NextEra Energy Canada, ULC

Draft Construction Plan Report – Goshen Wind Energy Centre

Prepared by:

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60155032

Date:

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Glossary of Terms

ABCA .....Ausable Bayfield Conservation Authority
ANSI.....Area of Natural and Scientific Interest
DFO .....Department of Fisheries and Oceans Canada
EIS .....Environmental Impact Study
GE.....General Electric
GIS.....Geographic Information System
kV.....Kilovolt
LLC .....Limited Liability Company
m .....Metre
MNR.....Ontario Ministry of Natural Resources
MOE.....Ontario Ministry of the Environment
MTCS.....Ontario Ministry of Tourism, Culture and Sport
MTO .....Ontario Ministry of Transportation
MW.....Megawatt
NextEra .....NextEra Energy Canada
O.Reg. 359/09.....Ontario Regulation 359/09
PDR .....Project Description Report
PSW.....Provincially Significant Wetland
REA.....Renewable Energy Approval
SGRA.....Significant Groundwater Recharge Area
The Project.....Goshen Wind Energy Centre
ULC.....Unlimited Liability Corporation
UTRCA.....Upper Thames River Conservation Authority

1. Introduction

Goshen Wind, Inc., a wholly owned subsidiary of NextEra Energy Canada, ULC (NextEra) is proposing to construct a wind energy Project in Bluewater and South Huron, Huron County, Ontario (**Figure 1-1**). The project will be referred to as the Goshen Wind Energy Centre (the "Project") and will be located on private lands in the vicinity of the shoreline of Lake Huron. The wind turbine technology proposed for the Project is the GE 1.6-100 Wind Turbine and GE 1.56-100 Wind Turbine. With a total nameplate capacity of 102 MW, the Project is categorized as a Class 4 facility. Although NextEra is seeking a Renewable Energy Approval (REA) for up to 72 wind turbines, only 63 will be constructed for the Project.

This Construction Plan Report was prepared in accordance with the requirements of the REA process outlined in Ontario Regulation 359/09 (*O. Reg. 359/09*) and the Technical Guide to Renewable Energy Approvals (Ontario Ministry of the Environment (MOE), 2011).

The following sections provide information on the construction and installation activities, potential negative environmental effects of construction and installation activities and mitigation measures for the identified negative effects.

1.1 Summary of Construction Plan Report Requirements

The requirements for the Construction Plan Report defined under *O.Reg. 359/09* are provided in the following table (**Table 1-1**) in addition to the corresponding report section.

Table 1-1 Adherence to Construction Plan Report Requirements

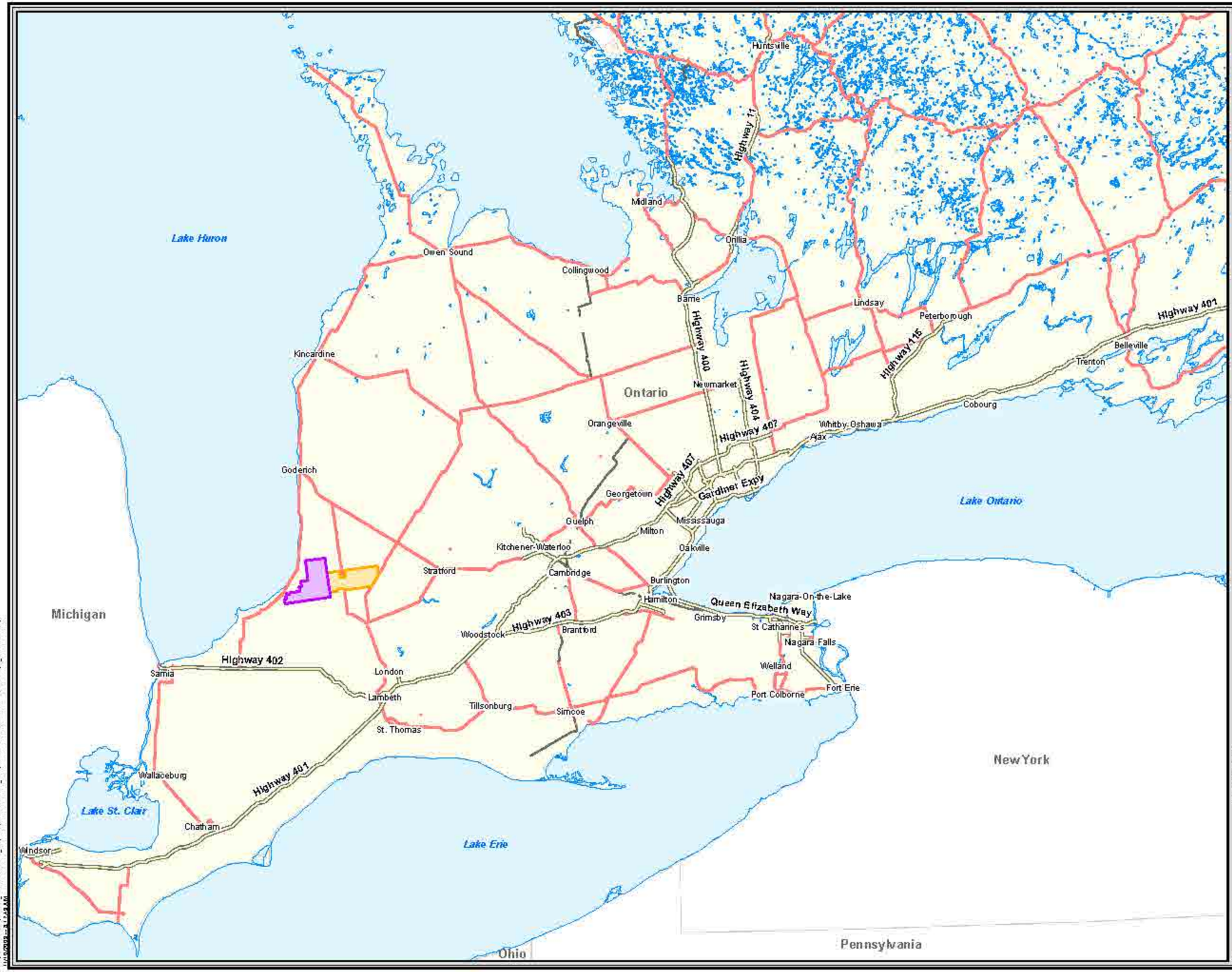
Requirement	Completed	Corresponding Section
Details of construction or installation activities	Yes	Section 2
The location and timing of any construction or installation activities for the duration of the construction or installation	Yes	Section 1.3 and Figure 2-1 Section 2.1
Any negative environmental effects that may result from construction or installation activities	Yes	Section 3
Mitigation measures in respect of any negative environmental effects	Yes	Section 3 and the Environmental Effects Monitoring Plan in the Design and Operation Report

1.2 The Proponent

The Project will be owned and operated by Goshen Wind, Inc., a subsidiary of NextEra. NextEra's parent company is NextEra Energy Resources, LLC, a global leader in wind energy generation with a current operating portfolio of over 85 wind energy projects in North America. In Canada, wind energy centres currently owned and operated by NextEra Energy Canada include: Mount Copper and Mount Miller, (both 54 megawatts (MW)) located in Murdochville, Quebec; Pubnico Point, (31 MW) located near Yarmouth, Nova Scotia; and Ghost Pine (82 MW), located in Kneehill County, Alberta.

The primary contacts for the Project are as follows:

Project Proponent	Project Consultant
Derek Dudek Community Relations Consultant NextEra Energy Canada, ULC 5500 North Service Road, Suite 205 Burlington, Ontario, L7L 6W6 Phone: 1-877-257-7330 Email: Goshen.Wind@NextEraEnergy.com Website: www.NextEraEnergyCanada.com	Marc Rose Senior Environmental Planner AECOM 300-300 Town Centre Blvd. Markham, Ontario, L3R 5Z6 Phone: 905-477-8400 x388 Email: marc.rose@aecom.com



Legend

- Wind Energy Centre Study Area
- Transmission Line Study Area
- Expressway
- Highway
- Secondary Highway

Basemapping from Ontario Ministry of Natural Resources

Kilometers

0 10 20 40 60 80

1:1,500,000

UTM Zone 17N, NAD 83

Goshen Wind Energy Centre

Study Area in Ontario

September 2012
Project 60155032

AECOM

Figure 1-1

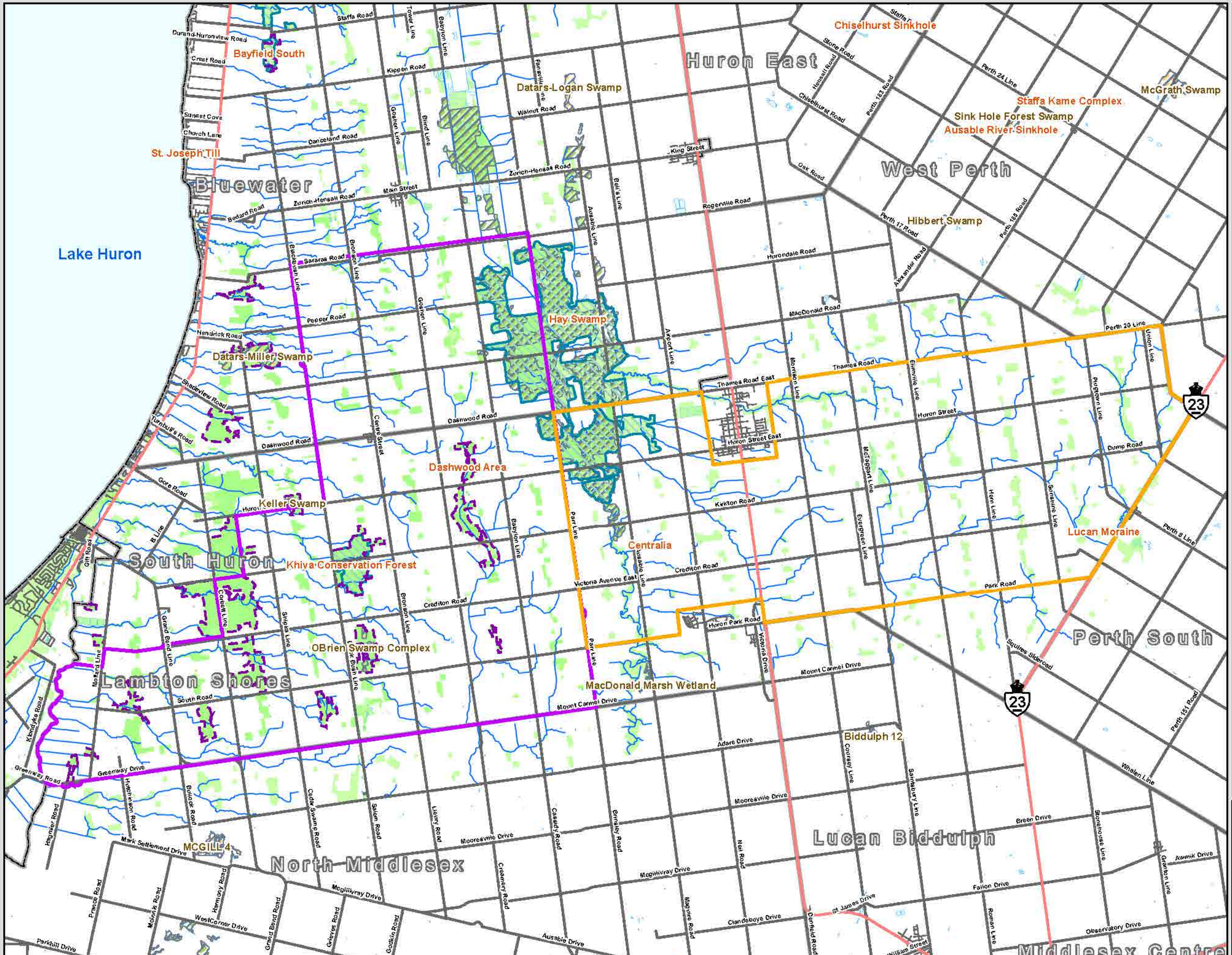
1.3 Project Study Area

The proposed Project is located in Huron County, within the Municipalities of Bluewater and South Huron. The Project Study Area consists of the areas being studied for the wind farm components (Wind Energy Centre Study Area), as well as for the interconnection route (i.e., the area being studied for transmission lines to connect the Project to the electrical grid) (Transmission Line Study Area) (**Figure 1-2**). The Wind Energy Centre Study Area is generally bounded by Klondyke Road to the west, Rogerville Road to the north, Parr Line to the east, and Mount Carmel Drive to the south, in the Municipalities of Bluewater and South Huron. The Transmission Line Study Area is located to the east of the Wind Energy Centre Study Area, and is generally bounded by Parr Line to the west, Thames Road to the north, Perth 164 Road to the east, and Park Road to the south, extending into the Municipality of South Huron.

The location of the Project Study Area was defined early in the planning process for the proposed wind energy facility, based on the availability of wind resources, approximate area required for the proposed project, and availability of existing infrastructure for connection to the electrical grid. The Project Study Area was used to facilitate information collection.

The following co-ordinates define the external boundaries of the Project Study Area:

Longitude	Latitude
-81.6753290	43.4155312
-81.3011931	43.3810955
-81.3303330	43.3036317
-81.7743607	43.2379854



Legend

- Wind Energy Centre Study Area
- Transmission Line Study Area
- Municipal Division

Natural Features

- Natural Features (ABCA)
- Provincially Significant Life Science ANSI
- Regionally Significant Life Science ANSI
- Regionally Signficant Candidate Life Science ANSI
- Regionally Signficant Candidate Earth Science ANSI
- Provincially Significant Wetland
- Locally Significant Wetland
- ESA (ABCA)
- Waterbody
- Cartographic Wetland

Basemapping from Ontario Ministry of Natural Resources

N / E / S / W

Kilometers

0 1.5 3 6

1:125,000

UTM Zone 17N, NAD 83

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Goshen Wind Energy Centre

Project Study Area

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Figure 1-2

2. Description of Construction and Installation Activities

The Project Location is defined as per *O. Reg. 359/09* as "*a part of land and all or part of any building or structure in, on or over which a person is engaging in or proposes to engage in the project and any air space in which a person is engaging in or proposes to engage in the project*" (Government of Ontario, 2009). As described therein, the Project Location boundary is the outer limit of where site preparation and construction activities will occur (i.e., Disturbance Areas described below) and where permanent infrastructure will be located, including the air space occupied by turbine blades.

The proposed Project Location is shown on **Figures 2-1, 2-2** and **2-3**, and includes the components of the Project listed below:

- Up to 71 GE 1.6-100 Wind Turbine generator locations and pad mounted step-up transformers and one GE 1.56-100 Wind Turbine generator location and pad mounted step-up transformer (however, only 63 turbines will be constructed);
- Laydown and storage areas (including temporary staging areas, crane pads and turnaround areas surrounding each wind turbine);
- Temporary electrical service line for the purpose of providing power to the construction trailers located at the laydown area;
- A transformer substation;
- Underground 34.5 kV electrical collection lines to connect the turbines to the transformer substation and other ancillary equipment such as above-ground junction boxes;
- 115 kV transmission line to run from the transformer substation to a breaker switch station which will connect the electricity generated by the project to the existing Hydro One 115 kV transmission line;
- Turbine access roads;
- Three permanent meteorological towers; and
- An operations and maintenance building including an electrical service line connected to the local distribution service.

Disturbance Areas have been identified surrounding various Project components, which are depicted on the Project Location figure by the item "Project Location" in the legend. These denote areas where temporary disturbance during the construction phase may occur as a result of: temporary project component laydown and storage areas, crane pad construction, turbine turnaround areas, and construction of access roads and electrical collection system. With the exception of the project components described above, no permanent infrastructure is proposed within these areas. Following construction activities, the land will be returned to pre-construction conditions.

The above mentioned Project components are depicted in the Project Location figures described below:

- **Figure 2-1**: shows the locations of Project components and associated disturbance areas including: wind turbines, access roads, the electrical collection system, 115 kV transmission line, the operations and maintenance building, the transformer substation and breaker switch station, and temporary laydown/storage areas. This figure also shows topographical land contours and surface water drainage for all land within 120 m of the Project Location.
- **Figure 2-2**: shows the location of Project components and associated disturbance areas in relation to surrounding natural heritage and water body features such as: wetlands, woodlands, streams, and Areas of Natural and Scientific Interest, in addition to water wells identified in MOE's database. This figure also demonstrates compliance with the 120 m setback distance for natural heritage features, measured from the boundary of the Project Location, , and highlights significant natural heritage features that are within those setback distances.

Legend
Wind Energy Centre Study Area
Goshen Transmission Line Study Area
120 m Area of Investigation
Municipal Division
Roads
Freeway
Expressway / Highway
Major Road
Local Road
Natural Features
Watercourse (ABCA, UTRCA)
Watercourse (MNR)
Waterbody
Cartographic Wetland
Contour (5 m)
Woodlot
Project Location
GE Turbine
Permanent Meterological Tower
Access Road
Collection Line
Transmission Line
Disturbance Area
Breaker Switch Station
Transformer Substation
Temporary Laydown Area
Lake Huron
South Huron
Basemapping from Ontario Ministry of Natural Resources
Metres
0 500 1,000 1,500 2,000
1:50,000
UTM Zone 17N, NAD 83
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Goshen Wind Energy Centre
Project Location
August 2012
Project 60155032
AECOM
Figure 2-1

Legend

- Wind Energy Centre Study Area
- Transmission Line Study Area
- Municipal Division
- Freeway
- Expressway / Highway
- Major Road
- Local Road
- Ramp
- MOE Waterwell
- Permanent Meterological Tower

Project Location

- GE Turbine
- Transmission Line
- Collection Line
- Access Road
- Disturbance Area
- 120 m Area of Investigation
- Breaker Switch Station
- Transformer Substation

- Provincial.ANSI, Earth Science
- Regional.ANSI, Life Science
- Regional.Candidate ANSI, Earth Science
- Regional.Candidate ANSI, Life Science
- Locally Significant Wetland
- Provincial Significant Wetland
- Watercourse
- Waterbody
- Cartographic Wetland
- Wooded Area

Basemapping from Ontario Ministry of Natural Resources

Metres
0 250 500 1,000 1,500 2,000
1:50,000
UTM Zone 17N, NAD 83

Goshen Wind Energy Centre

Project Location and Natural Heritage Features

September 2012
Project 60155032

AECOM

Figure 2-2

- **Figure 2-3**: shows the location of Project components and associated disturbance areas in relation to surrounding socio-economic features such as: property boundaries, roads and railway right-of-ways, petroleum resources, landfills, aggregate resources and noise receptors. This figure also identifies the setback distances between these features and the Project components. Note that noise compliance is addressed in Appendix A - Noise Study Report, of the Design and Operations Report.

The exercise of siting infrastructure is an iterative process that involves balancing the wind resource with environmental, socio-economic and engineering constraints, including the preferences of individual landowners, while at the same time adhering to the setback distances prescribed by the Province and outlined in *O. Reg. 359/09*.

The following sections outline the activities anticipated for the Construction phase of the Project and provide details on the timing of the activities, materials brought on site, construction equipment used, and temporary uses of land. Note that water takings for the construction phase will be short-term (3-4 days) in duration and are not expected to exceed 73,000 L/day.

These project activities are also described in Section 2.2.1 of the Project Description Report (PDR) (AECOM, 2012).

2.1 Project Timing

Subject to the receipt of the necessary permits and approvals, site work for the Goshen Wind Energy Centre is expected to begin in 2013 and last for approximately 6 months. **Table 2-1** presents the currently anticipated construction schedule and approximate order of construction activities for the proposed Project.

Table 2-1 Construction Schedule

Activity		Timing of Activity	Duration
Surveying		Prior to construction – preference is winter months	Less than one day per turbine location
Geotechnical Sampling		Prior to construction – preference is winter months	One to two hours per turbine location
Land Clearing and Construction of Access Roads		Late spring or summer – preference is to conduct during drier months	One to three days per access road to each turbine
Installation of Culverts		Late spring or summer – preference is to conduct during drier months	One to two days per culvert
Construction Laydown Area		Late spring or summer – preference is to conduct during drier months	One week
Turbine Site and Crane Pad Construction		Late spring or summer – preference is to conduct during drier months	Two to four days per turbine location
Delivery of Equipment		Throughout construction phase as needed, and in compliance with Traffic Management Plan	As needed throughout construction phase
Turbine Foundations		Late spring or summer – preference is to conduct during drier months	Three to four days (excluding curing)
Wind Turbine Assembly and Installation		Late spring or summer – preference is to conduct during drier months	Four to five days per turbine location
Electrical Collector System	**Pad Mount Transformers**	Late spring or summer – preference is to conduct during drier months	Four to six days
	Collection Lines	Late spring or summer – preference is to conduct during drier months	Dependent upon the required length of the lines; however, between 4 and 8 km of collector lines can be installed in a week.
Transformer Substation and Breaker Switch Station		Late spring or summer – preference is to conduct during drier months	15 – 20 weeks
Operations Building		Late spring or summer – preference is to conduct during drier months	Eight weeks
Clean-up and Reclamation		Following turbine construction	Will be conducted as site is constructed
Turbine Commissioning		Late spring or summer – preference is to conduct during drier months	One to three days


Legend
Wind Energy Centre Study Area
Transmission Line Study Area
Municipal Division
Parcel Boundary
120 m Area of Investigation
Setback Distances
60 m Road/Rail Buffer
80 m Property Boundary Buffer
550 m Noise Receptor Buffer
500 m Substation Footprint Buffer
75 m Petroleum Resources Buffer
2 km Boundary from Project Location
Other Resources
Petroleum Well
Authorized Aggregate Site
Open Landfill
Closed Landfill
Roads
Expressway / Highway
Major Road
Local Road
Receptors
Participating Receptor
Non-participating Receptor
Vacant Lot Participating Receptor
Vacant Lot Non-participating Receptor
Project Location
GE Turbine
Permanent Meterological Tower
Access Road
Collection Line
Transmission Line
Disturbance Area
Breaker Switch Station
Transformer Substation
Temporary Laydown Area
Natural Features
Watercourse
Waterbody
Wetland Area
Woodlots
Basemapping from Ontario Ministry of Natural Resources
Metres
0 250500 1,000 1,500 2,000
1:50,000
UTM Zone 17N, NAD 83
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Goshen Wind Energy Centre
Project Location and Socio-Economic Features
September 2012
Project 60155032
AECOM
Figure 2-3
South Huron
Dashwood Road
Huron Street
Crediton Road
Victoria Avenue East
Mount Carmel Drive
Greenway Drive
Thames Road
Perth 20 Line
Whalen Line
Mooresville Drive
Mark Settlement Drive
McGillivray Drive
Clandeboye Drive
Ausable Drive
Prince William Street

2.2 Construction Activities

The proposed Project will consist of up to 71 GE 1.6-100 Wind Turbines and one GE 1.56-100 Wind Turbines with a nameplate capacity of 102 MW (however, only 63 turbines will be constructed). The electricity generated from the wind turbines will be collected through a network of collection lines to an on-site transformer substation located on leased private land. A 115 kV transmission line will connect the transformer substation to the Hydro One transmission system through a breaker switch station. Turbine access roads along with laydown and storage areas (including temporary staging areas) are planned for the site. Permanent meteorological (weather monitoring) towers and a maintenance and operations building will be constructed on site.

2.2.1 Surveying and Geotechnical Study Activities

Existing buried infrastructure located on public property will be identified using the Ontario One Call service and buried infrastructure located on private property will be identified by private contractors prior to construction and updated throughout construction, as required.

Geotechnical sampling will be required for turbine foundation locations. Typically, a truck-mounted drill rig visits the sampling locations, drills the borehole and collects geotechnical information. This operation typically uses two operators and requires one to two hours per turbine location.

Equipment will include, at a minimum, trucks, a truck mounted drill rig, and possibly a track-mounted drill rig. The trucks will be driven to the site via existing municipal roads. No materials will be brought on site for these activities and any waste generated would be comprised of drill cuttings which will be scattered in the vicinity of the boreholes. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling for all construction activities will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.2 Land Clearing and Construction of Access Roads

Access roads will be constructed to transport equipment to the construction sites. There will be a 60 m wide area for construction of the access roads. The access road will be sited within this area of disturbance in consultation with the landowner and taking into consideration potential environmental effects.

The construction of the access road will typically require clearing and grubbing of any vegetation, excavation of the topsoil layer and adding a layer of compacted material to a typical thickness of 300 to 600 mm, depending upon site specific geotechnical conditions. Clean granular material (typically “A” or “B” gravel) will be brought to the site as needed and will not be stockpiled onsite. The topsoil will be kept and re-used on site. The access road to each turbine will typically require one to three days of construction time. Depending on the length of the access roads, construction may require approximately 25 trucks of gravel.

New culverts may be required to maintain drainage in ditches at junctions with roadways and these will be constructed to support the construction equipment and delivery trucks. The location of proposed water crossings is summarized in the Water Assessment and Water Body Report (AECOM, 2012) and the potential effects are summarized below in Section 3. The exact details of culverts and their installation in addition to erosion control measures will be determined in conjunction with the Ausable Bayfield Conservation Authority (ABCA) and the Upper Thames River Conservation Authority (UTRCA) as part of their permitting process; however, the culverts are proposed to be open bottom and left in place following the operation phase.

Once the construction activities have been completed, the granular base of the access roads will be removed and distributed to the landowners, if desired, or removed from the site and disposed of in an approved and appropriate manner. The disturbed area will have the topsoil replaced from stockpiled material and will be reseeded in consultation with the landowner.

Equipment will include, at a minimum, trucks, graders, and bulldozers. Municipal and provincial roads will also be used for transporting equipment, and minor modifications may be required to some of the existing roads (e.g., widening the turning radius) to handle the oversized loads. Any road damages associated with the Project will be repaired prior to the completion of the construction phase. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.3 Construction of Laydown Areas

A 4 hectare (10 acre) site will be constructed for the temporary storage of construction material (i.e., no turbine components) and as a site for the construction office trailers. Following clearing and grubbing of any vegetation, the topsoil at the temporary laydown area will be removed and approximately 600 mm of clean compacted crushed gravel will be imported as needed. The excavated topsoil will be re-used on site as feasible. A temporary electrical service line will be connected to the existing distribution line adjacent to the laydown area for the purpose of providing power to the construction office trailers. Construction activities are expected to last approximately one week and will require approximately 100 loads of gravel, and a crew of six people. Following the construction phase, the gravel will be removed from the site or re-used, to be determined in consultation with the landowner. The temporary electrical service line and poles will be removed. The stockpiled topsoil will then be redistributed throughout the temporary laydown area.

Equipment will include, at a minimum, trucks, graders, and bulldozers. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.4 Construction of Turbine Sites and Crane Pads

Prior to construction, the construction area will be cleared and grubbed. In order to provide sufficient area for the laydown of the wind turbine components and its assembly, a 122 m by 122 m square around the wind turbine must be cleared, levelled, and be accessible during the construction phase. The topsoil is typically removed and some soil stabilizing material (i.e. crushed gravel or clean back fill) may need to be added depending upon site specific geotechnical conditions. Where the site laydown areas are close to watercourses, erosion control measures will be implemented, as outlined in Section 3.

Crane pads will be constructed at the same time as the road and will be located adjacent to the turbine locations. The crane pads will typically be 15 m by 35 m in area. The topsoil at the crane pad will be removed and approximately 600 mm of clean compacted crushed gravel will be imported as needed. The excavated topsoil will be re-used on site as feasible. Once the turbine erection is complete, the crane pad will be removed and will be restored to prior use. The construction crew is anticipated to require four to six people and construction activities are expected to last for approximately one to two days.

Equipment will include, at a minimum, trucks, graders, and bulldozers. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.5 Delivery of Equipment

Equipment will be delivered by truck and trailer throughout the construction phase and stored at the temporary lay-down sites surrounding each turbine. A road use agreement and Traffic Management Plan will be developed in consultation with the municipalities. Alternative traffic routes will be prepared to address traffic congestion, as needed.

2.2.6 Construction of Turbine Foundations

A backhoe will be used to excavate an area approximately 3 m deep x 20 m x 20 m with the material being stockpiled for future backfilling. Stockpiled material will have topsoil and subsoil separated out and surplus excavated material will be removed from the site for disposal in an approved manner. The foundation, with an approximate footprint of 400 m^2, will be constructed of poured concrete and reinforced with steel rebar to provide strength. The construction timeframe for turbine foundations is three to four days, excluding curing time. After construction the foundation will be backfilled and the surface will be landscaped for drainage. The only surface evidence of the foundation will be a small protrusion of concrete to which the tower is attached; as such land can be cultivated to within a few metres of the turbine. Any wood-waste generated will be removed from the site and recycled unless the landowner otherwise directs. Spent welding roads will be disposed of as hazardous waste by a licensed contractor.

Typical construction equipment, on a per turbine basis, will include:

- Excavator for removing material;
- Flatbed trucks (four to six) for delivery of rebar, turbine mounting assembly and forms;
- Truck mounted crane or rough terrain forklift for unloading and placement of rebar and forms;
- Concrete trucks for delivery of concrete (30-40 loads);
- Construction trucks (three to four vehicles with multiple visits); and,
- Dozer, loader and trucks to backfill and compact foundation and remove surplus excavated materials.

The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.7 Wind Turbine Assembly and Installation

Turbine components will arrive on-site using flat bed and other trucks and will be temporarily stored on-site in the immediate vicinity of the base prior to assembly. Typically two cranes will be used to install the turbines. The larger crane is usually a crawler type with a capacity of 400 tonnes or larger, and is used for the higher lifts.

Clearing and grubbing will be required for the erection area. The erection cranes and crew will follow the foundation crew and erect the wind turbines once the foundations are completed and the concrete has set. This will typically be in five lifts (three for the towers, one for the nacelle and one for the rotor) over a period of two to three days. The lower tower sections may be installed several days before the upper tower sections and the turbine to optimize installation sequence. The lower tower section will also include electrical and communications equipment. Total turbine assembly and installation will typically require four to five days for each turbine. Fifteen to twenty people may be required at the site during the turbine installation; they will be transported using light duty vehicles.

Packing frames for the turbine components are returned to the turbine vendor. Following commissioning, the surrounding area will be returned to its original use.

Equipment will include, at a minimum, trucks, two cranes, graders, and bulldozers. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The larger track mounted crane can move from turbine site to turbine site; however, it will need to be disassembled to move it along roadways and from the Project site. Alternatively, cranes may be moved between turbine sites without disassembly along crane paths. In such instances, no additional infrastructure is required to support the crane movement. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.8 Construction of Electrical Collector System

The electrical collector system will consist of pad mounted transformers, underground cabling for use on private property, above ground junction boxes and a buried collection system running along turbine access roads or municipal road right-of-ways. These components are described below.

- Pad Mount Transformers: A concrete transformer pad, approximately 2.2 m by 2.5 m in size, will be installed adjacent to each turbine at the same time as the turbine base installation. The construction will consist of excavation, soil storage, installation of the buried electrical grounding grid, installation of the concrete pad, installation of the transformer, and electrical connections. Transformer installation and cabling between the turbine and transformer is expected to take three days per turbine. Equipment will include flatbed trucks to transport the equipment to site, and a truck-mounted crane for the installation. These activities will likely require four to six trucks, a work force of two people per vehicle per day, and will last between four to six days.
- Collection Lines: Cables and fibre optics lines (for communications) from each turbine to the transformer substation will be buried and will be located adjacent to the turbine access roads, where feasible. There will be a 20 m wide area for construction of the collection lines. The collection lines will be sited within this area of disturbance in consultation with the landowner and taking into consideration potential environmental effects. The excavated soil will be stored temporarily and then reused as backfill. Power conductors will be approximately 0.9 m below grade and the location will be marked. Farming practices will not be affected by the underground cabling due to the depth of the cables and location of the cable beneath the access roads. Additional ancillary equipment such as above ground junction boxes may be required. Equipment will include trenchers or diggers (depending on soil type) and construction will require a crew of six people. The construction timeframe is dependent upon the required length of the lines.
- Horizontal Directional Drilling: Electrical cables may need to be installed using horizontal directional drilling to minimize effects to woodlots or watercourses. Erosion control devices will be installed at the drill location and drill cuttings will be collected and removed from the site for disposal in an approved and appropriate manner. An entrance and exit pit will be excavated on either side of the feature to be bored under. The directional drilling equipment will be set up at the entrance pit and a drill bit attached to rod segments is advanced until it reaches the exit pit. A slurry of bentonite and/or polymer mixed with water will be injected into the hole while drilling to help stabilize the bore hole and reduce friction. Once the drill bit has reached the exit pit the drill bit will be removed and a “reamer” attached and pulled back through the hole to enlarge the bore by 120-150%. The electrical cable will then be installed through the hole. Equipment will include a directional drilling rig and two to three support trucks to carry drilling rods, drilling supplies and cable.

The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment, and the polymer used for directional drilling. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.9 Construction of Electrical Transmission Line

Holes for new transmission line poles are typically augured in the ground using a truck mounted auger device. The poles will then be inserted using special cranes to a typical depth of 2 to 3 m below grade. The poles are typically "dressed" (made ready to accept conductors) on the ground prior to installation. In locations where the transmission line makes a turn, guy wires may be used to anchor the corner pole in place. At times, when guy wires cannot be used at corner poles, the steel poles may be mounted on concrete pier foundations. Typically, one crew will install the poles and one crew will dress them. Approximately six construction vehicles (including trucks and a pole loader) and a crew of 12 to 15 people are anticipated for construction of the transmission lines. A maximum of twelve to sixteen poles can be installed and dressed in one day. Once the poles are in place and dressed, cables will be strung in place using boom trucks and special cable reel trucks. Finally, any pre-existing poles that are no longer in use will be removed.

The transmission line will be directionally drilled in one location to avoid affecting a Provincially Significant Wetland. Construction will follow the same process described in Section 2.2.2.8 for directionally drilling the collector system.

Some packing-material waste may be generated from construction. All recyclable materials will be separated from non-recyclable materials and both streams will be removed from the site and disposed of at an approved and licenced facility.

Equipment will include, at a minimum, a truck mounted crane, a drill rig, flatbed trailers and a truck mounted auger. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. A lubricant is likely to be used when the cables are pulled in through the conduit. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.10 Construction of Transformer Substation and Breaker Switch Station

During construction of the substation and breaker, topsoil and subsoils will be stripped and stockpiled separately. Stripped topsoil and subsoil will be placed in the temporary storage facility area and topsoil stripped from the substation area will be distributed on other Project properties. An electrical service line of approximately 9 m and associated poles will likely be connected to the existing distribution line adjacent to the substation for the purpose of providing house service power to the substation control building. The construction crew will consist of approximately 25 to 40 people and construction is expected to last for about four months. Some packing-material waste may be generated. All recyclable materials will be separated from non-recyclable materials and both streams will be removed from the site and disposed of at an approved and licensed facility.

Construction equipment will include small trenchers, a small crane, a backhoe, forklifts, concrete trucks, auger truck and a bulldozer. The trucks and graders will be driven to the site and the bulldozers will be transported via trailers. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment and transformer oil. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.11 Construction of Operation and Maintenance Building

Construction of the operations building may take up to three months to complete and will require a crew of approximately 10 to 15 people.

Equipment will include, at a minimum, forklifts, concrete trucks and smaller crew trucks. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

2.2.12 Permanent Meteorological Towers

The towers will be erected using winches and secured with guy wires tied off to anchors or a monopole foundation. No significant soil or vegetation disturbance is anticipated. Construction of each meteorological tower will take approximately two days and require a crew of six people.

2.2.13 Clean-up and Reclamation

Site clean-up will occur throughout the construction phase and site reclamation will occur after construction has been completed. Waste and debris generated during the construction activities will be collected by a licensed operator and disposed of at an approved facility. All reasonable efforts will be made to minimize waste generated and to recycle materials including returning packaging material to suppliers for reuse/recycling.

Stripped soil will be replaced and re-contoured in the construction areas and disturbed areas will be re-seeded, as appropriate. Erosion control equipment will be removed once inspections have determined that the threat of erosion has diminished to the original land use level or lower. High voltage warning signs will be installed at the transformer substation and elsewhere, as appropriate. At the conclusion of construction vehicles and construction equipment will be removed from the site.

2.2.14 Turbine Commissioning

Turbine commissioning will occur once the wind turbines and substation are fully installed and Hydro One is ready to accept grid interconnection. The commissioning activities will consist of testing and inspection of electrical, mechanical and communications systems. Some packing-material waste may be generated. All recyclable materials will be separated from non-recyclable materials and both streams will be removed from the site and disposed of at an approved and licenced facility.

Temporary portable generator sets may be used to electrically commission the turbines prior to connection to the grid. The generators will be required for approximately one day per turbine. The generators may require an Environmental Compliance Approval. Following the commissioning phase, the portable generators will be removed from the site and returned to the owners.

Equipment will include support trucks which will be driven to the construction site. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment and portable generators, gearbox oil, and lubricants. Fuel-handling will be conducted in compliance with the mitigation measures outlined in Section 3.

3. Description of Environmental Effects and Mitigation Measures

The following section describes potential effects associated with the construction and installation of the Project, in addition to mitigation measures and monitoring commitments that will be implemented to minimize these potential effects. The potential effects described below are also presented in Section 3 of the PDR (AECOM, 2012).

For each potential effect, performance objectives were developed to describe a desired outcome of mitigation. Next, mitigation measures were proposed to achieve the performance objectives. Residual effects, which are those effects that remain following the application of mitigation measures and monitoring commitments, were then assessed based on professional judgment as well as previous Project experience. Where possible, the significance of residual adverse effects has been described based on the following:

Magnitude.....the size or degree of the effect compared against baseline conditions; and
Likelihood.....the probability that the effect will occur.

Finally, where monitoring commitments have been identified, they are intended to verify that the mitigation measures achieve performance objectives. Should the monitoring during construction and operation of the Project reveal that the mitigation measures are not achieving the intended results, the identified contingency measures will then be implemented.

This description of effects was completed for all 72 turbines and associated infrastructure shown on the Project Location figures. However, note that only 63 turbines will be constructed resulting in a conservative assessment of effects.

3.1 Cultural Heritage

Stage 1 and 2 Archaeological Assessments (Golder, 2012) were conducted and factored into the overall Project layout. The Stage 1 Archaeological Assessment consists of an initial desktop archaeological study and site visit and was carried out in summer 2010 and updated in spring 2012. This assessment determined that there are known archaeological resources within the Project Study Area **(Figure 1-2)**, in addition to properties with the potential to contain archaeological resources.

In 2011 and 2012, pedestrian surveys were conducted within the Project Study Area in support of the Stage 2 Archaeological Assessment, according to the 2011 *Standards and Guidelines for Consultant Archaeologists* issued by the Ontario Ministry of Tourism, Culture and Sport (MTCS) (Government of Ontario, 2011). A total of 61 archaeological sites were identified and 28 sites have been recommended for further Stage 3 archaeological assessment.

A Cultural Heritage Assessment (Golder, 2012) was also completed to identify built heritage and cultural heritage landscape resources related to the Euro-Canadian land use in the area dating prior to 1970. All work was carried out in accordance with the Ontario *Heritage Act*, the *Provincial Policy Statement*, and the *Environmental Assessment Act*. The report identified 98 structures (55 houses and 43 barns or barn complexes) as greater than 40 years old within the Project Study Area and as having general historical interest contributing to the character of the vernacular rural landscape. When applying the criteria set out in *Ontario Regulation 9/06*, 71 of these structures (35 houses and 36 barns) were determined to have cultural heritage value or interest. Following the evaluation of anticipated impacts, both direct and indirect, according to *InfoSheet #5* (Government of Ontario, 2006), no anticipated impacts were identified. As there are no anticipated impacts to the cultural heritage features, no further work is recommended.

3.1.1 Potential Effects

Potential effects from construction and installation activities include:

- Disturbance or displacement of 28 archaeological resources identified through the Stage 2 Archaeological Assessment due to construction of project infrastructure.

No effects to protected properties or heritage resources are anticipated. The Project Location was selected to avoid these features.

3.1.2 Mitigation Measures, Residual Effects and Monitoring Plan

Table 3-1 provides mitigation measures, residual effects and the monitoring plan for each potential effect identified above.

Table 3-1 Mitigation Measures, Residual Effects and Monitoring Plan: Cultural Heritage

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Disturbance or displacement of 28 archaeological resources identified through Stage 2 Assessment due to construction of project infrastructure.	• Avoid disturbance/ loss of archaeological sites	• Avoid site or conduct Stage 3 archaeological assessment if recommended based on the outcome of the Stage 2 assessment: ▪ To avoid, install a fence a minimum of 20 m from the site boundaries to protect it from adjacent construction activities and then enact the monitoring plan; or ▪ Conduct Stage 3 archaeological assessment, document findings in Stage 3 assessment report, and submit report to Ministry of Tourism, Culture and Sport (MTCS) for approval. Any potentially interested Aboriginal communities will be contacted, as appropriate, from at least this point onward. • Avoid site or conduct Stage 4 archaeological assessment if recommended based on the outcome of the Stage 3 assessment: ▪ To avoid, install a fence a minimum of 10 from the site boundaries to protect it from adjacent construction activities and then enact the monitoring plan; or ▪ Conduct Stage 4 archaeological assessment, document findings in Stage 4 assessment report, and submit report to MTCS for approval. Construction can then proceed without any further documentation or monitoring.	• Disturbance or displacement of archaeological resources avoided or minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Retain a licensed archaeologist to monitor any construction activities within a 50 m monitoring zone for an archaeological resource surrounded by a 20 m buffer where a Stage 3 archaeological assessment has been recommended. Submit a report to MTCS detailing the results of any monitoring activities. • Retain a licensed archaeologist to monitor any construction activities for Stage 4 avoidance close to the 10 m buffer area fenced off that may affect archaeological resources. Contingency Measures: • Cease work immediately should previously unidentified archaeological resources be discovered during the construction phase. The area will be secured and a licensed archaeologist contacted to conduct further archaeological work. Construction will only resume in the location when any archaeological assessment has been completed. Any potentially interested Aboriginal communities will be contacted, as appropriate. • Cease work immediately should human remains be found during construction, and contact the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

3.2 Natural Heritage

The potential effects, mitigation measures, residual effects and monitoring commitments regarding the natural heritage features (including significant wetlands, woodlands, valleylands, and wildlife habitat) were identified and evaluated in the Natural Heritage Assessment Report and Environmental Effects Monitoring Plan (AECOM, 2012) prepared based on the *Natural Heritage Assessment Guide for Renewable Energy Projects* (Government of Ontario, 2010) and submitted to the Ontario Ministry of Natural Resources (MNR) for review and sign-off.

Following the completion of the Records Review and Site Investigation for all natural heritage features located within 120 m of the Project Location, an Evaluation of Significance was conducted to identify any features that required an Environmental Impact Study (EIS).

Table 3-2 and **Figure 2-2** document the significant natural heritage features located within 120 m of the Project Location for which an EIS was conducted.

Table 3-1 Summary of Natural Features Included in the EIS

Feature	Natural Features Carried Forward to EIS
Wetlands	14 wetland units or wetland complexes were treated as significant and included in the EIS.
Woodlands	65 woodlands were determined to be significant or treated as significant and therefore included in the EIS.
Valleylands	One valleyland feature was determined to be significant and therefore included in the EIS.
Significant Wildlife Habitat	The following significant wildlife habitats were confirmed or treated as significant within the 120 m Area of Investigation and within 120 m of qualifying project infrastructure, and were therefore included in the EIS. • Bat maternity colonies; • Amphibian woodland breeding habitat; • Habitat for plant species of conservation concern (multiple); • Habitat for bird species of conservation concern (Red-headed Woodpecker); • Waterfowl (Tundra Swan) stopover and staging areas; • Reptile hibernacula; • Turtle over-wintering habitat; and • Habitat for Insect Species of Conservation Concern (Azure Bluet).
	The following candidate significant wildlife habitats were identified within the 120 m Area of Investigation however not within 120 m of qualifying project infrastructure, and were therefore included in the EIS as *Generalized Candidate Significant Wildlife Habitat*: • Colonial-nesting Bird Breeding Habitat (Tree/Shrub); • Waterfowl nesting areas; • Reptile hibernacula; • Bat maternity colonies; • Amphibian woodland breeding habitat; • Amphibian wetland breeding habitat; • Rare vegetation communities; • Habitat for area sensitive species: interior forest breeding birds; • Mature forest stands (numerous); • Turtle nesting habitat; • Turtle overwintering habitat; • Woodland raptor nesting habitat; • Seeps and springs; and • Habitats of species of conservation concern (numerous).

3.2.1 Potential Effects

3.2.1.1 Generalized Candidate Significant Wildlife Habitat

The features containing *Generalized Candidate Significant Wildlife Habitat* are identified above in **Table 3-2**.

The potential effects from construction and installation activities on *Generalized Candidate Significant Wildlife Habitat* are as follows:

- Increased erosion and sedimentation resulting in increased inputs of nutrients and contaminants to wetlands, woodlands and other significant natural features, resulting from:
  - clearing and grubbing for construction of turbines, access roads, pads/turnaround areas, collection lines, transmission line, operations building and substation;
  - excavation and backfilling for construction of turbines, collection lines, transmission line, operations building and substation;
  - directional drilling for construction of collection lines;
- Removal/disturbance of topsoil and increased soil compaction from manoeuvring of heavy machinery, excavation and backfilling of turbine foundation for construction of turbines, access roads, pads/turnaround areas, collection lines, transmission line, operations building and substation;
- Disturbance and/or mortality to terrestrial wildlife, including barriers to wildlife movement from construction of turbines, access roads, pads/turnaround areas, collection lines, transmission line, operations building and substation;
- Disturbance to or loss of wildlife habitat from construction of turbines, access roads, pads/turnaround areas, collection lines, transmission line, operations building and substation;
- Damage to vegetation while operating equipment used in construction of turbines, access roads, pads/turnaround areas, collection lines, transmission line, operations building and substation;
- Soil / water contamination by oils, gasoline, grease and other materials from:
  - construction equipment, material stockpiling and handling for construction of turbines, access roads, pads/turnaround areas, collection lines, transmission line, operations building and substation;
  - bentonite or polymer used during directional drilling of collection lines, resulting from the escape of drilling mud into the environment as a result of a spill, tunnel collapse or the rupture of mud to the surface in the event of a “frac-out”; and
- Changes in surface water drainage patterns (e.g., obstruction of lateral flows in surface water to wetlands) from construction of turbines, access roads, pads/turnaround areas, resulting in effects to soil moisture and species composition of vegetation.

3.2.1.2 Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat:

The features containing significant wetlands, woodlands, valleylands and wildlife habitat are identified above in **Table 3-2**. The potential effects from construction and installation activities on these features include those described above under *Generalized Candidate Significant Wildlife Habitat* as well as the following potential effects:

- Accidental intrusion into natural features resulting in damage to vegetation or wildlife habitat form or function resulting from:
  - turbine construction near Significant Wetland Features, Significant Woodland Features and Bat Maternity Colony Features;
  - access road construction near Significant Wetland Features, Significant Woodland Features, Amphibian Woodland Breeding Habitat Features, a Reptile Hibernaculum, and Turtle Over-wintering Habitat Features;

  - breaker switch station construction near a Significant Wetland Feature and a Significant Woodland Feature;
  - collection line construction near Significant Woodland Features;
  - transformer substation construction near Significant Woodland Features;
  - meteorological tower construction near a Significant Woodland Feature;
- Increased erosion and sedimentation resulting from:
  - turbine foundation excavation and construction near a Significant Wetland Feature and a Significant Valleyland Feature;
  - access road construction near Significant Wetland Features, with increased potential for sediment and erosion where construction will occur as close as 5 m from the dripline;
  - access road construction near Amphibian Woodland Breeding Habitat Features and a Turtle Over-wintering Habitat Feature;
  - breaker switch station construction near a Significant Wetland Feature;
  - collection line construction near Significant Wetland Features;
  - directional drilling of collection lines under Significant Wetland Features;
  - transmission line construction near Significant Wetland Features with increased potential for sediment and erosion where transmission line will be installed by directional drilling under Significant Wetland Features;
  - transmission line construction within a Significant Valleyland Feature, Azure Bluet habitat Feature, Turtle Over-wintering Habitat Feature, and Amphibian Woodland Breeding Habitat Features;
- Soil/water contamination resulting from accidental spills during:
  - construction of turbines near Significant Wetland Features;
  - access road construction near Significant Wetland Features;
  - directional drilling of collection lines under Significant Wetland Features and Significant Woodland Features;
  - directional drilling of transmission line under Significant Woodland Features;
  - transmission line construction near Significant Wetland Features with increased potential for soil/water contamination where the transmission line will be installed by directional drilling under Significant Wetland Features;
- Increased dust accumulation on peripheral wetland vegetation resulting from construction of access roads where construction will occur as close as 5 m from the dripline of Significant Wetland Features;
- Changes in surface water drainage patterns resulting in effects to soil moisture and species composition of vegetation where construction will occur as close as 5 m from the dripline of Significant Wetland Features; Unplanned intrusion into woodlands/wetlands in event of equipment malfunction during directional drilling for:
  - construction of collection lines under Significant Woodland Features and Significant Wetland Features;
  - construction of the transmission line under Significant Woodland Features and Significant Wetland Feature;
- Unintended damage to adjacent vegetation due to small size of the right-of-way, constrained work area and proximity of transmission line to:
  - Significant Wetland Features;
  - Significant Woodland Features;

- Loss of up to 2.86 ha of forest cover within Significant Woodland Features from clearing for the transmission line;
- Changes to surface water hydrology resulting from turbine and transmission line construction near a Significant Valleyland Feature;
- Disruption of Tundra Swan use of Waterfowl Stopover and Staging Area Features resulting from turbine, access road and collection line construction;
- Changes to surface water drainage patterns resulting in indirect effects on habitat condition from:
  - turbine, access road and collection line construction causing indirect effects on Waterfowl Stopover and Staging Area Features;
  - access road construction near Amphibian Woodland Breeding Habitat Features;
  - access road construction near a Turtle Over-wintering Habitat Feature;
  - transmission line construction within Azure Bluet Habitat Feature;
  - transmission line construction within a Turtle Over-wintering Habitat Feature;
  - transmission line construction within Amphibian Woodland Breeding Habitat Features;
- Noise disturbance to bats during turbine construction near Bat Maternity Colony Features;
- Disruption of amphibians moving between breeding pools and home range resulting from access road construction near Amphibian Woodland Breeding Habitat Features and from transmission line construction within Amphibian Woodland Breeding Habitat Features;
- Risk of mortality from construction equipment to:
  - amphibians during construction of access roads near a Amphibian Movement Corridor Feature;
  - reptiles during construction of access roads near a Reptile Hibernaculum Feature;
  - turtles during construction of the transmission line within a Turtle Over-wintering Habitat Feature;
- Disruption of turtles moving between over-wintering ponds and other areas from:
  - access road construction near a Turtle Over-wintering Habitat Feature;
  - transmission line construction within a Turtle Over-wintering Habitat Feature;
- Removal of vegetation within significant feature resulting in habitat damage from clearing for transmission line within:
  - Azure Bluet Habitat Feature;
  - Turtle Over-Wintering Habitat Feature;
  - Amphibian Woodland Breeding Habitat Features;
  - Red-headed Woodpecker Habitat Feature;
- Noise disturbance to breeding Red-headed Woodpeckers during transmission line construction within Red-headed Woodpecker Habitat Feature;
- Displacement and/or mortality of nursing female and juvenile bats resulting from vegetation clearing for transmission line construction within Bat Maternity Colony Features;
- Removal of confirmed significant cavity trees or other suitable cavity trees resulting from vegetation clearing for transmission line construction within Bat Maternity Colony Features; and
- Noise disturbance to bats and/or avoidance behaviour during transmission line construction within Bat Maternity Colony Features.

3.2.2 Mitigation Measures, Residual Effects and Monitoring Plan

3.2.2.1 Generalized Candidate Significant Wildlife Habitat

Table 3-2 provides mitigation measures, residual effects and the monitoring plan for *Generalized Candidate Significant Wildlife Habitat* potential effects identified above.

3.2.2.2 Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat:

Table 3-3 provides Feature/Unit specific mitigation measures, residual effects and the monitoring plan for each potential effect identified in Section 3.2.1.2. Note that at all locations described below, the best management practices and mitigation measures outlined in the Generalized Candidate Significant Wildlife Habitat table will be applied.

Table 3-2 Mitigation Measures, Residual Effects and Monitoring Plan: Generalized Candidate Significant Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Increased erosion and sedimentation resulting from clearing and grubbing, excavation, backfilling and stockpiling.	• Minimize erosion and sedimentation from clearing, grubbing, excavation, backfilling and stockpiling.	• Develop and implement an erosion and sediment control plan before commencement of construction as per Ontario Provincial Standard Specifications (OPSD 219.130). • Utilize erosion blankets, erosion control fencing, straw bales, siltation bags, etc. For construction activities within 30 m of a wetland, woodland or water body, to mitigate potential excessive erosion and sedimentation. Extra erosion and sediment control materials should be kept on hand, (i.e., heavy duty silt fencing, straw bales). • Keep sediment and erosion control measures in place until disturbed areas have been stabilized (i.e., re-vegetated). • Schedule grading within 30 m of a watercourse or wetland to avoid times of high runoff volumes (spring and fall), wherever possible. Temporarily suspend work if high runoff volume is noted or excessive flows of sediment discharges occur until mitigation measures are in place. • Re-vegetate temporary roads to pre-construction conditions as soon as possible after construction activities are complete using species native to Ontario in naturally vegetated areas.	• Increased erosion and sedimentation avoided or minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Monitor on-site conditions (i.e., erosion and sediment control, spills, flooding, etc.) where construction occurs within 30 m of a feature on the following basis: ▪ Weekly during active construction periods; ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet); ▪ Daily during extended rain or snowmelt periods; ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. • **Contingency Measures:** ▪ Suspend work if excessive flows of sediment discharges occur until additional mitigation measures are in place.
Removal/disturbance of topsoil and increased soil compaction from manoeuvring of heavy machinery, excavation and backfilling.	• Minimize removal/ disturbance of topsoil and increased soil compaction.	• Minimize vehicle traffic on exposed soils, avoid compacting or other hardening of natural ground surface, and avoid the movement of heavy machinery on areas with sensitive slopes. • Where feasible, lighter vehicles and lighter machinery should be used in and around natural areas. • Any vehicles used within natural areas should use wide-based tires. Tracked vehicles should be avoided.	• Increased erosion and sedimentation avoided or minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• See erosion and sedimentation above.
Increased erosion and sedimentation resulting from directional drilling.	• Minimize erosion and sedimentation.	• Conduct all drilling by licensed drillers in accordance with Regulation 903 under Ontario Water Resources Act, R.S.O. 1990. • Set back drill entry and exit pits at least 30 m from natural features (i.e., woodlands, wetlands) or water bodies. • Monitor natural features for signs of surface disturbance.	• Increased erosion and sedimentation avoided or minimized through application of mitigation measures. Moderate likelihood; if accidental damage occurs, negative effects may be measurable but would likely represent a small change relative to existing conditions.	• See erosion and sedimentation above.

Table 3-2 Mitigation Measures, Residual Effects and Monitoring Plan: Generalized Candidate Significant Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Disturbance and/or mortality to terrestrial wildlife, including barriers to wildlife movement.	• Minimize disturbance and/or mortality to terrestrial wildlife.	• Time vegetation removal to avoid periods of habitat use to the extent possible, particularly to avoid sensitive life stages (e.g., breeding season for migratory birds, May 1 to July 30). Undertake active nest surveys if clearing of vegetation must take place during this period. Avoid intersecting likely wildlife migration routes wherever possible. • Construction and decommissioning activities within 30 m of woodlands or wetlands should occur during daylight hours (7:00 am to 7:00 pm), wherever possible. • Clearly post construction speed limits. Install and maintain wildlife crossing and speed limit signs on access roads.	• Disturbance and/or mortality to terrestrial wildlife, including barriers to wildlife movement avoided or minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Undertake monthly site inspections to ensure that only specified trees are removed, protective fencing is intact and that there is no damage caused to the remaining trees during construction. • **Contingency Measures:** ▪ In the event that trees are damaged during construction, damaged trees should be pruned through implementation of proper arboricultural techniques, under supervision of an Arborist or Forester. ▪ Consultation with MNR to determine additional contingency measures if necessary.
Damage to vegetation while operating equipment.	• Minimize disturbance to/loss of wildlife habitat and vegetation.	• Keep vegetation removal to a minimum and limited to non-significant habitats (e.g., hedgerows). • For roadside collection line routes, vegetation removal (if any) will be kept to a minimum and will be limited to the road right-of-way. • Where construction is to occur within 30 m of natural features, install and maintain protective fencing to clearly define the construction area and prevent accidental damage to vegetation. • Trees at risk of being damaged during construction should be pruned through implementation of proper arboricultural techniques. • Where excavation for construction of access roads or collection lines is conducted within the rooting zone of trees (e.g., within 5 m of the dripline), proper root pruning measures should be implemented to protect tree roots.	• Disturbance to or loss of wildlife habitat and damage to vegetation while operating equipment avoided or minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Undertake monthly site inspections to ensure that only specified trees are removed, protective fencing is intact and that there is no damage caused to the remaining trees during construction. • **Contingency Measures:** ▪ In the event that trees are damaged during construction, damaged trees should be pruned through implementation of proper arboricultural techniques, under supervision of an Arborist or Forester. ▪ Consultation with MNR to determine additional contingency measures if necessary.
Disturbance to or loss of wildlife habitat, including active bird nests.	• Minimize vegetation removal and destruction of bird nests.	• Schedule vegetation removal outside of breeding season (May 1 to July 30) where possible. • Undertake active nest surveys if clearing of vegetation must take place during this period. • Construction and decommissioning activities within 30 m of woodlands or wetlands should occur during daylight hours (7:00 am to 7:00 pm), wherever possible.	• Vegetation removal minimized and destruction of active bird nests avoided through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Undertake monthly site inspections to ensure that only specified trees are removed, protective fencing is intact and that there is no damage caused to the remaining trees during construction. • **Contingency Measures:** ▪ In the event that trees are damaged during construction, damaged trees should be pruned through implementation of proper arboricultural techniques, under supervision of an Arborist or Forester. ▪ Consultation with MNR to determine additional contingency measures if necessary.

Table 3-2 Mitigation Measures, Residual Effects and Monitoring Plan: Generalized Candidate Significant Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Soil / water contamination by oils, gasoline, grease and other materials from construction equipment, materials storage and handling.	• Minimize soil/water contamination.	• Ensure machinery is maintained free of fluid leaks. • Site maintenance, vehicle washing and refuelling stations where contaminants are handled at least 30 m away from natural features or water bodies. Vehicle refuelling and maintenance should be done on spill collection pads. • Store any stockpiled materials at least 30 m away from a wetland, woodland or waterbody to prevent deleterious substances from inadvertently discharging to the environment. • Develop a spill response plan and train staff on associated procedures. • Maintain emergency spill kits on site. • Control soil / water contamination through best management practices. • Dispose of any waste material from construction activities by authorized and approved off-site vendors.	• Soil and water contamination avoided or minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Conduct daily inspections of construction equipment for leaks / spills. • Implement contingency measures in the event of a spill. • **Contingency Measures:** ▪ In the event of a spill, immediately stop all work until the spill is cleaned up. ▪ Install a spill collection pad for refuelling and maintenance. ▪ Notify MOE's Spills Action Centre of any leaks or spills. ▪ Assess and remediate affected soils and water by using spill kit kept on site. ▪ For spills near wetlands, analyze water samples for general chemistry (e.g., temperature, pH, dissolved oxygen, and conductivity), suspended solids, turbidity, nutrients and total metals (e.g., copper, iron, zinc and aluminum). ▪ Monitor daily to ensure proper cleanup is completed.
Soil / water contamination by oils, gasoline, grease and other materials from spills during directional drilling.	• Minimize soil/water contamination.	• Conduct all drilling by licensed drillers in accordance with Regulation 903 under Ontario Water Resources Act, R.S.O. 1990. • Develop and implement emergency spills plan outlining steps to contain any chemicals or to avoid contamination of adjacent features. • Collect drill cuttings as they are generated and place in a soil bin or bag for off-site disposal. • Ensure drill depth is at an appropriate depth below feature to reduce the risk of a "frac-out". • Install protective fencing around vegetation to prevent accidental damage.	• Risk of soil / water contamination avoided or minimized through application of mitigation measures. • Moderate likelihood; if accidental damage occurs, negative effects may be measurable but would likely represent a small change relative to existing conditions.	• Monitor directional drilling for the duration of such activities to ensure that "frac-out" or accidental intrusion does not occur, and if it does, to ensure that there are no effects on surface or groundwater. • **Contingency Measures:** ▪ In the event of a "frac-out", immediately stop all work, including the recycling of drilling mud / lubricant. ▪ Monitor "frac-out" for 4 hours to determine if the drilling mud congeals. If drilling mud congeals, take no other action that would potentially suspend sediments in the water column. If drilling mud does not congeal, erect isolation/containment environment (underwater boom and curtain). ▪ If the fracture becomes excessively large, engage a spill response team to contain and clean up excess drilling mud in the water. ▪ If the spill affects an area that is vegetated, the area will be seeded and/or replanted using species similar to those in the adjacent area, or allowed to re-grow from existing vegetation. Revegetated areas will

Table 3-2 Mitigation Measures, Residual Effects and Monitoring Plan: Generalized Candidate Significant Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
				be monitored twice per year for two years subsequent to "frac-out" to confirm revegetation is successful. ▪ Document post-cleanup conditions with photographs and prepare "frac-out" incident report describing time, place, actions taken to remediate "frac-out" and measures implemented to prevent recurrence. Provide incident report to MNR and MOE forthwith.
Changes in surface water drainage patterns. **Obstruction of lateral flows in surface water to wetlands.**	• Minimize changes in surface water drainage patterns and obstruction of lateral flows in surface water to wetlands.	• Minimize changes in land contours and natural drainage; maintain timing and quantity of flows. • Any grading of lands adjacent to natural features should match existing grades at the identified set-back, or buffer from the features.	• Changes in surface water drainage patterns and obstruction of lateral flows avoided through mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Inspect locations within 30 m of wetlands following completion of access roads to ensure no grade changes. • **Contingency Measures:** ▪ If surface water drainage alterations are detected, undertake corrective measures to restore drainage pattern.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Accidental intrusion resulting in damage to vegetation or wildlife habitat form or function within significant wetlands, woodlands and / or wildlife habitat.	• Minimize potential for accidental intrusion into significant features.	• Maintain 30 m setback from significant wetlands and woodlands, where possible or a minimum 5 m setback (measured from the dripline of trees or wetland edge if trees are absent). • Install and maintain protective fencing to clearly define the construction area and prevent accidental damage to vegetation. • Clearly delineate habitat boundaries using protective fencing to ensure that construction activities occur outside the habitat boundaries.	• Damage to vegetation or wildlife habitat minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Undertake monthly site inspections to ensure that protective fencing is intact and that there is no damage caused during construction. • **Contingency Measures:** ▪ In the event that trees are damaged during construction, damaged trees should be pruned through implementation of proper arboricultural techniques, under supervision of an Arborist or Forester.
Increased erosion and sedimentation resulting from clearing and grubbing, excavation, backfilling and stockpiling.	• Minimize erosion and sedimentation from clearing, grubbing, excavation, backfilling and stockpiling.	• Maintain 30 m setback from significant wetlands and woodlands, where possible or a minimum 5 m setback (measured from the dripline of trees or wetland edge if trees are absent). • Install sediment and erosion control fencing along edge of wetland if within 30 m as per Ontario Provincial Standard Specifications (OPSD 219.130). • For construction of turbines and transmission line at Significant Valleyland Feature: utilize erosion control fencing, and keep in place until disturbed areas are stabilized; schedule grading within 30 m of feature to avoid times of high runoff during spring and fall where possible. Suspend work during periods of excessive flows; store stockpiled materials away from feature to prevent substances from inadvertently entering feature; minimize the area and duration of soil exposure; and, minimize vehicle traffic on exposed soils and avoid the use of heavy machinery on slopes. • For construction of access roads at Turtle Over-Wintering Habitat Features: fence area as far from pond and as close to road as possible and install sediment and erosion control fencing at fenced area location. • For construction of the transmission line at Azure Bluet Habitat Feature, Turtle Over-Wintering Habitat Feature and Amphibian Woodland Breeding Habitat Features: ▪ Fence area as far from pond and as close to transmission line disturbance area as possible. ▪ Install sediment and erosion control fencing at fenced area location.	• Increased erosion and sedimentation minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Monitor on-site conditions (i.e., erosion and sediment control, spills, flooding, etc.) where construction occurs within 30 m of a feature on the following basis: ▪ Weekly during active construction periods; ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet); ▪ Daily during extended rain or snowmelt periods; ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. • **Contingency Measures:** ▪ Suspend work if excessive flows of sediment discharges occur until additional mitigation measures are in place. • For construction of the transmission line at Azure Bluet Habitat Feature, Turtle Over-Wintering Habitat Feature and Amphibian Woodland Breeding Habitat Features: ▪ Monitor condition of the pond during on-site monitoring events at frequency described above. ▪ Analyze water samples for general chemistry (e.g., temperature, pH, dissolved oxygen, and conductivity), suspended solids, turbidity, nutrients and total metals (e.g., copper, iron, zinc and aluminum) during and after construction. • **Contingency Measures:** ▪ If negative effects to the pond are detected, corrective measures will be taken, to be

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
		▪ Remove trees by hand-held equipment and drag them out of the natural area to minimize soil disturbance. ▪ Lighter vehicles and lighter machinery should be used in and around the natural area. Any vehicles used within the natural area should have wide-based tires. Tracked vehicles should be avoided. ▪ Re-vegetate disturbed areas as soon as possible after construction activities are complete using species native to Ontario in naturally vegetated areas.		determined through consultation with MNR. These habitat compensation or restoration measures will be described in a Compensation Plan, to be submitted to MNR.
Soil/water contamination resulting from accidental spills.	• Minimize soil/water contamination.	• Develop and implement emergency spills plan outlining steps to contain any chemicals or to avoid contamination of adjacent wetland features.	• Water contamination minimized through application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Conduct daily inspections of construction equipment for leaks / spills. • Implement contingency measures in the event of a spill. • **Contingency Measures:** ▪ In the event of a spill, immediately stop all work until the spill is cleaned up. ▪ Install a spill collection pad for refuelling and maintenance. ▪ Notify MOE's Spills Action Centre of any leaks or spills. ▪ Assess and remediate affected soils and water by using spill kit kept on site. ▪ For spills near wetlands, analyze water samples for general chemistry (e.g., temperature, pH, dissolved oxygen, and conductivity), suspended solids, turbidity, nutrients and total metals (e.g., copper, iron, zinc and aluminum). ▪ Monitor daily to ensure proper cleanup is completed.
Increased dust accumulation on peripheral wetland vegetation, causing damage to wetland plants resulting from construction of access roads where the minimum 5 m setback from dripline will be applied to Significant Wetland Features.	• Minimize dust accumulation on peripheral vegetation.	• Use of water as a dust suppressant along areas where construction is located within 5 m of a significant wetland.	• Accumulation of dust on peripheral vegetation will be minimized through the application of mitigation measures. • Residual effects likely however limited magnitude of effect as a result given the application of mitigation measures.	• Daily monitoring of areas where active construction is occurring within 5 m of a significant wetland by Environmental Monitor. • **Contingency Measures:** ▪ If dust accumulation on wetland plants occurs, spray down plants with water.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Changes in surface water drainage patterns resulting in effects to soil moisture and species composition of vegetation where the minimum 5 m setback from dripline will be applied to Significant Wetland Features.	• No effects to soil moisture and species composition of vegetation.	• Ensure Best Management Practices are used to maintain current drainage patterns.	• Changes in surface water drainage patterns will be minimized through the application of mitigation measures. • Low likelihood and limited magnitude of effect as a result.	• Daily monitoring of areas where active construction is occurring within 5 m of a significant wetland by Environmental Monitor. • **Contingency Measures:** ▪ If surface water drainage alterations are detected, undertake corrective measures to restore drainage patterns.
Unplanned intrusion into significant woodlands/wetlands in event of equipment malfunction due to directional drilling and risk of sedimentation or erosion into significant wetlands when directionally drilling.	• Minimize potential for accidental intrusion and sedimentation or erosion into significant features.	• Where feasible, wetland/woodland crossings will be within existing right-of-ways adjacent to wetland/woodland areas. • Where features cannot be avoided, crossings will be completed via horizontal directional drilling as per O. Reg. 359/09. • Locate entrance and exit pits at least 30 m from feature edge. • Install protective fencing around vegetation to prevent accidental damage. • Ensure drill depth is at an appropriate depth below wetland to reduce the risk of a “frac-out”. • Restore drilling sites to pre-construction conditions once construction is complete. • Develop and implement an emergency spills plan outlining steps to contain any chemicals and avoid contamination of adjacent wetland features. As part of this plan, “frac-out” provisions will be provided. • Install sediment and erosion control fencing along edge of wetland if within 30 m as per Ontario Provincial Standard Specifications (OPSD 219.130).	• Risk of unplanned intrusion and sedimentation or erosion into feature due to directional drilling will be minimized through the use of mitigation measures. • Moderate likelihood; if accidental damage occurs, negative effects may be measurable but would represent a small change relative to existing conditions.	• See directional drilling above.
Unintended damage to adjacent vegetation due to proximity of transmission line to significant wetlands/woodlands, small size of the right-of-way and constrained work area.	• Minimize potential for unintended damage to significant wetlands/woodlands.	• Limit vegetation removal within significant wetlands to the existing right-of-way. • Maintain 30 m setback from significant wetlands and woodlands, where possible or a minimum 5 m setback (measured from the dripline of trees or wetland edge if trees are absent). • Install protective fencing around vegetation to prevent accidental damage.	• Damage to vegetation will be minimized through the application of mitigation measures. • Construction effects unlikely; if accidental damage occurred, negative effects may be measurable but would represent a small change relative to existing conditions.	• Undertake monthly site inspections to ensure that protective fencing is intact and that there is no damage caused during construction. • **Contingency Measures:** ▪ In the event that trees are damaged during construction, damaged trees should be pruned through implementation of proper arboricultural techniques, under supervision of an Arborist or Forester.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Loss of up to 2.86 ha of forest cover within Significant Woodland Features from clearing for transmission line.	• Minimize loss of forest cover over time.	• Establish an area of forest equal in area to the cleared area (up to 2.86 ha) through tree planting and management (e.g., in partnership with a local Conservation Authority). Details of the afforestation plan will be provided to MNR in a Compensation Plan. • Perform vegetation clearing outside of the breeding bird season (May 1 to July 31). • Clearly stake area to be cleared. • Fell trees with a chainsaw toward the construction area to reduce damage to adjacent vegetation being retained. • Limit size of machines entering significant woodlands to minimize soil compaction. • Removal of tree limbs on adjacent trees being retained should be carried out under supervision of an Arborist or Forester. • Damaged tree roots should be cut clean as soon as possible and exposed roots covered in approved topsoil. This work to be carried out under supervision of an Arborist or Forester.	• Clearing of vegetation will occur for the transmission line. • Moderate residual effects.	• Daily monitoring of areas where active vegetation removal is occurring by Environmental Monitor. • **Contingency Measures:** ▪ In the event that trees are damaged during construction, damaged trees should be pruned through implementation of proper arboricultural techniques, under supervision of an Arborist or Forester.
Changes to surface water hydrology resulting from turbine construction near Significant Valleyland Feature.	• Minimize changes to surface water hydrology.	• Limit changes in land contours. • Maintain streams and timing and quantity of flow.	• Changes in surface water drainage patterns and obstruction of lateral flows minimized through mitigation measures. • Low likelihood and limited magnitude of effects as a result.	• Inspect locations following completion of construction to ensure no grade changes. • **Contingency Measures:** ▪ If surface water drainage alterations are detected, undertake corrective measures to restore drainage pattern.
Changes to surface water drainage patterns resulting from turbine and access road construction causing indirect effects on Waterfowl (Tundra Swan) Stopover and Staging Area Features.	• Minimize changes in surface water drainage patterns.	• Minimize land contour changes.	• Habitat damage will be minimized through the application of mitigation measures. • Construction effects temporary and minor.	• Inspect locations following completion of construction to ensure no grade changes. • **Contingency Measures:** ▪ If surface water drainage alterations are detected, undertake corrective measures to restore drainage pattern.
Disruption of Tundra Swan use of Waterfowl (Tundra Swan) Stopover and Staging Area Features resulting from turbine, access road and collection line construction.	• Avoid disruption of Tundra Swan during migration.	• Construction activities within 300 m of the stopover and staging habitat should be timed to avoid migration timing windows (typically early to late March).	• Disruption of Tundra Swans will be minimized through the application of mitigation measures. • Negligible residual effects.	• No monitoring or contingency measures required as long as construction occurs outside migration period.
Noise disturbance to bats during turbine construction at Bat Maternity Colony Features	• Minimize disturbance to bat roosting habitat.	• Confine construction activities within 30 m of significant bat habitats to daylight hours during the period of May 15th to August 31st, wherever possible.	• Disturbance will be avoided through timing of construction.	• No monitoring or contingency measures required during constriction.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Disruption of amphibians moving to breeding pools and home range resulting from access road construction near Amphibian Woodland Breeding Habitat Features.	• Minimize disruption to amphibian movement.	• Limit construction of roads within 30 m of significant amphibian habitats to daylight hours between April 1st and June 30th (for significant frog breeding habitats) or between March 15th and April 30th (for significant salamander breeding habitat), to avoid excessive noise and vehicle caused mortality, wherever possible. • Post speed limits along construction access roads.	• Disruption to amphibians avoided with the application of mitigation measures. • Construction effects temporary and minor.	• No monitoring required if timing windows are applied. • **Contingency Measures:** ▪ If construction occurs after dark within the specified timing windows, amphibian mortality surveys will be conducted the following day.
Changes to surface water drainage patterns resulting from access road construction causing indirect effects on Amphibian Woodland Breeding Habitat Features.	• Minimize indirect effects on breeding pools.	• Ensure no grade changes within 30 m of vernal pools during construction.	• Habitat damage will be minimized through the application of mitigation measures. • Construction effects temporary and minor.	• Inspect locations following completion of access roads to ensure no grade changes. • Examine condition of vernal pools within 30 m of access road following completion of construction. • **Contingency Measures:** ▪ If surface water drainage alterations are detected, undertake corrective measures to restore drainage pattern.
Risk of mortality to amphibians moving between breeding pool and home range.	• Minimize amphibian mortality along access road.	• Avoid construction in proximity to this feature at night between April 1st and June 30th and any rainy nights from spring to early autumn, wherever possible. • Enforce slow vehicle speeds. Post and maintain speed limit signs.	• Risk of amphibian mortality reduced through mitigation measures. • Operation effects minor (i.e., no or limited mortality expected).	• No monitoring required if timing windows are applied. • **Contingency Measures:** ▪ If construction occurs after dark in or near identified movement corridors between April 1st and June 30th and rainy nights from spring to early autumn, amphibian mortality surveys will be conducted the following day.
Mortality to reptiles from construction equipment for construction of access roads near Reptile Hibernaculum Feature.	• Minimize mortality from equipment.	• Construction activities within 60 m of the hibernaculum should be timed to avoid timing windows during which snakes emerge (April 15 - May 31) and return (September 1 – October 15) to hibernaculum. • If construction must take place during these timing windows, erect temporary drift fence between edge of habitat and road if hibernaculum is within 60 m of road.	• Habitat damage will be avoided and mortality minimized through the application of mitigation measures. • Construction effects temporary and minor (i.e., no or limited mortality expected).	• No monitoring required if timing windows are applied. • **Contingency Measures:** ▪ Weekly inspection of drift fence if construction occurs during specified timing windows.
Disruption of turtles moving between over-wintering ponds and other areas or turtle mortality resulting from access road and transmission line construction near or within Turtle Over-wintering Habitat Features.	• Minimize disruption of turtle movement. • Minimize turtle mortality.	• Fence area as far from pond and as close to proposed road or transmission line clearing as possible. Post speed limits and turtle crossing signage along relevant construction access roads.	• Disruption to turtle movement and risk of turtle mortality minimized with the application of mitigation measures. • Construction effects temporary and minor (i.e., no or limited mortality expected).	• Undertake monthly site inspections to ensure that protective fencing is intact and that there is no damage caused during construction. • No contingency measures required.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Changes to surface water drainage patterns resulting from access road construction causing indirect effects on Turtle Over-wintering Habitat Features.	• Minimize indirect effects on over-wintering habitat through changes to surface water drainage patterns.	• Ensure no grade changes within 30 m of pond.	• Indirect effects to habitat minimized with the application of mitigation measures. • Construction effects temporary and minor.	• Monitor condition of the pond during on-site monitoring events at frequency described for sediment and erosion control. • **Contingency Measures:** • If surface water drainage alterations are detected, undertake corrective measures to restore drainage pattern.
Removal of vegetation within significant features resulting in habitat damage from clearing for transmission line within Azure Bluet Habitat Feature and Turtle Over-wintering Habitat Feature.	• Minimize disturbance to significant wildlife habitat. • No destruction of pond.	• Maintain a 10 m buffer around the breeding pond within which no vegetation removal will occur. • Fence area as far from pond and as close to transmission line disturbance area as possible. • Minimize the area of tree removal within the natural area to the extent possible. • Re-vegetate disturbed areas as soon as possible after construction activities are complete using species native to Ontario in naturally vegetated areas.	• Clearing of vegetation will occur for the transmission line. • Disruption to significant wildlife habitat minimized through setback and protective fencing. • Moderate residual effects.	• Monitor condition of the pond during on-site monitoring events at frequency described for sediment and erosion control. • **Contingency Measures:** ▪ If negative effects to the pond are detected, corrective measures will be taken, to be determined through consultation with MNR. These habitat compensation or restoration measures will be described in a Compensation Plan, to be submitted to MNR.
Changes to surface water drainage patterns resulting from transmission line construction causing indirect effects on Azure Bluet Habitat Feature, Turtle Over-wintering Habitat Feature and Amphibian Woodland Breeding Habitat Features.	• Minimize indirect effects on pond through changes to surface water drainage patterns.	• Ensure no grade changes within 30 m of pond.	• Indirect effects to significant wildlife habitat minimized with the application of mitigation measures. • Construction effects temporary and minor.	▪ Monitor condition of the pond during on-site monitoring events at frequency described for sediment and erosion control. • **Contingency Measures:** ▪ If negative effects to the pond are detected, corrective measures will be taken, to be determined through consultation with MNR. These habitat compensation or restoration measures will be described in a Compensation Plan, to be submitted to MNR.
Removal of vegetation within significant features resulting in habitat damage from clearing for transmission line within Amphibian Woodland Breeding Habitat Features.	• Minimize disturbance to amphibian breeding habitat. • No destruction of breeding pond.	• Focus construction activities within the woodland to outside April 1st and June 30th (for significant frog breeding habitats) or March 15th and April 30th (for significant salamander breeding habitat), to avoid disturbance to breeding amphibians and vehicle caused mortality. • Maintain a 10 m buffer around the breeding pond within which no vegetation removal will occur. • Minimize the area of tree removal within the natural area to the extent possible. • Re-vegetate disturbed areas as soon as possible after construction activities are complete using species native to Ontario in naturally vegetated areas.	• Some permanent vegetation removal within woodlands containing amphibian breeding habitat will occur. Breeding habitat should remain undisturbed. • Significance of residual effects will be determined based on the results of post-construction monitoring.	• Monitor condition of the pond during on-site monitoring events at frequency described for sediment and erosion control. • **Contingency Measures:** ▪ If negative effects to the pond are detected based on the results of post-construction monitoring, corrective measures will be taken, to be determined through consultation with MNR. These habitat compensation or restoration measures will be described in a Compensation Plan, to be submitted to MNR.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Disruption of amphibians moving between breeding pools and home range resulting from transmission line construction within Amphibian Woodland Breeding Habitat Features.	• Minimize disruption to amphibian movement.	• Focus construction activities within the woodland to outside April 1st and June 30th (for significant frog breeding habitats) or March 15th and April 30th (for significant salamander breeding habitat), to avoid disturbance to breeding amphibians and vehicle caused mortality.	• Disruption to amphibians minimized with the application of mitigation measures. • Construction effects temporary and minor.	• No monitoring or contingency measures required if timing windows are applied.
Removal of vegetation within significant feature resulting in habitat damage from clearing for transmission line within Red-headed Woodpecker Habitat Feature.	• Minimize disturbance to breeding habitat. • No destruction of nest site.	• Focus construction activities within habitat to outside the breeding season of May 1st to July 31st. • Maintain a 10 m buffer around the nest within which no vegetation removal will occur. • Clearly delineate habitat boundaries (i.e. 10 m buffer) using protective fencing to ensure that construction activities occur outside the habitat boundaries. • Minimize the area of tree removal within the natural area to the extent possible. • Remove trees by hand-held equipment and drag them out of the natural area to minimize soil disturbance. If possible, leave some woody debris to decompose naturally. • Lighter vehicles and lighter machinery should be used in and around the natural area. Any vehicles used within the natural area should have wide-based tires. Tracked vehicles should be avoided.	• Some permanent vegetation removal within the woodlot containing the Red-Headed Woodpecker nesting site will occur. • Significance of residual effects will be determined based on the results of post-construction monitoring.	• Supervision of vegetation removal by a qualified Biologist to ensure no destruction of nesting habitat. • No additional monitoring or contingency measures required if timing window is applied.
Noise disturbance to breeding Red-headed Woodpeckers during transmission line construction within Red-headed Woodpecker Habitat Feature.	• Minimize disturbance to breeding birds.	• Focus construction activities within habitat to outside the breeding season of May 1st to July 31st.	• Disturbance avoided through timing of construction activities. • No residual effects anticipated.	• No monitoring or contingency measures required if timing window is applied.
Displacement and/or mortality of nursing female and juvenile bats resulting from vegetation clearing for transmission line construction within Bat Maternity Colony Features.	• No displacement and/or mortality of nursing female and juvenile bats.	• Prepare a tree preservation plan which identifies specific trees to be removed and whether each tree contains a cavity suitable for potential use as a bat maternity colony. • Tree removal will occur outside of the maternity and summer swarming period of May 15 to August 31, wherever possible. If this is not possible, MNR will be consulted regarding any additional mitigation measures that may be required.	• Significance of residual effects will be determined based on the results of post-construction monitoring.	• No monitoring or contingency measures required during construction.

Table 3-3 Mitigation Measures, Residual Effects and Monitoring Plan: Significant Wetlands, Woodlands, Valleylands and Wildlife Habitat

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Removal of confirmed significant cavity trees or other suitable, but not studied, cavity trees resulting from vegetation clearing for transmission line construction within Bat Maternity Colony Features.	• Successful relocation of any significant maternity colonies that may be removed (if applicable).	• For each suitable cavity tree to be removed, a bat house will be installed in the closest suitable woodland habitat (the remainder of the woodland for each of the affected habitats). • Details of bat box construction and placement will be provided to MNR for approval prior to installation. • If a significant maternity colony must be removed, timing, location, and bat house design will be of utmost importance for the colony to successfully re-establish, and will be discussed with the MNR.	• Significance of residual effects will be determined based on the results of post-construction monitoring.	• No monitoring or contingency measures required during construction.
Noise disturbance and/or avoidance behaviour to bats during transmission line construction within Bat Maternity Colony Features.	• Minimize noise disturbance and/or avoidance behaviour during construction.	• Tree removal should occur outside of the summer swarming and roosting period of local bat species (May 15th-August 31st).	• Disturbance avoided through timing of construction activities. • No residual effects anticipated.	• No monitoring or contingency measures required during construction.

3.3 Surface Water and Groundwater

Potential effects to surface water and groundwater, resulting from locating a Project component within the prescribed setbacks to water bodies, are evaluated in the Water Assessment and Water Body Report (AECOM, 2012) and are described below.

3.3.1 Surface Water

Following the Records Review and Site Investigation, 83 water bodies were identified. The Project was found to be within the prescribed setback distance for all identified water bodies. To aid in the assessment of water bodies and to focus mitigation measures, information was collected during site investigations that incorporated water quality, flow, aquatic habitat and riparian features in order to provide some understanding on the system's resiliency. Based on a sensitivity ranking conducted by AECOM, 1 water body was classified as high sensitivity (i.e., not very resilient to environmental change); 45 water bodies were moderate sensitivity; and 37 water bodies were low sensitivity. The assessment concluded that the majority of the watersheds are fairly resilient to environmental perturbations. In general, water quality throughout the Study Area is heavily influenced by agriculture, as evidenced by tile drain runoffs, high suspended solids and turbidity of the water, as well as algae growth in some of the channels.

In compliance with *O.Reg. 359/09*, a Water Assessment and Water Body Report (AECOM, 2012) was prepared to assess negative environmental effects, identify mitigation measures and describe monitoring commitments to address any effects. For a detailed account of this assessment and associated methodology, please refer to the Water Assessment and Water Body Report (AECOM, 2012).

3.3.1.1 Potential Effects

Potential effects from construction and installation activities include:

- Reduced groundwater upwelling areas (and hence stream base flows) from groundwater dewatering activities (if required) for excavation of foundation area, resulting in increased surface water temperatures from reduced groundwater contributions;
- Increased streamflows in watercourses that receive temporary groundwater dewatering discharge (if required). Groundwater discharge has potential to cause streambed and/or bank erosion and downstream sedimentation if not managed properly;
- Increased erosion, sedimentation and turbidity in watercourse from:
  - clearing and grubbing for construction of turbines and pads/turnaround areas, access roads, transmission line pole installation, the substation and laydown area, and a meteorological tower;
  - directional drilling activities for the transmission line, collection line crossings and for collection lines within a water body buffer;
- Soil compaction, which may result in increased runoff into watercourses from turbine construction;
- Release/discharge of sediment-laden runoff from the construction area, which has the potential to transport nutrients and contaminants into the watercourse due to construction of turbines, road crossings and for roads within a water body buffer, collection line crossings and for collection lines within a water body buffer, the transmission line, substation and laydown area; and a meteorological tower;
- Obstruction of lateral flows in watercourses from water crossings;
- Temporary disruption of substrates/habitat at locations where in-water work is required;

- Degradation and loss of fish habitat for water crossings;
- Soil/water contamination by oils, grease and other materials from accidental spills and release of contaminants from construction equipment at water body locations for turbine construction, road crossings and for roads within a water body buffer, directional drilling of collection line crossings, collection lines within a water body buffer, transmission line, substation and laydown area, and meteorological tower;
- Release of pressurized drilling fluids into watercourse due to fractures in the substrate resulting in a “frac out” for directional drilling of the transmission line and for collection line crossings;
- Reduction of streamflow due to the withdrawal of surface water for construction activities such as dust suppression, equipment washing and land reclamation (e.g., hydroseeding);
- Loss of riparian habitat adjacent to watercourses from the construction of the transmission line; and
- Damage to stream banks from the use of heavy machinery for the construction of the transmission line.

3.3.2 Mitigation Measures, Residual Effects and Monitoring Plan

Table 3-4 provides mitigation measures, residual effects and the monitoring plan for each potential effect identified above.

3.3.3 Geology and Groundwater

The Project Study Area is located within the Wyoming Moraine, which influences the surface topography producing typical hummocky/rolling topography standing 30 to 60 m above the surrounding terrain. The belt is approximately 8 km wide and roughly parallels the Lake Huron Shore (Cooper, 1979). The predominant overburden material throughout the Project Study Area is the St. Joseph Till, which is characterized by glaciolacustrine-derived silty to clayey till (OGS, 2003). The St. Joseph Till has a high clay content which likely restricts infiltration and groundwater movement. Therefore shallow groundwater transport is likely through the weathered overburden flowing west toward Lake Huron or is vertical along fractures until it reaches a flow path at depth. Typically the overburden thickness is greater than 20 m.

Groundwater recharge areas within the Project Study Area are restricted to the small patches of highly permeable beach ridge and glacial outwash deposits found running north-south in the centre of the Project Study Area (OGS, 2003). The largest north-south silty sand (glacial outwash) deposit has been designated as both a Significant Groundwater Recharge Area (SGRA) and a Highly Vulnerable Aquifer (HVA) by the Government of Ontario. Other significant areas include the northwest corner of the Project Study Area, which is identified as part of the Intake Protection Zone for the Lake Huron Primary Water Supply System.

Available MOE water well records within the Project Study Area indicate that the majority of the water supply wells within the area are screened within bedrock aquifers with static water levels greater than 20 m below ground surface (mbgs). This suggests groundwater flow characteristics reflect that of the bedrock surface topography and that the useable groundwater in the area is typically close to the buried bedrock surface.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Reduced groundwater upwelling areas (and hence streamflows) from groundwater dewatering activities (if required) for excavation of foundation area, resulting in increased surface water temperatures and reduced baseflows from reduced groundwater contributions.	• Minimize reduction of stream baseflows and groundwater upwelling areas, and increase in water temperatures.	**Water Management** • Control rate and timing of water pumping; pump from deep wells to infiltration galleries adjacent to water bodies or wetlands. • Control quantity and quality of stormwater discharge using best management practices, and implement infiltration techniques to the extent possible. • Restrict taking groundwater and surface water during drought conditions. • The water taker will regulate the discharge at such a rate that there is no flooding in the downstream area and no soil erosion, or stream channel scouring is caused at the point of discharge. The water taker will use a discharge diffuser or other energy dissipation device, if necessary, to mitigate flows which physically alter the stream channel or banks. • Siltation control measures will be installed at both the taking location upstream of the construction site and (if necessary) the discharge site and will be sufficient for the volumes pumped. All measures will be taken to properly maintain these control devices throughout the construction period. **Timing Windows** • Time construction to avoid periods of habitat use to the extent possible, these timing windows are applied to protect fish from any works in and around water during spawning, migration and other critical life history stages. Construction timing windows are based on site specific criteria such as type of fish species present, thermal regime and fish spawning times (spring or fall). The generic restricted in-water work timing windows established by DFO are: ▪ Fall Spawning Period – October 1st to May 31st ▪ Spring Spawning Period – May 1st to July 15th **Water Quality** • Develop a spill response plan and train staff on associated procedures. • Maintain emergency spill kits on site. • Pass groundwater from dewatering activities (if required) through a sediment filtration system prior to being discharged to a watercourse. • Control soil / water contamination through best management practices.	• Reduced stream baseflows, groundwater upwelling areas and increase in water temperatures minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects as there will only be small scale dewatering (if required).	• Where known groundwater dewatering is required, install staff gauges to monitor stream levels. • Monitor water level at these locations to monitor watercourse depth and estimated flow before, during and after dewatering activities. • Contingency Measures: ▪ Control rate and timing of water pumping. In the event of a decrease in stream water levels, of which it can be attributed to the dewatering activities, stop all dewatering until appropriate site specific mitigation plan has been developed.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Increase to streamflows in watercourses that receive temporary groundwater dewatering discharge (if required). Groundwater discharge has potential to cause streambed and/or bank erosion and downstream sedimentation if not managed properly.	• Minimize increase in flows to watercourses and erosion and/or sedimentation.	**Erosion and Sediment Control** • Develop and implement an erosion and sediment control plan before commencement of construction. • Install erosion blankets, erosion control fencing, straw bales, etc., where necessary to mitigate potential excessive erosion and sedimentation. • Ensure any materials placed in floodline are free from silt and other such particles. • Maintain extra erosion and sediment control materials on site (e.g., heavy duty silt fencing, strawbales). • Maintain sediment and erosion control measures in place until disturbed areas have been stabilized (i.e., re-vegetated). • Schedule grading within 30 m of watercourses to avoid times of high runoff volumes. • Temporarily suspending work if excessive flows of sediment discharges occur until mitigation measures are in place. • Direct discharged water to an appropriately sized energy dissipating outlet device to prevent erosion at the point of discharge. **Water Management – See above** **Timing Windows – See above**	• Increased flows to watercourses and associated streambed and/or bank erosion minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects as there will only be small scale dewatering (if required).	• Monitor erosion and sedimentation of receiving watercourse before and during dewatering events. • Monitor water level and stream flow at these locations to test watercourse depth and flow speed before and during construction. • Collect surface water samples from discharge locations before and after construction. Analyze for general chemistry (e.g., temperature, pH, dissolved oxygen, and conductivity), suspended solids, turbidity, nutrients and total metals (e.g., copper, iron, zinc and aluminum). These data will be used to determine background watercourse water quality at discharge locations. In conjunction with the streamflow measurements, these data will allow for site-specific loading calculations to determine watercourse assimilation capacity. • The findings of the monitoring program will be reported back to MOE following the completion of dewatering activities. • Contingency Measures: ▪ Install a temporary storage basin adjacent to foundation area to allow water to infiltrate.
Increased erosion, sedimentation and turbidity from clearing and grubbing on adjacent lands for construction of turbines, pads/turnaround areas, and access roads and from directional drilling activities.	• Minimize erosion, sedimentation and turbidity.	**Erosion and Sediment Control – See above** **Grading and Excavation** • Minimize changes in land contours and natural drainage; maintain timing and quantity of flows. **Equipment Use** • Ensure machinery arrives on site in a clean, washed condition and is maintained free of fluid leaks. • Minimize vehicle traffic on exposed soils, avoid compacting or other hardening of natural ground surface, and avoid the movement of heavy machinery on areas with sensitive slopes. • Locate site maintenance, vehicle washing and refuelling stations where contaminants are handled at least 30 m away from natural features including water bodies and significant woodlands, wetlands, and wildlife habitat. • Implement vehicle and equipment cleaning procedures and practices to minimize or eliminate the discharge of pollutants from vehicle/ equipment cleaning operations to watercourses or natural areas. • Limit speed of vehicles near watercourse crossings.	• Increased erosion, sedimentation and turbidity from clearing and grubbing minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects as a result.	• Monitor on-site conditions (i.e., erosion and sediment control, spills, flooding, etc.) where construction occurs within 30 m of a water course on the following basis: ▪ Weekly during active construction periods. ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet). ▪ Daily during extended rain or snowmelt periods. ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. • In the event that a spill / flooding occurs, the details of the event will be reported back to MOE, including a description of any assessment and remediation undertaken. • Contingency Measures: ▪ Suspend work if excessive flows of sediment discharges occur until mitigation measures are in place.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Soil compaction, which may result in hardening of surfaces and increased runoff into watercourses	• Minimize soil compaction and increased runoff into watercourses.	• **Erosion and sediment control – See above** • **Grading and Excavation – See above** • **Water Quality – See above**	• Soil compaction and associated increase in runoff into watercourses minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects as a result.	• Monitor on-site conditions (i.e., erosion and sediment control, spills, flooding, etc.) where construction occurs within 30 m of a water course on the following basis: ▪ Weekly during active construction periods. ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet). ▪ Daily during extended rain or snowmelt periods. ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. • Contingency Measures: • Suspend work if excessive flows of sediment discharges occur until mitigation measures are in place.
Release or discharge of sediment-laden runoff from the construction area, which has the potential to transport nutrients and contaminants from construction of turbines, access roads, collection lines, and water crossings	• Minimize release or discharge of sediment-laden surface water into adjacent watercourse or drainage features.	• **Water Quality – See above** • **Erosion and Sediment Control – See above** • **Timing Windows – See above**	• Release or discharge of sediment laden surface water into the adjacent watercourse or drainage features minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects as a result.	• Monitor on-site conditions (i.e., erosion and sediment control, spills, flooding, etc.) where construction occurs within 30 m of a water course on the following basis: ▪ Weekly during active construction periods. ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet). ▪ Daily during extended rain or snowmelt periods. ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. • In the event that a spill / discharge of sediment occurs, the details of the event will be reported back to MOE, including a description of any assessment and remediation undertaken. • Contingency Measures: ▪ Suspend work if excessive flows of sediment discharges occur until mitigation measures are in place.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Obstruction of lateral flows in watercourses from water crossings	• Minimize obstruction of lateral flows in watercourses.	**Stream Flow** • Design and install culverts to prevent creation of barriers to fish movement and maintain bankfull channel functions. • Design culverts to accommodate high flows of the watercourse. • Embed the culvert below the streambed to maintain lateral flow. • Install adequate gravel base to maintain flow of shallow groundwater. • Locate crossings within straight sections of the stream, perpendicular to the bank. Avoid crossings on meander bends, braided streams and any other unstable areas. • Use only clean material (i.e., rock or coarse gravel) for approaches to culverts. **Isolated Crossing** • Install in-water works for permanent water bodies in the dry via dam and pump method or creation of a diversion channel to maintain flow around the work site. For intermittent water bodies, work is preferred to be completed in the dry and carried out during seasonally dry or when the water body is frozen to the bottom. • Develop and implement a fish rescue plan for dewatering areas. This will include appropriate sized end-of-pipe fish screen to prevent potential losses of fish due to entrainment or impingement as outlined in the DFO Freshwater Intake End-of-Pipe Fish Screen Guideline. • Retain an adequate portion of channel with sufficient width and depth to allow for fish passage if construction requires that an instream work area be isolated from the primary channel. In the event that an area must be blocked from bank to bank, construct a temporary by-pass to allow fish passage around the construction area.	• Obstruction of lateral flows in watercourses avoided through application of mitigation measures. • No likelihood of effect occurring.	• Monitor on-site conditions at all water body crossings (i.e., culverts are installed properly and embedded below the streambed.): ▪ Prior to, during and after the installation of the culvert to ensure lateral flows have been maintained. • Contingency Measures: ▪ In the event the culvert creates issues relating to lateral flow and fish barriers, steps will be required to fix issues which may involve re-installing the culvert to ensure it is properly installed and embedded within the streambed.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Temporary disruption of substrates/habitat associated with in-water works	• Minimise temporary disruption of substrates/habitats.	**Timing Windows – See above** **Isolated Crossing – See above** **Erosion and Sediment Control – See above** **Rehabilitation** • Re-vegetate and restore the turbine staging area following turbine installation with tiling (if desired by the owner). • Restore and maintain vegetative buffers around water bodies including within the foundation footprint where possible. • Restore and maintain vegetative buffers around water bodies including within the temporary construction areas. • Keep vegetation removal to a minimum. • Add suitable stream substrates (e.g., gravel or rip rap) to stabilize sediment and provide cover.	• Temporary disruption of substrates/habitat associated with in-water works minimized through application of mitigation measures. • Moderate likelihood and magnitude of effect occurring due to number of watercourse crossings.	• Monitor fish habitat once per week or as required throughout duration of in-water construction to identify any minor or major disturbances caused by construction activities by undertaking the following : ▪ Turbidity monitoring for sediment loading; ▪ Monitoring bank stability; ▪ Monitoring substrate composition; ▪ Monitoring stream flow and ensure fish passage is maintained at all times. • Document changes to aquatic habitat as a result of construction activities and obtain photographic documentation. • The findings of the monitoring program will be reported back to MOE following the completion of in-water construction activities. • Contingency Measures: ▪ Mitigate or compensate for any disturbance to fish habitat according to Department of Fisheries and Oceans Canada (DFO) authorization and in consultation with ABCA and UTRCA.
Degradation of fish habitat.	• Minimize degradation of fish habitat.	**Stream Flow – See above**	• Degradation of fish habitat minimized through application of mitigation measures. • Moderate likelihood of effect occurring due to number of watercourse crossings; however, magnitude of effect limited due to marginal habitat and common species; as such fish passage will be maintained and will continue to provide habitat.	• Monitor fish habitat throughout duration of in-water construction to identify any minor or major disturbances caused by construction activities. • Document changes to aquatic habitat as a result of construction activities and obtain photographic documentation. • Contingency Measures: ▪ Mitigate or compensate for any disturbance to fish habitat according to Department of Fisheries and Oceans Canada (DFO) authorization and in consultation with ABCA and UTRCA.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Soil/water contamination by oils, grease and other materials from accidental spills and release of contaminants from construction equipment.	• Minimize soil/water contamination.	**Equipment Use – See above** **Material Stockpiling and Handling** • Store any stockpiled materials away from natural features to prevent deleterious substances from inadvertently discharging to the environment. • Dispose of any waste material from construction activities by authorized and approved off-site vendors. **Water Quality – See above** **Timing Windows – See above**	• Soil / water contamination minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects on surface water and groundwater as a result.	• Conduct daily inspections of construction equipment for leaks / spills. • Implement Contingency Measures in the event of a spill: ▪ Install a spill collection pad for refuelling and maintenance. ▪ In the event of a spill, immediately stop all work until the spill is cleaned up. ▪ Notify MOE's Spills Action Centre of any leaks or spills. ▪ Assess and remediate affected soils and water by using spill kit kept on site. ▪ Analyze water samples for general chemistry (e.g., temperature, pH, dissolved oxygen, and conductivity), suspended solids, turbidity, nutrients and total metals (e.g., copper, iron, zinc and aluminum) during and after construction. ▪ Monitor daily to ensure proper cleanup is completed.
Fractures in substrate releasing pressurized drilling fluids into watercourse and causing potential change to groundwater flow patterns due to directional drilling.	• Minimize fractures in substrates and release of pressurized drilling fluids into watercourse.	**Directional Drilling** • Conduct all drilling by licensed drillers in accordance with Regulation 903 under Ontario Water Resources Act, R.S.O. 1990. • Locate drill entry and exit pits at least 30 m from water bodies. • Collect drill cuttings as they are generated and place in a soil bin or bag for off-site disposal. • Ensure drill depth is at an appropriate depth below the water body to reduce the risk of a 'frac-out'. **Water Quality – See above**	• Fractures in substrate releasing pressurized drilling fluids into watercourse and causing potential change to groundwater flow patterns minimized through application of mitigation measures**.** • Low likelihood of effects as a result of mitigation measures; however magnitude of effects could be high as benthic invertebrates, aquatic plants and fish and their eggs could be smothered by the fine particles if bentonite were discharged to waterways.	• Monitor directional drilling for the duration of such activities to ensure that "frac-out" does not occur, and if it does, to ensure that effects are minimized on surface or groundwater. • Contingency Measures: ▪ In the event of a "frac-out", immediately stop all work, including the recycling of drilling mud / lubricant. ▪ Monitor frac-out for 4 hours to determine if the drilling mud congeals. If drilling mud congeals, take no other action that would potentially suspend sediments in the water column. If drilling mud does not congeal, erect isolation/containment environment (underwater boom and curtain). ▪ If the fracture becomes excessively large, engage a spill response team to contain and clean up excess drilling mud in the water and bottom substrates. ▪ If the spill affects an area that is vegetated, reseed and/or replant the area using species similar to those in the adjacent area, or allowed to re-grow from existing vegetation. Revegetated areas will be monitored twice per year for two years subsequent to frac-out to confirm revegetation is successful.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
				▪ Document post-cleanup conditions with photographs and prepare frac-out incident report describing time, place, actions taken to remediate frac-out and measures implemented to prevent recurrence. Provide incident report to MNR and MOE within 30 days of the incident.
Reduction of streamflow due to the withdrawal of surface water for construction activities such as dust suppression, equipment washing and land reclamation (e.g., hydroseeding).	• Minimize effects to surface water and fish habitat	**Erosion and Sediment Control – see above** **Water Management** • **Restrict taking groundwater and surface water during drought conditions** • **Control rate and timing of water pumping from surface water features** • **Regulate the discharge of water-taking to ensure there is no soil erosion, or stream channel scouring is caused by the point of discharge.**	• Low likelihood and limited magnitude of effects on surface water as a result.	• Monitor all surface water-taking activities to ensure no damage to watercourse and fish habitat occurs, including drops in water levels and damage to stream banks and bed from discharge. Contingency Measures: • In the event of decreased water levels and damage to stream banks and bed, suspend work until mitigation measures are in place.
Loss of riparian habitat adjacent to watercourses for installation of hydro poles.	• Minimize loss of riparian habitat adjacent to watercourses	**Rehabilitation** • **Keep vegetation removal to a minimum** • **Restore and maintain vegetative buffers around water bodies including within the temporary construction areas** **Erosion and Sediment Control – see above**	• Loss of riparian habitat adjacent to watercourses minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects riparian cover and adjacent watercourse.	• Monitor site during riparian vegetation removal. • Monitor on-site conditions (i.e., erosion and sediment control, etc.) where construction occurs within 30 m of a water course on the following basis: ▪ Weekly during active construction periods. ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet). ▪ Daily during extended rain or snowmelt periods. ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. Contingency Measures: • Suspend work if excessive flows of sediment discharges occur until mitigation measures are in place. • Restabilize banks with plantings as soon as works are complete to ensure no further damage to stream banks.

Table 3-4 Mitigation Measures, Residual Effects and Monitoring Plan: Surface Water and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Damage to stream banks from the use of heavy machinery	• Minimize damage to stream banks	**Work Area** • **Stabilize banks where necessary, minimizing area and duration of soil exposure.** • **Operate machinery on land and in a manner that minimizes disturbance to stream banks** • **Erect sediment fencing around water bodies and areas to be avoided** **Erosion and Sediment Control – see above** **Rehabilitation** • **Keep vegetation removal to a minimum** • **Restore and maintain vegetative buffers around water bodies including within the temporary construction areas**	• Damage to stream banks minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects on surface water and groundwater as a result.	• Monitor on-site conditions (i.e., erosion and sediment control, etc.) where construction occurs within 30 m of a water course on the following basis: ▪ Weekly during active construction periods. ▪ Prior to, during and post forecasted large rainfall events (>20 millimetres in 24 hours) or significant snowmelt events (i.e., spring freshet). ▪ Daily during extended rain or snowmelt periods. ▪ Monthly during inactive construction periods, where the site is left alone for 30 days or longer. Contingency Measures: • Suspend work if excessive flows of sediment discharges occur until mitigation measures are in place. • Restabilize banks with appropriate measures as soon as works are complete to ensure no further damage to stream banks.

Perched conditions are expected to exist within the overburden, especially to the west of the Site closer to Lake Huron and near the eastern border of the Project Site. Shallow water table conditions may be encountered during construction of the turbines, especially near to surface water bodies such as streams and wetlands and within the beach ridge and glacial outwash deposits. If directional drilling is proposed for the collection lines within the organic deposits near Turbines 31, 32, 33, 47, 71 and 82, further investigation into the depth, continuity and geotechnical properties of these deposits may be required to determine if linear drilling is viable.

An anthropogenic feature of note is the underground water pipeline that runs from the pumping station/filtration plant at the end of Gore Road (north of Grand Bend) at Lake Huron and transects the southwest portion of the Project Study Area in a southeasterly direction. The construction of Turbines 16, 36, 37, 64 and 78 and associated collection lines will need to account for the presence of the underground water pipeline.

Any water taking conducted during the construction phase is subject to the Renewable Energy Approval application and as such does not require a separate Permit to Take Water (MOE, 2011). The extraction of groundwater for construction dewatering purposes is expected to be of low volume due to the short duration of dewatering activities (3 to 4 days per turbine base), and the shallow depth of the excavation for the turbine bases (up to 4 mbgs). There is the potential that water taking could be less than 50,000 L/day for turbines within the clayey-till unit but has the potential to be greater than 50,000 L/day for turbines with the silty sand unit, depending on the number of turbine foundations/collection line trenches installed at one time[1], the surficial material being excavated (sand and gravel, or silty/clayey till based on surficial conditions reported by the Ontario Geological Survey and the available MOE Water Well Records for the Study Area), and the amount of precipitation that occurs directly before or during construction activities.

As such the water taking may be classified as Groundwater – Category 2 (short-term, non-recurring taking less than 30 consecutive days and less than 400,000 L/day; MOE, 2005). **Appendix A** contains detailed calculations on the dewatering estimates and radii of influence for the construction dewatering. Based on these calculations the conservative water taking per turbine base excavation could range from 2,300 L/day to 73,000 L/day with calculated radii of influence for the construction dewatering of 15 m and 102 m for the silty/clayey till unit and the silty sand unit respectively. As noted previously, all turbine locations within the silty sand unit are a minimum of 120 m from any natural surface water features or wetlands, and therefore the calculated maximum radius of influence is not expected to intersect those surface water features or wetlands.

As these calculations are based on estimations from the available data, it is recommended that at least one geotechnical borehole be drilled for each turbine base location and these calculations be revisited using the new soil data found through these geotechnical investigations.

3.3.3.1 Potential Effects

Potential effects from construction and installation activities include:

- Dewatering when excavating and constructing the turbine bases, resulting in a reduction in quality and quantity of groundwater; and
- Increase in impervious area created by the turbine base and access roads resulting in reduced infiltration near to groundwater recharge areas.

1. Requires that a maximum of one foundation for turbines within the sand / silt unit be excavated at a time

3.3.4 Mitigation Measures, Residual Effects and Monitoring Plan

Table 3-5 provides mitigation measures, residual effects and the monitoring plan for each potential effect identified above.

Table 3-5 Mitigation Measures, Residual Effects and Monitoring Plan: Geology and Groundwater

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Reduction in groundwater quality and quantity due to dewatering when excavating and constructing the turbine bases.	• Minimize reduction in groundwater quality and quantity.	• Restrict dewatering during extreme low flow conditions (i.e., high summer) and direct the discharge from dewatering back into the nearest watercourse (following sediment control practices) to negate the potential that drawdown will decrease baseflow into streams. • Maintain a setback of 120 m from the nearest water wells, buildings, and significant natural features. • Avoid excavating more than one foundation at a time for turbines within the silty sand units (Turbines 3, 8, 10, 11, 13, 39, 41, 65, 67, and 73).	• Reduction in groundwater quality and quantity minimized through application of mitigation measures. • Low likelihood and negligible magnitude of effects based on the limited amount of dewatering required and distance between known water wells, buildings, and significant natural features (> 120 m) and dewatering activities.	• As no water wells, buildings, or significant natural features are located within the calculated radius of influence for construction dewatering, no monitoring or contingency measures are required.
Increase in impervious area created by the turbine base and access roads resulting in reduced infiltration near to the noted groundwater recharge areas (beach ridge and glacial outwash deposits).	• Minimize increase in impervious areas.	• Direct runoff from the constructed impervious surfaces to ground surface to prevent any decrease in infiltration and recharge.	• Reduced infiltration near groundwater recharge areas minimized through application of mitigation measures. • Low likelihood and limited magnitude of effects based on amount of dewatering required.	• No monitoring or contingency measures required.

3.4 Emissions to Air

Construction and installation activities require the operation of equipment, including trucks, cranes, and bulldozers, which represent a source of air emissions from the engines in addition to the generation of dust.

3.4.1 Potential Effects

Potential effects from construction and installation activities include:

- Emissions of contaminants from portable generator sets, truck traffic and other construction vehicles, including but not limited to, nitrogen dioxide, sulphur dioxide, suspended particulates, emissions of greenhouse gases (carbon dioxide, methane); and
- Dust as a result of vehicle traffic over gravel roads and/or cleared areas.

No odour emissions are anticipated.

3.4.2 Mitigation Measures, Residual Effects and Monitoring Plan

Table 3-6 provides mitigation measures, residual effects and the monitoring plan for each potential effect identified above.

Table 3-6 Mitigation Measures, Residual Effects and Monitoring Plan: Emissions to Air

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Increased dust and air emissions due to construction activity.	• Minimize deterioration of air quality.	• Use spray water and environmentally friendly dust suppressants applied at an environmentally acceptable rate to minimize the release of dust from gravel, paved areas and exposed soils only where necessary on problem areas; • Implement a speed limit that will lead to reduced disturbance of dust on paved and unpaved roads; and, • Ensure proper maintenance of vehicles and machinery to limit noise, Criteria Air Contaminant (CAC) emissions and leaks.	• Increased dust and air emissions minimized through application of mitigation measures. • High likelihood of effects occurring; however, any dust and air emissions are short-term and magnitude of such effects will be limited.	• Track all complaints and conduct follow-up monitoring (see Complaints Resolution Process in Emergency Response and Communications Plan). • Contingency Measures: ▪ Suspend construction in high winds.

3.5 Noise

As discussed above, construction activities require the operation of equipment, including trucks, cranes and bulldozers that generate noise.

3.5.1 Potential Effects

Potential effects from construction and installation activities are as follows:

- An increase in noise levels due to trucks, cranes and other equipment used to construct the turbines and ancillary infrastructure.

3.5.2 Mitigation Measures, Residual Effects and Monitoring Plan

Table 3-7 provides mitigation measures, residual effects and the monitoring plan for each potential effect identified above.

Table 3-7 Mitigation Measures, Residual Effects and Monitoring Plan: Noise

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Increased noise due to construction activity.	• Minimize noise increases for inhabited areas.	• Ensure that construction equipment is kept in good condition and does not exceed noise emissions as specified in MOE publication NPC-115. • Operate construction vehicles in accordance with municipal by-laws. • Implement speed limit on unpaved roads.	• Increased noise minimized through application of mitigation measures. • High likelihood of effect occurring; however, increase in noise levels associated with construction is short-term and magnitude of such effects will be limited.	• Track all complaints and conduct follow-up monitoring (see Complaints Resolution Process in Emergency Response and Communications Plan). • Contingency Measures: ▪ Repair faulty equipment resulting in increased noise levels in a timely fashion.

3.6 Local Interests, Land Use and Infrastructure

Land uses within 300 m of the Project Study Area were identified through the REA planning process and in consultation with the Municipalities, MTO and local landowners. The following section describes the results of the effects assessment for the construction phase of the Project.

3.6.1 Existing Land Uses and Infrastructure

Common agricultural land uses in southern Huron County are cash crops (e.g., soybeans, corn and wheat) and livestock farming. Other land uses include non-farm residential uses on separate lots created through severances for farm retirement lots, surplus farm dwelling lots and older estate lots, which are scattered throughout the Project Study Area in limited numbers.

3.6.1.1 Potential Effects

Potential effects from construction and installation activities on local interests, land use and infrastructure may include:

- Minor reduction in usable agricultural land;
- Increased congestion due to an increase in truck traffic and short-term lane closures on local roads during delivery of project components; and
- Disruption or damage to local infrastructure such as roads, water and sewage pipelines.

3.6.2 Mitigation Measures, Residual Effects and Monitoring Plan

Table 3-8 provides mitigation measures, residual effects and the monitoring plan for each potential effect identified above.

Table 3-8 Mitigation Measures, Residual Effects and Monitoring Plan: Local Interests, Land Use and Infrastructure

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Minor reduction in usable agricultural land.	• Minimize reduction in usable agricultural land.	• Minimize length of access roads (most agricultural use only affected during construction) where possible.	• Minor reduction in usable agricultural land minimized through application of mitigation measures. • High likelihood of effect occurring; however, however limited magnitude due to size of overall footprint within the entire Project Study Area.	• No monitoring or contingency measures required.
Increased congestion due to increase in truck traffic and short-term lane closures on local roads during delivery of project components.	• Minimize disturbances to local traffic patterns.	• Develop a traffic management plan for the construction phase and submit to the Municipalities prior to construction; and, • Notify the community in advance of construction delivery schedules and install signage to notify road users of construction activity.	• Increased congestion due to increase in truck traffic and short-term lane closures minimized through application of mitigation measures. • High likelihood of effect occurring; however, limited magnitude due to spread-out nature of the project and duration of lane closures.	• Track all complaints and conduct follow-up monitoring (see Complaints Resolution Process in Emergency Response and Communications Plan). • Contingency Measures: ▪ Establish alternate delivery routes.

Table 3-8 Mitigation Measures, Residual Effects and Monitoring Plan: Local Interests, Land Use and Infrastructure

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Damage to local infrastructure	• Minimize damage to local infrastructure.	• Adhere to best practices regarding the operation of construction equipment and delivery of construction materials; and, • Undertake roads condition survey prior to construction and post-construction.	• Damage to local infrastructure minimized through application of mitigation measures. • Moderate likelihood and magnitude of effects occurring due to presence oversize loads during delivery of turbine components.	• Track all complaints and conduct follow-up monitoring (see Complaints Resolution Process in Emergency Response and Communications Plan). • Contingency Measures: ▪ Return damaged infrastructure to original condition (or better) where appropriate.

3.7 Areas Protected Under Provincial Plans and Policies

The REA requires a determination as to whether the Project is being proposed in any of the following protected or plan areas:

- Protected Countryside or Natural Heritage Systems in the Greenbelt Plan;
- Oak Ridges Moraine Conservation Plan Areas;
- Niagara Escarpment Plan Area; or
- Lake Simcoe Watershed Plan Area.

The Goshen Wind Energy Centre is not proposed in any of these protected or plan areas. As such, there will be no effects on these areas as a result of the Project.

3.8 Public Health and Safety

Effects on public health and safety during construction have been described in Section 3.4 (Emissions to Air, including Odour and Dust), Section 3.5 (Noise), and 3.6 (Local Interests, Land Use and Infrastructure).

3.9 Other Resources

A search for landfills, aggregate resources, forest resources and petroleum resources was undertaken based upon data from the Huron County online GIS database (Huron County, 2011) and from the MNR's Oil, Gas & Salt Resources (OGSR) library (Ontario Oil, Gas & Salt Resource Library, 2011).

3.9.1 Landfills

There are five closed landfills within the Project Study Area (as shown on **Figure 2-3**), all of which are municipally-owned. The Stephen landfill (South Huron) is located within the Wind Energy Centre Study Area approximately 550 m south of the collection line between Turbines 42 and 78. Due to the distance between the landfill and Project infrastructure, construction activities are not anticipated to have an effect upon the closed landfill. The Usborne landfill (South Huron) is located within the Transmission Line Study Area, directly south of the breaker switch station and across the other side of Dump Road. Construction activities are not anticipated to have an effect upon the closed landfill because there is sufficient separation between the landfill and the Project infrastructure due to the presence of the road.

There is also an unidentified closed landfill located adjacent to the southern boundary of the Transmission Line Study Area to the west of Ausable Line (1.2 km from the closest Project infrastructure) and two closed landfills located on Centre Street, south of Dashwood Road (1.3 km from the closest Project infrastructure) and on Ausable Line south of Kirkton Road (395 m from the Project infrastructure). These closed landfills are not located within close proximity to any Project infrastructure. As a result, no construction-related effects on the closed landfills are anticipated.

There is one open landfill located within the Wind Energy Centre Study Area, the municipally-owned Hay landfill (Bluewater), which is approximately 70 m from the closest Project infrastructure (collection line between Turbines 4 and 5). This landfill is small, and although relatively close to Project infrastructure, appears to have sufficient buffer (greater than 30 m) within the property boundary. As a result, construction related activities are not anticipated to have an effect on the open landfill. The municipally-owned Exeter landfill (South Huron), which is currently open, is located adjacent to the northern boundary of the Transmission Line Study Area near Ausable Line, outside of the Project Study Area and is not in close proximity to any Project infrastructure (2.8 km away). As such, no effects from construction activities are anticipated.

3.9.2 Aggregate Resources

Table 3-9 and **Figure 2-3** shows that there are seven authorized aggregate resources located within the Project Study Area. None of these resources are located within close proximity to Project infrastructure.

Table 3-9 Aggregate Resources

Owner	Area (ha)	Licence Class	Status	Distance to Closest Project Infrastructure
McCann Construction Inc.	40.47	Class A > 20000 tonnes	Active	330 m
Prout Farms	90.60	Class A > 20000 tonnes	Active	1.2 km
Jennison Construction Ltd.	11.24	Class A > 20000 tonnes	Surrendered	2.2 km
Scott, Alan E.	47.50	Class A > 20000 tonnes	Surrendered	370 m
McCann Redi-Mix Inc.	8.78	Class A > 20000 tonnes	Active	7 km
The Municipality of South Huron	16.13	Class A > 20000 tonnes	Surrendered	1 km
Taylor, Jeffrey	23.76	Class A > 20000 tonnes	Active	1.2 km

There are also three pits or quarries located within the Project Study Area. One of the three is located approximately 50 m east of the collection line between Turbines 14 and 15. However, this pit/quarry is relatively small and construction related activities are not anticipated to have an effect on this resource. Another pit/quarry is located approximately 380 m east of the breaker switch station, adjacent to the eastern boundary of the Transmission Line Study Area. It is not anticipated to experience any effects from construction activities. The remaining pit/quarry of the three identified is located approximately 530 m north of the access road between Turbines 7 and 10, close to the northern boundary of the Wind Energy Centre Study Area. Again, the construction activities are not anticipated to have an effect on this resource due to the distance from Project infrastructure.

3.9.3 Forest Resources

Based on the MNR's Sustainable Forest Licences (SFL) database (Ontario Ministry of Natural Resources, 2012), there are no SFLs within the Project Study Area.

3.9.4 Petroleum Resources

One petroleum resource was identified within 75 m of Project infrastructure. Specifically, the access road and collection line between Turbines 54 and 84 is approximately 60 m from a petroleum resource.

There are no oil and gas companies operating pipelines within the Project Study Area.

3.9.5 Potential Effects

No effects on open or closed landfills, aggregate resources, forest resources or petroleum wells are anticipated as a result of the construction phase of the Project due to the distance between the Project and these resources. An Engineer's Report will be submitted to the MNR prior to construction to confirm that there are no effects on the one petroleum resource located within 75 m of Project infrastructure.

4. Summary and Conclusions

Field work and data collection were undertaken to determine the potential effects to the various environmental and social features during the construction and installation phase of the Project. Mitigation measures to manage these potential effects have been identified and monitoring and contingency plans proposed to ensure effects are minimized as outlined above.

The overall conclusion of this Construction Plan Report is that this project can be constructed and installed without any significant adverse residual effects.

5. References

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Appendix A

Hydrogeological Calculations for Dewatering Activities

Appendix A Hydrogeological Calculations for Dewatering Activities

1. Introduction

As described in the *Technical Guide to Renewable Energy Approvals (MOE, 2011)*, an important environmental effect to consider in the Construction Plan report is the potential for the Project to interfere with existing uses of a water resource.

Section 3.3.3 (Geology and Groundwater) of the Construction Plan Report determines that the extraction of groundwater for construction dewatering purposes will be less than 50,000 litres per day (L/day). This is attributable to the following reasons:

- A short duration of dewatering activities (3-4 days per turbine base);
- The number of turbine foundations / collection line trenches installed at one time; and
- The surficial material being excavated.

2. Calculation of Water Takings

An estimate of 73,000 L/day for a turbine foundation excavation in the sand/silt unit running down the centre of the Project Study Area, and 2,300 L/day for the silty/clayey till unit covering the majority of the Project Study Area were calculated. These values were calculated based on an assumed excavation of 21 x 21 m and 4 m deep with a drawdown of 3 m. The hydraulic conductivity was assumed to be 1.00E-04 m/s for the sand/silt unit and 1.00E-07 m/s for the silty/clayey till unit.

In addition, the calculated radii of influence for the construction dewatering were 102 m and 15 m for the sand/silt unit and the silty/clayey till unit respectively.

The analytical calculations used to determine the predicted groundwater inflow and radii of influence were based upon Powers *et al.* (2007)[1] and Sichart *et al.* (1930)[2].

Table 1 summarizes the predicted groundwater inflow and radii of influence.

Table 2 shows the calculations used to determine the radius of influence and groundwater inflow for the sand/silt unit.

Table 3 shows the calculations used to determine the radius of influence and groundwater inflow for the silty/clayey till unit.

Figure A1 graphically represents the radii of influence from construction dewatering for an excavation for a turbine foundation for each unit.

1. *Powers, J.P, Corwin, A.B., Schmall, P.C., Kaeck, W.E., and Herridge, C.J., 2007. Construction Dewatering and Groundwater Control: New Methods and Applications, 3rd Ed. John Wiley and Sons Inc.*
2. *Sichart, W. and Kyrieleis, W., 1930. Grundwasser Absekungen bei Fundierungsarbeiten. Berlin, Germany.*

Table 1. Summary of Predicted Groundwater Inflow and Radii of Influence

Area:	Excavation for base of single turbine
Initial Head:	3 m
Final Head:	0 m
Excavation Length:	21 m
Side Slope Wall Ratio:	Varies, but assume 1H:1V for calculation
Trench Width:	21 m
Number of Sides:	4
Silty/Clayey Till Hydraulic Conductivity:	1.00E-07 m/s
Sand/Silt Hydraulic Conductivity	1.00E-04 m/s

	Hydraulic Conductivity (m/s)			
	Silty/Clayey Till	***1.00E-07***	***Sand/Silt***	***1.00E-04***
Q (L/d)	2,295		72,576	
ROI (m)	15		102	

Notes: *Q – Flow rate (L/day)*
ROI –Radius of Influence (m)
Calculated values are based on an initial water level of 1 mbgs and a turbine base excavation of 21 m x 21 m x 4 m

Table 2. Radius of Influence and Groundwater Inflow Rate Calculations (Silty Sand Unit)

Radius of Influence and Groundwater Inflow Rate Calculations - Unconfined Aquifer, Silty Sand Unit

After: Powers et al, 2007 & Sichart and Kryieleis, 1930.
USE FOR BOX SHAPED EXCAVATIONS, WHERE x/a IS SMALL (I.E. <1.5)

x/a 1

Radius of Influence

Ro = 3000(H-h)K^1/2

Sichardt's empirical relationship

Raduis of Influence	Ro =	90.00	m
Saturated Thickness before Dewatering	H =	3	m
Saturated Thickness after Dewatering	h =	0	m
Hydrualic Conductivity	K =	1.00E-04	m/s
Number of Sides	n =	4	

Equivalent Radius of Influence for Square or rectangular shaped areas

$r_e = (ax/Pi)^{1/2}$

Width of Trench	a =	21	m
Length of Trench	x =	21	m
Pi	3.1415926		
Equiv Radius of Infleunce	r_e =	11.85	m

Therefore, the Total Radius of Influence equals $R_T = Ro + r_e$

	R_T =	101.85	m

Groundwater Seepage Rate

Jacob's modified non-equilibrium equation**

Q= [(xK(H^2-h^2)/2L]*n

Radius of Influence	Ro =	90.00	m
Equiv Radius of Infleunce	r_e =	11.8	m
Saturated Thickness before Dewatering	H =	3	m
Saturated Thickness after Dewatering	h =	0	
Hydrualic Conductivity	K =	1.00E-04	m/s
Length of Trench	x =	21	m
Line Source Distance*	L =	45	m
Pi	3.1415926		
Groundwater Inflow Rate	Q =	8.40E-04	m3/s
	Q =	**72,576**	L/day
Sheet Pile % reduction	%	0	%
Revised Total Groundwater Inflow Rate	**Q' =**	**72,576**	L/day

Notes:

*** Only good for horizontal flow, need to use darcy for vertical flow*

***First Term is for Gravity Flow*

***Second Term is for artesian flow (confined aquifer)*

**Line source distance is the distance where the confined aqufier is drained (i.e., under gravity flow conditions), but the confining unit is still flowing under pressure*

References:

Powers, J.P, Corwin, A.B., Schmall, P.C., Kaeck, W.E., and Herridge, C.J., 2007. Construction Dewatering and Groundwater Control: New Methods and Applications, 3rd Ed. John Wiley and Sons Inc

Sichart, W. and Kyrieleis, W., 1930. Grundwasser Absekungen bei Fundierungsarbeiten. Berlin, Germany.

Table 3. Radius of Influence and Groundwater Inflow Rate Calculations (Till Unit)

Radius of Influence and Groundwater Inflow Rate Calculations - Unconfined Aquifer, Till Unit

After: Powers et al, 2007 & Sichart and Kryieleis, 1930.

USE FOR BOX SHAPED EXCAVATIONS, WHERE x/a IS SMALL (I.E. <1.5)

x/a 1

Radius of Influence

Ro = 3000(H-h)K^1/2

Sichardt's empirical relationship

Raduis of Influence	Ro =	2.85	m
Saturated Thickness before Dewatering	H =	3	m
Saturated Thickness after Dewatering	h =	0	m
Hydrualic Conductivity	K =	1.00E-07	m/s
Number of Sides	n =	4	

Equivalent Radius of Influence for Square or rectangular shaped areas

$r_e = (ax/Pi)^{1/2}$

Width of Trench	a =	21	m
Length of Trench	x =	21	m
Pi	3.1415926		
Equiv Radius of Infleunce	r_e =	11.85	m

Therefore, the Total Radius of Influence equals $R_T = Ro + r_e$

R_T = 14.69 m

Groundwater Seepage Rate

Jacob's modified non-equilibrium equation**

Q= [(xK(H^2-h^2)/2L]*n

Radius of Influence	Ro =	2.85	m
Equiv Radius of Infleunce	r_e =	11.8	m
Saturated Thickness before Dewatering	H =	3	m
Saturated Thickness after Dewatering	h =	0	
Hydrualic Conductivity	K =	1.00E-07	m/s
Length of Trench	x =	21	m
Line Source Distance*	L =	1.423024947	m
Pi	3.1415926		
Groundwater Inflow Rate	Q =	2.66E-05	m3/s
	Q =	**2,295**	L/day
Sheet Pile % reduction	%	0	%
Revised Total Groundwater Inflow Rate	**Q' =**	**2,295**	L/day

Notes:

*** Only good for horizontal flow, need to use darcy for vertical flow*

***First Term is for Gravity Flow*

***Second Term is for artesian flow (confined aquifer)*

**Line source distance is the distance where the confined aqufier is drained (i.e., under gravity flow conditions), but the confining unit is still flowing under pressure*

References:

Powers, J.P, Corwin, A.B., Schmall, P.C., Kaeck, W.E., and Herridge, C.J., 2007. Construction Dewatering and Groundwater Control: New Methods and Applications, 3rd Ed. John Wiley and Sons Inc

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Figure A1. Radii of Influence from Construction Dewatering