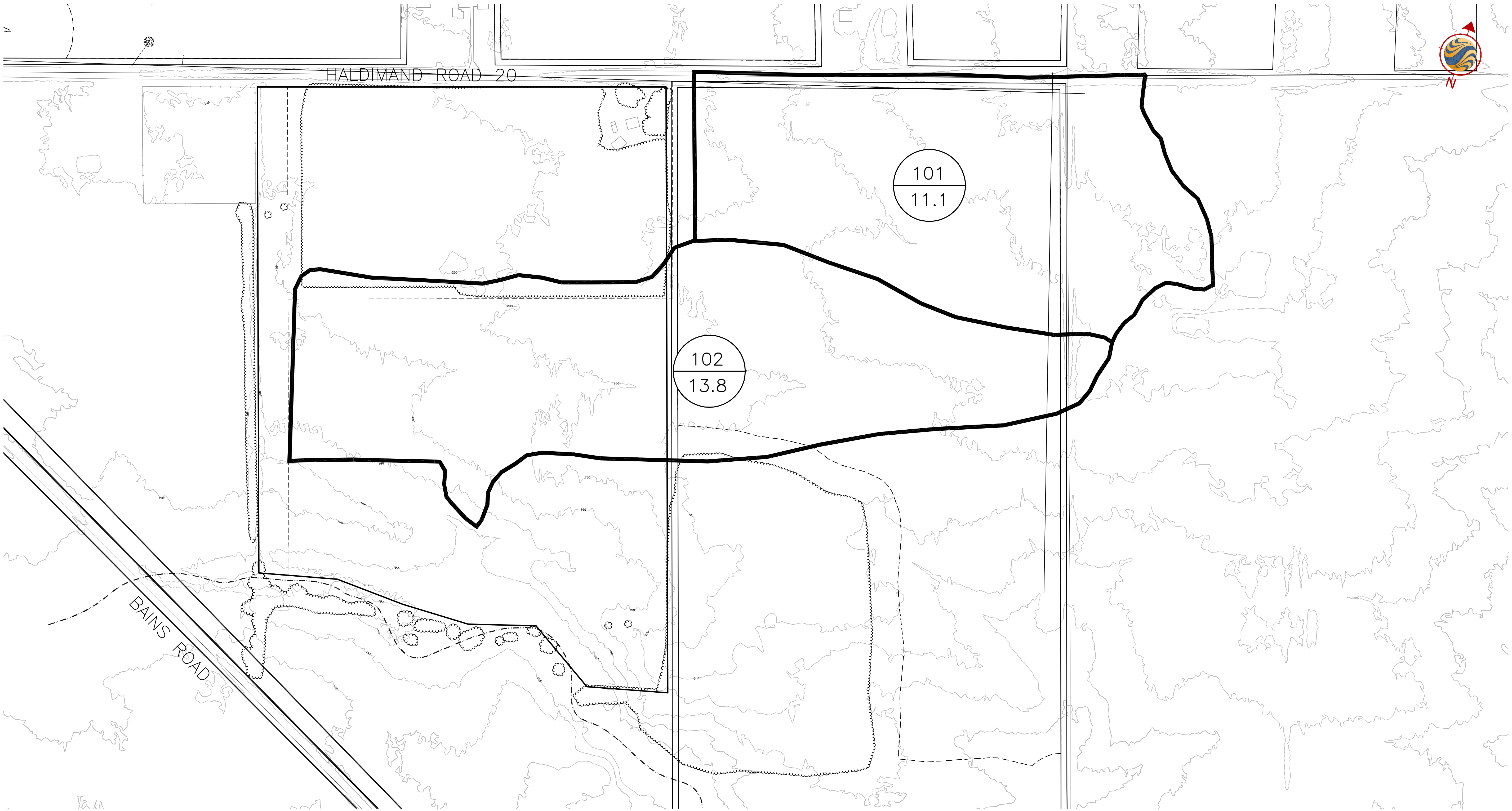
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
5.0

Title
SUBSTATION SWM FACILITY -
OUTLET PROFILE AND DETAILS



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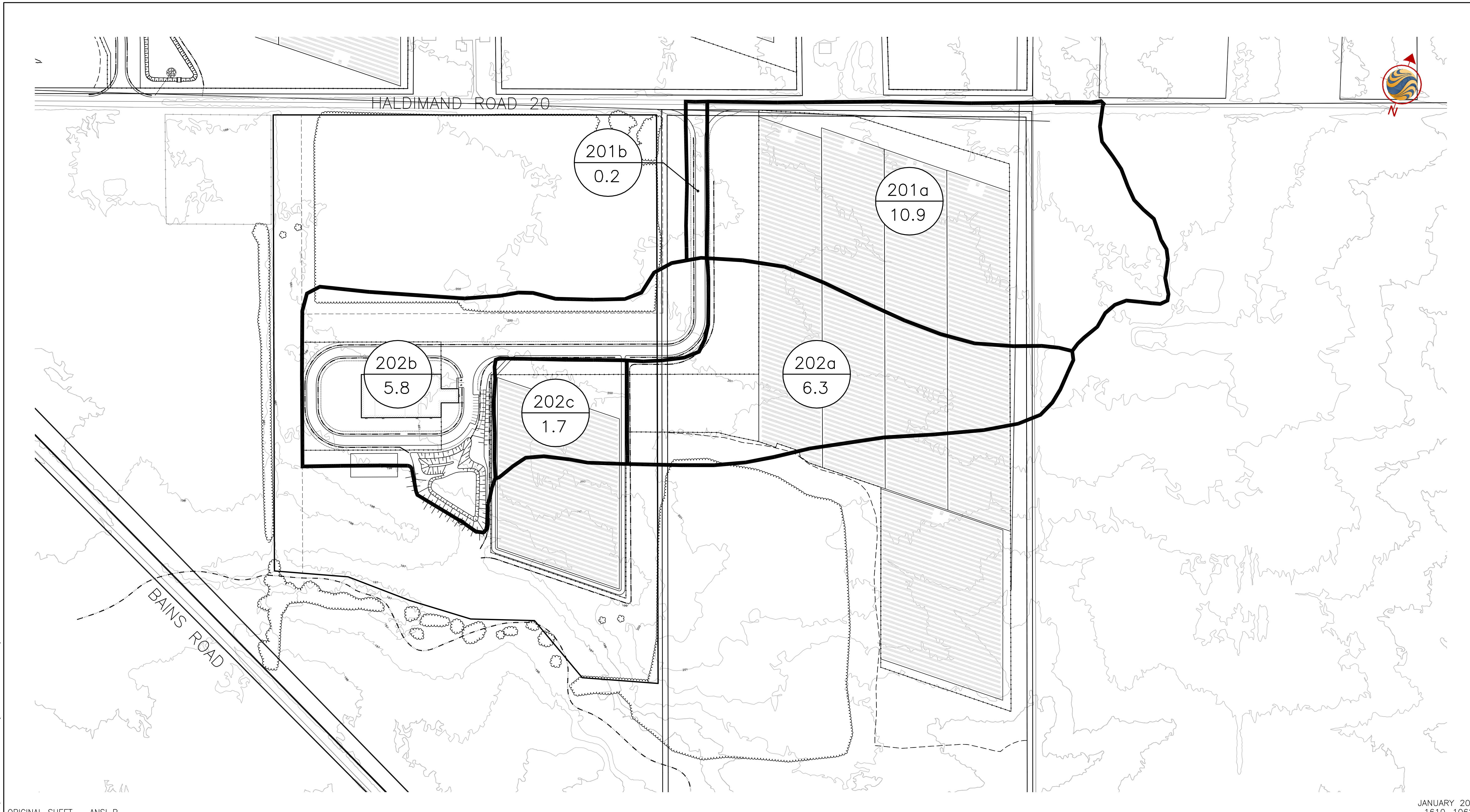
102	DRAINAGE CATCHMENT NUMBER
13.8	CONTRIBUTING AREA (ha)
(thick line)	DRAINAGE CATCHMENT BOUNDARY

1:4000 — 0, 40, 120, 200m

Client/Project
SAMSUNG RENEWABLE ENERGY INC.
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
6.0

Title
EXISTING CONDITIONS DRAINAGE PLAN - O & M FACILITY



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201a / 10.9 — DRAINAGE CATCHMENT NUMBER / CONTRIBUTING AREA (ha)

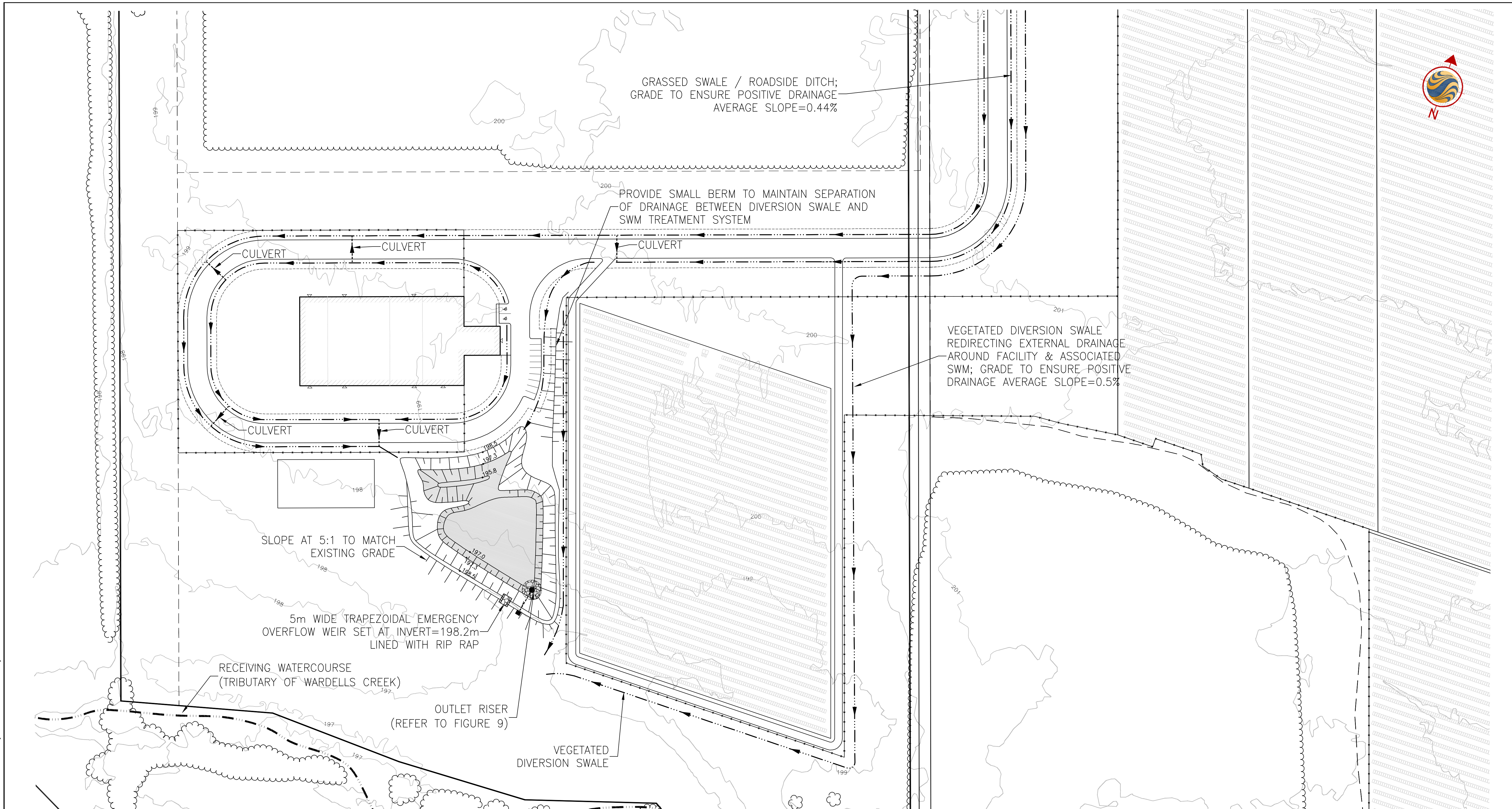
DRAINAGE CATCHMENT BOUNDARY

1:4000 — 0, 40, 120, 200m

Client/Project
SAMSUNG RENEWABLE ENERGY INC.
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
7.0

Title
PROPOSED CONDITIONS DRAINAGE PLAN - O & M FACILITY



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SLOPE (5:1 UNLESS NOTED OTHERWISE)
200.00 ELEVATION
200.0 CONTOUR
SWALE

1:2000 — 0 20 60 100m

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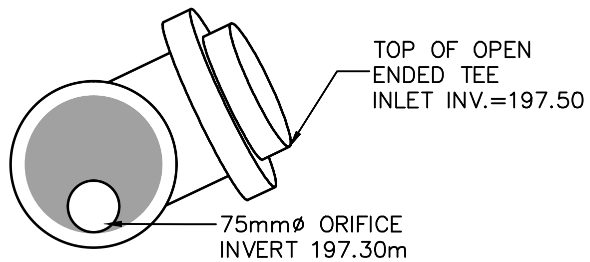
GRAND RENEWABLE ENERGY PARK
HALDIMAND, ON

Figure No.
8.0

Title
O & M SWM FACILITY - PLAN VIEW



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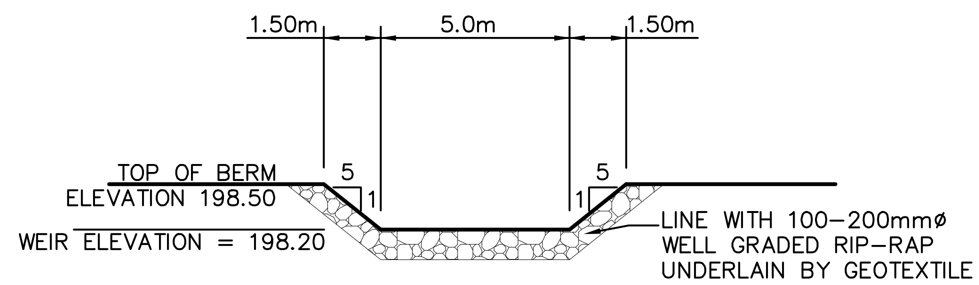

EMERGENCY WEIR CROSS–SECTION

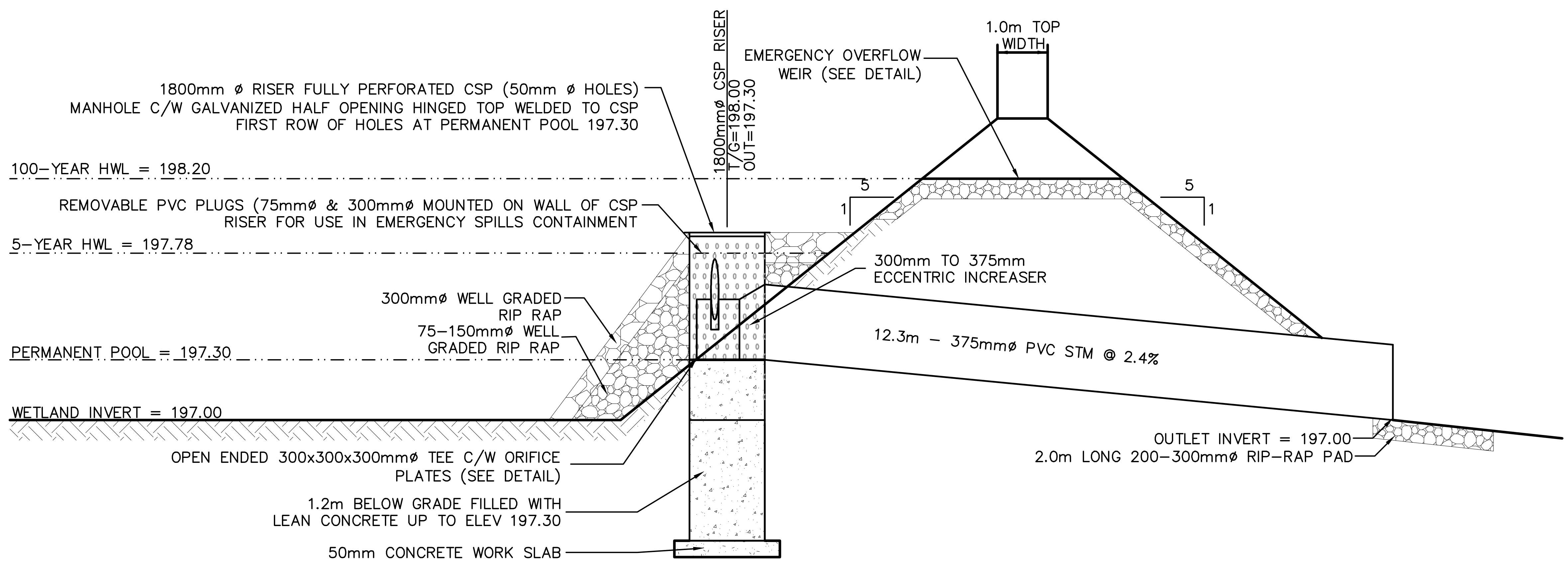

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Figure No.
9.0

Title
O&M SWM FACILITY
OUTLET PROFILE AND DETAIL

APPENDIX B

SUBSTATION ANALYSES

Grand Renewable Energy Park - Substation Facility
Samsung Renewable Energy Inc.
SCS Curve Number Determination
Existing Conditions

Site Soils: (as per Soil Survey Complex, OMAFRA / MNR, 2009)

Soil Type	**Hydrologic Soil Group**
Hal: Haldimand (clay)	C
Lic: Lincoln (clay)	D

TABLE OF CURVE NUMBERS (CN's)

Land Use	Hydrologic Soil Type						
	A	AB	B	BC	C	CD	D
Meadow	50	54	58	64.5	71	74.5	78
Woodlot	50	55.3	60.5	67	73.5	76.8	80
Long Grass	55	60	65	72	79	81.5	84
Lawns	60	65.5	71	77	83	86	89
Pasture/Range	58	61.5	65	70.5	76	78.5	81
Crop	66	70	74	78	82	84	86
Fallow (Bare)	77	82	86	89	91	93	94
Wetland	50	50	50	50	50	50	50

HYDROLOGIC SOIL TYPE (%) - Existing Conditions

Catchment	Hydrologic Soil Type							TOTAL
	A	AB	B	BC	C	CD	D	
101					56		44	100

LAND USE (%) - Existing Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Total
101						100			100

CURVE NUMBER (CN) - Existing Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Weighted CN
101	0	0	0	0	0	84	0	0	83

** post development catchments concerned with pervious CN values only
** AMC II assumed
** Hydrological Soil Group taken from MTO Drainage Manual for each soil type

Grand Renewable Energy Park - Substation Facility
Samsung Renewable Energy Inc.
SCS Curve Number Determination (Applies to Pervious Component of Developed Catchments Only)
Proposed Conditions

Site Soils: (as per Soil Survey Complex, OMAFRA / MNR, 2009)

Soil Type	**Hydrologic Soil Group**
Hal: Haldimand (clay)	C
Lic: Lincoln (clay)	D

TABLE OF CURVE NUMBERS (CN's)

Land Use	Hydrologic Soil Type						
	A	AB	B	BC	C	CD	D
Meadow	50	54	58	65	71	75	78
Woodlot	50	55	61	67	74	77	80
Long Grass	55	60	65	72	79	82	84
Lawns	60	66	71	77	83	86	89
Pasture/Range	58	62	65	71	76	79	81
Crop	66	70	74	78	82	84	86
Fallow (Bare)	77	82	86	89	91	93	94
Wetland	50	50	50	50	50	50	50

HYDROLOGIC SOIL TYPE (%) - Proposed Conditions

Catchment	Hydrologic Soil Type							
	A	AB	B	BC	C	CD	D	TOTAL
201					68		32	100
202					57		43	100
203					20		80	100
204					85		15	100

LAND USE (%) - Proposed Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Total
201			100						100
202			11			89			100
203			100						100
204			100						100

CURVE NUMBER (CN) - Proposed Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Weighted CN
201	0	0	81	0	0	0	0	0	81
202	0	0	9	0	0	75	0	0	83
203	0	0	83	0	0	0	0	0	83
204	0	0	80	0	0	0	0	0	80

** post development catchments concerned with pervious CN values only
** AMC II assumed
** Hydrological Soil Group taken from MTO Drainage Manual for each soil type

Grand Renewable Energy Park - Substation Facility
Samsung Renewable Energy Inc.
SWMHYMO Parameters

Existing Conditions

Catchment Number	Area Description	SWMHYMO Command	Area (ha)	CN	TIMP	XIMP	Slope (%)	Length (m)	Tc (hrs)	Tp (hrs)
101	Agricultural area just east of Mount Olivet Road containing area of proposed access road	DESIGN NASHYD	34.10	83	5.00	5.00	0.63	1000	1.80	1.08

Proposed Conditions

Catchment Number	Area Description	SWMHYMO Command	Area (ha)	CN	TIMP	XIMP	Slope (%)	Length (m)	Tc (hrs)	Tp (hrs)
201	Solar module field draining to diversion swale on east side of access road	DESIGN NASHYD	10.62	81	0.05	0.05	0.58	950	1.81	1.08
202	Agricultural area + 1 solar module draining to diversion swale on west side of access road	DESIGN NASHYD	18.25	83	0.05	0.05	0.44	1020	2.05	1.23
203	Substation, access road, and grassed swale drainage ditches, and SWM facility	DESIGN STANDHYD	2.53	83	0.60	0.60	0.43	1050	2.10	1.26
204	Solar module area draining to diversion swale on east side of SWM facility	DESIGN NASHYD	3.20	80	0.00	0.00	0.46	650	1.61	0.97

Total area draining to SWMF including SWM Block = 2.53 ha
Total area draining to SWMF requiring quality control = 2.03 ha 75%

Notes:

CN calculated for pervious areas only for DESIGN STANDHYD. CN is a weighed average for DESIGN NASHYD

TIMP → *Total percent impervious*

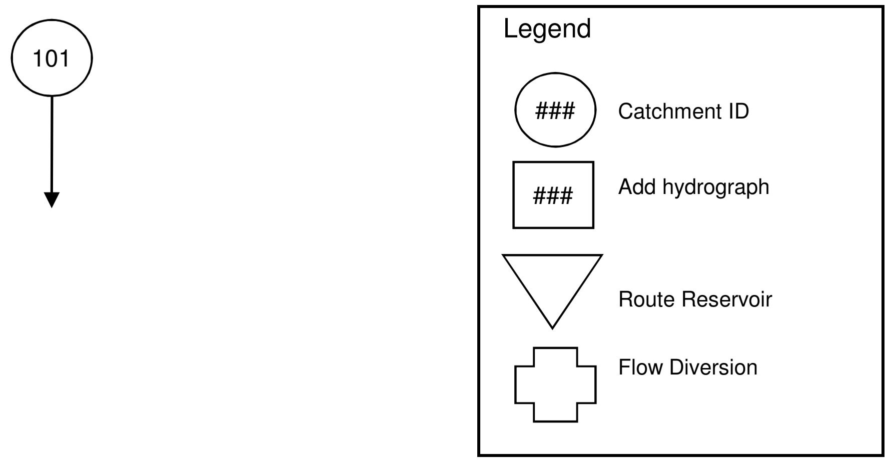
XIMP → *Percent impervious directly connected*

Time of Concentration calculated using the Airport Method → $Tc = [\ 3.26\ (1.1\text{-}C)\ L^{0.5}\ ] / S^{0.33}$

Where: *C = Runoff Coefficient = 0.2 for undeveloped areas*
L = Length of Overland Flow (m)
= (Area/1.5)^0.5
S = Slope (%)

Time to Peak → *Tp = 0.6Tc*

Grand Renewable Energy Park - Substation Facility
Samsung Renewable Energy Inc.
Existing Conditions SYMHYMO Schematic

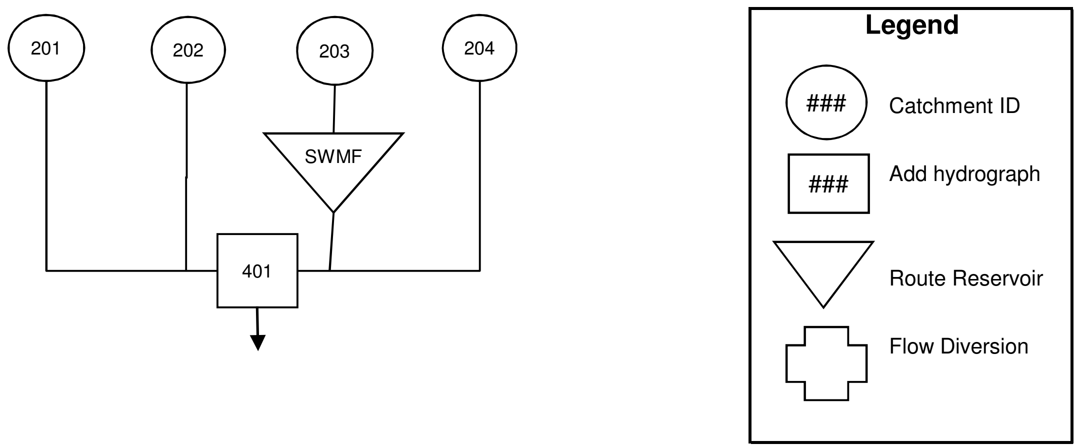


```
2     Metric units
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
*%                   ["hald2yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|----------------------------------------------------------|
READ STORM           STORM_FILENAME=["STORM.001"]
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
DESIGN NASHYD        ID=[1], NHYD=["101"], DT=[5]min, AREA=[34.10](ha),
                     DWF=[0](cms), CN/C=[83], TP=[1.08]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[2]
*                    ["hald5yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[3]
*                    ["hald10yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[4]
*                    ["hald25yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[5]
*                    ["hald50yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[6]
*                    ["Hald100.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|----------------------------------------------------------|
FINISH
```

```
==============================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O       9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9 =========
                                                      9   9  9   9 # 4730904
      StormWater Management HYdrologic Model           999    999  =========

 *************************************************************************
 ************************** SWMHYMO-99 Ver/4.02 **************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                OTTHYMO-83 and OTTHYMO-89.                   *******
 *************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
 *******                  Ottawa,  Ontario: (613) 727-5199           *******
 *******                  Gatineau, Quebec: (819) 243-6858           *******
 *******                  E-Mail: swmhymo@jfsa.Com                   *******
 *************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Stantec Consulting Ltd. (Kitchener)        +++++++
 +++++++                Kitchener            SERIAL#:4730904        +++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 *************************************************************************
 *******           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *******
 *******           Maximum value for ID numbers  :     10            *******
 *******           Max. number of rainfall points:  15000            *******
 *******           Max. number of flow points    :  15000            *******
 *************************************************************************


 *******************   D E T A I L E D   O U T P U T   ******************
 *************************************************************************
 *       DATE: 2011-09-13     TIME: 09:51:16     RUN COUNTER: 001139       *
 *************************************************************************
 * Input   filename: C:\PROGRA~1\SWMHYMO\Sub_Ex.dat                         *
 * Output  filename: C:\PROGRA~1\SWMHYMO\Sub_Ex.out                         *
 * Summary filename: C:\PROGRA~1\SWMHYMO\Sub_Ex.sum                         *
 * User comments:                                                           *
 * 1:______________________________________________________________________*
 * 2:______________________________________________________________________*
 * 3:______________________________________________________________________*
 *************************************************************************

------------------------------------------------------------------------------
001:0001----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
--------------------
| START              |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   1
           #  1=hald2yr.3hr
------------------------------------------------------------------------------
001:0002----------------------------------------------------------------------
--------------------
| READ STORM         |    Filename: C:\PROGRA~1\SWMHYMO\hald2yr.3hr
| Ptotal=  32.67 mm|    Comments: 2-yr, 3hr Chicago Storm - Haldimand Coun
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   2.850 |   1.00   6.930 |   1.83  10.920 |   2.67   3.420
               .33   3.200 |   1.17  10.320 |   2.00   7.380 |   2.83   3.040
               .50   3.670 |   1.33  21.580 |   2.17   5.640 |   3.00   2.750
               .67   4.320 |   1.50  73.990 |   2.33   4.600 |
               .83   5.290 |   1.67  22.240 |   2.50   3.910 |

------------------------------------------------------------------------------
001:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD       |   Area    (ha)=   34.10   Curve Number   (CN)=83.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=    1.206

     PEAK FLOW       (cms)=     .468 (i)
     TIME TO PEAK    (hrs)=    2.750
     RUNOFF VOLUME    (mm)=   11.681
     TOTAL RAINFALL   (mm)=   32.675
     RUNOFF COEFFICIENT   =     .358

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
001:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
  ** END OF RUN :   1

******************************************************************************





--------------------
| START              |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
           #  1=hald5yr.3hr
------------------------------------------------------------------------------
002:0002----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
002:0002----------------------------------------------------------------------
--------------------
| READ STORM         |    Filename: C:\PROGRA~1\SWMHYMO\hald5yr.3hr
| Ptotal=  46.99 mm|    Comments: 5-yr, 3hr Chicago Storm - Haldimand Coun
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   3.900 |   1.00  10.080 |   1.83  16.310 |   2.67   4.730
               .33   4.410 |   1.17  15.370 |   2.00  10.770 |   2.83   4.180
               .50   5.100 |   1.33  32.790 |   2.17   8.090 |   3.00   3.750
               .67   6.070 |   1.50 103.040 |   2.33   6.510 |
               .83   7.550 |   1.67  33.800 |   2.50   5.470 |

------------------------------------------------------------------------------
002:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD       |   Area    (ha)=   34.10   Curve Number   (CN)=83.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=    1.206

     PEAK FLOW       (cms)=     .857 (i)
     TIME TO PEAK    (hrs)=    2.750
     RUNOFF VOLUME    (mm)=   21.219
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .452

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
002:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
002:0002----------------------------------------------------------------------
  ** END OF RUN :   2

******************************************************************************





--------------------
| START              |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 003
    NSTORM=   1
           #  1=hald10yr.3hr
------------------------------------------------------------------------------
003:0002----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
003:0002----------------------------------------------------------------------
--------------------
| READ STORM         |    Filename: C:\PROGRA~1\SWMHYMO\hald10yr.3hr
| Ptotal=  56.54 mm|    Comments: 10-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.570 |   1.00  12.200 |   1.83  19.980 |   2.67   5.580
               .33   5.200 |   1.17  18.800 |   2.00  13.060 |   2.83   4.910
               .50   6.040 |   1.33  40.380 |   2.17   9.720 |   3.00   4.390
               .67   7.230 |   1.50 122.290 |   2.33   7.760 |
               .83   9.060 |   1.67  41.620 |   2.50   6.480 |

------------------------------------------------------------------------------
003:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD       |   Area    (ha)=   34.10   Curve Number   (CN)=83.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=    1.206

     PEAK FLOW       (cms)=    1.147 (i)
     TIME TO PEAK    (hrs)=    2.667
     RUNOFF VOLUME    (mm)=   28.299
     TOTAL RAINFALL   (mm)=   56.545
     RUNOFF COEFFICIENT   =     .500

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
003:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
003:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
003:0002----------------------------------------------------------------------
  ** END OF RUN :   3

******************************************************************************





--------------------
| START              |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 004
    NSTORM=   1
           #  1=hald25yr.3hr
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
```

```
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald25yr.3hr
| Ptotal=  68.72 mm|    Comments: 25-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   5.460 |   1.00  14.960 |   1.83  24.740 |   2.67   6.700
              .33   6.230 |   1.17  23.260 |   2.00  16.040 |   2.83   5.870
              .50   7.260 |   1.33  50.040 |   2.17  11.850 |   3.00   5.240
              .67   8.740 |   1.50 146.100 |   2.33   9.410 |
              .83  11.020 |   1.67  51.580 |   2.50   7.820 |

------------------------------------------------------------------------------
004:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   34.10   Curve Number   (CN)=83.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=    1.206

     PEAK FLOW       (cms)=    1.541 (i)
     TIME TO PEAK    (hrs)=    2.667
     RUNOFF VOLUME    (mm)=   37.893
     TOTAL RAINFALL   (mm)=   68.720
     RUNOFF COEFFICIENT   =     .551

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
004:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
  ** END OF RUN :   4

******************************************************************************





--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
           #  1=hald50yr.3hr
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald50yr.3hr
| Ptotal=  76.91 mm|    Comments: 50-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   6.030 |   1.00  16.650 |   1.83  27.610 |   2.67   7.420
              .33   6.890 |   1.17  25.950 |   2.00  17.860 |   2.83   6.490
              .50   8.040 |   1.33  56.090 |   2.17  13.160 |   3.00   5.790
              .67   9.690 |   1.50 164.610 |   2.33  10.440 |
              .83  12.240 |   1.67  57.820 |   2.50   8.660 |

------------------------------------------------------------------------------
005:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   34.10   Curve Number   (CN)=83.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=    1.206

     PEAK FLOW       (cms)=    1.820 (i)
     TIME TO PEAK    (hrs)=    2.667
     RUNOFF VOLUME    (mm)=   44.622
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .580

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
005:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
  ** END OF RUN :   5

******************************************************************************





--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 006
    NSTORM=   1
           #  1=Hald100.3hr
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - Substation Facility
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : SRobertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\Hald100.3hr
| Ptotal=  86.13 mm|    Comments: 100-yr, 3hr Chicago Storm - Haldimand Co
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   6.610 |   1.00  18.780 |   1.83  31.440 |   2.67   8.170
              .33   7.570 |   1.17  29.530 |   2.00  20.170 |   2.83   7.130
              .50   8.890 |   1.33  63.970 |   2.17  14.760 |   3.00   6.330
              .67  10.770 |   1.50 181.810 |   2.33  11.620 |
              .83  13.700 |   1.67  65.940 |   2.50   9.590 |

------------------------------------------------------------------------------
006:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   34.10   Curve Number   (CN)=83.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=    1.206

     PEAK FLOW       (cms)=    2.143 (i)
     TIME TO PEAK    (hrs)=    2.667
     RUNOFF VOLUME    (mm)=   52.411
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .609

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
006:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
     FINISH
------------------------------------------------------------------------------
******************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2011-09-13     at 09:51:17
==============================================================================
```

Grand Renewable Energy Park - Substation Facility
Samsung Renewable Energy Inc.
Proposed Conditions SYMHYMO Schematic



```
2     Metric units
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park-Substation
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : S Robertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  PROPOSED CONDITIONS
*#****************************************************************************
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
*%                   ["hald2yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|------------------------------------------------------------|
READ STORM           STORM_FILENAME=["STORM.001"]
*#-----------------|------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|------------------------------------------------------------|
DESIGN NASHYD        ID=[1], NHYD=["201"], DT=[5]min, AREA=[10.62](ha),
                     DWF=[0](cms), CN/C=[81], TP=[1.08]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|------------------------------------------------------------|
DESIGN NASHYD        ID=[2], NHYD=["202"], DT=[5]min, AREA=[18.25](ha),
                     DWF=[0](cms), CN/C=[83], TP=[1.23]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|------------------------------------------------------------|
DESIGN STANDHYD      ID=[3], NHYD=["203"], DT=[1]min, AREA=[2.53](ha),
                     XIMP=[0.60], TIMP=[0.60], DWF=[0](cms), LOSS=[2], CN=[83],
                     SLOPE=[0.43](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*#-----------------|------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|------------------------------------------------------------|
DESIGN NASHYD        ID=[4], NHYD=["204"], DT=[5]min, AREA=[3.20](ha),
                     DWF=[0](cms), CN/C=[80], TP=[0.97]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|------------------------------------------------------------|
*# Dry End-of-Pipe SWM Facility
*#-----------------|------------------------------------------------------------|
ROUTE RESERVOIR      IDout=[5],   NHYD=["501"],  IDin=[3],
                     RDT=[1](min),
                           TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
                                    [   0.0 ,  0.0    ]
                                    [ 0.001 ,  0.0018 ]
                                    [ 0.002 ,  0.0104 ]
                                    [ 0.006 ,  0.0181 ]
                                    [ 0.014 ,  0.0277 ]
                                    [ 0.027 ,  0.0387 ]
                                    [ 0.044 ,  0.0509 ]
                                    [ 0.073 ,  0.0642 ]
                                    [ 0.094 ,  0.0788 ]
                                    [ 0.111 ,  0.0971 ]
                                    [ 0.125 ,  0.1188 ]
                                    [ 0.138 ,  0.1411 ]
                                    [ 0.209 ,  0.1640 ]
                                    [ 0.336 ,  0.1876 ]
                                    [ 0.505 ,  0.2117 ]
                                    [ 0.713 ,  0.2365 ]
                                    [ 0.961 ,  0.2620 ]
                                    [   -1  ,  -1  ]  (max twenty pts)
                           IDovf=[   ], NHYDovf=[   ]
*%-----------------|------------------------------------------------------------|
ADD HYD              IDsum=[6], NHYD=["401"], IDs to add=[1+2+4+5]
*#-----------------|------------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[2]
*                    ["hald5yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|------------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[3]
*                    ["hald10yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|------------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[4]
*                    ["hald25yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|------------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[5]
*                    ["hald50yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|------------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[6]
*                    ["Hald100.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|------------------------------------------------------------|
FINISH
```

```
==============================================================================
 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999    999  =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O     9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O      9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO          9      9 =========
                                                     9   9  9   9 # 4730904
      StormWater Management HYdrologic Model           999    999  =========
 ***************************************************************************
 ************************** SWMHYMO-99 Ver/4.02 ****************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                   OTTHYMO-83 and OTTHYMO-89.                *******
 ***************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
 *******                  Ottawa,  Ontario: (613) 727-5199           *******
 *******                  Gatineau, Quebec: (819) 243-6858           *******
 *******                  E-Mail: swmhymo@jfsa.Com                   *******
 ***************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Stantec Consulting Ltd. (Kitchener)          +++++++
 +++++++                Kitchener                SERIAL#:4730904     +++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ***************************************************************************
 *******            ++++++ PROGRAM ARRAY DIMENSIONS ++++++           *******
 *******            Maximum value for ID numbers  :    10            *******
 *******            Max. number of rainfall points:  15000           *******
 *******            Max. number of flow points    :  15000           *******
 ***************************************************************************

 ********************  D E T A I L E D   O U T P U T  ********************
 ***************************************************************************
 *      DATE: 2011-09-13     TIME: 09:53:47     RUN COUNTER: 001140       *
 ***************************************************************************
 * Input   filename: C:\PROGRA~1\SWMHYMO\Sub_Pro.dat                      *
 * Output  filename: C:\PROGRA~1\SWMHYMO\Sub_Pro.out                      *
 * Summary filename: C:\PROGRA~1\SWMHYMO\Sub_Pro.sum                      *
 * User comments:                                                          *
 * 1:_____________________________________________________________________*
 * 2:_____________________________________________________________________*
 * 3:_____________________________________________________________________*
 ***************************************************************************

 -------------------------------------------------------------------------------
 001:0001-----------------------------------------------------------------------
 *#*****************************************************************************
 *#  Project Name  : Grand Renewable Energy Park-Substation
 *#  Project Number: 1610-10624
 *#  Date          : 1-24-2011
 *#  Company       : Stantec Consulting Ltd. (Kitchener)
 *#  Modeller      : George Golding, EIT
 *#  Reviewed / Revised : S Robertson (Jan 31, 2011)
 *#  License #     :  4730904
 *#*****************************************************************************
 *#  PROPOSED CONDITIONS
 *#*****************************************************************************
 --------------------
 | START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
 --------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
     TZERO =   .00 hrs on       0
     METOUT=   2 (output = METRIC)
     NRUN  = 001
     NSTORM=   1
            #  1=hald2yr.3hr
 -------------------------------------------------------------------------------
 001:0002-----------------------------------------------------------------------
 --------------------
 | READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald2yr.3hr
 | Ptotal=  32.67 mm|    Comments: 2-yr, 3hr Chicago Storm - Haldimand Coun
 --------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   2.850 |   1.00   6.930 |   1.83  10.920 |   2.67   3.420
                .33   3.200 |   1.17  10.320 |   2.00   7.380 |   2.83   3.040
                .50   3.670 |   1.33  21.580 |   2.17   5.640 |   3.00   2.750
                .67   4.320 |   1.50  73.990 |   2.33   4.600 |
                .83   5.290 |   1.67  22.240 |   2.50   3.910 |

 -------------------------------------------------------------------------------
 001:0003-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Catchment North of Haldimand Road
 *#-----------------|-----------------------------------------------------------|
 ----------------------
 | DESIGN NASHYD      |   Area    (ha)=   10.62   Curve Number   (CN)=81.00
 | 01:201    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=   1.080

      Unit Hyd Qpeak  (cms)=     .376

      PEAK FLOW       (cms)=     .134 (i)
      TIME TO PEAK    (hrs)=    2.750
      RUNOFF VOLUME    (mm)=   10.709
      TOTAL RAINFALL   (mm)=   32.675
      RUNOFF COEFFICIENT   =     .328

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -------------------------------------------------------------------------------
 001:0004-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Catchment North of Haldimand Road
 *#-----------------|-----------------------------------------------------------|
 ----------------------
 | DESIGN NASHYD      |   Area    (ha)=   18.25   Curve Number   (CN)=83.00
 | 02:202    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=   1.230

      Unit Hyd Qpeak  (cms)=     .567

      PEAK FLOW       (cms)=     .227 (i)
      TIME TO PEAK    (hrs)=    2.917
      RUNOFF VOLUME    (mm)=   11.681
      TOTAL RAINFALL   (mm)=   32.675
      RUNOFF COEFFICIENT   =     .358

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -------------------------------------------------------------------------------
 001:0005-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Catchment North of Haldimand Road
 *#-----------------|-----------------------------------------------------------|
 ----------------------
 | DESIGN STANDHYD    |   Area    (ha)=    2.53
 | 03:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
 ----------------------
                             IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=       1.52        1.01
      Dep. Storage     (mm)=        .80        1.50
      Average Slope     (%)=        .43         .43
      Length            (m)=     129.87       40.00
      Mannings n           =       .013        .250

      Max.eff.Inten.(mm/hr)=      73.99       15.81
                over (min)        4.00       28.00
      Storage Coeff.  (min)=       4.34 (ii)   27.75 (ii)
      Unit Hyd. Tpeak (min)=       4.00       28.00
      Unit Hyd. peak  (cms)=        .27         .04
                                                          *TOTALS*
      PEAK FLOW       (cms)=        .28         .03          .284 (iii)
      TIME TO PEAK    (hrs)=       1.50        1.93         1.500
      RUNOFF VOLUME    (mm)=      31.87       11.68        23.798
      TOTAL RAINFALL   (mm)=      32.67       32.67        32.675
      RUNOFF COEFFICIENT   =        .98         .36          .728

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  83.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -------------------------------------------------------------------------------
 001:0006-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Catchment North of Haldimand Road
 *#-----------------|-----------------------------------------------------------|
 ----------------------
 | DESIGN NASHYD      |   Area    (ha)=    3.20   Curve Number   (CN)=80.00
 | 04:204    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=    .970

      Unit Hyd Qpeak  (cms)=     .126

      PEAK FLOW       (cms)=     .042 (i)
      TIME TO PEAK    (hrs)=    2.583
      RUNOFF VOLUME    (mm)=   10.265
      TOTAL RAINFALL   (mm)=   32.675
      RUNOFF COEFFICIENT   =     .314

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -------------------------------------------------------------------------------
 001:0007-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Dry End-of-Pipe SWM Facility
 *#-----------------|-----------------------------------------------------------|
 --------------------
 | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
 |  IN>03:(203   )   |
 | OUT<05:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
 --------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |     .111  .9710E-01
                             .001  .1800E-02   |     .125  .1188E+00
                             .002  .1040E-01   |     .138  .1411E+00
                             .006  .1810E-01   |     .209  .1640E+00
                             .014  .2770E-01   |     .336  .1876E+00
                             .027  .3870E-01   |     .505  .2117E+00
                             .044  .5090E-01   |     .713  .2365E+00
                             .073  .6420E-01   |     .961  .2620E+00
                             .094  .7880E-01   |     .000  .0000E+00

      ROUTING RESULTS              AREA     QPEAK     TPEAK       R.V.
      --------------------         (ha)     (cms)     (hrs)       (mm)
      INFLOW >03: (203   )         2.53      .284     1.500     23.798
      OUTFLOW<05: (501   )         2.53      .033     2.517     23.797

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   11.484
                    TIME SHIFT OF PEAK FLOW         (min)=    61.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.4271E-01

 -------------------------------------------------------------------------------
 001:0008-----------------------------------------------------------------------
 --------------------
 | ADD HYD (401   ) | ID: NHYD     AREA      QPEAK   TPEAK   R.V.    DWF
 --------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                   ID1 01:201      10.62      .134    2.75  10.71    .000
                  +ID2 02:202      18.25      .227    2.92  11.68    .000
                  +ID3 04:204       3.20      .042    2.58  10.27    .000
                  +ID4 05:501       2.53      .033    2.52  23.80    .000
                   ====================================================
                   SUM 06:401      34.60      .432    2.83  12.14    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 -------------------------------------------------------------------------------
 001:0009-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
   ** END OF RUN :    1

 *******************************************************************************

 --------------------
 | START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
 --------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
     TZERO =   .00 hrs on       0
     METOUT=   2 (output = METRIC)
     NRUN  = 002
     NSTORM=   1
            #  1=hald5yr.3hr
 -------------------------------------------------------------------------------
 002:0002-----------------------------------------------------------------------
 *#*****************************************************************************
 *#  Project Name  : Grand Renewable Energy Park-Substation
 *#  Project Number: 1610-10624
 *#  Date          : 1-24-2011
 *#  Company       : Stantec Consulting Ltd. (Kitchener)
 *#  Modeller      : George Golding, EIT
 *#  Reviewed / Revised : S Robertson (Jan 31, 2011)
 *#  License #     :  4730904
 *#*****************************************************************************
 *#  PROPOSED CONDITIONS
 *#*****************************************************************************
 -------------------------------------------------------------------------------
 002:0002-----------------------------------------------------------------------
 --------------------
 | READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald5yr.3hr
 | Ptotal=  46.99 mm|    Comments: 5-yr, 3hr Chicago Storm - Haldimand Coun
 --------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   3.900 |   1.00  10.080 |   1.83  16.310 |   2.67   4.730
                .33   4.410 |   1.17  15.370 |   2.00  10.770 |   2.83   4.180
                .50   5.100 |   1.33  32.790 |   2.17   8.090 |   3.00   3.750
                .67   6.070 |   1.50 103.040 |   2.33   6.510 |
                .83   7.550 |   1.67  33.800 |   2.50   5.470 |

 -------------------------------------------------------------------------------
 002:0003-----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
```

```
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   10.62   Curve Number   (CN)=81.00
| 01:201    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=     .376

     PEAK FLOW       (cms)=     .247 (i)
     TIME TO PEAK    (hrs)=    2.750
     RUNOFF VOLUME    (mm)=   19.693
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .419

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
002:0004--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   18.25   Curve Number   (CN)=83.00
| 02:202    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.230

     Unit Hyd Qpeak  (cms)=     .567

     PEAK FLOW       (cms)=     .415 (i)
     TIME TO PEAK    (hrs)=    2.917
     RUNOFF VOLUME    (mm)=   21.219
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .452

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
002:0005--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=    2.53
| 03:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.52        1.01
     Dep. Storage     (mm)=        .80        1.50
     Average Slope     (%)=        .43         .43
     Length            (m)=     129.87       40.00
     Mannings n          =       .013        .250

     Max.eff.Inten.(mm/hr)=     103.04       34.59
                over (min)       4.00       21.00
     Storage Coeff.  (min)=       3.80 (ii)   20.92 (ii)
     Unit Hyd. Tpeak (min)=       4.00       21.00
     Unit Hyd. peak  (cms)=        .29         .05
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .40         .06           .419 (iii)
     TIME TO PEAK    (hrs)=       1.50        1.82          1.500
     RUNOFF VOLUME    (mm)=      46.19       21.22         36.199
     TOTAL RAINFALL   (mm)=      46.99       46.99         46.987
     RUNOFF COEFFICIENT   =        .98         .45           .770

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  83.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
002:0006--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    3.20   Curve Number   (CN)=80.00
| 04:204    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .970

     Unit Hyd Qpeak  (cms)=     .126

     PEAK FLOW       (cms)=     .078 (i)
     TIME TO PEAK    (hrs)=    2.583
     RUNOFF VOLUME    (mm)=   18.984
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .404

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
002:0007--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Dry End-of-Pipe SWM Facility
*#-----------------|-----------------------------------------------------------|
--------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>03:(203   )   |
| OUT<05:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
--------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .111  .9710E-01
                            .001  .1800E-02   |     .125  .1188E+00
                            .002  .1040E-01   |     .138  .1411E+00
                            .006  .1810E-01   |     .209  .1640E+00
                            .014  .2770E-01   |     .336  .1876E+00
                            .027  .3870E-01   |     .505  .2117E+00
                            .044  .5090E-01   |     .713  .2365E+00
                            .073  .6420E-01   |     .961  .2620E+00
                            .094  .7880E-01   |     .000  .0000E+00

     ROUTING RESULTS              AREA      QPEAK      TPEAK        R.V.
     --------------------         (ha)      (cms)      (hrs)        (mm)
     INFLOW >03: (203   )         2.53       .419      1.500      36.199
     OUTFLOW<05: (501   )         2.53       .067      2.233      36.199

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   16.020
                    TIME SHIFT OF PEAK FLOW         (min)=    44.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.6152E-01

----------------------------------------------------------------------------
002:0008--------------------------------------------------------------------
-------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
-------------------                 (ha)     (cms)   (hrs)   (mm)   (cms)
               ID1 01:201       10.62      .247    2.75  19.69    .000
              +ID2 02:202       18.25      .415    2.92  21.22    .000
              +ID3 04:204        3.20      .078    2.58  18.98    .000
              +ID4 05:501        2.53      .067    2.23  36.20    .000
               ==================================================
               SUM 06:401       34.60      .796    2.75  21.64    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

----------------------------------------------------------------------------
002:0009--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
----------------------------------------------------------------------------
002:0002--------------------------------------------------------------------
  ** END OF RUN :   2

*****************************************************************************





--------------------
| START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
   TZERO =   .00 hrs on        0
   METOUT=   2 (output = METRIC)
   NRUN  = 003
   NSTORM=   1
           #  1=hald10yr.3hr
----------------------------------------------------------------------------
003:0002--------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park-Substation
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : S Robertson (Jan 31, 2011)
*#  License #     :  4730904
*#****************************************************************************
*#  PROPOSED CONDITIONS
*#****************************************************************************
----------------------------------------------------------------------------
003:0002--------------------------------------------------------------------
--------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\hald10yr.3hr
| Ptotal=  56.54 mm|    Comments: 10-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   4.570 |   1.00  12.200 |   1.83  19.980 |   2.67   5.580
                .33   5.200 |   1.17  18.800 |   2.00  13.060 |   2.83   4.910
                .50   6.040 |   1.33  40.380 |   2.17   9.720 |   3.00   4.390
                .67   7.230 |   1.50 122.290 |   2.33   7.760 |
                .83   9.060 |   1.67  41.620 |   2.50   6.480 |

----------------------------------------------------------------------------
003:0003--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   10.62   Curve Number   (CN)=81.00
| 01:201    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=     .376

     PEAK FLOW       (cms)=     .333 (i)
     TIME TO PEAK    (hrs)=    2.750
     RUNOFF VOLUME    (mm)=   26.434
     TOTAL RAINFALL   (mm)=   56.545
     RUNOFF COEFFICIENT   =     .467

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
003:0004--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   18.25   Curve Number   (CN)=83.00
| 02:202    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=   1.230

     Unit Hyd Qpeak  (cms)=     .567

     PEAK FLOW       (cms)=     .555 (i)
     TIME TO PEAK    (hrs)=    2.917
     RUNOFF VOLUME    (mm)=   28.299
     TOTAL RAINFALL   (mm)=   56.545
     RUNOFF COEFFICIENT   =     .500

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
003:0005--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=    2.53
| 03:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.52        1.01
     Dep. Storage     (mm)=        .80        1.50
     Average Slope     (%)=        .43         .43
     Length            (m)=     129.87       40.00
     Mannings n          =       .013        .250

     Max.eff.Inten.(mm/hr)=     122.29       49.60
                over (min)       4.00       18.00
     Storage Coeff.  (min)=       3.55 (ii)   18.37 (ii)
     Unit Hyd. Tpeak (min)=       4.00       18.00
     Unit Hyd. peak  (cms)=        .30         .06
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .48         .09           .515 (iii)
     TIME TO PEAK    (hrs)=       1.50        1.77          1.500
     RUNOFF VOLUME    (mm)=      55.74       28.30         44.767
     TOTAL RAINFALL   (mm)=      56.54       56.54         56.545
     RUNOFF COEFFICIENT   =        .99         .50           .792

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  83.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
003:0006--------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    3.20   Curve Number   (CN)=80.00
| 04:204    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .970

     Unit Hyd Qpeak  (cms)=     .126

     PEAK FLOW       (cms)=     .106 (i)
```

```
      TIME TO PEAK    (hrs)=    2.583
      RUNOFF VOLUME    (mm)=   25.559
      TOTAL RAINFALL   (mm)=   56.545
      RUNOFF COEFFICIENT   =     .452

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
003:0007------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Dry End-of-Pipe SWM Facility
*#-----------------|-------------------------------------------------------------|
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>03:(203   )   |
| OUT<05:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .111  .9710E-01
                           .001  .1800E-02    |     .125  .1188E+00
                           .002  .1040E-01    |     .138  .1411E+00
                           .006  .1810E-01    |     .209  .1640E+00
                           .014  .2770E-01    |     .336  .1876E+00
                           .027  .3870E-01    |     .505  .2117E+00
                           .044  .5090E-01    |     .713  .2365E+00
                           .073  .6420E-01    |     .961  .2620E+00
                           .094  .7880E-01    |     .000  .0000E+00

      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
      --------------------       (ha)     (cms)     (hrs)       (mm)
      INFLOW >03: (203   )       2.53      .515     1.500     44.767
      OUTFLOW<05: (501   )       2.53      .088     2.200     44.766

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   17.123
                   TIME SHIFT OF PEAK FLOW         (min)=    42.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.7481E-01

--------------------------------------------------------------------------------
003:0008------------------------------------------------------------------------
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201      10.62      .333    2.75  26.43    .000
                +ID2 02:202      18.25      .555    2.92  28.30    .000
                +ID3 04:204       3.20      .106    2.58  25.56    .000
                +ID4 05:501       2.53      .088    2.20  44.77    .000
                 =====================================================
                 SUM 06:401      34.60     1.068    2.75  28.68    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
003:0009------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
--------------------------------------------------------------------------------
003:0002------------------------------------------------------------------------
--------------------------------------------------------------------------------
003:0002------------------------------------------------------------------------
  ** END OF RUN :   3

********************************************************************************






--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 004
    NSTORM=   1
           #  1=hald25yr.3hr
--------------------------------------------------------------------------------
004:0002------------------------------------------------------------------------
*#*******************************************************************************
*#  Project Name  : Grand Renewable Energy Park-Substation
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : S Robertson (Jan 31, 2011)
*#  License #     :  4730904
*#*******************************************************************************
*#  PROPOSED CONDITIONS
*#*******************************************************************************
--------------------------------------------------------------------------------
004:0002------------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald25yr.3hr
| Ptotal=  68.72 mm|    Comments: 25-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.460 |   1.00  14.960 |   1.83  24.740 |   2.67   6.700
               .33   6.230 |   1.17  23.260 |   2.00  16.040 |   2.83   5.870
               .50   7.260 |   1.33  50.040 |   2.17  11.850 |   3.00   5.240
               .67   8.740 |   1.50 146.100 |   2.33   9.410 |
               .83  11.020 |   1.67  51.580 |   2.50   7.820 |

--------------------------------------------------------------------------------
004:0003------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   10.62   Curve Number   (CN)=81.00
| 01:201    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=   1.080

      Unit Hyd Qpeak  (cms)=     .376

      PEAK FLOW       (cms)=     .451 (i)
      TIME TO PEAK    (hrs)=    2.667
      RUNOFF VOLUME    (mm)=   35.635
      TOTAL RAINFALL   (mm)=   68.720
      RUNOFF COEFFICIENT   =     .519

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
004:0004------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   18.25   Curve Number   (CN)=83.00
| 02:202    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=   1.230

      Unit Hyd Qpeak  (cms)=     .567

      PEAK FLOW       (cms)=     .744 (i)
      TIME TO PEAK    (hrs)=    2.833
      RUNOFF VOLUME    (mm)=   37.893
      TOTAL RAINFALL   (mm)=   68.720
      RUNOFF COEFFICIENT   =     .551

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
004:0005------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN STANDHYD    |   Area    (ha)=    2.53
| 03:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=      1.52        1.01
      Dep. Storage     (mm)=       .80        1.50
      Average Slope     (%)=       .43         .43
      Length            (m)=    129.87       40.00
      Mannings n           =      .013        .250

      Max.eff.Inten.(mm/hr)=    146.10       69.37
                 over (min)       3.00       16.00
      Storage Coeff.  (min)=      3.31 (ii)   16.26 (ii)
      Unit Hyd. Tpeak (min)=      3.00       16.00
      Unit Hyd. peak  (cms)=       .35         .07
                                                             *TOTALS*
      PEAK FLOW       (cms)=       .59         .12              .646 (iii)
      TIME TO PEAK    (hrs)=      1.50        1.73             1.500
      RUNOFF VOLUME    (mm)=     67.92       37.89            55.909
      TOTAL RAINFALL   (mm)=     68.72       68.72            68.720
      RUNOFF COEFFICIENT   =       .99         .55              .814

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  83.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
004:0006------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=    3.20   Curve Number   (CN)=80.00
| 04:204    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .970

      Unit Hyd Qpeak  (cms)=     .126

      PEAK FLOW       (cms)=     .143 (i)
      TIME TO PEAK    (hrs)=    2.583
      RUNOFF VOLUME    (mm)=   34.566
      TOTAL RAINFALL   (mm)=   68.720
      RUNOFF COEFFICIENT   =     .503

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
004:0007------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Dry End-of-Pipe SWM Facility
*#-----------------|-------------------------------------------------------------|
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>03:(203   )   |
| OUT<05:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .111  .9710E-01
                           .001  .1800E-02    |     .125  .1188E+00
                           .002  .1040E-01    |     .138  .1411E+00
                           .006  .1810E-01    |     .209  .1640E+00
                           .014  .2770E-01    |     .336  .1876E+00
                           .027  .3870E-01    |     .505  .2117E+00
                           .044  .5090E-01    |     .713  .2365E+00
                           .073  .6420E-01    |     .961  .2620E+00
                           .094  .7880E-01    |     .000  .0000E+00

      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
      --------------------       (ha)     (cms)     (hrs)       (mm)
      INFLOW >03: (203   )       2.53      .646     1.500     55.909
      OUTFLOW<05: (501   )       2.53      .108     2.200     55.909

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   16.674
                   TIME SHIFT OF PEAK FLOW         (min)=    42.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.9358E-01

--------------------------------------------------------------------------------
004:0008------------------------------------------------------------------------
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201      10.62      .451    2.67  35.64    .000
                +ID2 02:202      18.25      .744    2.83  37.89    .000
                +ID3 04:204       3.20      .143    2.58  34.57    .000
                +ID4 05:501       2.53      .108    2.20  55.91    .000
                 =====================================================
                 SUM 06:401      34.60     1.432    2.75  38.21    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
004:0009------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
--------------------------------------------------------------------------------
004:0002------------------------------------------------------------------------
--------------------------------------------------------------------------------
004:0002------------------------------------------------------------------------
--------------------------------------------------------------------------------
004:0002------------------------------------------------------------------------
  ** END OF RUN :   4

********************************************************************************






--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
           #  1=hald50yr.3hr
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
*#*******************************************************************************
*#  Project Name  : Grand Renewable Energy Park-Substation
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
```

```
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : S Robertson (Jan 31, 2011)
*#  License #     :  4730904
*#*****************************************************************************
*#  PROPOSED CONDITIONS
*#*****************************************************************************
 ----------------------------------------------------------------------------
005:0002---------------------------------------------------------------------
 --------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\hald50yr.3hr
| Ptotal=  76.91 mm|    Comments: 50-yr, 3hr Chicago Storm - Haldimand Cou
 --------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   6.030 |   1.00  16.650 |   1.83  27.610 |   2.67   7.420
                .33   6.890 |   1.17  25.950 |   2.00  17.860 |   2.83   6.490
                .50   8.040 |   1.33  56.090 |   2.17  13.160 |   3.00   5.790
                .67   9.690 |   1.50 164.610 |   2.33  10.440 |
                .83  12.240 |   1.67  57.820 |   2.50   8.660 |

 ----------------------------------------------------------------------------
005:0003---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN NASHYD      |   Area    (ha)=   10.62   Curve Number   (CN)=81.00
| 01:201    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=     .376

     PEAK FLOW       (cms)=     .534 (i)
     TIME TO PEAK    (hrs)=    2.667
     RUNOFF VOLUME    (mm)=   42.124
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .548

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ----------------------------------------------------------------------------
005:0004---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN NASHYD      |   Area    (ha)=   18.25   Curve Number   (CN)=83.00
| 02:202    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=   1.230

     Unit Hyd Qpeak  (cms)=     .567

     PEAK FLOW       (cms)=     .878 (i)
     TIME TO PEAK    (hrs)=    2.833
     RUNOFF VOLUME    (mm)=   44.622
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .580

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ----------------------------------------------------------------------------
005:0005---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN STANDHYD    |   Area    (ha)=    2.53
| 03:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
 ----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.52         1.01
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .43          .43
     Length            (m)=     129.87        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     164.61        84.73
                over (min)        3.00        15.00
     Storage Coeff.  (min)=       3.15 (ii)   15.11 (ii)
     Unit Hyd. Tpeak (min)=       3.00        15.00
     Unit Hyd. peak  (cms)=        .36          .08
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .67          .15          .743 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.70         1.500
     RUNOFF VOLUME    (mm)=      76.11        44.62        63.513
     TOTAL RAINFALL   (mm)=      76.91        76.91        76.907
     RUNOFF COEFFICIENT   =        .99          .58          .826

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  83.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ----------------------------------------------------------------------------
005:0006---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN NASHYD      |   Area    (ha)=    3.20   Curve Number   (CN)=80.00
| 04:204    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=    .970

     Unit Hyd Qpeak  (cms)=     .126

     PEAK FLOW       (cms)=     .170 (i)
     TIME TO PEAK    (hrs)=    2.583
     RUNOFF VOLUME    (mm)=   40.935
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .532

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ----------------------------------------------------------------------------
005:0007---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Dry End-of-Pipe SWM Facility
*#-----------------|----------------------------------------------------------|
 --------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>03:(203    )  |
| OUT<05:(501    )  |    =========  OUTLFOW STORAGE TABLE  =========
 --------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .111  .9710E-01
                            .001  .1800E-02   |     .125  .1188E+00
                            .002  .1040E-01   |     .138  .1411E+00
                            .006  .1810E-01   |     .209  .1640E+00
                            .014  .2770E-01   |     .336  .1876E+00
                            .027  .3870E-01   |     .505  .2117E+00
                            .044  .5090E-01   |     .713  .2365E+00
                            .073  .6420E-01   |     .961  .2620E+00
                            .094  .7880E-01   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >03: (203   )       2.53      .743     1.500     63.513
     OUTFLOW<05: (501   )       2.53      .118     2.200     63.512

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   15.830
                    TIME SHIFT OF PEAK FLOW         (min)=    42.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1075E+00

 ----------------------------------------------------------------------------
005:0008---------------------------------------------------------------------
 --------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
 --------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201       10.62      .534    2.67  42.12    .000
                +ID2 02:202       18.25      .878    2.83  44.62    .000
                +ID3 04:204        3.20      .170    2.58  40.94    .000
                +ID4 05:501        2.53      .118    2.20  63.51    .000
                 ==================================================
                 SUM 06:401       34.60     1.686    2.75  44.89    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ----------------------------------------------------------------------------
005:0009---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
 ----------------------------------------------------------------------------
005:0002---------------------------------------------------------------------
 ----------------------------------------------------------------------------
005:0002---------------------------------------------------------------------
 ----------------------------------------------------------------------------
005:0002---------------------------------------------------------------------
 ----------------------------------------------------------------------------
005:0002---------------------------------------------------------------------
  ** END OF RUN :   5

******************************************************************************




 --------------------
| START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
 --------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 006
    NSTORM=   1
           #  1=Hald100.3hr
 ----------------------------------------------------------------------------
006:0002---------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name  : Grand Renewable Energy Park-Substation
*#  Project Number: 1610-10624
*#  Date          : 1-24-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : George Golding, EIT
*#  Reviewed / Revised : S Robertson (Jan 31, 2011)
*#  License #     :  4730904
*#*****************************************************************************
*#  PROPOSED CONDITIONS
*#*****************************************************************************
 ----------------------------------------------------------------------------
006:0002---------------------------------------------------------------------
 --------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\Hald100.3hr
| Ptotal=  86.13 mm|    Comments: 100-yr, 3hr Chicago Storm - Haldimand Co
 --------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   6.610 |   1.00  18.780 |   1.83  31.440 |   2.67   8.170
                .33   7.570 |   1.17  29.530 |   2.00  20.170 |   2.83   7.130
                .50   8.890 |   1.33  63.970 |   2.17  14.760 |   3.00   6.330
                .67  10.770 |   1.50 181.810 |   2.33  11.620 |
                .83  13.700 |   1.67  65.940 |   2.50   9.590 |

 ----------------------------------------------------------------------------
006:0003---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN NASHYD      |   Area    (ha)=   10.62   Curve Number   (CN)=81.00
| 01:201    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=   1.080

     Unit Hyd Qpeak  (cms)=     .376

     PEAK FLOW       (cms)=     .632 (i)
     TIME TO PEAK    (hrs)=    2.667
     RUNOFF VOLUME    (mm)=   49.665
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .577

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ----------------------------------------------------------------------------
006:0004---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN NASHYD      |   Area    (ha)=   18.25   Curve Number   (CN)=83.00
| 02:202    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ----------------------   U.H. Tp(hrs)=   1.230

     Unit Hyd Qpeak  (cms)=     .567

     PEAK FLOW       (cms)=    1.033 (i)
     TIME TO PEAK    (hrs)=    2.833
     RUNOFF VOLUME    (mm)=   52.411
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .609

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ----------------------------------------------------------------------------
006:0005---------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Catchment North of Haldimand Road
*#-----------------|----------------------------------------------------------|
 ----------------------
| DESIGN STANDHYD    |   Area    (ha)=    2.53
| 03:203    DT= 1.00 |   Total Imp(%)=   60.00   Dir. Conn.(%)=   60.00
 ----------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.52         1.01
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .43          .43
     Length            (m)=     129.87        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     181.81       102.07
```

```
                  over (min)        3.00        14.00
      Storage Coeff.  (min)=       3.03 (ii)   14.13 (ii)
      Unit Hyd. Tpeak (min)=       3.00        14.00
      Unit Hyd. peak  (cms)=        .37          .08
                                                            *TOTALS*
      PEAK FLOW       (cms)=        .74          .19          .841 (iii)
      TIME TO PEAK    (hrs)=       1.50         1.68         1.500
      RUNOFF VOLUME    (mm)=      85.33        52.41        72.163
      TOTAL RAINFALL   (mm)=      86.13        86.13        86.130
      RUNOFF COEFFICIENT   =        .99          .61          .838

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  83.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ------------------------------------------------------------------------------
 006:0006----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Catchment North of Haldimand Road
 *#-----------------|-----------------------------------------------------------|
 ---------------------
 | DESIGN NASHYD      |   Area    (ha)=    3.20   Curve Number   (CN)=80.00
 | 04:204    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ---------------------    U.H. Tp(hrs)=    .970

      Unit Hyd Qpeak  (cms)=     .126

      PEAK FLOW       (cms)=     .201 (i)
      TIME TO PEAK    (hrs)=    2.583
      RUNOFF VOLUME    (mm)=   48.351
      TOTAL RAINFALL   (mm)=   86.130
      RUNOFF COEFFICIENT   =     .561

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ------------------------------------------------------------------------------
 006:0007----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 *# Dry End-of-Pipe SWM Facility
 *#-----------------|-----------------------------------------------------------|
 --------------------
 | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
 |  IN>03:(203   )   |
 | OUT<05:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
 ---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)     (ha.m.)   |    (cms)     (ha.m.)
                             .000  .0000E+00   |      .111  .9710E-01
                             .001  .1800E-02   |      .125  .1188E+00
                             .002  .1040E-01   |      .138  .1411E+00
                             .006  .1810E-01   |      .209  .1640E+00
                             .014  .2770E-01   |      .336  .1876E+00
                             .027  .3870E-01   |      .505  .2117E+00
                             .044  .5090E-01   |      .713  .2365E+00
                             .073  .6420E-01   |      .961  .2620E+00
                             .094  .7880E-01   |      .000  .0000E+00

      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
      --------------------       (ha)     (cms)     (hrs)       (mm)
      INFLOW >03: (203   )       2.53      .841     1.500     72.163
      OUTFLOW<05: (501   )       2.53      .128     2.217     72.162

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=   15.208
                   TIME SHIFT OF PEAK FLOW         (min)=    43.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1238E+00

 ------------------------------------------------------------------------------
 006:0008----------------------------------------------------------------------
 --------------------
 | ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
 --------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201       10.62      .632    2.67  49.67    .000
                +ID2 02:202       18.25     1.033    2.83  52.41    .000
                +ID3 04:204        3.20      .201    2.58  48.35    .000
                +ID4 05:501        2.53      .128    2.22  72.16    .000
                 =====================================================
                 SUM 06:401       34.60     1.978    2.75  52.64    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ------------------------------------------------------------------------------
 006:0009----------------------------------------------------------------------
 *#-----------------|-----------------------------------------------------------|
 ------------------------------------------------------------------------------
 006:0002----------------------------------------------------------------------
 ------------------------------------------------------------------------------
 006:0002----------------------------------------------------------------------
 ------------------------------------------------------------------------------
 006:0002----------------------------------------------------------------------
 ------------------------------------------------------------------------------
 006:0002----------------------------------------------------------------------
 ------------------------------------------------------------------------------
 006:0002----------------------------------------------------------------------
       FINISH
 ------------------------------------------------------------------------------
 ******************************************************************************
      WARNINGS / ERRORS / NOTES
      -------------------------
    Simulation ended on 2011-09-13     at 09:53:48
 ==============================================================================
```

Grand Renewable Energy Park

Samsung Renewable Energy Inc.

Substation Facility SWM Drainage Area Characteristics and Storage Requirements

	Drainage Areas (See below)
Total Area Tributary to Basin (ha)	2.53
Tributary Area requiring quality control (ha)	2.03
MOE Quality Control Requirement	Basic
Basin Design	Dry Pond
[1]Quality Control Volume Requirement (m^3/ha)	213
Extended Detention - Quality Control (m^3)	433

[1] Based on MOE guidelines and overall percent impervious

Catchment Number	Area (ha)	% Imperv (XIMP)
203	2.53	60%
Quality Control Area	**2.03**	**75%**
Quantity Control Area	**2.53**	**60%**

Grand Renewable Energy Park
Samsung Renewable Energy Inc.
Substation Facility SWM Basin Stage-Storage-Discharge Calculations

Rating Curve				
Elevation	Discharge	Active Storage	Drawdown (hrs)	
(m)	(m^3/s)	(m^3)	Increment	Total
199.45				
199.50	0.001	4	2.9	2.9
199.55	0.001	18	3.2	6.2
199.60	0.002	48	5.1	11.3
199.65	0.002	104	7.7	19.0
199.70	0.006	181	5.6	24.6
199.75	0.014	277	2.7	27.4
199.80	0.027	387	1.5	28.9
199.85	0.044	509	1.0	29.8
199.90	0.073	642	0.6	30.5
199.95	0.094	788	0.5	30.9
200.00	0.111	971	0.5	31.4
200.05	0.125	1,188	0.5	31.9
200.10	0.138	1,411	0.5	32.4
200.15	0.209	1,640	0.4	32.8
200.20	0.336	1,876	0.2	33.0
200.25	0.505	2,117	0.2	33.2
200.30	0.713	2,365	0.1	33.3
200.35	0.961	2,620	0.1	33.4

Volume Estimation			
Elevation	Area	Int. Vol	Cum. Vol
(m)	(m^2)	(m^3)	(m^3)
199.45			
199.50	175	4	4
199.55	350	13	18
199.60	860	30	48
199.65	1370	56	104
199.70	1735	78	181
199.75	2100	96	277
199.80	2315	110	387
199.85	2530	121	509
199.90	2795	133	642
199.95	3060	146	788
200.00	4270	183	971
200.05	4396	217	1188
200.10	4521	223	1411
200.15	4647	229	1640
200.20	4773	236	1876
200.25	4899	242	2117
200.30	5024	248	2365
200.35	5150	254	2620

Outlet Structure Controls				
Elevation	Orifice 1	Orifice 2	Weir	Total Flow
(m)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
199.45				
199.50	0.001			0.001
199.55	0.001			0.001
199.60	0.002			0.002
199.65	0.002			0.002
199.70	0.002	0.003		0.006
199.75	0.003	0.011		0.014
199.80	0.003	0.024		0.027
199.85	0.003	0.040		0.044
199.90	0.003	0.070		0.073
199.95	0.004	0.090		0.094
200.00	0.004	0.107		0.111
200.05	0.004	0.121		0.125
200.10	0.004	0.134		0.138
200.15	0.004	0.146	0.059	0.209
200.20	0.004	0.157	0.175	0.336
200.25	0.005	0.167	0.333	0.505
200.30	0.005	0.176	0.532	0.713
200.35	0.005	0.185	0.770	0.961

Parameters	
Orifice 1	
Orifice Invert Elev. (m)	Orifice Coeff.
199.45	0.60
Orifice Mid-point Elev. (m)	Perimeter (m)
199.48	0.16
Orifice Diam.(mm)	Area (m^2)
50	0.002
Weir Coeff. (semi-circular)	Orientation
1.62	Vertical
Orifice 2	
Orifice Invert Elev. (m)	Orifice Coeff.
199.65	0.60
Orifice Mid-point Elev. (m)	Perimeter (m)
199.83	1.10
Orifice Diam.(mm)	Area (m^2)
350	0.096
Weir Coeff. (semi-circular)	Orientation
1.62	Vertical
Emergency Overflow Weir	
Weir Invert (m)	Weir Length m)
200.10	3.0
Weir Coeff. (rect.)	Side Slopes
1.70	(H:V) (?:1)
Weir Coeff. (tri.)	3.0
0.60	

Orifice Equation Used: Orifice flow equation

$Q = C \cdot A \cdot (2 \cdot g \cdot h)^{0.5}$

where
- C = orifice coefficient
- A = area of orifice
- g = acceleration due to gravity
- h = head above centre line of orifice

Note: Sharp crested weir equation with equivalent linear length used for calculating orifice flow rates when head is below centre line

Sharp crested semi-circular weir equation

$Q=C*D^{2.5}*(H/D)^{1.88}$

where
- C = sharp crested semi-circular weir coefficient
- D = diameter of orifice
- H = head above orifice invert

Note: used when water elevation is below mid-point of orifice

Broad Crested Weir Equation: $Q = (C_{rectangle} \cdot L \cdot H^{3/2}) + ((C_{triangle} \cdot (8/15 \cdot (2*g)^{1/2} \cdot \tan \Theta/2) \cdot H^{5/2})$

where
- L = bottom width of weir
- H = head above weir invert
- S = side slopes (ratio of H:V)
- $C_{triangle}$ = triangular weir coefficient
- $C_{rectangle}$ = broad-crested rectangular weir coefficient
- g = 9.81 m/s^2
- $\Theta/2$ = angle formed by trapezoidal weir side slopes

APPENDIX C

OPERATION AND MAINTENANCE FACILITY ANALYSES

Grand Renewable Energy Park - O & M Facility
Samsung Renewable Energy Inc.
SCS Curve Number Determination
Existing Conditions

Site Soils: (as per Soil Survey Complex, OMAFRA / MNR, 2009)

Soil Type	**Hydrologic Soil Group**
Hal: Haldimand (clay)	C
Lic: Lincoln (clay)	D

TABLE OF CURVE NUMBERS (CN's)

Land Use	Hydrologic Soil Type						
	A	AB	B	BC	C	CD	D
Meadow	50	54	58	64.5	71	74.5	78
Woodlot	50	55.3	60.5	67	73.5	76.8	80
Long Grass	55	60	65	72	79	81.5	84
Lawns	60	65.5	71	77	83	86	89
Pasture/Range	58	61.5	65	70.5	76	78.5	81
Crop	66	70	74	78	82	84	86
Fallow (Bare)	77	82	86	89	91	93	94
Wetland	50	50	50	50	50	50	50

HYDROLOGIC SOIL TYPE (%) - Existing Conditions

Catchment	Hydrologic Soil Type						TOTAL
	A	AB	B	BC	C	CD	D	
101					100			100
102					93		7	100

LAND USE (%) - Existing Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Total
101						100			100
102		4				96			100

CURVE NUMBER (CN) - Existing Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Weighted CN
101	0	0	0	0	0	82	0	0	82
102	0	3	0	0	0	79	0	0	81

** post development catchments concerned with pervious CN values only
** AMC II assumed
** Hydrological Soil Group taken from OMAFRA website

Grand Renewable Energy Park - O & M Facility
Samsung Renewable Energy Inc.
SCS Curve Number Determination (Applies to Pervious Component of Developed Catchments Only)
Proposed Conditions

Site Soils: (as per Soil Survey Complex, OMAFRA / MNR, 2009)

Soil Type	**Hydrologic Soil Group**
Hal: Haldimand (clay)	C
Lic: Lincoln (clay)	D

TABLE OF CURVE NUMBERS (CN's)

Land Use	Hydrologic Soil Type						
	A	AB	B	BC	C	CD	D
Meadow	50	54	58	64.5	71	74.5	78
Woodlot	50	55.3	60.5	67	73.5	76.8	80
Long Grass	55	60	65	72	79	81.5	84
Lawns	60	65.5	71	77	83	86	89
Pasture/Range	58	61.5	65	70.5	76	78.5	81
Crop	66	70	74	78	82	84	86
Fallow (Bare)	77	82	86	89	91	93	94
Wetland	50	50	50	50	50	50	50
Streets, paved	98	98	98	98	98	98	98

HYDROLOGIC SOIL TYPE (%) - Proposed Conditions

Catchment	Hydrologic Soil Type							TOTAL
	A	AB	B	BC	C	CD	D	
201a					100			100
201b					100			100
202a					100			100
202b					87		13	100
202c					97		3	100

LAND USE (%) - Proposed Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Total
201a			75			25			100
201b			100						100
202a		4	96						100
202b		7	93						100
202c			100						100

CURVE NUMBER (CN) - Proposed Conditions

Catchment	Meadow	Woodlot	Long Grass	Lawns	Pasture Range	Crop	Fallow (Bare)	Wetland	Weighted CN
201a	0	0	59	0	0	21	0	0	80
201b	0	0	79	0	0	0	0	0	79
202a	0	3	76	0	0	0	0	0	79
202b	0	5	74	0	0	0	0	0	79
202c	0	0	79	0	0	0	0	0	79

** post development catchments concerned with pervious CN values only
** AMC II assumed
** Hydrological Soil Group taken from MTO Drainage Manual for each soil type

Grand Renewable Energy Park - O & M Facility
Samsung Renewable Energy Inc.
SWMHYMO Parameters

Existing Conditions

Catchment Number	Area Description	SWMHYMO Command	Area (ha)	CN	TIMP	XIMP	Slope (%)	Length (m)	Tc (hrs)	Tp (hrs)
101	Agricultural area draining to location of proposed access road	DESIGN NASHYD	11.1	82			0.60	500	1.29	0.78
102	Agricultural area draining to location of access road / solar module / O&M works	DESIGN NASHYD	13.8	81			0.90	650	1.29	0.77
		Total Area	24.9							

Proposed Conditions

Catchment Number	Area Description	SWMHYMO Command	Area (ha)	CN	TIMP	XIMP	Slope (%)	Length (m)	Tc (hrs)	Tp (hrs)
201a	Agricultural area to draining to diversion swale at east side of proposed access road	DESIGN NASHYD	10.9	80			0.60	470	1.25	0.75
201b	Access road right-of-way (most northerly 160 m stretch)	DESIGN STANDHYD	0.2	79	0.50	0.50	0.40	160	0.84	0.50
202a	Agricultural area draining to diversion swale at east side of access road / solar module	DESIGN NASHYD	6.3	79			0.60	470	1.25	0.75
202b	Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands	DESIGN STANDHYD	5.8	79	0.50	0.50	0.90	450	1.07	0.64
202c	Solar module area draining to diversion swale at west side of module	DESIGN NASHYD	1.7	79			0.63	150	0.70	0.42
		Total Area	24.9							

Notes:

CN calculated for pervious areas only for DESIGN STANDHYD. CN is a weighed average for DESIGN NASHYD

TIMP ········► *Total percent impervious*

XIMP ········► *Directly connected percent impervious*

Time of Concentration calculated using the Airport Method ········► $Tc = [\,3.26\,(1.1\text{-}C)\,L^{0.5}\,] / S^{0.33}$

Where: *C = Runoff Coefficient = 0.2 for undeveloped areas*

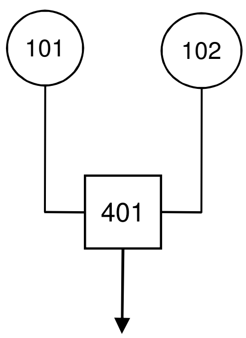
L = Length of Overland Flow (m)

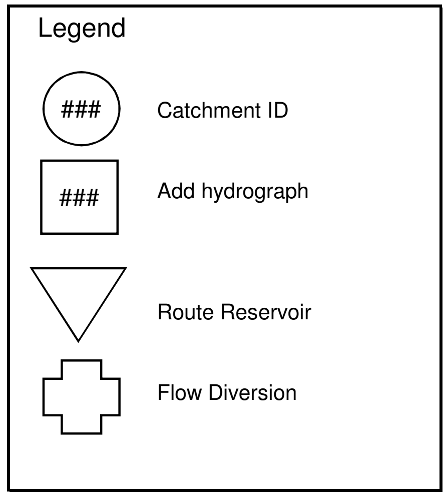
= (Area/1.5)^0.5

S = Slope (%)

Time to Peak ········► *Tp = 0.6Tc*

Grand Renewable Energy Park - O & M Facility
Samsung Renewable Energy Inc.
Existing Conditions SYMHYMO Schematic





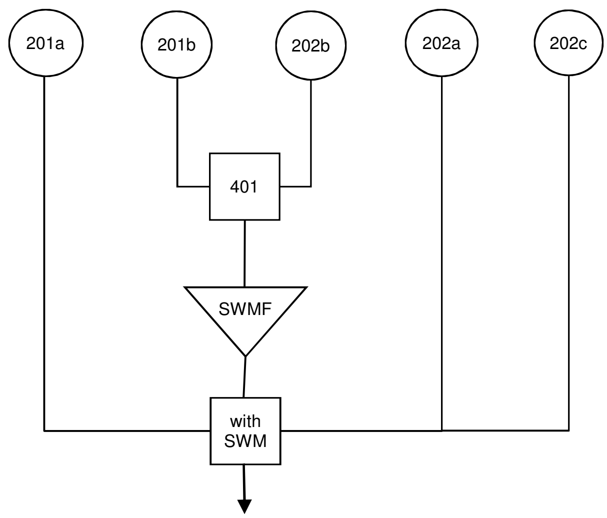
```
2     Metric units
*#*****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#*****************************************************************************
*#  EXISTING CONDITIONS
*#*****************************************************************************
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
*%                   ["hald2yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|-----------------------------------------------------------|
READ STORM           STORM_FILENAME=["STORM.001"]
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|-----------------------------------------------------------|
DESIGN NASHYD        ID=[1], NHYD=["101"], DT=[5]min, AREA=[11.10](ha),
                     DWF=[0](cms), CN/C=[82], TP=[0.78]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|-----------------------------------------------------------|
DESIGN NASHYD        ID=[2], NHYD=["102"], DT=[5]min, AREA=[13.8](ha),
                     DWF=[0](cms), CN/C=[81], TP=[0.77]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
ADD HYD              IDsum=[3], NHYD=["401"], IDs to add=[1+2]
*#-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[2]
*                    ["hald5yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[3]
*                    ["hald10yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[4]
*                    ["hald25yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[5]
*                    ["hald50yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[6]
*                    ["Hald100.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|-----------------------------------------------------------|
FINISH
```

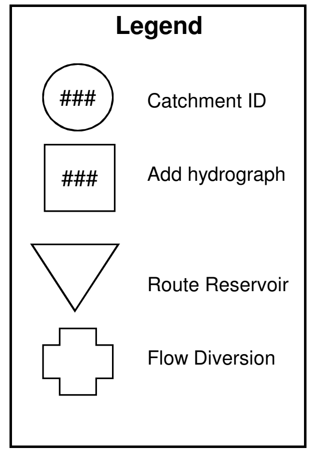
```
===========================================================================

SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  ========
S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
    S   W W   M   M  H   H    Y    M   M  O   O       9999   9999 July 1999
SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9 ========
                                                     9   9  9   9 # 4730904
      StormWater Management HYdrologic Model          999    999  ========

**************************************************************************
************************* SWMHYMO-99 Ver/4.02 ****************************
*******  A single event and continuous hydrologic simulation model  *******
*******     based on the principles of HYMO and its successors      *******
*******                 OTTHYMO-83 and OTTHYMO-89.                  *******
**************************************************************************
******* Distributed by:  J.F. Sabourin and Associates Inc.          *******
*******                  Ottawa,  Ontario: (613) 727-5199           *******
*******                  Gatineau, Quebec: (819) 243-6858           *******
*******                  E-Mail: swmhymo@jfsa.Com                   *******
**************************************************************************

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++ Licensed user: Stantec Consulting Ltd. (Kitchener)          +++++++
+++++++         Kitchener                  SERIAL#:4730904          +++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

**************************************************************************
*******           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *******
*******           Maximum value for ID numbers  :     10            *******
*******           Max. number of rainfall points:  15000            *******
*******           Max. number of flow points    :  15000            *******
**************************************************************************


 *******************   D E T A I L E D   O U T P U T   *******************
**************************************************************************
*       DATE: 2011-09-13      TIME: 08:59:44      RUN COUNTER: 001137       *
**************************************************************************
* Input   filename: C:\PROGRA~1\SWMHYMO\OM_Ex.dat                          *
* Output  filename: C:\PROGRA~1\SWMHYMO\OM_Ex.out                          *
* Summary filename: C:\PROGRA~1\SWMHYMO\OM_Ex.sum                          *
* User comments:                                                           *
* 1:_______________________________________________________________________*
* 2:_______________________________________________________________________*
* 3:_______________________________________________________________________*
**************************************************************************

-----------------------------------------------------------------------------
001:0001---------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   1
           #  1=hald2yr.3hr
-----------------------------------------------------------------------------
001:0002---------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald2yr.3hr
| Ptotal=  32.67 mm|    Comments: 2-yr, 3hr Chicago Storm - Haldimand Coun
--------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   2.850 |   1.00   6.930 |   1.83  10.920 |   2.67   3.420
                .33   3.200 |   1.17  10.320 |   2.00   7.380 |   2.83   3.040
                .50   3.670 |   1.33  21.580 |   2.17   5.640 |   3.00   2.750
                .67   4.320 |   1.50  73.990 |   2.33   4.600 |
                .83   5.290 |   1.67  22.240 |   2.50   3.910 |

-----------------------------------------------------------------------------
001:0003---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   11.10   Curve Number   (CN)=82.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .780

     Unit Hyd Qpeak  (cms)=     .544

     PEAK FLOW       (cms)=     .186 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   11.180
     TOTAL RAINFALL   (mm)=   32.675
     RUNOFF COEFFICIENT   =     .342

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0004---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   13.80   Curve Number   (CN)=81.00
| 02:102    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .770

     Unit Hyd Qpeak  (cms)=     .685

     PEAK FLOW       (cms)=     .223 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   10.709
     TOTAL RAINFALL   (mm)=   32.675
     RUNOFF COEFFICIENT   =     .328

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0005---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:101       11.10     .186    2.33  11.18     .000
                +ID2 02:102       13.80     .223    2.33  10.71     .000
                 ==================================================
                 SUM 03:401       24.90     .409    2.33  10.92     .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-----------------------------------------------------------------------------
001:0006---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
  ** END OF RUN :   1

*****************************************************************************





--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
           #  1=hald5yr.3hr
-----------------------------------------------------------------------------
002:0002---------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
-----------------------------------------------------------------------------
002:0002---------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald5yr.3hr
| Ptotal=  46.99 mm|    Comments: 5-yr, 3hr Chicago Storm - Haldimand Coun
--------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   3.900 |   1.00  10.080 |   1.83  16.310 |   2.67   4.730
                .33   4.410 |   1.17  15.370 |   2.00  10.770 |   2.83   4.180
                .50   5.100 |   1.33  32.790 |   2.17   8.090 |   3.00   3.750
                .67   6.070 |   1.50 103.040 |   2.33   6.510 |
                .83   7.550 |   1.67  33.800 |   2.50   5.470 |

-----------------------------------------------------------------------------
002:0003---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   11.10   Curve Number   (CN)=82.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .780

     Unit Hyd Qpeak  (cms)=     .544

     PEAK FLOW       (cms)=     .344 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   20.436
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .435

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
002:0004---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   13.80   Curve Number   (CN)=81.00
| 02:102    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .770

     Unit Hyd Qpeak  (cms)=     .685

     PEAK FLOW       (cms)=     .416 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   19.693
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .419

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
002:0005---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:101       11.10     .344    2.33  20.44     .000
                +ID2 02:102       13.80     .416    2.33  19.69     .000
                 ==================================================
                 SUM 03:401       24.90     .760    2.33  20.02     .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-----------------------------------------------------------------------------
002:0006---------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
-----------------------------------------------------------------------------
002:0002---------------------------------------------------------------------
  ** END OF RUN :   2

*****************************************************************************





--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 003
    NSTORM=   1
           #  1=hald10yr.3hr
-----------------------------------------------------------------------------
003:0002---------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#****************************************************************************
*#  EXISTING CONDITIONS
*#****************************************************************************
-----------------------------------------------------------------------------
003:0002---------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald10yr.3hr
```

```
| Ptotal=  56.54 mm|    Comments: 10-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.570 |   1.00  12.200 |   1.83  19.980 |   2.67   5.580
               .33   5.200 |   1.17  18.800 |   2.00  13.060 |   2.83   4.910
               .50   6.040 |   1.33  40.380 |   2.17   9.720 |   3.00   4.390
               .67   7.230 |   1.50 122.290 |   2.33   7.760 |
               .83   9.060 |   1.67  41.620 |   2.50   6.480 |
-------------------------------------------------------------------------------
003:0003-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|------------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   11.10   Curve Number   (CN)=82.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .780
     Unit Hyd Qpeak  (cms)=     .544
     PEAK FLOW       (cms)=     .463 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   27.346
     TOTAL RAINFALL   (mm)=   56.545
     RUNOFF COEFFICIENT   =     .484
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
-------------------------------------------------------------------------------
003:0004-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|------------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   13.80   Curve Number   (CN)=81.00
| 02:102    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .770
     Unit Hyd Qpeak  (cms)=     .685
     PEAK FLOW       (cms)=     .562 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   26.434
     TOTAL RAINFALL   (mm)=   56.545
     RUNOFF COEFFICIENT   =     .467
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
-------------------------------------------------------------------------------
003:0005-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:101       11.10     .463    2.33  27.35    .000
                +ID2 02:102       13.80     .562    2.33  26.43    .000
                 ==================================================
                 SUM 03:401       24.90    1.025    2.33  26.84    .000
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
003:0006-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
-------------------------------------------------------------------------------
003:0002-----------------------------------------------------------------------
-------------------------------------------------------------------------------
003:0002-----------------------------------------------------------------------
  ** END OF RUN :   3
*******************************************************************************
--------------------
| START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 004
    NSTORM=   1
           #  1=hald25yr.3hr
-------------------------------------------------------------------------------
004:0002-----------------------------------------------------------------------
*******************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*******************************************************************************
*#  EXISTING CONDITIONS
*******************************************************************************
-------------------------------------------------------------------------------
004:0002-----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald25yr.3hr
| Ptotal=  68.72 mm|    Comments: 25-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.460 |   1.00  14.960 |   1.83  24.740 |   2.67   6.700
               .33   6.230 |   1.17  23.260 |   2.00  16.040 |   2.83   5.870
               .50   7.260 |   1.33  50.040 |   2.17  11.850 |   3.00   5.240
               .67   8.740 |   1.50 146.100 |   2.33   9.410 |
               .83  11.020 |   1.67  51.580 |   2.50   7.820 |
-------------------------------------------------------------------------------
004:0003-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|------------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   11.10   Curve Number   (CN)=82.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .780
     Unit Hyd Qpeak  (cms)=     .544
     PEAK FLOW       (cms)=     .625 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   36.743
     TOTAL RAINFALL   (mm)=   68.720
     RUNOFF COEFFICIENT   =     .535
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
-------------------------------------------------------------------------------
004:0004-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|------------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   13.80   Curve Number   (CN)=81.00
| 02:102    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .770
     Unit Hyd Qpeak  (cms)=     .685
     PEAK FLOW       (cms)=     .761 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   35.635
     TOTAL RAINFALL   (mm)=   68.720
     RUNOFF COEFFICIENT   =     .519
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
-------------------------------------------------------------------------------
004:0005-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:101       11.10     .625    2.33  36.74    .000
                +ID2 02:102       13.80     .761    2.33  35.64    .000
                 ==================================================
                 SUM 03:401       24.90    1.386    2.33  36.13    .000
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
004:0006-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
-------------------------------------------------------------------------------
004:0002-----------------------------------------------------------------------
-------------------------------------------------------------------------------
004:0002-----------------------------------------------------------------------
-------------------------------------------------------------------------------
004:0002-----------------------------------------------------------------------
  ** END OF RUN :   4
*******************************************************************************
--------------------
| START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
           #  1=hald50yr.3hr
-------------------------------------------------------------------------------
005:0002-----------------------------------------------------------------------
*******************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*******************************************************************************
*#  EXISTING CONDITIONS
*******************************************************************************
-------------------------------------------------------------------------------
005:0002-----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald50yr.3hr
| Ptotal=  76.91 mm|    Comments: 50-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   6.030 |   1.00  16.650 |   1.83  27.610 |   2.67   7.420
               .33   6.890 |   1.17  25.950 |   2.00  17.860 |   2.83   6.490
               .50   8.040 |   1.33  56.090 |   2.17  13.160 |   3.00   5.790
               .67   9.690 |   1.50 164.610 |   2.33  10.440 |
               .83  12.240 |   1.67  57.820 |   2.50   8.660 |
-------------------------------------------------------------------------------
005:0003-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|------------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   11.10   Curve Number   (CN)=82.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .780
     Unit Hyd Qpeak  (cms)=     .544
     PEAK FLOW       (cms)=     .741 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   43.352
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .564
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
-------------------------------------------------------------------------------
005:0004-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|------------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   13.80   Curve Number   (CN)=81.00
| 02:102    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .770
     Unit Hyd Qpeak  (cms)=     .685
     PEAK FLOW       (cms)=     .902 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   42.124
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .548
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
-------------------------------------------------------------------------------
005:0005-----------------------------------------------------------------------
*#-----------------|------------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:101       11.10     .741    2.33  43.35    .000
                +ID2 02:102       13.80     .902    2.33  42.12    .000
                 ==================================================
                 SUM 03:401       24.90    1.643    2.33  42.67    .000
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
```

```
005:0006----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
  ** END OF RUN :   5

******************************************************************************





--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 006
    NSTORM=   1
           #  1=Hald100.3hr
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#*****************************************************************************
*#  EXISTING CONDITIONS
*#*****************************************************************************
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\Hald100.3hr
| Ptotal=  86.13 mm|    Comments: 100-yr, 3hr Chicago Storm - Haldimand Co
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   6.610 |   1.00  18.780 |   1.83  31.440 |   2.67   8.170
               .33   7.570 |   1.17  29.530 |   2.00  20.170 |   2.83   7.130
               .50   8.890 |   1.33  63.970 |   2.17  14.760 |   3.00   6.330
               .67  10.770 |   1.50 181.810 |   2.33  11.620 |
               .83  13.700 |   1.67  65.940 |   2.50   9.590 |

------------------------------------------------------------------------------
006:0003----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of proposed access road
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   11.10   Curve Number   (CN)=82.00
| 01:101    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .780

     Unit Hyd Qpeak  (cms)=     .544

     PEAK FLOW       (cms)=     .874 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   51.018
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .592

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
006:0004----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to location of access road/solar module/O&M works
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   13.80   Curve Number   (CN)=81.00
| 02:102    DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .770

     Unit Hyd Qpeak  (cms)=     .685

     PEAK FLOW       (cms)=    1.067 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   49.665
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .577

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
006:0005----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:101       11.10      .874    2.33  51.02    .000
               +ID2 02:102       13.80     1.067    2.33  49.67    .000
                ===================================================
                SUM 03:401       24.90     1.942    2.33  50.27    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
006:0006----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
006:0002----------------------------------------------------------------------
      FINISH
------------------------------------------------------------------------------
******************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2011-09-13     at 08:59:45
==============================================================================
```

Grand Renewable Energy Park - O & M Facility
Samsung Renewable Energy Inc.
Proposed Conditions SYMHYMO Schematic





```
2     Metric units
*#*****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#*****************************************************************************
*#  PROPOSED CONDITIONS
*#*****************************************************************************
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
*%                   ["hald2yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|-----------------------------------------------------------|
READ STORM           STORM_FILENAME=["STORM.001"]
*#-----------------|-----------------------------------------------------------|
*# Agricultural area to draining to diversion swale at east side of access road
*#-----------------|-----------------------------------------------------------|
DESIGN NASHYD        ID=[1], NHYD=["201a"], DT=[5]min, AREA=[10.9](ha),
                     DWF=[0](cms), CN/C=[80], TP=[0.75]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
*# Access road right-of-way (most northerly 160 m stretch)
*#-----------------|-----------------------------------------------------------|
DESIGN STANDHYD      ID=[2], NHYD=["201b"], DT=[1]min, AREA=[0.2](ha),
                     XIMP=[0.5], TIMP=[0.5], DWF=[0](cms), LOSS=[2], CN=[79],
                     SLOPE=[0.6](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to diversion swale at access road/solar module
*#-----------------|-----------------------------------------------------------|
DESIGN NASHYD        ID=[3], NHYD=["202a"], DT=[5]min, AREA=[6.3](ha),
                     DWF=[0](cms), CN/C=[79], TP=[0.75]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
*# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
*#-----------------|-----------------------------------------------------------|
DESIGN STANDHYD      ID=[4], NHYD=["202b"], DT=[1]min, AREA=[5.8](ha),
                     XIMP=[0.5], TIMP=[0.5], DWF=[0](cms), LOSS=[2], CN=[79],
                     SLOPE=[0.9](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
*# Sum of flows to constructed wetland SWMF
*#-----------------|-----------------------------------------------------------|
ADD HYD              IDsum=[5], NHYD=["401"], IDs to add=[2+4]
*#-----------------|-----------------------------------------------------------|
*# Constructed wetland SWMF
*#-----------------|-----------------------------------------------------------|
ROUTE RESERVOIR      IDout=[6],   NHYD=["501"],  IDin=[5],
                     RDT=[1](min),
                           TABLE of ( OUTFLOW-STORAGE ) values
                                    (cms) - (ha-m)
                                  [   0.0 ,  0.0 ]
                                  [ 0.003 ,  0.0289 ]
                                  [ 0.005 ,  0.0595 ]
                                  [ 0.016 ,  0.0916 ]
                                  [ 0.049 ,  0.1253 ]
                                  [ 0.081 ,  0.1607 ]
                                  [ 0.103 ,  0.1976 ]
                                  [ 0.121 ,  0.2361 ]
                                  [ 0.136 ,  0.2763 ]
                                  [ 0.150 ,  0.3180 ]
                                  [ 0.454 ,  0.3613 ]
                                  [ 1.062 ,  0.4063 ]
                                  [ 1.932 ,  0.4528 ]
                                  [   -1  ,  -1  ]  (max twenty pts)
                           IDovf=[   ], NHYDovf=[   ]
*%-----------------|-----------------------------------------------------------|
*# Solar module area draining to diversion swale at west side of module
*#-----------------|-----------------------------------------------------------|
DESIGN NASHYD        ID=[7], NHYD=["202c"], DT=[5]min, AREA=[1.70](ha),
                     DWF=[0](cms), CN/C=[79], TP=[0.42]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*#-----------------|-----------------------------------------------------------|
ADD HYD              IDsum=[8], NHYD=["woutSWM"], IDs to add=[1+2+3+4+7]
*#-----------------|-----------------------------------------------------------|
ADD HYD              IDsum=[10], NHYD=["withSWM"], IDs to add=[1+3+6+7]
*#-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[2]
*                    ["hald5yr.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[3]
*                    ["hald10yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[4]
*                    ["hald25yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[5]
*                    ["hald50yr.3hr"] <--storm filename, one per line for NSTORM
*%-----------------|-----------------------------------------------------------|
START                TZERO=[0.0]hrs or date,  METOUT=[2],  NSTORM=[1],  NRUN=[6]
*                    ["Hald100.3hr"] <--storm filename, one per line for NSTORM t
*%-----------------|-----------------------------------------------------------|
FINISH
```

```
===========================================================================
 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  =========
 S       W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9   9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9   9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O      9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO          9      9 =========
                                                      9   9   9   9 # 4730904
      StormWater Management HYdrologic Model           999    999  =========
 **************************************************************************
 ************************* SWMHYMO-99 Ver/4.02 ****************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                OTTHYMO-83 and OTTHYMO-89.                    *******
 **************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.          *******
 *******                  Ottawa,  Ontario: (613) 727-5199           *******
 *******                  Gatineau, Quebec: (819) 243-6858           *******
 *******                  E-Mail: swmhymo@jfsa.Com                   *******
 **************************************************************************
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Stantec Consulting Ltd. (Kitchener)          +++++++
 +++++++                 Kitchener            SERIAL#:4730904        +++++++
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 **************************************************************************
 *******            ++++++ PROGRAM ARRAY DIMENSIONS ++++++          *******
 *******            Maximum value for ID numbers  :     10          *******
 *******            Max. number of rainfall points:  15000          *******
 *******            Max. number of flow points    :  15000          *******
 **************************************************************************
 *******************   D E T A I L E D   O U T P U T   ******************
 **************************************************************************
 *       DATE: 2011-09-13     TIME: 09:22:02     RUN COUNTER: 001138      *
 **************************************************************************
 * Input   filename: C:\PROGRA~1\SWMHYMO\OM_Prop.dat                      *
 * Output  filename: C:\PROGRA~1\SWMHYMO\OM_Prop.out                      *
 * Summary filename: C:\PROGRA~1\SWMHYMO\OM_Prop.sum                      *
 * User comments:                                                         *
 * 1:_____________________________________________________________________*
 * 2:_____________________________________________________________________*
 * 3:_____________________________________________________________________*
 **************************************************************************
-----------------------------------------------------------------------------
001:0001--------------------------------------------------------------------
*#***************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#***************************************************************************
*#  PROPOSED CONDITIONS
*#***************************************************************************
--------------------
| START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   1
           #  1=hald2yr.3hr
-----------------------------------------------------------------------------
001:0002--------------------------------------------------------------------
--------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\hald2yr.3hr
| Ptotal=  32.67 mm|    Comments: 2-yr, 3hr Chicago Storm - Haldimand Coun
--------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   2.850 |   1.00   6.930 |   1.83  10.920 |   2.67   3.420
                .33   3.200 |   1.17  10.320 |   2.00   7.380 |   2.83   3.040
                .50   3.670 |   1.33  21.580 |   2.17   5.640 |   3.00   2.750
                .67   4.320 |   1.50  73.990 |   2.33   4.600 |
                .83   5.290 |   1.67  22.240 |   2.50   3.910 |
-----------------------------------------------------------------------------
001:0003--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Agricultural area to draining to diversion swale at east side of access road
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   10.90   Curve Number   (CN)=80.00
| 01:201a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .555

     PEAK FLOW       (cms)=     .172 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   10.265
     TOTAL RAINFALL   (mm)=   32.675
     RUNOFF COEFFICIENT   =     .314

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0004--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Access road right-of-way (most northerly 160 m stretch)
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=     .20
| 02:201b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=         .10          .10
     Dep. Storage     (mm)=         .80         1.50
     Average Slope     (%)=         .60          .60
     Length            (m)=       36.51        40.00
     Mannings n           =        .013         .250

     Max.eff.Inten.(mm/hr)=       73.99        14.62
                over (min)         2.00        24.00
     Storage Coeff.  (min)=        1.84 (ii)   23.69 (ii)
     Unit Hyd. Tpeak (min)=        2.00        24.00
     Unit Hyd. peak  (cms)=         .59          .05
                                                            *TOTALS*
     PEAK FLOW       (cms)=         .02          .00          .021 (iii)
     TIME TO PEAK    (hrs)=        1.50         1.87         1.500
     RUNOFF VOLUME    (mm)=       31.87         9.85        20.861
     TOTAL RAINFALL   (mm)=       32.67        32.67        32.675
     RUNOFF COEFFICIENT   =         .98          .30          .638

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0005--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Agricultural area draining to diversion swale at access road/solar module
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    6.30   Curve Number   (CN)=79.00
| 03:202a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .321

     PEAK FLOW       (cms)=     .095 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=    9.847
     TOTAL RAINFALL   (mm)=   32.675
     RUNOFF COEFFICIENT   =     .301

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0006--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=    5.80
| 04:202b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        2.90         2.90
     Dep. Storage     (mm)=         .80         1.50
     Average Slope     (%)=         .90          .90
     Length            (m)=      196.64        40.00
     Mannings n           =        .013         .250

     Max.eff.Inten.(mm/hr)=       73.99        14.62
                over (min)         4.00        24.00
     Storage Coeff.  (min)=        4.46 (ii)   23.81 (ii)
     Unit Hyd. Tpeak (min)=        4.00        24.00
     Unit Hyd. peak  (cms)=         .26          .05
                                                            *TOTALS*
     PEAK FLOW       (cms)=         .53          .07          .546 (iii)
     TIME TO PEAK    (hrs)=        1.50         1.87         1.517
     RUNOFF VOLUME    (mm)=       31.87         9.85        20.861
     TOTAL RAINFALL   (mm)=       32.67        32.67        32.675
     RUNOFF COEFFICIENT   =         .98          .30          .638

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0007--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Sum of flows to constructed wetland SWMF
*#-----------------|----------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                  ID1 02:201b       .20      .021    1.50  20.86    .000
                 +ID2 04:202b      5.80      .546    1.52  20.86    .000
                  =================================================
                  SUM 05:401       6.00      .567    1.50  20.86    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-----------------------------------------------------------------------------
001:0008--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Constructed wetland SWMF
*#-----------------|----------------------------------------------------------|
--------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(401   )   |
| OUT<06:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
--------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)     (ha.m.)   |    (cms)     (ha.m.)
                            .000  .0000E+00   |     .121  .2361E+00
                            .003  .2890E-01   |     .136  .2763E+00
                            .005  .5950E-01   |     .150  .3180E+00
                            .016  .9160E-01   |     .454  .3613E+00
                            .049  .1253E+00   |    1.062  .4063E+00
                            .081  .1607E+00   |    1.932  .4528E+00
                            .103  .1976E+00   |     .000  .0000E+00

     ROUTING RESULTS              AREA     QPEAK     TPEAK        R.V.
     --------------------         (ha)     (cms)     (hrs)        (mm)
     INFLOW >05: (401   )         6.00      .567     1.500      20.861
     OUTFLOW<06: (501   )         6.00      .033     3.067      20.860

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=     5.767
                  TIME SHIFT OF PEAK FLOW         (min)=     94.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.1086E+00

-----------------------------------------------------------------------------
001:0009--------------------------------------------------------------------
*# Solar module area draining to diversion swale at west side of module
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    1.70   Curve Number   (CN)=79.00
| 07:202c   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------   U.H. Tp(hrs)=    .420

     Unit Hyd Qpeak  (cms)=     .155

     PEAK FLOW       (cms)=     .039 (i)
     TIME TO PEAK    (hrs)=    1.917
     RUNOFF VOLUME    (mm)=    9.847
     TOTAL RAINFALL   (mm)=   32.675
     RUNOFF COEFFICIENT   =     .301

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0010--------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
--------------------
| ADD HYD (woutSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                  ID1 01:201a     10.90      .172    2.33  10.27    .000
                 +ID2 02:201b       .20      .021    1.50  20.86    .000
                 +ID3 03:202a      6.30      .095    2.33   9.85    .000
                 +ID4 04:202b      5.80      .546    1.52  20.86    .000
                 +ID5 07:202c      1.70      .039    1.92   9.85    .000
                  =================================================
                  SUM 08:woutSW   24.90      .624    1.52  12.68    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-----------------------------------------------------------------------------
001:0011--------------------------------------------------------------------
```

```
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (withSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .172    2.33  10.27    .000
                +ID2 03:202a       6.30      .095    2.33   9.85    .000
                +ID3 06:501        6.00      .033    3.07  20.86    .000
                +ID4 07:202c       1.70      .039    1.92   9.85    .000
                 =======================================================
                 SUM 10:withSW    24.90      .321    2.33  12.68    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0012-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
  ** END OF RUN :   1

*******************************************************************************





--------------------
| START            |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
          #  1=hald5yr.3hr
-------------------------------------------------------------------------------
002:0002-----------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#*****************************************************************************
*#  PROPOSED CONDITIONS
*#*****************************************************************************
-------------------------------------------------------------------------------
002:0002-----------------------------------------------------------------------
--------------------
| READ STORM       |    Filename: C:\PROGRA~1\SWMHYMO\hald5yr.3hr
| Ptotal=  46.99 mm|    Comments: 5-yr, 3hr Chicago Storm - Haldimand Coun
--------------------
              TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
               .17   3.900 |  1.00  10.080 |  1.83  16.310 |  2.67   4.730
               .33   4.410 |  1.17  15.370 |  2.00  10.770 |  2.83   4.180
               .50   5.100 |  1.33  32.790 |  2.17   8.090 |  3.00   3.750
               .67   6.070 |  1.50 103.040 |  2.33   6.510 |
               .83   7.550 |  1.67  33.800 |  2.50   5.470 |

-------------------------------------------------------------------------------
002:0003-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area to draining to diversion swale at east side of access road
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=   10.90   Curve Number   (CN)=80.00
| 01:201a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .555

     PEAK FLOW       (cms)=     .323 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   18.984
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .404

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0004-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Access road right-of-way (most northerly 160 m stretch)
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN STANDHYD    |   Area    (ha)=     .20
| 02:201b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .10          .10
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .60          .60
     Length            (m)=      36.51        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     103.04        31.97
                over (min)       2.00        18.00
     Storage Coeff.  (min)=       1.61 (ii)   17.59 (ii)
     Unit Hyd. Tpeak (min)=       2.00        18.00
     Unit Hyd. peak  (cms)=        .64          .06
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .03          .01          .031 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.77         1.500
     RUNOFF VOLUME    (mm)=      46.19        18.31        32.248
     TOTAL RAINFALL   (mm)=      46.99        46.99        46.987
     RUNOFF COEFFICIENT   =        .98          .39          .686

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0005-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Agricultural area draining to diversion swale at access road/solar module
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=    6.30   Curve Number   (CN)=79.00
| 03:202a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .321

     PEAK FLOW       (cms)=     .180 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   18.309
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .390

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0006-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN STANDHYD    |   Area    (ha)=    5.80
| 04:202b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.90         2.90
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .90          .90
     Length            (m)=     196.64        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     103.04        31.97
                over (min)       4.00        18.00
     Storage Coeff.  (min)=       3.91 (ii)   18.06 (ii)
     Unit Hyd. Tpeak (min)=       4.00        18.00
     Unit Hyd. peak  (cms)=        .29          .06
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .76          .16          .820 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.77         1.517
     RUNOFF VOLUME    (mm)=      46.19        18.31        32.248
     TOTAL RAINFALL   (mm)=      46.99        46.99        46.987
     RUNOFF COEFFICIENT   =        .98          .39          .686

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0007-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Sum of flows to constructed wetland SWMF
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 02:201b        .20      .031    1.50  32.25    .000
                +ID2 04:202b       5.80      .820    1.52  32.25    .000
                 =======================================================
                 SUM 05:401        6.00      .850    1.50  32.25    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
002:0008-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
*# Constructed wetland SWMF
*#-----------------|-----------------------------------------------------------|
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(401   )   |
| OUT<06:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |   (cms)    (ha.m.)
                            .000  .0000E+00   |     .121  .2361E+00
                            .003  .2890E-01   |     .136  .2763E+00
                            .005  .5950E-01   |     .150  .3180E+00
                            .016  .9160E-01   |     .454  .3613E+00
                            .049  .1253E+00   |    1.062  .4063E+00
                            .081  .1607E+00   |    1.932  .4528E+00
                            .103  .1976E+00   |     .000  .0000E+00

     ROUTING RESULTS             AREA     QPEAK      TPEAK        R.V.
     --------------------        (ha)     (cms)      (hrs)        (mm)
     INFLOW >05: (401   )        6.00      .850      1.500      32.248
     OUTFLOW<06: (501   )        6.00      .076      2.767      32.246

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.913
                    TIME SHIFT OF PEAK FLOW         (min)=    76.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1549E+00

-------------------------------------------------------------------------------
002:0009-----------------------------------------------------------------------
*# Solar module area draining to diversion swale at west side of module
*#-----------------|-----------------------------------------------------------|
----------------------
| DESIGN NASHYD      |   Area    (ha)=    1.70   Curve Number   (CN)=79.00
| 07:202c   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .420

     Unit Hyd Qpeak  (cms)=     .155

     PEAK FLOW       (cms)=     .073 (i)
     TIME TO PEAK    (hrs)=    1.917
     RUNOFF VOLUME    (mm)=   18.309
     TOTAL RAINFALL   (mm)=   46.987
     RUNOFF COEFFICIENT   =     .390

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0010-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (woutSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .323    2.33  18.98    .000
                +ID2 02:201b        .20      .031    1.50  32.25    .000
                +ID3 03:202a       6.30      .180    2.33  18.31    .000
                +ID4 04:202b       5.80      .820    1.52  32.25    .000
                +ID5 07:202c       1.70      .073    1.92  18.31    .000
                 =======================================================
                 SUM 08:woutSW    24.90      .969    1.52  21.96    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
002:0011-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
--------------------
| ADD HYD (withSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .323    2.33  18.98    .000
                +ID2 03:202a       6.30      .180    2.33  18.31    .000
                +ID3 06:501        6.00      .076    2.77  32.25    .000
                +ID4 07:202c       1.70      .073    1.92  18.31    .000
                 =======================================================
                 SUM 10:withSW    24.90      .628    2.25  21.96    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
002:0012-----------------------------------------------------------------------
*#-----------------|-----------------------------------------------------------|
-------------------------------------------------------------------------------
002:0002-----------------------------------------------------------------------
  ** END OF RUN :   2

*******************************************************************************
```

```


 -------------------
 | START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
 -------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 003
    NSTORM=   1
           #  1=hald10yr.3hr
 ---------------------------------------------------------------------------------
 003:0002-------------------------------------------------------------------------
 *#********************************************************************************
 *#  Project Name  : Grand Renewable Energy Park - O & M Facility
 *#  Project Number: 1610-10624
 *#  Date          : 1-27-2011
 *#  Company       : Stantec Consulting Ltd. (Kitchener)
 *#  Modeller      : S Robertson
 *#  License #     : 4730904
 *#********************************************************************************
 *#  PROPOSED CONDITIONS
 *#********************************************************************************
 ---------------------------------------------------------------------------------
 003:0002-------------------------------------------------------------------------
 -------------------
 | READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\hald10yr.3hr
 | Ptotal=  56.54 mm|    Comments: 10-yr, 3hr Chicago Storm - Haldimand Cou
 -------------------
               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                .17   4.570 |   1.00  12.200 |   1.83  19.980 |   2.67   5.580
                .33   5.200 |   1.17  18.800 |   2.00  13.060 |   2.83   4.910
                .50   6.040 |   1.33  40.380 |   2.17   9.720 |   3.00   4.390
                .67   7.230 |   1.50 122.290 |   2.33   7.760 |
                .83   9.060 |   1.67  41.620 |   2.50   6.480 |

 ---------------------------------------------------------------------------------
 003:0003-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 *# Agricultural area to draining to diversion swale at east side of access road
 *#-----------------|---------------------------------------------------------------|
 ---------------------
 | DESIGN NASHYD      |   Area    (ha)=   10.90   Curve Number   (CN)=80.00
 | 01:201a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ---------------------   U.H. Tp(hrs)=    .750

      Unit Hyd Qpeak  (cms)=     .555

      PEAK FLOW       (cms)=     .437 (i)
      TIME TO PEAK    (hrs)=    2.333
      RUNOFF VOLUME    (mm)=   25.560
      TOTAL RAINFALL   (mm)=   56.545
      RUNOFF COEFFICIENT   =     .452

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ---------------------------------------------------------------------------------
 003:0004-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 *# Access road right-of-way (most northerly 160 m stretch)
 *#-----------------|---------------------------------------------------------------|
 ---------------------
 | DESIGN STANDHYD    |   Area    (ha)=     .20
 | 02:201b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
 ---------------------
                            IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=       .10         .10
      Dep. Storage     (mm)=       .80        1.50
      Average Slope     (%)=       .60         .60
      Length            (m)=     36.51       40.00
      Mannings n           =      .013        .250

      Max.eff.Inten.(mm/hr)=    122.29       46.64
                 over (min)       2.00       15.00
      Storage Coeff.  (min)=      1.50 (ii)  15.24 (ii)
      Unit Hyd. Tpeak (min)=      2.00       15.00
      Unit Hyd. peak  (cms)=       .66         .07
                                                          *TOTALS*
      PEAK FLOW       (cms)=       .03         .01          .038 (iii)
      TIME TO PEAK    (hrs)=      1.50        1.72         1.500
      RUNOFF VOLUME    (mm)=     55.74       24.72        40.233
      TOTAL RAINFALL   (mm)=     56.54       56.54        56.545
      RUNOFF COEFFICIENT   =       .99         .44          .712

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  79.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ---------------------------------------------------------------------------------
 003:0005-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 *# Agricultural area draining to diversion swale at access road/solar module
 *#-----------------|---------------------------------------------------------------|
 ---------------------
 | DESIGN NASHYD      |   Area    (ha)=    6.30   Curve Number   (CN)=79.00
 | 03:202a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ---------------------   U.H. Tp(hrs)=    .750

      Unit Hyd Qpeak  (cms)=     .321

      PEAK FLOW       (cms)=     .244 (i)
      TIME TO PEAK    (hrs)=    2.333
      RUNOFF VOLUME    (mm)=   24.721
      TOTAL RAINFALL   (mm)=   56.545
      RUNOFF COEFFICIENT   =     .437

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ---------------------------------------------------------------------------------
 003:0006-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 *# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
 *#-----------------|---------------------------------------------------------------|
 ---------------------
 | DESIGN STANDHYD    |   Area    (ha)=    5.80
 | 04:202b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
 ---------------------
                            IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=      2.90        2.90
      Dep. Storage     (mm)=       .80        1.50
      Average Slope     (%)=       .90         .90
      Length            (m)=    196.64       40.00
      Mannings n           =      .013        .250

      Max.eff.Inten.(mm/hr)=    122.29       45.30
                 over (min)       4.00       16.00
      Storage Coeff.  (min)=      3.65 (ii)  15.96 (ii)
      Unit Hyd. Tpeak (min)=      4.00       16.00
      Unit Hyd. peak  (cms)=       .30         .07
                                                          *TOTALS*
      PEAK FLOW       (cms)=       .91         .23         1.017 (iii)
      TIME TO PEAK    (hrs)=      1.50        1.73         1.517
      RUNOFF VOLUME    (mm)=     55.74       24.72        40.233
      TOTAL RAINFALL   (mm)=     56.54       56.54        56.545
      RUNOFF COEFFICIENT   =       .99         .44          .712

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  79.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ---------------------------------------------------------------------------------
 003:0007-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 *# Sum of flows to constructed wetland SWMF
 *#-----------------|---------------------------------------------------------------|
 --------------------
 | ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
 --------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                  ID1 02:201b       .20      .038    1.50  40.23    .000
                 +ID2 04:202b      5.80     1.017    1.52  40.23    .000
                  ==================================================
                  SUM 05:401       6.00     1.054    1.50  40.23    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ---------------------------------------------------------------------------------
 003:0008-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 *# Constructed wetland SWMF
 *#-----------------|---------------------------------------------------------------|
 ---------------------
 | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
 |  IN>05:(401   )    |
 | OUT<06:(501   )    |    =========  OUTLFOW STORAGE TABLE  =========
 ---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)     (ha.m.)   |   (cms)     (ha.m.)
                             .000  .0000E+00    |     .121  .2361E+00
                             .003  .2890E-01    |     .136  .2763E+00
                             .005  .5950E-01    |     .150  .3180E+00
                             .016  .9160E-01    |     .454  .3613E+00
                             .049  .1253E+00    |    1.062  .4063E+00
                             .081  .1607E+00    |    1.932  .4528E+00
                             .103  .1976E+00    |     .000  .0000E+00

      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
      --------------------       (ha)     (cms)     (hrs)       (mm)
      INFLOW >05: (401   )       6.00     1.054     1.500     40.233
      OUTFLOW<06: (501   )       6.00      .099     2.683     40.231

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.360
                   TIME SHIFT OF PEAK FLOW          (min)=    71.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1903E+00

 ---------------------------------------------------------------------------------
 003:0009-------------------------------------------------------------------------
 *# Solar module area draining to diversion swale at west side of module
 *#-----------------|---------------------------------------------------------------|
 ---------------------
 | DESIGN NASHYD      |   Area    (ha)=    1.70   Curve Number   (CN)=79.00
 | 07:202c   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
 ---------------------   U.H. Tp(hrs)=    .420

      Unit Hyd Qpeak  (cms)=     .155

      PEAK FLOW       (cms)=     .100 (i)
      TIME TO PEAK    (hrs)=    1.917
      RUNOFF VOLUME    (mm)=   24.721
      TOTAL RAINFALL   (mm)=   56.545
      RUNOFF COEFFICIENT   =     .437

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ---------------------------------------------------------------------------------
 003:0010-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 --------------------
 | ADD HYD (woutSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
 --------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                  ID1 01:201a     10.90      .437    2.33  25.56    .000
                 +ID2 02:201b       .20      .038    1.50  40.23    .000
                 +ID3 03:202a      6.30      .244    2.33  24.72    .000
                 +ID4 04:202b      5.80     1.017    1.52  40.23    .000
                 +ID5 07:202c      1.70      .100    1.92  24.72    .000
                  ==================================================
                  SUM 08:woutSW   24.90     1.223    1.52  28.83    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ---------------------------------------------------------------------------------
 003:0011-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 --------------------
 | ADD HYD (withSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
 --------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                  ID1 01:201a     10.90      .437    2.33  25.56    .000
                 +ID2 03:202a      6.30      .244    2.33  24.72    .000
                 +ID3 06:501       6.00      .099    2.68  40.23    .000
                 +ID4 07:202c      1.70      .100    1.92  24.72    .000
                  ==================================================
                  SUM 10:withSW   24.90      .852    2.25  28.82    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ---------------------------------------------------------------------------------
 003:0012-------------------------------------------------------------------------
 *#-----------------|---------------------------------------------------------------|
 ---------------------------------------------------------------------------------
 003:0002-------------------------------------------------------------------------
 ---------------------------------------------------------------------------------
 003:0002-------------------------------------------------------------------------
   ** END OF RUN :   3

 **********************************************************************************





 -------------------
 | START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
 -------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 004
    NSTORM=   1
           #  1=hald25yr.3hr
 ---------------------------------------------------------------------------------
 004:0002-------------------------------------------------------------------------
 *#********************************************************************************
 *#  Project Name  : Grand Renewable Energy Park - O & M Facility
 *#  Project Number: 1610-10624
 *#  Date          : 1-27-2011
 *#  Company       : Stantec Consulting Ltd. (Kitchener)
 *#  Modeller      : S Robertson
 *#  License #     : 4730904
 *#********************************************************************************
```

```
*#  PROPOSED CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
-------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\hald25yr.3hr
| Ptotal=  68.72 mm|    Comments: 25-yr, 3hr Chicago Storm - Haldimand Cou
-------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.460 |   1.00  14.960 |   1.83  24.740 |   2.67   6.700
               .33   6.230 |   1.17  23.260 |   2.00  16.040 |   2.83   5.870
               .50   7.260 |   1.33  50.040 |   2.17  11.850 |   3.00   5.240
               .67   8.740 |   1.50 146.100 |   2.33   9.410 |
               .83  11.020 |   1.67  51.580 |   2.50   7.820 |

------------------------------------------------------------------------------
004:0003----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Agricultural area to draining to diversion swale at east side of access road
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=   10.90   Curve Number   (CN)=80.00
| 01:201a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .555

     PEAK FLOW       (cms)=     .593 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   34.566
     TOTAL RAINFALL   (mm)=   68.720
     RUNOFF COEFFICIENT   =     .503

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
004:0004----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Access road right-of-way (most northerly 160 m stretch)
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=     .20
| 02:201b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .10          .10
     Dep. Storage     (mm)=       .80         1.50
     Average Slope     (%)=       .60          .60
     Length            (m)=     36.51        40.00
     Mannings n           =      .013         .250

     Max.eff.Inten.(mm/hr)=    146.10        67.33
                over (min)       1.00        13.00
     Storage Coeff.  (min)=      1.40 (ii)   13.26 (ii)
     Unit Hyd. Tpeak (min)=      1.00        13.00
     Unit Hyd. peak  (cms)=       .87          .09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       .04          .01           .047 (iii)
     TIME TO PEAK    (hrs)=      1.50         1.68          1.500
     RUNOFF VOLUME    (mm)=     67.92        33.54         50.728
     TOTAL RAINFALL   (mm)=     68.72        68.72         68.720
     RUNOFF COEFFICIENT   =       .99          .49           .738

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
004:0005----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Agricultural area draining to diversion swale at access road/solar module
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    6.30   Curve Number   (CN)=79.00
| 03:202a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .321

     PEAK FLOW       (cms)=     .332 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   33.535
     TOTAL RAINFALL   (mm)=   68.720
     RUNOFF COEFFICIENT   =     .488

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
004:0006----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=    5.80
| 04:202b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      2.90         2.90
     Dep. Storage     (mm)=       .80         1.50
     Average Slope     (%)=       .90          .90
     Length            (m)=    196.64        40.00
     Mannings n           =      .013         .250

     Max.eff.Inten.(mm/hr)=    146.10        64.93
                over (min)       3.00        14.00
     Storage Coeff.  (min)=      3.40 (ii)   14.06 (ii)
     Unit Hyd. Tpeak (min)=      3.00        14.00
     Unit Hyd. peak  (cms)=       .35          .08
                                                          *TOTALS*
     PEAK FLOW       (cms)=      1.12          .34          1.292 (iii)
     TIME TO PEAK    (hrs)=      1.50         1.70          1.500
     RUNOFF VOLUME    (mm)=     67.92        33.53         50.728
     TOTAL RAINFALL   (mm)=     68.72        68.72         68.720
     RUNOFF COEFFICIENT   =       .99          .49           .738

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
004:0007----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Sum of flows to constructed wetland SWMF
*#-----------------|----------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 02:201b        .20      .047    1.50  50.73    .000
                +ID2 04:202b       5.80     1.292    1.50  50.73    .000
                 =======================================================
                 SUM 05:401        6.00     1.340    1.50  50.73    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
004:0008----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
*# Constructed wetland SWMF
*#-----------------|----------------------------------------------------------|
---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>05:(401   )    |
| OUT<06:(501   )    |    =========  OUTLFOW STORAGE TABLE  =========
---------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |      .121  .2361E+00
                             .003  .2890E-01   |      .136  .2763E+00
                             .005  .5950E-01   |      .150  .3180E+00
                             .016  .9160E-01   |      .454  .3613E+00
                             .049  .1253E+00   |     1.062  .4063E+00
                             .081  .1607E+00   |     1.932  .4528E+00
                             .103  .1976E+00   |      .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >05: (401   )       6.00     1.340     1.500     50.728
     OUTFLOW<06: (501   )       6.00      .122     2.633     50.726

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.131
                  TIME SHIFT OF PEAK FLOW         (min)=    68.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.2396E+00

------------------------------------------------------------------------------
004:0009----------------------------------------------------------------------
*# Solar module area draining to diversion swale at west side of module
*#-----------------|----------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    1.70   Curve Number   (CN)=79.00
| 07:202c   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .420

     Unit Hyd Qpeak  (cms)=     .155

     PEAK FLOW       (cms)=     .136 (i)
     TIME TO PEAK    (hrs)=    1.917
     RUNOFF VOLUME    (mm)=   33.535
     TOTAL RAINFALL   (mm)=   68.720
     RUNOFF COEFFICIENT   =     .488

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
004:0010----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
--------------------
| ADD HYD (woutSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .593    2.33  34.57    .000
                +ID2 02:201b        .20      .047    1.50  50.73    .000
                +ID3 03:202a       6.30      .332    2.33  33.54    .000
                +ID4 04:202b       5.80     1.292    1.50  50.73    .000
                +ID5 07:202c       1.70      .136    1.92  33.54    .000
                 =======================================================
                 SUM 08:woutSW    24.90     1.557    1.50  38.13    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
004:0011----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
--------------------
| ADD HYD (withSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .593    2.33  34.57    .000
                +ID2 03:202a       6.30      .332    2.33  33.54    .000
                +ID3 06:501        6.00      .122    2.63  50.73    .000
                +ID4 07:202c       1.70      .136    1.92  33.54    .000
                 =======================================================
                 SUM 10:withSW    24.90     1.149    2.25  38.13    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
004:0012----------------------------------------------------------------------
*#-----------------|----------------------------------------------------------|
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
------------------------------------------------------------------------------
004:0002----------------------------------------------------------------------
  ** END OF RUN :   4

******************************************************************************





--------------------
| START              |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------    Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
           #  1=hald50yr.3hr
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#****************************************************************************
*#  PROPOSED CONDITIONS
*#****************************************************************************
------------------------------------------------------------------------------
005:0002----------------------------------------------------------------------
--------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\hald50yr.3hr
| Ptotal=  76.91 mm|    Comments: 50-yr, 3hr Chicago Storm - Haldimand Cou
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   6.030 |   1.00  16.650 |   1.83  27.610 |   2.67   7.420
               .33   6.890 |   1.17  25.950 |   2.00  17.860 |   2.83   6.490
               .50   8.040 |   1.33  56.090 |   2.17  13.160 |   3.00   5.790
               .67   9.690 |   1.50 164.610 |   2.33  10.440 |
               .83  12.240 |   1.67  57.820 |   2.50   8.660 |

------------------------------------------------------------------------------
005:0003----------------------------------------------------------------------
```

```
*#-----------------|-------------------------------------------------------------|
*# Agricultural area to draining to diversion swale at east side of access road
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD       |   Area    (ha)=   10.90   Curve Number   (CN)=80.00
| 01:201a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .555

     PEAK FLOW       (cms)=     .705 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   40.935
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .532

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0004------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Access road right-of-way (most northerly 160 m stretch)
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN STANDHYD    |   Area    (ha)=     .20
| 02:201b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .10          .10
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .60          .60
     Length            (m)=      36.51        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     164.61        84.04
                over (min)       1.00        12.00
     Storage Coeff.  (min)=       1.33 (ii)   12.19 (ii)
     Unit Hyd. Tpeak (min)=       1.00        12.00
     Unit Hyd. peak  (cms)=        .90          .09
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .05          .02          .055 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.67         1.500
     RUNOFF VOLUME    (mm)=      76.11        39.78        57.945
     TOTAL RAINFALL   (mm)=      76.91        76.91        76.907
     RUNOFF COEFFICIENT   =        .99          .52          .753

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0005------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Agricultural area draining to diversion swale at access road/solar module
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD       |   Area    (ha)=    6.30   Curve Number   (CN)=79.00
| 03:202a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .321

     PEAK FLOW       (cms)=     .396 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   39.784
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .517

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0006------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN STANDHYD    |   Area    (ha)=    5.80
| 04:202b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.90         2.90
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .90          .90
     Length            (m)=     196.64        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     164.61        80.60
                over (min)       3.00        13.00
     Storage Coeff.  (min)=       3.24 (ii)   13.02 (ii)
     Unit Hyd. Tpeak (min)=       3.00        13.00
     Unit Hyd. peak  (cms)=        .36          .09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.27          .42         1.502 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.67         1.500
     RUNOFF VOLUME    (mm)=      76.11        39.78        57.945
     TOTAL RAINFALL   (mm)=      76.91        76.91        76.907
     RUNOFF COEFFICIENT   =        .99          .52          .753

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0007------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Sum of flows to constructed wetland SWMF
*#-----------------|-------------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 02:201b        .20      .055    1.50  57.95    .000
                +ID2 04:202b       5.80     1.502    1.50  57.95    .000
                 ==================================================
                 SUM 05:401        6.00     1.556    1.50  57.95    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0008------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Constructed wetland SWMF
*#-----------------|-------------------------------------------------------------|
--------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(401   )   |
| OUT<06:(501   )   |    =========  OUTLFOW STORAGE TABLE  =========
--------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .121  .2361E+00
                            .003  .2890E-01   |     .136  .2763E+00
                            .005  .5950E-01   |     .150  .3180E+00
                            .016  .9160E-01   |     .454  .3613E+00
                            .049  .1253E+00   |    1.062  .4063E+00
                            .081  .1607E+00   |    1.932  .4528E+00
                            .103  .1976E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >05: (401   )       6.00     1.556     1.500     57.945
     OUTFLOW<06: (501   )       6.00      .136     2.633     57.943

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.708
                  TIME SHIFT OF PEAK FLOW         (min)=    68.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.2750E+00

--------------------------------------------------------------------------------
005:0009------------------------------------------------------------------------
*# Solar module area draining to diversion swale at west side of module
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD       |   Area    (ha)=    1.70   Curve Number   (CN)=79.00
| 07:202c   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .420

     Unit Hyd Qpeak  (cms)=     .155

     PEAK FLOW       (cms)=     .162 (i)
     TIME TO PEAK    (hrs)=    1.917
     RUNOFF VOLUME    (mm)=   39.784
     TOTAL RAINFALL   (mm)=   76.907
     RUNOFF COEFFICIENT   =     .517

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0010------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
--------------------
| ADD HYD (woutSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .705    2.33  40.94    .000
                +ID2 02:201b        .20      .055    1.50  57.95    .000
                +ID3 03:202a       6.30      .396    2.33  39.78    .000
                +ID4 04:202b       5.80     1.502    1.50  57.95    .000
                +ID5 07:202c       1.70      .162    1.92  39.78    .000
                 ==================================================
                 SUM 08:woutSW    24.90     1.822    1.52  44.66    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0011------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
--------------------
| ADD HYD (withSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:201a      10.90      .705    2.33  40.94    .000
                +ID2 03:202a       6.30      .396    2.33  39.78    .000
                +ID3 06:501        6.00      .136    2.63  57.94    .000
                +ID4 07:202c       1.70      .162    1.92  39.78    .000
                 ==================================================
                 SUM 10:withSW    24.90     1.357    2.25  44.66    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0012------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
  ** END OF RUN :   5

********************************************************************************

--------------------
| START             |  Project  dir.: C:\PROGRA~1\SWMHYMO\
--------------------  Rainfall dir.: C:\PROGRA~1\SWMHYMO\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 006
    NSTORM=   1
           #  1=Hald100.3hr
--------------------------------------------------------------------------------
006:0002------------------------------------------------------------------------
*#******************************************************************************
*#  Project Name  : Grand Renewable Energy Park - O & M Facility
*#  Project Number: 1610-10624
*#  Date          : 1-27-2011
*#  Company       : Stantec Consulting Ltd. (Kitchener)
*#  Modeller      : S Robertson
*#  License #     : 4730904
*#******************************************************************************
*#  PROPOSED CONDITIONS
*#******************************************************************************
--------------------------------------------------------------------------------
006:0002------------------------------------------------------------------------
--------------------
| READ STORM        |    Filename: C:\PROGRA~1\SWMHYMO\Hald100.3hr
| Ptotal=  86.13 mm|    Comments: 100-yr, 3hr Chicago Storm - Haldimand Co
--------------------
             TIME    RAIN |  TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |   hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   6.610 |  1.00  18.780 |   1.83  31.440 |   2.67   8.170
              .33   7.570 |  1.17  29.530 |   2.00  20.170 |   2.83   7.130
              .50   8.890 |  1.33  63.970 |   2.17  14.760 |   3.00   6.330
              .67  10.770 |  1.50 181.810 |   2.33  11.620 |
              .83  13.700 |  1.67  65.940 |   2.50   9.590 |

--------------------------------------------------------------------------------
006:0003------------------------------------------------------------------------
*#-----------------|-------------------------------------------------------------|
*# Agricultural area to draining to diversion swale at east side of access road
*#-----------------|-------------------------------------------------------------|
----------------------
| DESIGN NASHYD       |   Area    (ha)=   10.90   Curve Number   (CN)=80.00
| 01:201a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .555

     PEAK FLOW       (cms)=     .835 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   48.351
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .561
```

```
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
006:0004--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
*# Access road right-of-way (most northerly 160 m stretch)
*#-----------------|-------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=     .20
| 02:201b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .10          .10
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .60          .60
     Length            (m)=      36.51        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     181.81       103.35
                over (min)        1.00        11.00
     Storage Coeff.  (min)=       1.28 (ii)   11.28 (ii)
     Unit Hyd. Tpeak (min)=       1.00        11.00
     Unit Hyd. peak  (cms)=        .92          .10
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .05          .02           .063 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.63          1.500
     RUNOFF VOLUME    (mm)=      85.33        47.07         66.202
     TOTAL RAINFALL   (mm)=      86.13        86.13         86.130
     RUNOFF COEFFICIENT   =        .99          .55           .769

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
006:0005--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
*# Agricultural area draining to diversion swale at access road/solar module
*#-----------------|-------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    6.30   Curve Number   (CN)=79.00
| 03:202a   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .750

     Unit Hyd Qpeak  (cms)=     .321

     PEAK FLOW       (cms)=     .470 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   47.074
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .547

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
006:0006--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
*# Southern 2/3 of access road, O&M facility, SWMF, and surrounding lands
*#-----------------|-------------------------------------------------------|
---------------------
| DESIGN STANDHYD    |   Area    (ha)=    5.80
| 04:202b   DT= 1.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.90         2.90
     Dep. Storage     (mm)=        .80         1.50
     Average Slope     (%)=        .90          .90
     Length            (m)=     196.64        40.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     181.81        98.62
                over (min)        3.00        12.00
     Storage Coeff.  (min)=       3.11 (ii)   12.13 (ii)
     Unit Hyd. Tpeak (min)=       3.00        12.00
     Unit Hyd. peak  (cms)=        .37          .09
                                                            *TOTALS*
     PEAK FLOW       (cms)=       1.41          .52          1.720 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.65          1.500
     RUNOFF VOLUME    (mm)=      85.33        47.07         66.202
     TOTAL RAINFALL   (mm)=      86.13        86.13         86.130
     RUNOFF COEFFICIENT   =        .99          .55           .769

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  79.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
006:0007--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
*# Sum of flows to constructed wetland SWMF
*#-----------------|-------------------------------------------------------|
--------------------
| ADD HYD (401   ) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 02:201b        .20      .063    1.50  66.20    .000
               +ID2 04:202b       5.80     1.720    1.50  66.20    .000
                =====================================================
                SUM 05:401        6.00     1.782    1.50  66.20    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

----------------------------------------------------------------------------
006:0008--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
*# Constructed wetland SWMF
*#-----------------|-------------------------------------------------------|
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>05:(401   )   |
| OUT<06:(501   )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .121  .2361E+00
                            .003  .2890E-01   |      .136  .2763E+00
                            .005  .5950E-01   |      .150  .3180E+00
                            .016  .9160E-01   |      .454  .3613E+00
                            .049  .1253E+00   |     1.062  .4063E+00
                            .081  .1607E+00   |     1.932  .4528E+00
                            .103  .1976E+00   |      .000  .0000E+00

     ROUTING RESULTS              AREA     QPEAK     TPEAK       R.V.
     --------------------         (ha)     (cms)     (hrs)       (mm)
     INFLOW >05: (401   )         6.00     1.782     1.500     66.202
     OUTFLOW<06: (501   )         6.00      .149     2.633     66.198

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.387
                    TIME SHIFT OF PEAK FLOW         (min)=    68.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.3164E+00

----------------------------------------------------------------------------
006:0009--------------------------------------------------------------------
*# Solar module area draining to diversion swale at west side of module
*#-----------------|-------------------------------------------------------|
---------------------
| DESIGN NASHYD      |   Area    (ha)=    1.70   Curve Number   (CN)=79.00
| 07:202c   DT= 5.00 |   Ia      (mm)=   1.500   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .420

     Unit Hyd Qpeak  (cms)=     .155

     PEAK FLOW       (cms)=     .193 (i)
     TIME TO PEAK    (hrs)=    1.917
     RUNOFF VOLUME    (mm)=   47.074
     TOTAL RAINFALL   (mm)=   86.130
     RUNOFF COEFFICIENT   =     .547

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
006:0010--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
--------------------
| ADD HYD (woutSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:201a      10.90      .835    2.33  48.35    .000
               +ID2 02:201b        .20      .063    1.50  66.20    .000
               +ID3 03:202a       6.30      .470    2.33  47.07    .000
               +ID4 04:202b       5.80     1.720    1.50  66.20    .000
               +ID5 07:202c       1.70      .193    1.92  47.07    .000
                =====================================================
                SUM 08:woutSW    24.90     2.112    1.52  52.24    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

----------------------------------------------------------------------------
006:0011--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
--------------------
| ADD HYD (withSW) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.    DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:201a      10.90      .835    2.33  48.35    .000
               +ID2 03:202a       6.30      .470    2.33  47.07    .000
               +ID3 06:501        6.00      .149    2.63  66.20    .000
               +ID4 07:202c       1.70      .193    1.92  47.07    .000
                =====================================================
                SUM 10:withSW    24.90     1.599    2.25  52.24    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

----------------------------------------------------------------------------
006:0012--------------------------------------------------------------------
*#-----------------|-------------------------------------------------------|
----------------------------------------------------------------------------
006:0002--------------------------------------------------------------------
----------------------------------------------------------------------------
006:0002--------------------------------------------------------------------
----------------------------------------------------------------------------
006:0002--------------------------------------------------------------------
----------------------------------------------------------------------------
006:0002--------------------------------------------------------------------
----------------------------------------------------------------------------
006:0002--------------------------------------------------------------------
      FINISH
----------------------------------------------------------------------------
****************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2011-09-13     at 09:22:04
============================================================================

```

Grand Renewable Energy Park - O & M Facility
Samsung Renewable Energy Inc.
O&M SWM Facility - Drainage Area Characteristics and Storage Requirements

	Drainage Areas (See below)
Total Area Tributary to Basin (ha)	6.00
Tributary Area requiring quality control (ha)	6.00
MOE Quality Control Requirement	Enhanced
Basin Design	Wetland
[1]Quality Control Volume Requirement (m^3/ha)	99
[2]Permanent Pool (m^3)	353
[3]Extended Detention - Quality Control (m^3)	240

[1] Based on MOE guidelines and overall percent impervious

[2]Permanent Pool sized for quality control - All but 40 m^3/ha of required quality control volume

[3]Extended Detention sized for quality control - 40 m^3/ha

Catchment Number	Area (ha)	% Imperv (XIMP)
201b	0.20	50%
201c	5.80	50%
Quality Control Area	**6.00**	**50.0%**
Quantity Control Area	**6.00**	**50.0%**

Grand Renewable Energy Park
Samsung Renewable Energy Inc.
Operations and Maintenance Facility SWM Basin Stage-Storage-Discharge Calculations

Rating Curve

Elevation (m)	Discharge (m³/s)	Total SWMF Storage (m³)	Active Storage (m³)	Drawdown (hrs) Increment	Drawdown (hrs) Total
195.80					
195.90		9			
196.00		22			
196.10		40			
196.20		63			
196.30		90			
196.40		122			
196.50		159			
196.60		200			
196.70		247			
196.80		297			
196.90		353			
197.00		413			
197.10		645			
197.20		896			
197.30		1,168			
197.40	0.003	1,457	289	27.4	27.4
197.50	0.005	1,763	595	22.1	49.5
197.60	0.016	2,084	916	8.6	58.0
197.70	0.049	2,421	1,253	2.9	60.9
197.80	0.081	2,775	1,607	1.5	62.4
197.90	0.103	3,144	1,976	1.1	63.6
198.00	0.121	3,529	2,361	1.0	64.5
198.10	0.136	3,931	2,763	0.9	65.4
198.20	0.150	4,348	3,180	0.8	66.2
198.30	0.454	4,781	3,613	0.4	66.6
198.40	1.062	5,231	4,063	0.2	66.8
198.50	1.932	5,696	4,528	0.1	66.8

Volume Estimation

Elevation (m)	Forebay Area (m²)	Forebay Volume (m³)	Main Pond Area (m²)	Main Pond Volume (m³)	Total Pond Area (m²)	Total Pond Volume (m³)	Total SWMF Volume (m³)
195.80	63						
195.90	110	9					9
196.00	157	22					22
196.10	204	40					40
196.20	250	63					63
196.30	297	90					90
196.40	344	122					122
196.50	391	159					159
196.60	438	200					200
196.70	485	247					247
196.80	532	297					297
196.90	579	353					353
197.00	625	413	1,594				413
197.10	672	478	1,745	167			645
197.20	719	547	1,896	349			896
197.30	766	622	2,047	546	2,813		1,168
197.40					2,973	289	1,457
197.50					3,133	595	1,763
197.60					3,293	916	2,084
197.70					3,453	1,253	2,421
197.80					3,613	1,607	2,775
197.90					3,774	1,976	3,144
198.00					3,934	2,361	3,529
198.10					4,094	2,763	3,931
198.20					4,254	3,180	4,348
198.30					4,414	3,613	4,781
198.40					4,574	4,063	5,231
198.50					4,734	4,528	5,696

Outlet Structure Controls

Elevation (m)	Orifice 1 (m³/s)	Orifice 2 (m³/s)	Weir (m³/s)	Total Flow (m³/s)
195.80				
195.90				
196.00				
196.10				
196.20				
196.30				
196.40				
196.50				
196.60				
196.70				
196.80				
196.90				
197.00				
197.10				
197.20				
197.30				
197.40	0.003			0.003
197.50	0.005			0.005
197.60	0.006	0.010		0.016
197.70	0.007	0.042		0.049
197.80	0.008	0.073		0.081
197.90	0.009	0.094		0.103
198.00	0.010	0.111		0.121
198.10	0.010	0.126		0.136
198.20	0.011	0.139		0.150
198.30	0.012	0.151	0.291	0.454
198.40	0.012	0.163	0.887	1.062
198.50	0.013	0.173	1.746	1.932

Outlet Structure Characteristics

Parameter	Value	Parameter	Value
Orifice 1			
Orifice Invert Elev. (m)	197.30	Orifice Coeff.	0.60
Orifice Mid-point Elev. (m)	197.34	Perimeter (m)	0.24
Orifice Diam.(mm)	75	Area (m^2)	0.004
Weir Coeff. (semi-circular)	1.62	Orientation	Vertical
Orifice 2			
Orifice Invert Elev. (m)	197.50	Orifice Coeff.	0.60
Orifice Mid-point Elev. (m)	197.65	Perimeter (m)	0.94
Orifice Diam.(mm)	300	Area (m^2)	0.071
Weir Coeff. (semi-circular)	1.62	Orientation	Vertical
Emergency Overflow Weir			
Weir Invert	198.20	Weir Length	5
Weir Coeff. (rect.)	1.700	Weir Side Slopes (H:V) (?:1)	5
Weir Coeff. (tri.)	0.600		

Orifice Equation Used: Orifice flow equation

$Q = C \cdot A \cdot (2 \cdot g \cdot h)^{0.5}$

where

C = orifice coefficient

A = area of orifice

g = acceleration due to gravity

h = head above centre line of orifice

Note: Sharp crested weir equation with equivalent linear length used for calculating orifice flow rates when head is below centre line

Sharp crested semi-circular weir equation

$Q = C^*D^{2.5}*(H/D)^{1.88}$

where

C = sharp crested semi-circular weir coefficient

D = diameter of orifice

H = head above orifice invert

Note: used when water elevation is below mid-point of orifice

Weir Equation Used: $Q = (C_{rectangle} \cdot L \cdot H^{3/2}) + ((C_{triangle} \cdot (8/15 \cdot (2^*g)^{1/2} \cdot \tan \Theta/2) \cdot H^{5/2})$

where

L = bottom width of weir

H = head above weir invert

S = side slopes (ratio of H:V)

$C_{triangle}$ = triangular weir coefficient

$C_{rectangle}$ = broad-crested rectangular weir coefficient

g = 9.81 m/s^2

$\Theta/2$ = angle formed by trapezoidal weir side slopes

Grand Renewable Energy Park

Operations and Maintenance Facility SWM Basin

Sediment Forebay Sizing Calculations

Using MOE - SWMPD Manual Criteria (2003)

STORMWATER MANAGEMENT FACILITY

Settling

Dist = $\text{sqrt}(r^*Q_p/v_s)$			r : 1 = l to w ratio	r =	3.00
=	**5.5**	**m**	Q_p = peak SWM outflow for water quality portion of E.D. zone	Q_p =	0.0030
			v_s = settling velocity for 0.15 mm particles (m/s)	v_s =	0.0003

Dispersion Length (not applicable given the swale/ditch character of inlet conveyance - i.e. no jet dispersion)

Dist = 8Q/dv			Q = 10 yr max inlet flow (m^3/s)	Q =	n/a
=	**n/a**	**m**	d = depth of perm pool in forebay (m)	d =	1
			v_f = desired vel in forebay (m/s)	v_f =	0.5

Velocity

			y = total depth of forebay from perm. pool (m)	y =	1	Note 1.
v = Q/A			b = bottom width (avg) of forebay (m)	b =	2	
=	**0.04**	**m/s**	Q = 10 yr inlet flow (m^3/s)	Q =	0.878	
			A = cross-sectional area (m^2)	A =	24	Note 1.
			Target velocity = 0.15	V_{targ} =	0.15	

Therefore, **Velocity Target Satisfied**

Cleanout Frequency

Table 6.3 MOE SWMPD Guidelines			A_{sew} = Contributing Sewer Area (ha)	A_{sew} =	6.00	
			Imp = Percent Impervious (%)	Imp =	50%	
cleanout = Vol/(load*A_{sew}*effic)			load = Sediment Loading (m^3/ha)	load =	1.6	Note 2.
=	**11.9**	**years**	effic = Removal Efficiency (%)	effic =	80%	
			Targ = Cleanout Frequency Target (years)	Targ =	7	
Therefore,	**Cleanout Time OK**		Vol = Sediment volume (m^3) (0.5m depth)	Vol =	90	Note 3.

Surface Area Check

SA_f/SA_{pp} =	**27.2%**	SA_f = Forebay Surface Area (m^2)	SA_f =	766
		SA_{pp} = Total Permanent Pool Surface Area (m^2)	SA_{pp} =	2,813
		Targ = Forebay size (as % of Permanent Pool Area)	Targ =	20%

The recommended design parameter limiting the forebay area to 20% of the total permanent pool surface area is a reflection of the fact that the volumetric sizing criteria for constructed wetland-type SWM facilities relies on the wetland vegetation component of the facility to perform the majority of the sediment removal functions, as opposed to a wet pond facility that relies on the dilution properties of the permanent pool. In this instance, it should be noted that the permanent pool volumetric sizing requirements, as defined by the MOE 2003 SWMPD Manual, are achieved within the wetland component *without accounting for storage volume provided within the forebay*. Therefore, it is suggested that that the facility, as designed, achieves the targets of the MOE Design Manual.

Notes

1. Total depth and cross-sectional area are 'worst-case' values, representative of conditions just prior to sediment clean-out
2. Interpolated based on percent impervious
3. Volume of bottom 0.5 m depth, the maximum sediment accumulation depth

Attachment F

Analysis of Potential Health Effects of Wind Turbines

Health Effects and Wind Turbines: A Review for Renewable Energy Approval (REA) Applications submitted Under Ontario Regulation 359/09

Prepared by: Stantec Consulting Ltd

May, 2011

EXECUTIVE SUMMARY

Wind power has been identified as a clean renewable energy source that does not contribute to global warming and is without known emissions or harmful wastes. Although wind power has been harnessed as a source of power for several decades around the world, debate is ongoing with respect to the relationship between reported health effects and wind turbines, specifically in terms of audible and inaudible noise. People interested in this debate turn to two sources of information in order to make informed decisions: scientific peer-reviewed studies published in scientific journals and the popular literature and internet. The purpose of this report is to provide results of a review of the peer-reviewed scientific literature, government (medical) agency reports on wind turbine health effects, and the most prominent information found in the popular literature. We found that conclusions of the peer reviewed literature differ in some ways from the conclusions of the studies published in the popular literature. In the peer reviewed studies, wind turbine annoyance has been statistically associated with wind turbine noise, but found to be more strongly related to subjective factors like visual impact, attitude to wind turbines in general and sensitivity to noise. To date, no peer reviewed scientific journal articles have identified a causal link between people living in proximity to modern wind turbines, the noise (audible, low frequency noise, or infrasound) they emit and resulting physiological health effects. In the popular literature, self-reported health outcomes are related to distance from turbines and the claim is made that infrasound is the causative factor for the reported effects, even though sound pressure levels are not measured. What both types of studies have in common is the conclusion that wind turbines can be a source of annoyance for some people. The literature suggests that annoyance-related effects can be managed and mitigated though behavioural and cognitive behavioural interventions.

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1 INTRODUCTION

Wind power has been identified as a clean renewable energy source that does not contribute to global warming and is without known emissions or harmful wastes (WHO, 2004). Studies on public attitudes in Europe and Canada show strong support for the implementation of wind power (Devine-Wright, 2005). Indeed, wind power has become an integrated part of provincial energy strategies across Canada. In Ontario, the Ontario Power Authority has placed a great deal of emphasis on procuring what they term ―renewable and cleaner sources of electricity”, such as wind (OPA, 2008).

Although wind has been harnessed as a source of electricity for several decades around the world, its widespread use as a significant source of energy in Ontario is relatively recent. As with the introduction of any new technology, concerns have been raised that it could lead to impacts on human health. These concerns are related to two primary issues: wind turbine design (i.e., electromagnetic frequencies from transmission lines, shadow flicker from rotor blades, ice throw from rotor blades and structural failure) and wind turbine noise (i.e., levels of audible noise, low frequency noise and infrasound). If left unchecked and unmanaged, it is possible that individually or cumulatively, these concerns could lead to potential health impacts. For example, high sound pressure levels (loudness) of audible noise (including low frequency) and infrasound have been associated with learning, sleep and cognitive disruptions as well as stress and anxiety (Leventhall, 2003; Kristiansen et al., 2009; Yuan et al., 2009; WHO Europe, 2009). Ice throw and structural failure could lead to physical injuries.

As a result of these issues, minimum setback distances have been established world-wide to reduce or avoid potential effects for people living in proximity to wind turbines. For example, under the Ontario Renewable Energy Approval (REA) Regulation (O. Reg. 359/09, as amended by O. Reg. 521/10), a minimum setback distance of 550 m must exist between the centre of the base of the wind turbine and the nearest noise receptor. This minimum setback distance was developed through noise modeling under worst-case conditions to give a conservative estimate of the required distance to attain a sound level of 40dB(A) (MOE, 2009). The World Health Organization (WHO) Europe Region has stated that 40 dB(A) corresponds to the sound from a quiet street in a residential area (WHO, 2009). Globally, rural residential noise limits are generally set at 35 to 55 dB(A) (Walsh, 2010). In addition, the industry has changed to minimize structural issues: for example, modern turbines are geared to sense blade imbalances due to ice build-up and will shut turbines down to prevent ice throw, and turbines have braking mechanisms to stop in the event of a short-circuit or when wind speeds are too high.

Regardless, some people and organizations have expressed concern about the potential of wind turbine projects to adversely affect the health of residents living nearby. Groups such as the Alliance to Protect Prince Edward County, Wind Concerns Ontario and The Society of Wind Vigilance play an important role throughout the planning and development of wind farms. Such organizations unite those with common concerns and speak as one voice to ensure that their concerns are heard by the general public, regulators and wind energy developers. In fact, The Society of Wind Vigilance sponsored the ―First International Symposium-The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?” in Picton, Ontario from October 29-31, 2010. Proceedings are available at http://www.windvigilance.com/symp_2010_proceedings.aspx. Numerous websites have been constructed by individuals or groups to support or oppose the development of wind farms. Often these websites state the perceived impacts on, or benefits to, human health to support the position(s) of the individual or group. The majority of information posted on these websites cannot, unfortunately, be traced back to a scientific, peer-reviewed source and is typically anecdotal in nature. In some cases, the information contained on and propagated by internet websites and the media is not supported, or is even refuted, by scientific research. This serves to spread misconceptions about the potential impacts of wind energy on human health, which either fuels or diminishes opposition to wind farm development. In other cases, the information posted points to data gaps in the scientific literature that should be filled. Therefore it is difficult for the general public to ascertain which claims, from both sides of the issue can be substantiated by scientific evidence, are refuted by scientific evidence; and/or have no scientific evidence to either support or refute.

The purpose of this evaluation of potential health effects is not an attempt to discount the self-reported health issues of residents living near wind turbines. Rather, the purpose of this report is to provide results of a review of the peer-reviewed scientific literature, review of government (medical) agency reports on wind turbine health effects that can be used to draw conclusions about wind turbines and health effects using a weight-of-evidence approach.

2 POTENTIAL EFFECTS (NOISE, ANNOYANCE, EPILEPSY)

2.1 Peer-Reviewed Literature

Publication of scientific findings is the basis of scientific discourse, communication and debate. The peer review process is considered a fundamental tenet of quality control in scientific publishing. Once a research paper has been submitted to a journal for publication it is reviewed by external independent expert(s) in the field. The expert(s) review the validity, reliability and importance of the results and recommends that the manuscript be accepted, revised or rejected. This process ensures that the methods employed and the findings of the research receive a high level of scrutiny, such that an independent researcher could repeat the experiment or calculation of results, prior to their publication. This process seeks to ensure that the published research is of a high standard of quality, accurate, can be reproduced and demonstrates academic / professional integrity.

In order to assess peer-reviewed studies designed to test hypotheses about the association between potential health effects in humans and wind turbines, a review of the primary scientific literature was conducted. While this review did not strictly follow the evaluation process outlined in the ―Cochrane Handbook for Systematic Reviews of Interventions, the standard for conducting information reviews in healthcare and pharmaceutical industries" (Higgins and Green, 2009), it was conducted in the spirit of the Cochrane systematic review, in that it was designed based on the principle that ―science is cumulative", and by considering all available evidence, decisions can be made that reflect the best science available.

To facilitate this review, combinations of key words (Table 1) were selected and entered into the Thomson Reuters (formerly ISI) Web of Knowledge^{SM}. The Web of Knowledge^{SM} is a database that covers over 10,000 high-impact journals (i.e., a measure of the number of times an article in a journal has been cited in a given period) in the sciences, social sciences, and arts and humanities, as well as international proceedings coverage for over 120,000 conferences. The Web of Knowledge^{SM} comprises seven citation databases, two of which are relevant to the search: the Science Citation Index Expanded (SCI-Expanded) and the Social Sciences Citation Index (SSCI). The SCI-Expanded includes over 6,650 major journals across 150 scientific disciplines and includes all cited references captured from indexed articles. Coverage of the literature spans the year 1900 to the present. On average, 19,000 new records per week are added to the SCI-Expanded.

SSCI is a multidisciplinary index of the social sciences literature. SSCI includes over 1,950 journals across 50 social sciences disciplines from the year 1956 to the present. It averages 2,900 new records per week.

Table 1: Key Words Selected for Primary Literature Database Search

Annoyance	Noise
Environmental change	Sleep disturbance
Epilepsy	Stress
Health effect(s)	Wind farm(s)
Infrasound	Wind turbine(s)
Low frequency noise	Wind turbine syndrome
Neighborhood change	

Although hundreds of articles were found during the search, very few were related to the association between potential health effects and wind turbines. For example, numerous articles have been published about infrasound, but very few have been published about infrasound and wind turbines. Indeed, only fifteen articles, published between 2003 and 2011, were found relevant and are summarized below. These summaries may contain excerpts taken directly from the articles.

van den Berg, G.P. 2003. Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration 277:955–970

In 2003 van den Berg published the results of a study designed to assess sound immission (noise affecting people opposed to emission which is noise from the turbine itself) from a 30MW, 17-turbine wind park (in Germany) at two locations (Location A: 400m from closest turbine; Location B: 1500 m from closest turbine) in neighboring residential areas in Holland. The study was conducted because residents living 500m or more from the park reacted strongly to the noise and residents up to 1900 m from the park expressed annoyance, especially during night-time periods. The sound was described as ―a low pitched thumping sound with a repetition rate of about once a second (coinciding with the frequency of blades passing a turbine mast), not unlike distant pile driving, superimposed on a constant broadband ‗noisy' sound".

Between May 13 and June 22, 2002, sound immission measurements were made over 1435 hours, of which 417 hours were at night, within four months at two consecutive locations. Briefly, sound was measured with a type 1 sound level meter with a microphone 4.5 m above the ground and protected by a foam wind shield. Wind speed was measured at 2 and 10 m above the ground. Every second, wind speed and wind direction and A-weighted sound level was measured. At Location A, van den Berg found that wind turbine sound was the dominant sound in the environment 25% of the time and predominantly at night (72% of all 105 measurement hours) compared to during daytime (4% of 191 measurement hours). At location B, the turbine sound remained dominant for over one-third of the time at night (38% of 312 measurement hours). At Location A, the 5 minute equivalent immission sound levels (Leq5 min) ranged from roughly 25 dB(A) at a wind speed (at 10 m above ground) of 0 m/s to between roughly 35 and 50 dB(A) at a wind speed of between 4 and 6 m/s. At a wind speed of 8 m/s, Leq5 min was between 40 and 45 dB(A). At Location B, Leq5 min ranged from 20 to 35 dB(A) at a wind speed of 1 m/s, roughly 23 to 37 dB(A) between wind speeds of 4 and 6 m/s and between 27 and 33 dB(A) at speeds above 6 m/s.

Wind speed at hub height at night was found to be up to 2.6 times greater than predicted by the turbine operator possibly because noise modeling took surface roughness into account but not atmospheric stability, which varied between day and night. This caused a higher rotational speed of the wind turbines and consequentially up to 15 dB(A) higher sound levels, relative to the same wind speed in daytime. The change in wind profile at night also resulted in lower ambient background levels than expected: at night the wind speed near the ground may be lower than expected from the speed at a height of 10m and a logarithmic wind profile, resulting in low levels of wind induced sound from vegetation.

The contrast between wind turbine and ambient sound levels was therefore more pronounced at night. At night the turbines caused a low pitched thumping sound superimposed on a broadband ‗noisy‘ sound, the ‗thumps‘ occurring at the rate at which blades pass a turbine tower. It appears that the characteristic, but usually small ‗swishing‘ pulses that can be heard at the rate at which blades pass a turbine tower, coincide because turbines operate nearly synchronously. van den Berg concluded that the number and severity of noise complaints near the wind park were in part explained by the study findings: actual sound levels were considerably higher than predicted by the operator and wind turbines produced sound with an impulsive character.

Pedersen, E. and K. Persson Waye. 2004. Perception and annoyance due to wind turbine noise – a dose–response relationship. Journal of the Acoustical Society of America 116:3460-3470

In 2004 Pedersen and Persson Waye published the findings of their cross-sectional study performed in Sweden in 2000. The purpose of the study was to: evaluate the prevalence of annoyance due to wind turbine noise, to assess any dose–response relationships, and to determine if any interrelationships existed between noise annoyance and sound characteristics, as well as the influence of subjective variables such as attitude and noise sensitivity. Pedersen and Persson Waye delivered questionnaires to 627 households in five areas comprising 16 wind turbines. One week later questionnaires were collected: the response rate was 68.4% (n=351). For the participating households, A-weighted (dB(A)) sound pressure levels due to wind turbines were calculated using the sound propagation model for wind power plants adopted by the Swedish Environmental Protection Agency and verified by field measurements.

The questionnaire was divided into four sections. Briefly, the first had questions regarding housing and satisfaction with the living environment, including questions about degree of annoyance experienced outdoors and indoors and sensitivity to environmental factors. The second section had questions about wind turbines (noise, shadows, and disturbances), respondents‘ level of perception and annoyance, and verbal descriptors of sound and perceptual characteristics. The third section had questions about chronic health (e.g., diabetes, tinnitus, cardiovascular diseases), general well-being (e.g., headache, undue tiredness feeling tensed/stressed, irritable) and normal sleep habits (e.g., quality of sleep, whether or not sleep was disturbed by any noise source). The last section comprised questions on employment and working hours. Of import, the purpose of the study was masked in the questionnaire.

People assessed in the study fell into six sound categories: those living in areas of sound pressure levels <30.0, 30.0-32.5, 32.5-35.0, 35.0-37.5, 37.5-40.0, and >40.0 dB(A). Percent respondents in each category were similar and ranged from 60% (<30.0 dB(A)) to 78% (>40 dB(A)). Results of the study revealed that the proportion of respondents who noticed noise from wind turbines outdoors increased sharply from 39% (n=27) at sound category 30.0–32.5 dB(A) to 85% (n=53) at sound category 35.0–37.5 dB(A). The proportion of those annoyed by wind turbine noise outdoors also increased with higher sound category, at sound categories exceeding 35.0 dB(A). However, 20% of the 40 respondents living in sound category 37.5–40.0 dB(A) and 36% of the 25 respondents living in sound category >40.0 dB(A) were very annoyed by wind turbines. No respondent self-reported as annoyed at sound categories below 32.5 dB(A).

Among those who noticed wind turbine noise (n=223), 25% (n=47) reported that they were disturbed every day or almost every day. 17% of people were disturbed once or twice a week. Annoyance was most frequently reported when relaxing outdoors and at barbecue nights. 7% of respondents (n=25) were annoyed by noise from wind turbines indoors, and this was related to noise category. 23% (n=80) of respondents stated that they were disturbed in their sleep by noise. At lower sound categories, no respondents were disturbed in their sleep by wind turbine noise. Of the 128 respondents living at sound exposure above 35.0 dB(A), 16% (n=20) stated that they were disturbed in their sleep by wind turbine noise. Of the 351 people assessed, 26% (91) reported chronic health issues (e.g., diabetes, tinnitus, cardiovascular diseases), but these issues were not associated with noise levels.

Pedersen and Persson Waye revealed that attitude to visual impact, attitude to wind turbines in general, and sensitivity to noise were also related to the way people perceived noise from turbines. For example, 13% of the variance in annoyance from wind farms could be explained by noise and the odds that respondents would be annoyed by noise from wind turbines increased 1.87 times from one sound category to the next. When noise and attitude to visual impact was statistically assessed, 46% of the variance in annoyance from wind farms could be explained and the odds that respondents would be annoyed from wind turbines increased 5.05 times from one sound category to the next. Statistical analyses showed that while attitude to wind turbines in general and sensitivity to noise were also related to annoyance, visual effect was the most significant variable in terms of predicting annoyance.

Results of this study also showed that the proportions of respondents annoyed by wind turbine noise was higher than for other community noise sources (i.e., railways, road traffic and aircraft) at the same A-weighted sound pressure level and that the proportion of annoyed people increased more rapidly. Pedersen and Persson Waye suggest that these differences could be due to the rural environment where turbines are placed (where low background noise allows perception of noise sources when dB(A) is low), the intrusive characteristics of aerodynamic sound, and the impact of visual interference.

Leventhall, G. 2006. Infrasound from wind turbines – fact, fiction or deception? Canadian Acoustics 34:29-36

In this paper Leventhall discusses infrasound in terms of what it is and how it is related to wind turbines. Leventhall states that the common assumption that ―infrasound” is inaudible is incorrect, and that sound remains audible at frequencies well below 16Hz. Low frequency sound experienced at high sound pressure levels can have effects: people with both hearing ability and hearing loss (and with normal middle ears), exhibit aural pain at about 165dB at 2Hz, reducing to 145dB at 20Hz. Leventhall suggests that naturally occurring infrasound, in the range from about 0.01 Hz to 2Hz and at inaudible levels, is ubiquitous and comes from meteors, volcanic eruptions, ocean waves, wind and any effect which leads to slow oscillations of the air. Infrasound is also emitted from anthropogenic sources like explosions, combustion processes, slow speed fans and machinery.

In terms of wind turbines, infrasound is a component of the frequency spectrum, but found at low sound levels and only in the inaudible range. Leventhall suggests that that there is insignificant infrasound from wind turbines and that attention should be focused on the audio frequency fluctuating swish, which some people may well find to be very disturbing and stressful, depending on its level.

Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and well-being in different living environments. Occupational and Environmental Medicine 64:480-486

Building on their 2004 paper, Pedersen and Persson Waye conducted a cross-sectional study in seven areas in Sweden across dissimilar terrain and different degrees of urbanisation. The objective of the study was to: evaluate the prevalence of perception and annoyance due to wind turbine noise among people living near the turbines and to study relations between noise and perception/annoyance, with focus on differences between living environments. 1309 questionnaires were sent to households in seven selected areas, three of which had wind turbines situated on flat ground (e.g., agricultural field) and four had turbines situated on ground that was hilly/rocky and comprised of trees and/or the altitude of the base of the wind turbine differed considerably from that of the dwellings nearby (called complex ground in the study). Three areas were classified as suburban; four as rural. The area and number of respondents sought was based on a statistical power analysis and, like their 2004 study, the purpose of the study was masked in the questionnaire.

Of the 1309 questionnaires delivered, 754 (57.6%) were satisfactorily completed and returned. The questionnaire consisted of questions about living conditions, reaction to possible sources of annoyance in the living environment, sensitivity to environmental factors, health and well-being. A-weighted (dB(A)) sound pressure levels due to wind turbines were calculated using the sound propagation model for wind power plants adopted by the Swedish Environmental Protection Agency.

One of the differences between this study and the one conducted in 2004 was the inclusion of the assessment of the influence of a tall object near the dwelling. This ―vertical visual angle" was calculated for each respondent and defined as the angle between the horizontal plane and an imaginary line from a respondent‘s house to the hub of the nearest wind turbine, expressed in degrees.

Perception of annoyance with wind turbine noise was statistically correlated with sound pressure level on the dB(A) scale (p<0.001). Of the 754 respondents, 307 (39%) noticed sound from wind turbines outside their dwelling (range of sound pressure level: <32.5, 32.5-35.0, 35.0-37.5, 37.5-40.0, and >40.0 dB(A)) and the proportion of respondents who noticed sound increased almost linearly with increasing noise. In the 37.5–40.0 dB(A) range, 76% of the 71 respondents reported that they noticed sound from the wind turbines; 90% of respondents (n=18) in the >40.0 dB(A) category noticed sound from the wind turbines. The odds of noticing sound increased by 30% for each increase in dB(A) category. Terrain did not statistically significantly influence the perception of noise but degrees of urbanization did: the odds that respondents would be annoyed by noise from wind turbines was 1.8 times more when living in rural vs. suburban environments. Further, respondents living in rural areas with complex ground were more likely to notice the sound than others.

In terms of annoyance, a total of 31 of the 754 respondents said they were annoyed by wind turbine noise. In the <32.5 to the 37.5 dB(A) category 3% to 4% of people said they were annoyed by wind turbine noise; in the 37.5–40.0 dB(A) category, 6% of the 71 respondents were annoyed; and in the >40.0 category, 15% of 20 of respondents said they were annoyed by wind turbine noise. In addition, of those 31 respondents who were annoyed by wind turbine noise, 36% reported that their sleep was disturbed by a noise source, compared with 9% among those 733 not noise annoyed.

Pedersen and Persson Waye concluded that ―living in a rural landscape in contrast with an urbanised area enhanced the risk of perceiving wind turbine noise and, furthermore, the risk of annoyance. Type of terrain had no major influence on perception in urbanised areas; however, in a rural landscape, complex terrain substantively increased the risk". One suggestion of the difference between rural and suburban areas is level of background sound and interestingly, perception and annoyance was associated with type of landscape, ―indicating that the wind turbine noise interfered with personal expectations in a less urbanised area…

pointing towards a personal factor related to the living environment". The authors also concluded that visual exposure enhances the negative associations with turbines when coupled with audible exposure. They also point out that their study showed that aesthetics play a role in annoyance: ―respondents who think of wind turbines as ugly are more likely to appraise them as not belonging to the landscape and therefore feel annoyed".

Keith, S.E., D.S. Michaud, and S.H.P. Bly. 2008. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control 27:253-265

As a starting point for the development of a Health Canada guidance document on how to assess noise impacts in environmental assessments of wind turbine projects conducted under the Canadian Environmental Assessment Act (CEAA), Keith et al. published this report, the purpose of which was to provide criteria for evaluating the potential health effects of wind turbine noise. In the report Keith et al. propose that the predicted sound level from a wind turbine should not exceed 45 dB(A) at a sensitive receptor location (e.g., residences, hospitals, schools) situated in a quiet rural setting. The Health Canada definition of a quiet rural area is when the human made background sound levels are below 45 dB(A) during the day and 35 dB(A) during the night, and where population density is typically less than 8 dwellings/km^2.

The authors go on to say that 45 dB(A) is below the World Health Organization guideline for sleep and speech disturbance, moderate annoyance and hearing impairment. Since publication of their study, the WHO Europe Region has released new Night Noise Guidelines for Europe (WHO, 2009): ―The new limit is an annual average night exposure not exceeding 40 decibels (dB), corresponding to the sound from a quiet street in a residential area". It was acknowledged that in quiet rural areas there is a greater expectation for and value placed on peace and quiet, and this factor was taken into account when developing the proposed criteria. It is suggested that in these areas, predicted project sound levels should be adjusted by +10 dB(A). This criterion is also expected to protect against low frequency noise from wind turbines.

Based on literature review and calculations of the percentage of high annoyance, Keith et al. suggest that the proposed criterion value would lead to a 6.5% increase in the percentage of highly annoyed (%HA) people. The authors state that there will always be a small part of the population in quite rural areas that are highly annoyed by man-made sources of noise. When Keith et al. redo their calculations assuming that 1% of the population is expected to be highly annoyed, the sound level criteria is 43.3 dB(A).

Harding, G., Harding, P. and A. Wilkins. 2008. Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. Epilepsia 49:1095-98

Photosensitive epilepsy (PSE) occurs in one in 4,000 of the population. Because the rotating blades of wind turbines can produce shadow flicker, Harding et al. (2008) applied known parameters of the seizure-provoking effect of flicker (e.g., contrast, frequency) to wind turbine features to calculate the proportion of people liable to be at risk for seizures. Flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz pose a potential risk of inducing photosensitive seizures at an incidence of 1.7 per 100,000 of the photosensitive population. The study found that seizure risk does not decrease significantly until distance from the turbine exceeds 100 times the hub height, a distance typically more than 4 km.

Given that the risk of seizure does not decrease with viewing distance up to approximately 4 km from the turbine, it is critical that flash frequency is maintained at or below 3 Hz. For turbines with three blades, this translates to a maximum speed of rotation of 60 rpm, ―the normal practice for large wind farms". Harding et al. (2008) also noted that when several turbines are in line with the sun's shadow, the flicker produced is from a combination of blades from different turbines, which can have a higher frequency than from a single turbine. However, these should all be below the 3.0 Hz from modern wind turbines.

Pedersen, E. and K. Persson Waye. 2008. Wind turbines - low level noise sources interfering with restoration? Environmental Research Letters 3:1-5

In this paper, Pedersen and Persson Waye summarize their previous work (2004, 2007) with the emphasis on perception, annoyance and consequences for restoration, defined as the degree to which an environment can aid recovery from mental fatigue and restoration of attentional capabilities. The hypothesis for their work was: low and moderate stressors such as wind turbine noise could have an impact on health. Based on the 1095 people involved in both studies, the proportion of respondents who noticed sound from wind turbines increased almost linearly with increasing sound pressure level (dB(A)), from roughly 5-15% noticing noise at 29 dB(A) to 45-90% noticing noise at 41 dB(A) (Figure 1). However, the proportion of respondents fairly annoyed or very annoyed remains quite level through the 29-37 dB(A) range and increases at noise levels above 37 dB(A), with peaks at 38 db(A) and 41 dB(A). Of note, at 40 dB(A), the criteria for wind turbine noise in Ontario, less than 10% of the 1095 respondents were very annoyed and roughly 15% were fairly annoyed. Pedersen and Persson Waye indicate that this increase is not statistically significant.

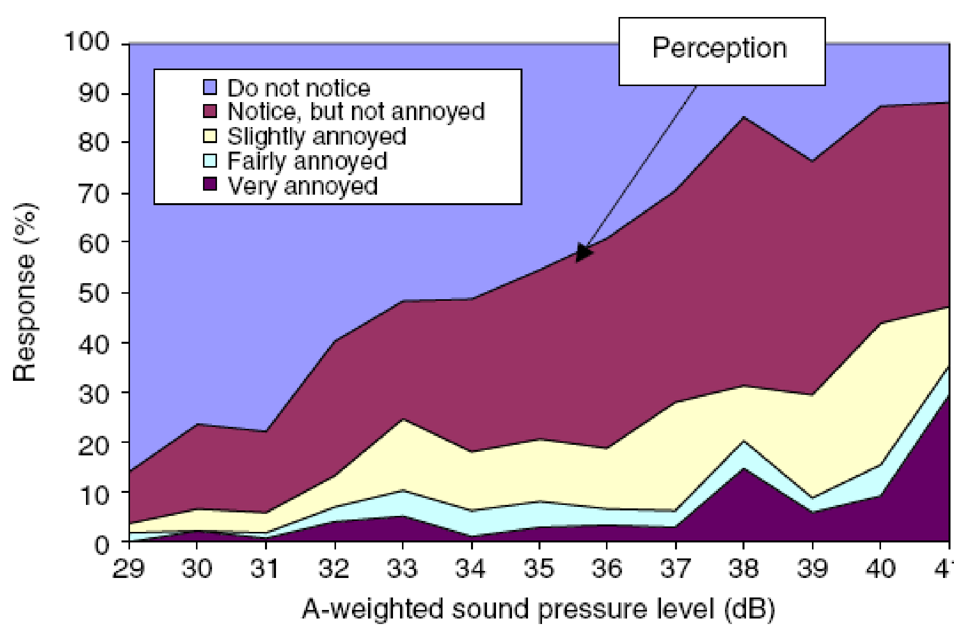

Figure 1: Response to wind turbine noise in relation to A-weighted sound pressure levels outside the dwellings of the respondents (reproduced from Pedersen and Persson Waye 2008).

Swishing, whistling, resounding and pulsating/throbbing were the sound characteristics that were most highly correlated with annoyance by wind turbine noise among respondents who noticed the noise outside their dwellings. Respondents described wind turbines as environmentally friendly, necessary and efficient, but also described them as ugly. Annoyance with wind turbine noise was associated with a negative attitude toward wind turbines in general and toward their visual impact; however, only noise level and visual impact were statistically significantly related to annoyance ($p<0.001$), with visual impact being the variable most strongly associated with annoyance. Response to wind turbine noise was also correlated with the respondent‘s judgment of the possibility for recovery and regaining of strength in the current living place.

Pedersen, E., L.R.-M. Hallberg, and Persson Waye, K. 2007. Living in the vicinity of wind turbines—a grounded theory study. Qualitative Research in Psychology 4: 49–63.

The goal of this study was to gain a deeper understanding of how people living near wind turbines perceive and are affected by them, by following grounded theory, an inductive method for generating conceptual models and hypotheses for further testing. Fifteen participants took part in this study and were part of a previous study by Pedersen and Persson Waye (2004). Participants described –three main types of stimuli from the wind turbines: noise, flickering light, and rotor blade movement. The noise was often classified as a swishing sound, but throbbing, resounding, rattling, and howling were also used as descriptors. The flickering light was depicted by some as being like a strobe light. The movement was described as a constant rotation that always attracted attention, and that was more annoying in winter when there were no leaves on the trees to hide the rotor blades". Noise was typically the dominating stimulus of disturbance.

Some people felt that –wind turbines led to feelings of intrusion into privacy" while others –felt that if one chooses to live in a rural area, one must accept disturbances typical of the countryside such as flies or odor from manure and hence also noise and shadows from wind turbines".

Findings indicated that the relationship between exposure and response is complex and possibly influenced by variables not yet identified, some of which are nonphysical. The notion that wind turbines are –intruders" is a finding not reported elsewhere. Pedersen et al. suggest that values about the living environment are important when the impacts of wind turbines are assessed, as values are firmly rooted within a personality and difficult to change.

Pedersen, E. and P. Larsman. 2008. The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines. Journal of Environmental Psychology 28:379-89.

Pedersen and Larsman conducted this study to assess visibility of the noise source (i.e., wind turbines), visual attitude and vertical visual angle (VVA) in different landscapes. This study follows up on the findings of previous work showing a relationship between noise annoyance in people living near wind turbines and the impact of visual factors as well as an individual‘s attitude toward noise (Pedersen and Nielsen 1994; Pedersen and Persson Waye 2004, 2007; Pedersen et al. 2007). It should be noted that Pedersen and Nielsen (1994) is a report written in Danish, for the Lydtekniske Institut in Denmark.

Data from studies conducted by Pedersen and Persson Waye (2004, 2007) were used as the basis of this study and a theoretic model built that takes into account the interactions amongst the factors tested, namely: noise level, response to turbine noise, response to rotor blade noise, impact on landscape (beautiful-ugly, natural-unnatural descriptors), evaluation of wind turbines (efficient-inefficient, necessary-unnecessary descriptors) and vertical visual angle. These variables were categorized according to whether or not wind turbines were visible, if the terrain was flat or hilly/rocky and if turbines were found in built-up (suburban) or rural areas. These interactions have been illustrated in a conceptual model (Figure 2).

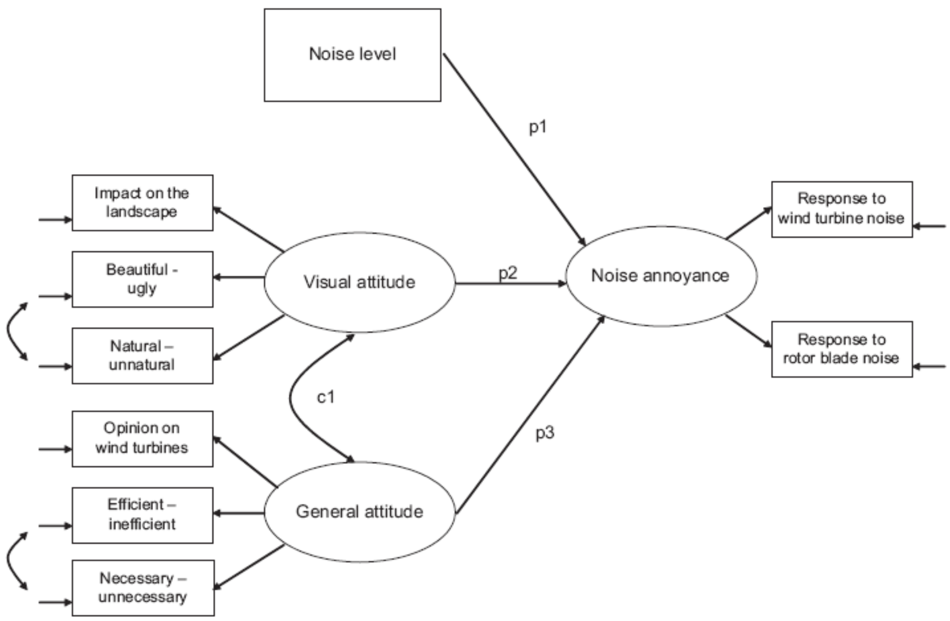

Figure 2: The structural equation model tested in the Pedersen and Larsmann study. ‗Noise level" refers to calculated sound pressure levels (dB(A)) outside the dwellings of the respondents due to wind turbine noise. Visual attitude, general attitude and noise annoyance are latent constructs. Regression weights (paths) are labelled ‗path 1 (p1)" to ‗path 3 (p3)" and the correlation between visual and general attitude is labelled ‗c1". (reproduced from Pedersen and Larsmann 2008).

Because VVA was strongly correlated with noise exposure, Pedersen and Larsman did not include it in the multivariable model. Rather, VVA was assessed separately using multiple linear regression. Overall, Pedersen and Larsman concluded that respondents in a landscape where wind turbines could be perceived as contrasting with their surroundings (i.e., flat areas) had a greater probability of noise annoyance than those in hilly areas (where turbines were not as obvious), regardless of sound pressure level, if they thought wind turbines were ugly, unnatural devices that would have a negative impact on the scenery. The enhanced negative response could be linked to aesthetic response, rather than to multi-modal effects of simultaneous auditory and visual stimulation. Moreover, VVA was associated with noise annoyance, especially for respondents who could see at least one wind turbine from their dwelling, if they were living in flat terrain and rural areas. Pedersen and Larsman suggest that these results underscore the importance of visual attitude towards the noise source when exploring response to environmental noise.

Pedersen, E., F. van den Berg, R. Bakker, and J. Bouma, 2009. Response to noise from modern wind farms in The Netherlands. J. Acoust. Soc. Am. 126 (2): 634-643.

Pedersen et al. published this study expanding on their previous works. This new study was based on the results of a 2007 field study conducted in the Netherlands with 725 respondents. Overall, results suggested that ―wind turbine noise was more annoying than transportation noise or industrial noise at comparable levels, possibly due to specific sound properties such as a ―swishing" quality, temporal variability, and lack of nighttime abatement".

Pedersen et al. also showed, as before, that wind turbines being visible from a dwelling statistically significantly increased the risk of annoyance, and annoyance was correlated with a negative attitude toward the visual impact of wind turbines on the landscape. What was new was the finding that people who economically benefited from wind turbines had a significantly decreased level of annoyance compared to individuals that received no economic benefit, despite exposure to similar sound levels.

Different from previous studies was the finding that annoyance was highest in urban areas rather than rural ones. The authors hypothesized that this was because of ―place attachment", and inhabitants who may feel that turbines are not beneficial to the living environment tend to exhibit a negative reaction. Though not tested, this hypothesis is supported by the work of Pedersen et al. 2007.

Pedersen, E., F. van den Berg, R. Bakker, and J. Bouma, 2010. Can road traffic mask the sound from wind turbines? Response to wind turbine sound at different levels of road traffic. Energy Policy 38: 2520-2527.

In this paper, Pedersen et al. hypothesize that if high levels of background sound can reduce annoyance by masking the noise from a wind farm (either physically or cognitively), then turbines could cause less noise annoyance when placed next to motorways instead of in quiet agricultural areas. Accordingly, the objective of this study was to determine if ―perception and annoyance with wind turbine sound is reduced when road traffic sound dominates the wind turbine sound."

Data utilized for this study were those used by Pedersen et al. 2009, and are based on the results of a 2007 field study conducted in the Netherlands with 725 respondents. Noise levels in dB(A) outside of the homes of each respondent were calculated in accordance with ISO-9613 (1993) for a wind speed of 8m/s at 10 m height and a wind profile in a neutral atmosphere. Day–evening–night sound immission levels (Lden) from road, air and rail traffic were obtained from the Dutch National Institute for Public Health and the Environment (RIVM).

In general, the hypothesis was not supported by the available data. Indeed, ―the relationships between sound levels and annoyance with the noise were in most cases separate for wind turbine and road traffic, respectively, and not interacting". If anything, results of the study show that road traffic may provide a significant masking effect of wind farm noise in the 35–40 dB(A) range. However this only occurs when road traffic is 20 dB(A) louder than noise from the turbines, indicating that less noise annoyance as a result of wind farms would be expected if situated in areas where road traffic sound levels are in the 55–60 dB(A) range.

Smedley, A.R.D., A.R. Webb, and A.J. Wilkins. 2010. Potential of wind turbines to elicit seizures under various meteorological conditions. Epilepsia 51: 1146-1151.

The work published by Smedley et al. builds upon that by Harding et al. 2008 (who stated that flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz pose a potential risk of inducing photosensitive seizures at an incidence of 1.7 per 100,000 of the photosensitive population). In that atmospheric effects that reduce shadow contrast are included in a model used to calculate the proportion of people liable to be at risk for seizures. The current view used by United Kingdom planning authorities is that ‗Flicker effects have been proven to occur only within ten rotor diameters of a turbine‘.

Smedley et al. conclude that wind turbines rotate at a rate below that at which the flicker is likely to present a risk, but like Harding et al. 2008, suggest that there is a risk when flicker is more than three times per second. Moreover, for the scenarios considered in their assessment, Smedley et al. found that the ―risk of wind turbine induced seizures is negligible at a distance more than about nine times the maximum height reached by the turbine blade”.

Salt, A.N., and T.E. Hullar. 2010. Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research 268: 12-21

Infrasound is produced by physiological processes like respiration, heartbeat and coughing, as well as man-made sources like air conditioning systems, vehicles, some industrial processes and wind turbines. Salt and Hullar suggest that ―it is widely assumed that infrasound presented at an amplitude below what is audible has no influence on the ear”; in this paper Salt and Hullar summarize the results of previous studies that show a physiological response of the human ear to low frequency noise (LFN) and infrasound. At very low frequencies the outer hair cells (OHC) of the cochlea may be stimulated by sounds in the inaudible range. Salt and Hullar hypothesize that ―if infrasound is affecting cells and structures at levels that cannot be heard this leads to the possibility that wind turbine noise could be influencing function or causing unfamiliar sensations”. These authors do not test this hypothesis in their paper but suggest the need for further research.

Pedersen, E. 2011. Health aspects associated with wind turbine noise—Results from three field studies. Noise Control Eng. J. 59 (1), Jan-Feb: 47-53.

The purpose of this study by Pedersen was to assess the relationship between wind turbine noise and possible adverse health effects based on three cross-sectional studies conducted in two areas on Sweden and one location in the Netherlands. One of the Swedish studies took place in a flat, rural landscape (SWE-00; n=351) while the other took place in suburban sites with hilly terrain (SWE-05; n=754). The study in the Netherlands was also in a flat landscape, but with different degrees of road traffic intensity (NL-07; n=725). The selection of study areas corresponds with previous work conducted by Pedersen and colleagues that have investigated the influence of terrain, different degrees of urbanisation and traffic on noise annoyance.

Questionnaires were mailed to people in the three areas to obtain information about annoyance and health effects in response to wind turbines noise. Pedersen included questions about several potential environmental stressors and did not allow participants to know that the focus of the study was on wind turbine noise. For each respondent, sound pressure levels (dB(A)) were calculated for nearby wind turbines. The questionnaires were designed to obtain information about people‘s response to noise (i.e., annoyance), diseases or symptoms of impaired health (i.e., chronic disease, diabetes, high blood pressure, cardiovascular disease, tinnitus, impaired hearing), stress symptoms (i.e., headache, undue tiredness, feeling tense or stressed, feeling irritable), and disturbed sleep (i.e., interruption of the sleep by any noise source). Answers were either given as ―yes/no" or as: do not notice, notice, but not annoyed, slightly annoyed, rather annoyed, and very annoyed.

Results showed that the frequency of those annoyed was related to an increase in sound pressure level as shown by odds ratios (OR) with 95% confidence intervals (CI) greater than 1.0. Sleep interruption was associated with sound level in two of the three studies: in the SWE-00 and NL-07 studies, sleep disturbance was associated with levels of sound of approximately 40 dBA and 45 dBA, respectively. It should be noted that the effect of noise on sleep did not increase gradually with noise levels, but spiked at 40 dBA and 45 dBA, and these sound pressure levels corresponded with the recommended highest exposure levels in the two countries where the studies took place. Pedersen also showed that, after adjusting for noise level, many variables were related to annoyance itself: feeling tense or stressed, as well as irritable, were associated with noise annoyance in all three studies (OR and 95%CI > 1.0). Sleep interruption was associated with sound level and annoyance (OR and 95%CI > 1.0). In general, OR were greater in the SWE-00 and NL-7 studies (flat landscape) than the SWE-05 study (hilly).

Though there are limitations to the study design (as acknowledged by Pedersen), results support those published in previous studies: that terrain is a variable that can be related to the way people respond to wind turbines and effects like stress are more strongly related to annoyance, and not wind turbine noise (e.g., Pedersen and Persson Waye, 2004; 2007; 2008; Pedersen and Larsman, 2008). Pedersen states that this is not to say that this result should be taken as evidence of a causal relationship between wind turbine noise and stress, mediated by annoyance, but rather explained by cognitive stress theory, in which an individual appraises an environmental stressor, such as noise, as beneficial or not, and behaves accordingly.

O'Neal, R.D., Hellweg Jr., R.D., and Lampeter, R.M. 2011. Low frequency noise and infrasound from wind turbines. Noise Control Eng. J. 59 (2), March-April: 135-157

To assess the possibility that the operation of wind turbines may create unacceptable levels of low frequency noise and infrasound, O'Neal et al. conducted a study (commissioned by a wind energy developer, NextEra Energy Resources, LLC) to: determine guidelines/standards used to evaluate low frequency sound and infrasound; to measure wind turbine noise outside and within nearby residences of turbines; and to compare the field results to the obtained guidelines and standards.

At the Horse Hollow Wind Farm in Taylor and Nolan Counties, Texas, broadband (A-weighted) and one-third octave band data (3.15 hertz to 20,000 hertz bands) were simultaneously collected from General Electric (GE) 1.5sle (1.5 MW) and Siemens SWT-2.3-93 (2.3 MW) wind turbines. Collection took place using two Norsonic Model Nor140 precision sound analyzers with a Norsonic-1209 Type 1 Preamplifier, a Norsonic-1225 half-inch microphone and a 7-inch Aco-Pacific untreated foam windscreen Model WS7. Data were collected outdoors and indoors over the course of one week under a variety of operational conditions at two distances from the nearest wind turbines: 305 meters and 457 meters.

Outdoor measurements were compared to criteria for audibility: disturbance using equivalent outdoor levels from the UK DEFRA (Department for Environment, Food, and Rural Affairs); for rattle and annoyance criteria as contained in ANSI (American National Standards Institute) S12.9/Part 4; for evaluating complaints of rattling using Japan Ministry of Environment guidance; and for perceptible vibration using equivalent outdoor levels from ANSI/ASA S12.2. Indoor measurements were compared to criteria for audibility: for disturbance from UK DEFRA; for evaluating complaints of mental and physical discomfort using Japan Ministry of Environment guidance; and for suitability of bedrooms, hospitals and schools and perceptible vibration from ANSI/ASA S12.2.

O'Neal et al. found that the measured low frequency sound and infrasound at both distances (from both turbine types at maximum noise conditions) were less than the standards and criteria published by the cited agencies and organizations. The authors concluded that results of their study suggest that there should be no adverse public health effects from infrasound or low frequency noise at distances greater than 305 meters from the two wind turbine types measured.

2.2 Summary

What can be seen from these articles is that the relationship between wind turbines and human responses to them is extremely complex and influenced by numerous variables, the majority of which are nonphysical. What is clear is that some people living near wind turbines experience annoyance due to wind turbines. Swishing, whistling, resounding and pulsating/throbbing were the sound characteristics that were most highly correlated with annoyance by wind turbine noise among respondents who noticed the noise outside their dwellings. Some people are also disturbed in their sleep by wind turbines. Key points that have come out of these peer-reviewed studies are listed below.

1. People tend to noticed sound from wind turbines almost linearly with increasing sound pressure level, from roughly 5-15% noticing noise at 29 dB(A) to 45-90% noticing noise at 41 dB(A).
2. Of people that notice sound from wind turbines, the proportion who are fairly annoyed or very annoyed remains quite level through the 29-37 dB(A) range (no more than roughly 5%) but increases at noise levels above 37 dB(A), with peaks at 38 db(A) and 41 dB(A) where up to 30% of people may be very annoyed.
3. Noise annoyance is not only related to wind turbine noise itself, but also to subjective factors like attitude to visual impact (e.g., beautiful vs. ugly), attitude to wind turbines in general (benign vs. intruders) and sensitivity to noise. Noise annoyance related to wind turbines is also statistically related to whether or not people live in suburban or rural areas and landscape (flat vs. hilly/complex).
4. Visual impact has come out as a stronger predictor of noise annoyance than wind turbine noise itself.
5. People who economically benefit from wind turbines have significantly decreased levels of annoyance compared to individuals that received no economic benefit, despite exposure to similar sound levels.
6. Studies have shown that placement of wind turbines in already noisy areas rather than quiet ones can help mitigate noise annoyance.
7. Flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz pose a potential risk of inducing photosensitive seizures at an incidence of 1.7 per 100,000 of the photosensitive population. The normal practice for large wind farms is for frequencies below this threshold.
8. Health Canada has proposed that the predicted sound level from a wind turbine should not exceed 45 dB(A) at a sensitive receptor location (e.g., residences, hospitals, schools) situated in a quiet rural setting. The proposed criterion value is expected to lead to a 6.5% increase in the percentage of highly annoyed people.

2.3 Popular Literature

Scientific studies peer reviewed and published in scientific journals are one way of disseminating information about wind turbines and health effects. The general public does not always have access to scientific journals and often receive information, and form opinions, from sources that are less accountable (e.g., popular literature and the internet). Numerous websites have been constructed by individuals or groups to support (e,g., David Suzuki, 2005; The Pembina Institute http://www.pembina.org/re/wind-power-101) or oppose (e.g., Wind Concerns Ontario http://windconcernsontario.wordpress.com; The Society of Wind Vigilance http://www.windvigilance.com) the development of wind turbine projects.

Often these websites state the perceived impacts on, or benefits to, human health to support the position(s) of the individual or group. The majority of information posted on these websites cannot, unfortunately, be traced back to a scientific, peer-reviewed sources and is typically anecdotal in nature. In some cases, the information contained on and propagated by internet websites and the media is not supported, or is even refuted, by scientific research. This serves to spread misconceptions about the potential impacts of wind energy on human health, which either increases or diminishes opposition to wind farm development. Therefore it is difficult for the general public to ascertain which claims from both sides of the issue are relevant and defensible.

There are a number of cases available on the internet (presented as reports or as slide presentations) suggesting a link between human health effects and wind turbines (e.g., works by Dr. Michael Nissenbaum conducted at Mars Hill and Vinalhaven Maine, Dr. Robert McMurtry and Carmen Krogh in Ontario, Lorrie Gillis, Carmen Krogh, and Dr. Nicholas Kouwen in Ontario). Authors of these studies have presented their findings in various forums (e.g., lectures, affidavits, public meetings). Dr. Nissenbaum evaluated 22 exposed adults (defined as living withing 3500 ft of an arrangement of 28 1.5 MW wind turbines) and 27 unexposed (living about 3 miles away from the nearest turbine). In 2009, a book entitled Wind Turbine Syndrome: A Report on a Natural Experiment by Dr. Nina Pierpont, was self-published and describes ―Wind Turbine Syndrome", the clinical name Dr. Pierpont coined for the collection of symptoms reported to her by people residing near wind turbines. The book describes a case series study she conducted involving interviews of 10 families experiencing adverse health effects and who reside near wind turbines. Briefly, for these studies a limited number of people living near wind turbines were given questionnaires, and information about their health obtained. Generally, self-reported symptoms included sleep disturbance, headache, tinnitus (ringing in the ears), ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia (rapid heart rate), irritability, problems with concentration and memory, and panic episodes. These symptoms have been purported to be associated with proximity to wind turbines, and specifically, to the infrasound emitted by the turbines. Unlike the studies published in the peer-reviewed literature, the purpose of the studies was made clear to participants prior to undertaking questionnaires.

To date, these studies have not been subjected to scientific peer review and, given the venue for their distribution, it is extremely difficult to assess whether or not the information provided is reliable or valid. What is apparent is that these studies:

1. were not designed incorporating the fundamental principles of epidemiology;
2. do not contain noise measurements;
3. do not have adequate statistical representation of potential health effects;
4. provide limited rationale for the selection of study participants;

5. suffer from a small number of participants; and
6. suffer from a lack of objectivity, as authors are also known advocates who oppose wind turbines.

Of note is that conclusions of the peer reviewed literature differ in some ways from the conclusions of the studies published in the popular literature. In the peer reviewed studies, annoyance tends to peak in the >35 dB(A) range but tends to be more strongly related to subjective factors like visual impact, attitude to wind turbines in general (benign vs. intruders) and sensitivity to noise rather than noise itself from turbines. In the popular literature, health outcomes tend to be more strongly related to distance from turbines and the claim that infrasound is the causative factor. Though sound pressure level in the peer reviewed studies was scaled to dB(A), infrasound is a component of the sound measurements and was inherently accounted for in the studies. What both types of studies have in common is the conclusion that wind turbines can be a source of annoyance for some people.

2.4 Governmental Agency Reports

A number of reviews of potential health effects associated with wind turbines have been written in recent years for governments and governmental agencies (WHO, 2004; National Research Council, 2007; Chatham-Kent Public Health Unit, 2008; Minnesota Department of Health, 2009; Chief Medical Officer of Health Ontario, 2010; Australian Government, National Health and Medical Research Council, 2010).

In June 2008, the Chatham Kent Public Health Unit of Chatham, Ontario published a review entitled ―The Health Impact of Wind Turbines: A Review of the Current White, Grey, and Published Literature”. This review was one of the first of its kind to be released and concludes with the statement ―This paper concludes and concurs with the original quote from Chatham-Kent‘s Acting Medical Officer of Health, Dr. David Colby, ‗In summary, as long as the Ministry of Environment Guidelines for location criteria of wind farms are followed, it is my opinion that there will be negligible adverse health impacts on Chatham-Kent citizens. Although opposition to wind farms on aesthetic grounds is a legitimate point of view, opposition to wind farms on the basis of potential adverse health consequences is not justified by the evidence.”

In May of 2010, the Chief Medical Officer of Health (CMOH) for Ontario released a report entitled ―The Potential Health Impacts of Wind Turbines”. Quoting directly from the Summary of the Review ―The review concludes that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying.” It is important to note that the CMOH for Ontario did not consider these reports of annoyance to be sufficient at this point to warrant medical consideration.

In July 2010, the National Health and Medical Research Council (NHMRC) of the Australian Government published ―Wind Turbines and Health, A Rapid Review of the Evidence”, in which they concluded ―This review of the available evidence, including journal articles, surveys, literature reviews and government reports, supports the statement: There are no direct pathological health effects from wind farms and that any potential impact on humans can be minimised following existing planning guidelines.” It should be noted that the Australian Senate, specifically the Community Affairs References Committee, is holding an inquiry into the social and economic impact of rural wind farms. Results of the inquiry are expected in a final report by 1 June 2011 (Australian Government, 2011).

It is important to recognize that of these reviews, all of which include medical doctors, none classified the self-reported annoyance issues of residents as a pathological medical entity. Overall, governmental health agencies agree that noise from wind turbines is not loud enough to cause hearing impairment and are not causally related to adverse effects, however, they acknowledge that wind turbines can be a source of annoyance and suggest that impacts can be minimized by following existing planning guidelines.

2.5 Annoyance

Studies on the health effects of wind turbines, both published and peer-reviewed and presented in the popular literature, tend to conclude that wind turbines can cause annoyance for some people. It has been hypothesized that the self reported health effects found in popular literature (e.g., sleep disturbance, headache, tinnitus (ringing in the ears), ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia (rapid heart rate), irritability, problems with concentration and memory, and panic episodes) are related to infrasound emitted from wind turbines. This hypothesis likely stems from studies that have proposed a relationship between biological effects and exposure to infrasound (e.g., Alves-Pereira and Branco, 2007).

Given the following points, however, it appears that the link between wind turbine-generated infrasound and health effects are not substantiated.

- Studies where biological effects were observed due to infrasound exposure were conducted at sound pressure levels (e.g., Leventhall, 2006; 145 dB and 165 dB; Yuan et al., 2009: 130 dB) much greater than what is produced by wind turbines.
- Infrasound is not unique to wind turbines but is ubiquitous in the environment due to natural and man-made sources, meaning that people living near wind turbines were exposed to infrasound prior to turbine operation (e.g., Leventhall, 2006).
- Peer reviewed and scientifically defensible studies suggest that annoyance and health effects are more strongly related to subjective factors like visual impact and attitude to wind turbines than to noise itself (both audible and inaudible [i.e., infrasound]) (e.g., papers by Pedersen and others).
- The self reported health effects are associated with numerous issues, many of which can be attributed to anxiety and annoyance. For example, Berglund and Hassmen. 1996 reported that infrasound (a component of low frequency sound) is emitted from road vehicles, aircraft, industrial machinery, artillery and mining explosions, air movement machinery including wind turbines, compressors, and air-conditioning units, and Leventhall 2006 reported that infrasound comes from natural sources like meteors, volcanic eruptions and ocean waves. Indeed, many mammals communicate using infrasound (e.g., Langbauer, 2000).
- Shargorodsky et al. (2010) published that roughly 50 million adults in the United States reported having tinnitus, which is statistically correlated (based on 14,178 participants) to age, racial/ethnic group, hypertension, history of smoking, loud leisure-time, firearm, and occupational noise, hearing impairment and generalized anxiety disorder (based on 2265 participants) identified using a World Health Organization Composite Diagnostic Interview. In fact, the odds of tinnitus being related to anxiety disorder was greatest for any of the variables tested. Folmer and Griest (2000), based on a study of 174 patients undergoing treatment for tinnitus at the Oregon Health Sciences University Tinnitus Clinic between 1994 and 1997, reported that insomnia is associated with greater severity of tinnitus. Insomnia is also associated with anxiety and annoyance. Bowling et al., 2006 described statistically that people's perceptions of neighbourhood environment can influence health. Perceptions

of problems in the area (e.g., noise, crime, air quality, rubbish/litter, traffic, and graffiti) were predictive of poorer health score.

- In their 2003 publication Henningsen and Priebe discuss the characteristics of ―New Environmental Illness", illnesses where patients strongly believe their symptoms are caused by environmental factors, even though symptoms are not consistent with empirical evidence and medically unexplained. A key component to such illnesses is the patient's attitude toward the source of the environmental factor.

Given that annoyance appears to be more strongly related to visual cues and attitude than to noise itself, self reported health effects of people living near wind turbines are more likely attributed to physical manifestation from an annoyed state than from infrasound. This hypothesis is supported by the peer-reviewed literature pertaining to environmental stressors and health. What is more, health effects from annoyance can be mitigated though behavioural and cognitive behavioural interventions (Tazaki and Landlaw, 2006; Leventhall et al., 2008).

3 POTENTIAL EFFECTS (ICE SHED, STRAY VOLTAGE, EMF)

3.1 Ice Shed

Another potential public health and safety issue could result from the accumulation of ice on the turbine blades. This can occur when specific conditions of temperature and humidity exist. This condition is not unique to wind turbines and has the potential to occur on any structure that is exposed to the elements. In Ontario, this condition is most likely to occur in the winter months in extreme weather events. Under these conditions the turbines may be subject to ice coating from freezing rain or interception of low clouds containing super-cooled rain. There are two potential hazards associated with ice accumulation on wind turbines:

- danger of falling ice that may accumulate on the turbine itself as a result of freeze-thaw of snow and ice; and
- throwing of ice from the moving turbine blades.

Falling ice from an immobile turbine does not differ from other tall structures like telecommunication towers, power lines, and antenna masts. The potential ground area affected by falling ice depends to a large extent on the blade position and the prevailing wind speed and direction. When a turbine tip is at its highest point (approximately 120 m), ice would fall within a width of approximately 85 m from the turbine base (Seifert et al., 2003). This is dependent upon wind speed and direction. Garrad Hassan Canada (2007) estimated that only very high winds may cause ice fragments of any significant mass to be blown beyond 50 m of the base of a modern, stationary 2 MW turbine. Operating staff and landowners are briefed on this situation; therefore the risk is considered minimal (Garrad Hassan Canada, 2007).

Wind turbines typically operate when the wind speed is within the range of 4 m/s to 25 m/s; when turbines are in operation they can accumulate ice on the rotor blades. Ice fragments which detach from the rotor blades can be thrown from the wind turbine; any fragments will land in the plane of the wind turbine rotor or downwind (Garrad Hassan Canada, 2007). Throwing distance varies depending upon the rotor azimuth, rotor speed, local radius, and wind speed. Also, the geometry of the ice fragments and its mass will affect the flight trajectory.

Observations have shown that the ice fragments do not maintain their shape and immediately break into smaller fragments upon detaching from a blade. This would decrease the ice fragment's drag and potentially allow the ice fragment to be thrown greater distances. For human injury to result from wind turbine ice shed, several conditions would have to exist simultaneously (Garrad Hassan Canada, 2007):

- sustained weather condition conducive to icing;
- ice dislodging from the turbine blade;
- ice pieces large enough to remain intact through the air;
- ice traveling in a particular direction past setback guidelines; and,
- a person in the path of the ice as it lands.

A risk assessment methodology was developed by Garrad Hassan Canada and Partners, in conjunction with the Finnish Meteorological Institute and Deutsches Windenergie-Institut, as part of a research project on the implementation of Wind Energy in Cold Climates (WECO). Guidelines produced in the WECO project were based on a combination of numerical modelling and observations. The WECO database of observed ice fragments determined that recorded ice fragments are typically thrown to distances less than 125 m from the base of the turbine (Seifert et al., 2003).

Garrad Hassan Canada developed an Ontario-specific risk assessment methodology for ice shed based on the findings of the WECO project. Modelling was undertaken to determine the probability of an ice fragment landing within one square metre of ground area, as a function of distance from the turbine. The model result determined that the critical ice shed distance would be approximately 220 m from a turbine. At distances greater than 220 m, the probability of ice shed reaching ground level at a mass that would cause injury decreases rapidly. The critical distance can effectively be regarded as a –safe" distance, beyond which there is a negligible risk of injury from ice shed (Garrad Hassan Canada, 2007).

Example calculations were presented in the Garrad Hassan Canada (2007) report, using data representative of a typical wind farm project in rural southern Ontario. Risks to a fixed dwelling, vehicle travelling on a road, and individual person from being struck by an ice fragment thrown from an operating wind turbine were modelled, with the following results:

- fixed dwelling: equivalent to 1 strike per 500,000 years;
- vehicle travelling on a road: equivalent to 1 strike per 260,000 years; and,
- individual person: equivalent to 1 strike in 137,500,000 years.

These predictions seem markedly low; however, it is due to the fact that icing events are limited to only a few days per year. For example, Vestas Canada, which maintains turbines across Canada, has experienced no incidents related to falling ice in Canada (Jacques Whitford, 2006). Ice shed from the former Ontario Hydro's first wind turbine was monitored during its first six years of operation, with ice shed reported to have occurred thirteen times. The furthest ice fragment was recorded to be less than 100 m from the turbine (Garrad Hassan Canada, 2007).

3.2 Stray Voltage

Stray voltage results from an overflow of current traveling through the ground, and is manifested as an elevated voltage being developed between the neutral and ground wires. If a human touches two pieces of equipment that are at different voltage levels, a small electric current passes through the person and could have an adverse affect on their health if the voltage were strong enough. Stray voltage is not unique to wind farms and Hydro One is attempting to address stray voltage where it is a result of poor or faulty farm wiring, improper grounding of older Hydro One distribution lines (hydro lines connected to a farm/house), and other on and off farm sources. Stray voltage can be easily prevented through proper wiring practices, such as appropriate insulation, and can be easily measured and eliminated by qualified professionals should it occur.

3.3 Electromagnetic Fields (EMF)

To date, the largest evaluation of EMF and human health has been carried out in the United States by the Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) Program. Led by the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health and the Department of Energy, the EMF RAPID Program was a six-year project (ending in 1999) designed to provide scientific evidence to determine whether exposure to EMF could result in a potential risk to human health (EMF RAPID, 2002).

Overall, the EMF RAPID Program concluded that the body of scientific evidence linking human health risk from EMF exposure is weak. No consistent pattern of biological effects from exposure to EMF had emerged from laboratory studies with animals or with cells. However, epidemiological studies (i.e. studies of disease incidence in human populations) indicated a potential association with EMF exposure to a potential small increased risk of leukemia occurrence in children and chronic lymphocytic leukemia in occupationally exposed adults. They did not report at what EMF levels this causation would be expected to occur.

The Federal-Provincial-Territorial Radiation Protection Committee – Canada (FPTRPC) is comprised of a forum of delegates from the Canadian Nuclear Safety Commission, Health Canada - Radiation Protection Bureau, and the Provincial and Territorial Radiation Protection Programs (FPTRPC, 2009). In 2005, the FPTRPC released a review of all relevant scientific information reported in refereed journals with regard to EMF exposure, published from 1998 to 2002. The report concluded that laboratory research has shown that EMF at extremely low frequencies (ELF) can interact with biological systems. However,

- results to date have not provided conclusive evidence that these fields cause adverse health effects in humans, such as cancer;
- epidemiological studies have not established an association between exposure to ELF EMF and the development of cancer in adults; and
- the evidence associating cancer in children with exposure to ELF EMF remains inconclusive.

The FPTRPC‘s position on the potential link between childhood leukemia and exposure to EMF is stated thus: ―It is the opinion of FPTRPC that the epidemiological evidence to date is not strong enough to justify a conclusion that EMF in Canadian homes, regardless of locations from power lines, cause leukemia in children.” -- FPTRPC Response Statement to the Issue of Power-Frequency Magnetic Fields and Childhood Leukemia – Issued on January 20, 2005

Health Canada has reviewed numerous studies related to ELF EMF exposure and concluded that electrical devices and power lines can induce weak electric currents to flow through the human body. However, these currents are much smaller than those produced naturally by one‘s brain, nerves, and heart, and are not associated with any known health risks (Health Canada, 2004). Health Canada scientists are aware that some studies have suggested a possible link between exposure to ELF fields and certain types of childhood cancer. However, they determined that when all of the studies are evaluated, the evidence of such a link appears to be very weak (Health Canada, 2004) and no threshold values could be established.

In 2004, the International Agency for Research on Cancer (IARC) reported that there is ―limited evidence” that ELF magnetic field exposure could result in childhood leukemia (at exposure levels above 0.4 µT or 4 mG in a pooled analysis based on 9 well conducted studies), and ―inadequate evidence” for any other link between human health effects and exposure to EMF (WHO, 2004). Although a causal relationship between ELF and childhood leukemia had not been established (i.e., no clear evidence exists that indicates that ELF causes childhood leukemia), conflicting results of epidemiology studies indicated a higher incidence of childhood leukemia in children with higher exposure to ELF. ELF was therefore classified as ―a possible human carcinogen”. New laboratory (animal and in vitro) and epidemiological data evaluated since the 2004 classification by IARC showed no evidence that EMF causes cancer in animals or humans; however, enough uncertainty still existed in the epidemiology studies that the classification remained unchanged in their 2007 review (WHO, 2007).

The consensus among agencies and the literature reviewed is that:

- available evidence is not strong enough to conclude that EMF causes cancer in children or occupationally exposed adults;
- there is insufficient evidence linking EMF to any other human health effects; and,
- more studies are needed to draw firm conclusions.

4 CONCLUSIONS

To date, no peer reviewed scientific journal articles have been retrieved or reviewed that identified a causal link between people living in proximity to modern wind turbines, the noise (audible, low frequency noise, or infrasound) they emit and resulting physiological health effects. Both peer-reviewed and popular literature reports suggest that some people can be annoyed by wind turbine noise. Peer-reviewed studies suggest that annoyance is more strongly related to subjective factors like visual impact, attitude to wind turbines in general (benign vs. intrusive) and sensitivity to noise rather than noise itself from turbines. In the popular literature, self-reported health outcomes are related to distance from turbines and the claim is made that infrasound is the causative factor for the reported effects, even though sound pressure levels are not measured. Moreover, self reported health effects can be associated with numerous issues, not just wind turbines. What both types of studies have in common is the conclusion that wind turbines can be a source of annoyance for some people. The literature suggests that annoyance-related effects can be managed and mitigated though behavioural and cognitive behavioural interventions.

5 CLOSURE

This report may not be relied upon by any other person or entity without the express written consent of Stantec Consulting Ltd. Any use that a third party may make of this report, or any reliance on decisions made based on it, are the responsibility of such third parties. The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Conclusions and recommendations presented in this report should not be construed as legal advice.

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6 REFERENCES

1. Alves-Pereira, M., and N.A.A. Castelo Branco. 2007b. In-home wind turbine noise is conducive to vibroacoustic disease. Proceedings of the Second International Meeting on Wind Turbine Noise. Lyon, France: September 20-21, 2007. INCE/Europe.
2. Australian Government. National Health and Medical Research Council. 2010. Wind Turbines and Health: A Rapid Review of the Evidence.
3. Australian Government, Senate Community Affairs References Committee. 2011. Interim Report Inquiry into the Social and Economic Impacts of Rural Wind Farms. Available at: http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/interim_report/index.htm.
4. Berglund, B. and Hassmen, P. 1996. Sources and effects of low-frequency noise. J. Acoust. Soc. Am. 99 (5): 2985-3002.
5. Bowling. A., Barber, J., Morris, R., Ebrahim, S. 2006. Do perceptions of neighbourhood environment influence health? Baseline findings from a British survey of aging. J Epidemiol Community Health: 60:476–483.
6. Chatham-Kent Public Health Unit. 2008. The Health Impact of Wind Turbines: A Review of the Current White, Grey and Published Literature. June 2008.
7. Chief Medical Officer of Health (CMOH) Ontario. 2010. The Potential Health Impact of Wind Turbines. ISBN: 978-1-4435-3288-4 500.
8. Devine-Wright, P. 2005: Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. Wind Energy 8, 125–139.
9. Electric and Magnetic Fields Research and Public Information Dissemination Program (EMF RAPID). 2002. EMF Electric and Magnetic Fields Associated with the Use of Electric Power. June 2002. Available online at: http://www.niehs.nih.gov/health/topics/agents/emf/.
10. Federal Provincial Territorial Radiation Protection Committee (FPTRPC). 2009. Health Canada. Available online at: http://www.hc-sc.gc.ca/ewh-semt/radiation/fpt-radprotect/index-eng.php
11. Folmer, R.L. and Griest, S.E. 2000. Tinnitus and Insomnia. Am J Otolaryngol: 21:287-293.
12. Garrad Hassan Canada. 2007. Recommendations For Risk Assessments Of Ice Throw And Blade Failure In Ontario. 38079/OR/01.
13. Harding, G., Harding, P. and A. Wilkins. 2008. Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. Epilepsia 49:1095-98.

14. HATCH™. 2010. Kent Breeze Corporation - Kent Breeze Wind Farm and MacLeod Windmill Project Noise Assessment Report.

15. Health Canada. 2004. Electric and Magnetic Fields at Extremely Low Frequencies. Available online at: http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/magnet-eng.php

16. Henningsen, P. and Priebe, S. 2003. New environmental illnesses: What are their characteristics? Psychotherapy and Psychosomatics 72: 231-234.

17. Higgins JPT, Green S (editors). 2009. Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.2. The Cochrane Collaboration.

18. Keith, S.E., Michaud, D.S. and S.H.P. Bly. 2008. A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control 27:253-265.

19. Kristiansen, J., Mathiesen, L., Nielsen, P.K., Hansen, A.M., Shibuya, H., Petersen, H.M., Lund, S.P., Jørgensen, M.B., and Søgaard, K. 2009. Stress reactions to cognitively demanding tasks and open-plan office noise. Int Arch Occup Environ Health 82:631–641.

20. Langbauer, W.R. 2000. Elephant Communication. Zoo Biology 19:425–445.

21. Leventhall, G. 2006. Infrasound from wind turbines – fact, fiction or deception? Canadian Acoustics 34:29-36.

22. Leventhall, G., Benton, S., and Robertson, D. 2008. Coping strategies for low frequency noise. Journal of Low Frequency Noise, Vibration and Active Control 27:35-52.

23. O'Neal, R.D., Hellweg Jr., R.D., and Lampeter, R.M. 2011. Low frequency noise and infrasound from wind turbines. Noise Control Eng. J. 59 (2), March-April: 135-157.

24. Ontario Ministry of the Environment. 2009. Development of Noise Setbacks for Wind Farms Requirements for Compliance with MOE Noise Limits.

25. Ontario Power Authority (OPA). 2008. 2008 Annual Report. On the Path to a Sustainable Electricity Future.

26. Ontario Regulation 359/09 Renewable Energy Approvals Under Part V.0.1 Of The Act, 2011, amended by O. Reg. 521/10.

27. Pedersen, E. 2011. Health aspects associated with wind turbine noise—Results from three field studies. Noise Control Eng. J. 59 (1), Jan-Feb 2011.

28. Pedersen, E. and P. Larsman. 2008. The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines. Journal of Environmental Psychology 28:379-89.

29. Pedersen, E., Hallberg, L.R.-M., and Persson Waye, K. 2007. Living in the vicinity of wind turbines—a grounded theory study. Qualitative Research in Psychology 4: 49–63.

30. Pedersen, E. and K. Persson Waye. 2004. Perception and annoyance due to wind turbine noise – a dose – response relationship. Journal of the Acoustical Society of America 116:3460-3470.

31. Pedersen, E. and K. Persson Waye. 2007. Wind turbine noise, annoyance and self-reported health and well-being in different living environments. Occupational and Environmental Medicine 64:480-486.

32. Pedersen, E. and K. Persson Waye. 2008. Wind turbines - low level noise sources interfering with restoration? Environmental Research Letters 3:1-5.

33. Pedersen, E., van den Berg, F., Bakker, R., and Bouma, J. 2009. Response to noise from modern wind farms in The Netherlands. J. Acoust. Soc. Am. 126 (2): 634-643.

34. Pedersen, E., van den Berg, F., Bakker, R., and Bouma, J. 2010. Can road traffic mask the sound from wind turbines? Response to wind turbine sound at different levels of road traffic. Energy Policy 38: 2520-2527.

35. Salt, A.N., and Hullar, T.E. 2010. Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research 268: 12-21.

36. Seifert, H., Westerhellweg, A. and J. Kroning. 2003. Risk Analysis of Ice Throw From Wind Turbines. Paper Presented at BOREAS 6, 9 to 11 April, Pyha, Finland.

37. Shargorodsky, J., Curhan, G.C., and Farwell, W.R. 2010. Prevalence and Characteristics of Tinnitus among US Adults. The American Journal of Medicine 123: 711-718.

38. Smedley, A.R.D., Webb. A.R. and Wilkins, A.J. 2010. Potential of wind turbines to elicit seizures under various meteorological conditions. Epilepsia 51: 1146-1151.

39. Suzuki, D. 2005. They're welcome in my backyard: far from being a blot on the landscape, wind farms are an asset, especially when you look at the alternative. New Scientist, 186 (2495): 20.

40. Tazaki, M and Landlaw, K. 2006. Behavioural mechanisms and cognitive-behavioural interventions of somatoform disorders. International Review of Psychiatry 18: 67–73.

41. van den Berg, G.P. 2003. Effects of the wind profile at night on wind turbine sound. Journal of Sound and Vibration 277:955–970.

42. World Health Organization (WHO). 2004. Fourth Ministerial Conference on Environment and Health. Energy, Sustainable Development and Health.

43. World Health Organization (WHO). 2007. Environmental Health Criteria 238. Extremely Low Frequency Fields. ISBN 978 92 4 157238 5.

44. World Health Organization Europe. 2009. Night Noise Guidelines For Europe. ISBN 978 92 890 4173 7.

45. Yuan, H., Long, H., Liu. J., Qu, L., Chen, J. and X. Mou. 2009. Effects of infrasound on hippocampus-dependent learning and memory in rats and some underlying mechanisms. Environmental Toxicology and Pharmacology 28:243-247.