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1. Introduction

Jericho Wind, LP (Jericho), is currently constructing a wind energy project in the Municipality of Lambton Shores and the Township of Warwick, in Lambton County, Ontario and in the Municipality of North Middlesex, in Middlesex County, Ontario. The project is referred to as the Jericho Wind Energy Centre (the "Project"). The project obtained the Renewable Energy Approval (REA), as outlined in Ontario regulation 359/09 (O.Reg. 359/09) under the Environmental Protection Act by the Ontario Ministry of the Environment on April 14, 2014 (REA Approval Number 5855-9HHGQR)(MOE, 2014). AECOM Canada Ltd. (AECOM) was retained by Jericho to prepare the REA application and uphold the terms and conditions outlined in the issued approval.

As described in the *Technical Guide to Renewable Energy Approvals* (MOE, 2011), an important environmental effect to consider is the potential for the Project to interfere with existing uses of a water resource. Section 3.3.3 (Geology and Groundwater) of the *Jericho Wind Energy Centre Construction Plan Report* (AECOM, 2013a and AECOM, 2013b) provided an estimate for daily groundwater inflow rates and resulting radii of influence for turbine foundation excavations for the Project. Results of a geotechnical investigation, performed by AMEC Environment & Infrastructure later in 2013, were then used to confirm the presence of permeable sediments within the anticipated turbine foundation excavation for all turbines. Details of the hydrogeological investigation are found in the *Dewatering Assessment for the Jericho Wind Energy Centre* prepared by AECOM in 2014 (AECOM, 2014). Results of this investigation indicated that estimates of groundwater inflow rates were calculated to be less than 50,000 L/day for all turbines with the exception of turbines 8, 32, 33 and 34. Based on this assessment the following two (2) conditions were made in the REA approval letter pertaining to groundwater taking quantities:

> *H1. The Company shall not take more than 50,000 litres of water per day per turbine construction site by any means during the construction and retiring of the Facility.*
>
> *H2. Notwithstanding Condition H1, at the construction sites for Turbines 8, 25, 32, 33 and 34, the Company is authorized to take a maximum of 400,000 litres of water per day, for the purpose of construction dewatering for foundation construction.*

During the construction of several turbine foundations coarse grained soils, capable of transmitting large quantities of groundwater, were encountered. The geotechnical investigation performed at many of these locations comprised of Cone Penetration Tests (CPT) and identified fine grained soils within the excavation depth and therefore it was not anticipated to have groundwater dewatering requirements exceeding 50,000 L/day. However, during excavation for the turbine foundation the amount of groundwater seeping into the excavation exceeded the allowable dewatering limit of 50,000 L/day. As such, a dewatering assessment has been complete for the remaining turbines to be constructed to quantify dewatering needs, assess potential impacts and recommend appropriate mitigation.

The Purpose of this report is to provide additional hydrogeological information and discussion in support of a modification to the REA approval from the MOE for construction related dewatering activities associated with the foundation construction of the remaining 61 turbines. We are requesting that the conditions H1 and H2 be revised as follows:

> *H1. The Company shall not take more than 50,000 litres of groundwater per day per turbine construction site by any means during the construction and retiring of the Facility.*
>
> *H2. Notwithstanding Condition H1, at the construction sites for Turbines where groundwater dewatering in excess of 50,000 litres per day is anticipated, the Company is authorized to take a maximum amount of litres of water per day as indicated in Table 4 of the Hydrogeological Report in Support of a Modification to the Renewable Energy Approval for the Jericho Wind Energy Centre for the purpose of construction dewatering for foundation construction. In the event that groundwater dewatering*

requirements exceed those indicated in Table 4, the company may consult directly with the Southwest Region Technical Support Section to request an increase of the maximum allowable litres of water per day and determine associated mitigation measures.

H3. Notwithstanding Condition H1 and H2, at the construction sites for Turbines with minimal groundwater dewatering requirements the Company is authorized to take a maximum of 1,000,000 litres of surface water accumulation per day, for the purpose of construction dewatering.

In accordance with the submission requirements associated with securing a Category 3 Permit To Take Water (PTTW) prescribed by the MOE, this document presents the following information:

- A description of the proposed undertaking;
- Details regarding the geological and hydrogeological conditions of the project area;
- Predicted dewatering requirements;
- Anticipated discharge conditions;
- Anticipated radii of influence based on predicted dewatering requirements;
- An assessment of potential impacts related to dewatering activities; and
- An environmental management plan.

1.1 Study Area

The Project Study Area is considered to be the area that encompasses all turbines associated with the Project. For the purpose of this investigation the Turbine Study Area (Study Area) is defined as the area within a 500 m radius of any turbine center that has not been constructed to date and may require groundwater takings exceeding 50,000 L/day. A list of turbines included in this investigation, that are pending construction, is provided in **Table 1** below.

Table 1. Summary of Turbines Included in Hydrogeological Assessment

• 4	• 29	• 52	• 75	• 88	• 105
• 7	• 30	• 53	• 76	• 89	• 106
• 8	• 32	• 54	• 78	• 90	• 107
• 9	• 33	• 56	• 79	• 91	• 108
• 10	• 34	• 58	• 80	• 92	• 109
• 20	• 35	• 59	• 81	• 94	• 112
• 21	• 36	• 63	• 82	• 96	
• 22	• 37	• 64	• 83	• 97	
• 23	• 49	• 72	• 84	• 102	
• 24	• 50	• 73	• 85	• 103	
• 27	• 51	• 74	• 86	• 104	

2. Existing Conditions

2.1 Climate

There are no environment Canada climate stations within 25 km of the Project Study Area. A rain gauge was installed within the Project Study Area to record daily precipitation amounts and is maintained by the contractor.

Short duration severe rain events, precipitating large quantities of water in a short period of time, promotes higher levels of surface runoff than would typically occur during lighter rain falls over a longer period of time. This phenomenon has been observed within the last four months and has resulted in higher volumes of surface water accumulating within the excavation than anticipated.

2.2 Physiography and Topography

The Project Study Area lies within four physiographic regions; the Huron Fringe to the north, the Huron Slope to the east, the St. Clair Clay Plains to the west and the Horseshoe Moraines to the south.

The Huron Fringe physiographic region is characterized by Chapman and Putnam (1984) as a narrow fringe of glaciolacustrine deposits comprising of boulders, gravel bars and sand dunes that extend along Lake Huron from Sarnia to Tobermory. A weakly developed shore cliff divides the Huron Slope physiographic region from the Huron Slope to the southeast and the St. Clair Clay Plains to the southwest.

The Huron Slope physiographic region can be described as a clay plain modified by a narrow strip of sand. Lacustrine clay is generally less than one metre thick, overlying deeper silty clays and brown clayey tills with minimum amounts of sand and gravel.

The St. Clair Clay Plains are comprised of relatively uniform clay deposit across 5,880 square kilometers and generally 30 to 60 metres thick (over bedrock).

Horseshoe Moraines are an extensive feature stretching in a horseshoe shape north and east from the study area. The southwestern limb consists of morainic ridges combining fine grained till and long thin gravel units formed by ancient beaches.

Topography varies widely across the project study area but generally slopes in a northwest direction towards Lake Huron. The Ausable River valley forms the primary topographic low feature within the Project Study area. The Ausable River, located at the eastern extent of the Project Study Area, is generally characterized by a moderately deep valley with a broad, flat (AECOM, 2013c). Topographic highs within the Project Study Area are primarily found associated with the long bands of glacial lake beach-foreshore deposits that transect the study area in an east and northeast direction. Topography ranges within the Project Study Area from 176 meters Above Sea Level (mASL) in proximity to Turbine 7 to 258 mASL in proximity to Turbine 102.

Overall the study area surficial geology is characterized by broad gently sloping low permeability till deposits, with some areas of coarser deposits. Many of the turbine locations are in and around agricultural fields with moderate topographic features. The short intense rain fall events described in **Section 2.1** can often lead to significant over land flows due to the low permeability of the till deposits. Turbines are frequently positioned in low lying areas and collection of surface water runoff in the turbine foundation excavation is a frequent problem.

2.3 Geology and Hydrogeology

Existing geological and hydrogeological conditions within the Project Study Area were established based on a review of surficial geology and Paleozoic bedrock geological mapping from the Ministry of Natural Resources (MNR), and MOE water well records. Site specific geotechnical investigations performed by AMEC and field observations collected from construction inspectors were used to characterize the hydrogeological conditions within the Study Area.

The predominant overburden material throughout the Project Study Area is the St. Joseph Till, which is widely characterized as a clayey silt to silty clay till (Cooper, 1981) (**Figure 2**). The St. Joseph Till is not uniform in its lithology across the Project Study Area. Incorporation and interbedding of course grained sediments ranging from laminated silts and clays to sands and gravels are encountered. It is important to note these heterogeneities such as sand and gravel lenses, within the St. Joseph Till have the potential to contain significant quantities of groundwater. Predominantly, the St. Joseph Till has a high clay content, which likely restricts infiltration of precipitation and surface water as well as groundwater movement. The St. Joseph Till is considered a local aquitard based on these hydrogeological properties.

Coarse grained glaciolacustrine deposits transect the Project Study Area and are present as long bands of glacial lake beach-foreshore deposits of sand and gravel, typically trending in a southwest to northeast direction (**Figure 3**). Within the Project Study Area, these deposits are associated with glacial Lake Grassmere to the north, glacial Lake Warren transecting through the centre of the Project Study Area, and glacial Lake Arkona in the south. These deposits are highly permeable and are responsible for the majority of groundwater recharge within the Project Study Area. These deposits have been designated as a Significant Groundwater Recharge Area (SGRA) by the MOE (ABCA & MVCA, 2011). Typically, these deposits are underlain by fine grained sediments, creating perched aquifer conditions where the groundwater table is close to surface. Similar characteristics are found associated with the glacialfluvial outwash deposits, which are largely confined to the northeastern portion of the Project Study Area, within the Ausable River valley.

Found between glacial lake foreshore deposits and the current Lake Huron shore line are fine grained glaciolacustrine deposits of silt and clay. These deposits are considered to be relatively impermeable and likely restrict groundwater infiltration and groundwater movement.

Bedrock geology of the Project Study Area consists of Devonian age limestones of the Dundee Formation, and shales of the Hamilton Group and the Kettle Point Formation. In general, the bedrock underlying the Project Study Area is overlain by up to 60 m of overburden material (**Figure 3**). The Dundee Formation, exposed in the northeast portion of the Project Study Area, is overlain by approximately 60 m of overburden material (Cooper, 1981). The Hamilton Group underlies the central portion of the Project Study Area and forms a prominent bedrock ridge, known as the Ipperwash Escarpment, separating the Hamilton Group from the underlying Dundee Formation. This feature is exposed at surface northeast of the town of Thedford and trends northwest to southeast. The Kettle Point Formation becomes the overlying bedrock in the southwest portion of the Project Study Area. West of the Ipperwash Escarpment, bedrock topography slopes gently north and west into the Lake Huron basin.

Available MOE water well records within the Project Study Area indicate that the majority of the water supply wells are screened within bedrock aquifers. Overburden aquifers are used by water wells in the northern portion of the Project Study Area and are completed in the unconfined shallow sand aquifers, largely restricted to the course grained glaciolacustrine deposits (beach-foreshore deposits). These unconfined aquifers create perched groundwater conditions, where groundwater is found less than 2 m below ground surface. Shallow water table conditions have been encountered during construction of turbine foundations, and are anticipated to be encountered when in close proximity to the beach-foreshore sand and gravel deposits. In these instances dewatering of the overburden aquifer may be required.

2.4 Subsurface Stratigraphy

Site specific soil stratigraphy for each turbine location was inferred from results of the AMEC (2013) geotechnical investigation, geological mapping, MOE water well records and from field observations obtained during the excavation of completed turbines. Field investigations incorporated in the AMEC (2013) geotechnical investigation at the turbines currently not excavated included ten (10) sampled boreholes and forty-six (46) Cone Penetration Tests (CPT). No geotechnical information is available for five (5) turbines locations which include Turbines 106 to 109 and T112. At these locations, subsurface stratigraphy was inferred from nearby turbine locations with available geotechnical information.

Normalized CPT plots were used to evaluate the presence of potential groundwater aquifers within a 3 m excavation depth. At Turbines 7, 8, 20, 27, 32 to 34, 49 to 54, 56, 59, 64, 75, 76, 78, 79, 83 to 86, 88 to 90, 96, 97, 102, 103, and 105 borehole or CPT encountered silt and sand to sand and gravel deposits. Fine grained deposits of silty clay were encountered at the remaining turbine locations that are pending for excavation. At Turbine T4 a fossiliferous fractured limestone is present at 2.3 m Below Ground Surface (BGS). Similar conditions are assumed to be present at T106 due to its proximity to T4 (**Figure 2**).

Soil stratigraphy can only be inferred from CPT plots as no direct observation and description of soil type was made at these locations. During current excavating activities associated with the Project it has been observed that coarse grained soils were encountered that was not displayed on the CPT plot. For example, non-normalized CPT data collected at Turbine T9 showed the presence of 1.7 m of clay overlying approximately 0.3 m of sandy silt, overlying a sequence of bedded silt and sandy silt to the base of excavation (2.2 m). Normalized CPT data show 1.5 m of clay overlying sandy silt to sand to the base of excavation. No borehole was advanced at this location. Field soil observations during the excavation of the turbine foundation at Turbine 9 generally comprises of 0.3 m of topsoil, which is underlain (in descending order) by an approximately 1.15 m of sand (Upper Sand), 0.90 m of hard clay, and a sandy silt unit (Lower Sand) that potentially extends to the bottom of the excavation (approximately 3 m below ground surface (bgs).

2.5 Groundwater Conditions

Groundwater conditions were assessed during the field investigations associated with current excavation works associated with the Project as well as information present in the geotechnical report prepared by AMEC (2013). Groundwater levels vary widely across the site. As a conservative measure it is assumed that groundwater is present within coarse grained soils at ground surface.

3. Construction Methods and Proposed Groundwater Taking

3.1 Construction Methods

Construction methods are based on detailed design drawings of a typical turbine foundation and are appended to this report for reference (**Appendix A**). The foundation excavation will include the excavation of one or more sump pits located within the excavation.

3.2 Estimated Groundwater Dewatering Rates

3.2.1 Design Parameters

An excavation of 23 m wide by 23 m long will extend to a maximum depth of 3 mbgs in preparation for the installation of the turbine foundation. It is assumed that the groundwater table will be lowered to the base of the planned excavation (3 mbgs) to facilitate construction. As a conservative measure, pre-construction water table depths are assumed to be at ground surface. Design parameters for the turbine foundation construction are summarized in **Table 2**.

Table 2. Summary of Design Parameters for Turbine Foundation Construction

Parameter	Value
Excavation Length	23 m
Excavation Width	23 m
Excavation Depth	3.0 m
Required Water Table Drawdown	3.0 m

Dewatering will be required to draw the groundwater level in the turbine foundation excavation to a depth of approximately 3.0 m below the present static level. Sump pumping dewatering methods will be used to achieve the required drawdown and maintain a dry work area. The sump pump will typically operate 24 hours a day, 7 days a week, until the construction of the turbine foundation is complete.

3.2.2 Aquifer Properties

Estimated hydraulic conductivity has been interpreted from information present in the geotechnical investigation and associated borehole log and CPT logs. Site soils predominantly consist of silty sand to sand, silts and clay. According to Domenico and Schwartz (1990) the hydraulic conductivity of these materials can range from $1x10^{-11}$ to $5x10^{-3}$ m/s. As a conservative measure, the bulk hydraulic conductivity for the soils encountered within the excavation depth have been assumed to range between $5x10^{-5}$ to $5x10^{-4}$ m/s. **Table 3** below summarizes the assumed hydraulic conductivities for each soil type.

Table 3. Summary of Assumed Hydraulic Conductivities

Soil Type	Hydraulic Conductivity (m/s)
Sandy Silt to Silty Sand	$1x10^{-5}$
Fine Sand	$5x10^{-5}$
Sand	$1x10^{-4}$
Gravelly Sand	$5x10^{-4}$
Limestone Bedrock	$1.15x10^{-5}$

3.2.3 Dewatering Estimates

Volumetric dewatering estimates assume all inflows to the excavation will be dewatered. The foundation excavation will collect water from three primary sources:

- Lateral groundwater seepage from excavation side walls;
- Vertical groundwater inflows through the base of the excavation; and
- Direct precipitation

3.2.3.1 Lateral Groundwater Seepage

Lateral groundwater seepage into the excavation can be estimated using the Jacob's modified non-equilibrium equation for square trenches in an unconfined aquifer system (**Equation 1**)(Powers, 2007).

$$Q = \frac{\pi K(H^2-h^2)}{\ln(\frac{R_o}{r_s})} + 2\frac{xK\left(H^2-h^2\right)}{2L} \qquad \text{(Equation 1)}$$

Where:
- Q = *groundwater inflow (m^3/day)*
- K = *interpreted hydraulic conductivity (m/s)*
- H = *pre-construction saturated aquifer thickness (m)*
- h = *post construction saturated aquifer thickness (m)*
- x = *length of excavation (23 m)*
- a = *width of excavation (23 m)*
- L = *line source distance (m)*
- R_o = *radium of influence of the cone of depression (m)*
- r_s = *equivalent radium of dewatering area (m)*

Equation 2 provides the radius influence, R_o assuming radial flow to a well, after an empirical relationship developed by Sichart and Kryieleis:

$$R_o = 3000(H - h)\sqrt{K} \qquad \textit{(Equation 2)}$$

Where: $H =$ *pre-construction saturated aquifer thickness (ft)*
$h =$ *post construction saturated aquifer thickness(ft)*
$K =$ *hydraulic conductivity (m/s)*

Equation 3 provides the equivalent radius of influence, r_s for a rectangular area of length a and width b:

$$r_S = \sqrt{\frac{ab}{\pi}} \qquad \textit{(Equation 3)}$$

As a conservative measure, due to the uncertainty of subsurface conditions at each turbine site, the results of the above calculations were multiplied by a safety factor of 2 times the anticipated groundwater inflow rate (Q). Results of the above calculations can be found in **Table 4** below.

3.2.3.2 Groundwater Inflows through Base of Excavation

Vertical movement of groundwater through the base of the excavation is expected to be significant at some turbine locations due to the presence of a hard clay layer overlying a lower sand unit or sand present at the base of the excavation. At these locations, it is anticipated that the overlying clay aquitard is creating hydrostatic pressure resulting in an upward hydraulic gradient. Darcy's Law (**Equation 4**) is used to calculate groundwater inflows into the excavation.

$$Q = KiA \qquad \textit{(Equation 4)}$$

Where: Q = *seepage flow rate (m^3/day)*
K = *bulk hydraulic conductivity (m/day)*
i = *hydraulic gradient [required drawdown (m)/ length of excavation (23 m)]*
A = *area of excavation (441 m^2)*

The required drawdown is estimated to be approximately 1 m above the overlying aquitard or base of excavation. Based on **Equation 4**, the vertical groundwater seepage from a lower sand unit present at some turbine locations is shown in **Table 4**.

Table 4. Summary of Anticipated Total Dewatering Rates and Radius of Influence

Turbine ID	Required Drawdown (H-h) (m)	Assumed Hydraulic Conductivity (m/s)1	Radius of Infuence (R_o) (m)	Total Radius of Influence from Turbine Center (R_o + r_e) (m)	Lateral Groundwater Seepage from Excavation Side Walls (L/day)	Vertical Groundwater Inflow Through Base of Excavation[3] (L/day)	Total Groundwater Inflow Rate (L/day)	Total Daily Groundwater Taking Requested (Including Precipitation Allowance) (L/day)	Total Daily Surface Water Taking Requested - Precipitation and Surface Runoff (L/day)[5]
Turbines Requesting New Groundwater Dewatering Allowance									
4	1.67	1.15E-05	33.92	69.90	31,057	168,912	199,969	318,113	-
9	1.73	1.00E-05	73.32	214.88	69,326	254,362	323,688	465,407	-
10	1.73	1.00E-05	73.32	214.88	69,326	254,362	323,688	465,407	-
51	0.50	1.00E-04	29.99	65.97	29,720	198,720	228,440	370,159	-
54	2.20	1.00E-04	131.86	167.83	119,686	-	119,686	261,405	-
78	2.50	1.00E-04	149.96	185.94	135,676	-	135,676	277,396	-
79	2.00	1.00E-04	119.97	155.95	109,187	993,600	1,102,787	1,244,506	-
83	1.57	5.00E-05	94.00	129.98	86,251	198,720	284,971	426,691	-
84	1.57	5.00E-05	94.00	129.98	86,251	198,720	284,971	426,691	-
85	1.57	5.00E-05	94.00	129.98	86,251	198,720	284,971	426,691	-
89	1.50	1.00E-04	89.98	125.95	82,698	-	82,698	224,417	-
94	2.00	1.00E-04	119.97	155.95	109,187	794,880	904,067	1,045,786	-
96	1.50	1.00E-04	89.98	125.95	82,698	-	82,698	224,417	-
97	1.50	1.00E-04	89.98	125.95	82,698	-	82,698	224,417	-
102	2.00	5.00E-05	119.97	155.95	109,187	-	109,187	250,906	-
103	2.00	5.00E-05	119.97	155.95	109,187	-	109,187	250,906	-
106 (PT1)	1.67	1.15E-05	33.92	69.90	31,057	168,912	199,969	341,688	-
107 (PT2)	2.00	1.00E-04	119.97	155.95	109,187	993,600	1,102,787	1,244,506	-
112 (PT11)	2.97	1.00E-05	56.33	92.30	50,771	-	50,771	192,490	-
Turbines Requesting No Change to Groundwater Dewatering Allowance									
8	N/A[6]	N/A[6]	N/A[6]	200.00	400,000	-	*400,000*	*400,000*	-
32	N/A[6]	N/A[6]	N/A[6]	199.53	400,000	-	*400,000*	400,000	-
33	N/A[6]	N/A[6]	N/A[6]	178.94	400,000	-	*400,000*	400,000	-
34	N/A[6]	N/A[6]	N/A[6]	97.75	400,000	-	*400,000*	400,000	-
Turbines Requesting New Surface Water Taking Allowance									
7	3.00	1.00E-05	56.91	N/A[4]	51,281	-	*50,000*	-	1,000,000
20	1.10	1.00E-05	46.68	N/A[4]	43,515	-	50,000	-	1,000,000
21	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
22	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
23	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
24	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
27	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
29	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
30	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
35	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
36	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
37	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
49	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	50,000	-	1,000,000
50	2.37	1.00E-05	44.94	N/A[4]	40,708	-	*50,000*	-	1,000,000
52	1.49	1.00E-05	28.34	N/A[4]	26,049	-	*50,000*	-	1,000,000
53	2.20	1.00E-04	131.86	N/A[4]	N/A[4]	-	50,000	-	1,000,000
56	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
58	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
59	2.97	1.00E-05	56.33	92.30	50,771	-	*50,000*	-	1,000,000
63	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
64	2.00	1.00E-04	119.97	155.95	109,187	-	50,000	-	1,000,000
72	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
73	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
74	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
75	N/A[4]	1.00E-04	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
76	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
80	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
81	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
82	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
86	3.00	5.00E-05	127.25	163.22	114,668	397,440	50,000	-	1,000,000
88	0.70	1.00E-04	29.74	N/A[4]	28,553	-	*50,000*	-	1,000,000
90	2.69	1.00E-05	51.12	N/A[4]	46,174	-	*50,000*	-	1,000,000
91	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
92	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
104	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000
105	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	50,000	-	1,000,000
108 (PT4)	3.00	5.00E-05	127.25	163.22	114,668	397,440	50,000	-	1,000,000
109 (PT5)	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	*50,000*	-	1,000,000

Notes:
1. Hydraulic conductivity estimated from ranges of hydraulic conductivity values adapted from Domenico and Schwartz (1990)
2. After: Powers et al, 2007 & Sichart and Kryieleis, 1930.
3. Vertical flow calculated using Darcy's Law
4. No coarse grained soils within excavation depth. Therefore, groundwater inflow anticipated to be less than 50,000 L/day
5. Surface water runoff allowance of 1,000,000 L/day only applies to turbine foundations with no groundwater inflow (See Section 3.2.2.5). If Groundwater Inflow is present total requested dewatering rate is 168,144 L/day
6. As per REA approval Condition H1 and H2 (REA Approval Number 5855-9HHGQR)

3.2.3.3 Direct Precipitation

Based on the Intensity-Duration-Frequency (IDF) data presented by Environment Canada for the London CS climate station, the 25 year return period rainfall event, lasting 24 hours in duration and having 89.3 mm of precipitation, could result in the accumulation of 47,240 L in the turbine foundation excavation (assuming no evaporation). Assuming that dewatering would not be interrupted, the 24 hour rainfall could add an additional 141,719 L/day to the pumping rate over an 8 hour period.

3.2.4 Total Anticipated Groundwater Taking

Based on the above discussion, dewatering rates in the range of 192,490 L/day to 1,244,506 L/day may be required to maintain a dry work area. As presented in **Table 4**, the total daily dewatering rate requested for each turbine will allow for sufficient capacity to maintain dry working conditions and handle a 25 year return period rainfall event.

3.3 Predicted Radius of Influence

The radius of influence (R_o) is the distance from the dewatered zone to where no drawdown of the water table can be observed; drawdown is larger near the dewatering zone and tapers out such that the full ROI is often quite a bit larger than the distance to the end of significant drawdown. Using **Equation 2** and **Equation 3**, a hydraulic conductivity and the total required drawdown presented in **Table 4** for each turbine, a total radius of influence was calculated and is presented in **Table 4**. As discussed in **Section 3.2.3.1**, as a conservative measure, the total ROI reflects the anticipated ROI calculated to obtain an equivalent two-times the anticipated groundwater inflow (2xQ). For turbine locations with anticipated dewatering rates of less than 50,000 L/day, a total ROI is not presented.

3.4 Dewatering Discharge and Water Conservation

3.4.1 Discharge Location and Method

It is anticipated that groundwater inflow to the excavation will be pumped from a sump located at the lowest point of the excavation. Depending on conditions encountered in-field, the pump may need to run 24-hours a day to maintain a dry work area.

Sediment laden dewatering discharge shall be pumped to a filtration system (sediment bag) well away from any watercourse, downgradient from the turbine excavation. Contractor will ensure that any water discharged to the natural environment will not result in scouring, erosion or physical alteration of stream channels or banks and that there is no flooding of the receiving area or water body.

3.4.2 Water Conservation

Long-term water conservation measures are not anticipated for the proposed short-term water taking. The pumped water will remain within the same watershed as it travels from discharge point to ultimate receiving body.

4. Proposed Surface Water Taking

At many turbine locations currently under construction for the Project, large quantities of surface water runoff caused by sever precipitation events enters into the excavation. As discussed in **Section 2.1** and **2.2**, many turbine excavations are located at lower elevations than the surrounding area. These turbines are primarily surrounded by agricultural fields underlain by silty clay soils. The soils surrounding the turbine excavations do not offer the proper characteristics to promote rapid surface water infiltration. This results in large overland flows toward the excavation. When minimal groundwater seepage is observed in the excavation prior to the precipitation event the removal of the water is therefore considered a surface water taking, equivalent to that from a dug out pond.

The necessity to handle large volumes of surface water that enter the turbine excavation after precipitation events is required to maintain a dry working environment to pour concrete foundations. The following sections describe the proposed surface water taking calculations. A monitoring program and required mitigation measures for water discharge from the proposed surface water takings is described in **Section 6**.

4.1 Estimated Surface Water Taking Volumes

Based on the Intensity-Duration-Frequency (IDF) data presented by Environment Canada for the London CS climate station, the 25 year return period rainfall event, lasting 24 hours in duration may result in an accumulation of 89.3 mm of precipitation (MOE, 2014). Assuming a 1 km area surrounding a turbine excavation drains directly to the turbine excavation, this precipitation event could result in the accumulation of approximately 1,000,000 L of surface water runoff in the excavation. This is approximately equivalent to 2.0 m of water accumulation in a 23 m by 23 m excavation, which has been observed at turbine locations currently being constructed for the Project. Assuming that the quantity of surface water runoff accumulating in the excavation over a 24 hour period is constant this could result in a total dewatering rate of 1,000,000 L/day. It is expected that this quantity of water will be removed from the turbine excavation over a 12 hour period at a rate of 83,333 L/hour. This discharge rate (83,333 L/hour) is managed with the mitigations measures detailed in **Section 6**.

The water taking described above only pertains to turbine locations where groundwater seepage and water takings prior to the precipitation event are less than 50,000 L/day.

5. Assessment of Impacts

The objectives of this assessment of impacts are as follows:

- Confirm the private water wells, water body features and natural heritage features within the calculated dewatering zones of influence that are potentially affected by construction dewatering activities;
- Identify mitigation measures to address potential effects of construction dewatering and discharge on these features;
- Develop a monitoring plan to monitor for potential effects of construction dewatering and discharge on identified private water wells, water body features and natural heritage features prior to, during and post-construction, if required.

These objectives are addressed in the sections that follow.

5.1 Existing Groundwater Users

5.1.1 Methods

A desktop analysis was completed using the Ministry of the Environment (MOE) water well database and ArcGIS Software to identify wells located within 500 m of the all Turbines with an anticipated groundwater inflow rate greater than 50,000 L/day.

5.1.2 Results

There are no known MOE water wells (residential, commercial or municipal) located within the calculated radii of influence (**Figure 3**). A total of six (6) MOE water wells are located within 500 m of a turbine with anticipated groundwater inflow rates exceeding 50,000 L/day (**Figure 3**). Two (2) of these MOE water wells (MOE ID# 3400108 and 3406397) are completed to a depth of less than 10 mBGS, but are located more than 450 m from the turbine. The remaining four (4) MOE water wells are completed to depths greater than 10 mBGS. As a result, adverse impacts to existing groundwater users are not anticipated during construction dewatering. MOE water well records can be found in **Appendix B**.

5.2 Aquatic Resources

5.2.1 Methods

Water body features identified within 120 m of the Project Location are described in the Water Assessment and Water Body Report – Jericho Wind Energy Centre (AECOM, 2013c) and Revisions to the Water Assessment and Water Body Report – Jericho Wind Energy Centre (AECOM, 2013d). Water body features were identified within the turbine dewatering zones of influence through a desktop analysis using ArcGIS software. Water body features identified within the zones of influence were considered to be potentially affected by construction dewatering activities if they met both of the following criteria:

- Pond or watercourse feature is an REA water body; and
- Water body feature classified as having moderate to high sensitivity, and/or groundwater indicator species observed at the time of site investigation, and/or water body feature is classified as having a cool- or coldwater thermal regime.

Water body features for which this assessment could not be completed due to a lack of pre-existing available information (i.e., features located more than 120 m from the Project Location) are herein, as a conservative measure, considered to be potentially affected by proposed construction dewatering activities, with a commitment to complete a site reconnaissance visit to confirm the presence and sensitivity of the feature prior to implementing mitigation measures and monitoring as described below.

5.2.2 Results

A total of seven (7) water body features were identified within the turbine dewatering radii of influence (ROI) (**Figure 3 and Table 5**) and assessed following the methods described above. Of these, a total of 4 water features are considered potentially affected by construction dewatering at Turbines 33 (R2.10-B), 79 (R2.73), 83 (R2.101) and 85 (R2.102) (**Table 5**).

Table 5. Assessment of Impacts to Water Body Features

Turbine ID	Feature(s) Within ROI	Feature Sensitivity	Feature Description	Feature(s) Potentially Affected By Dewatering
4	None	Not applicable	Not applicable	No – no water body features present within ROI.
8	P3.44	Low	This pond is man made with an outflow culvert into R3.40. The water was clear at time of investigation. The substrate is silt and sand. *In-situ* cover is moderate and consists of aquatic vegetation and woody debris.	No – water feature not of significant sensitivity.
9	None	Not applicable	Not applicable	No – no water body features present within ROI.
10	None	Not applicable	Not applicable	No – no water body features present within ROI.
32	None	Not applicable	Not applicable	No – no water body features present within ROI.
33	R2.10-B	Moderate	The watercourse is classified as a channelized feature. The watercourse has a straight uniform channel. The water was turbid and had low flow with stagnant areas at time of investigation. It is classified as unknown by ABCA. Banks are stable and well vegetated. Substrate consists of silt. Canopy cover is low consisting of shrubs. Instream habitat cover is high and consists only of aquatic vegetation. Patches of groundwater indicator watercress were observed. Cyprinids were observed near the culvert at the laneway crossing. Fish are present approximately 1.5 km downstream in the Ausable River.	Yes – moderate sensitivity watercourse R2.10-B.
34	None	Not applicable	Not applicable	No – no water body features present within ROI.
51	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
54	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
78	R3.62	Non-REA	There was no channel. The feature has been ploughed through. It is classified as tiled by ABCA.	No – no sensitive features present within ROI.
79	R2.73	High	The watercourse is a defined natural feature. The watercourse follows a riffle/run sequence. The water was clear and had moderate flow at time of investigation. The system is classified as unknown by ABCA. Banks are stable and well vegetated. Substrate is dominated by cobble followed by sand, gravel and detritus. Canopy cover is high and is dominated by trees. Instream habitat cover is high and dominated by aquatic vegetation followed by woody debris and detritus. The watercourse begins with bank seepage, a groundwater indicator. Fish are present approximately 1 km downstream in the Ausable River.	Yes – high sensitivity watercourse R2.73.
83	R2.101	High	The watercourse is classified as tiled in the agricultural field and unknown in the forested area by ABCA. There is no surface water feature in the field. The watercourse in the forested area is a defined natural feature and is described as permanent. The watercourse follows a riffle/run/pool sequence. The water was clear and flowing slowly at the time of investigation Banks are moderately unstable. Substrate is dominated by cobble and sand followed by boulder and gravel. Canopy cover is high and dominated by trees. Instream habitat cover is high and is dominated by cobble and detritus followed by woody debris. Groundwater indicators watercress and bank seepage were observed. Fish are present approximately 1 km downstream in the Ausable River.	Yes – high sensitivity watercourse R2.101.
84	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
85	R2.102 (immediately outside ROI)	High	The watercourse is classified as tiled in the agricultural field and unknown in the forested area by ABCA. There is no surface water feature in the field. The watercourse in the forested area is a defined natural feature and is described as permanent. The watercourse follows a riffle/run/pool sequence. The water was clear and flowing slowly at the time of investigation Banks are moderately unstable. Substrate is dominated by cobble and sand followed by boulder and gravel. Canopy cover is high and dominated by trees. Instream habitat cover is high and is dominated by cobble and detritus followed by woody debris. Groundwater indicators watercress and bank seepage were observed. Fish are present approximately 1 km downstream in the Ausable River.	Yes – high sensitivity watercourse R2.102 (immediately outside ROI).

Turbine ID	Feature(s) Within ROI	Feature Sensitivity	Feature Description	Feature(s) Potentially Affected By Dewatering
89	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
94	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
96	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
97	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
102	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
103	R12.82	Non-REA	There was no surface feature present, it has been ploughed through. It is classified as tiled by SCRCA.	No – no sensitive features present within ROI.
106 (PT1)	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
107 (PT2)	None	Not applicable	Not applicable	No – no sensitive features present within ROI.
112 (PT11)	None	Not applicable	Not applicable	No – no sensitive features present within ROI.

5.3 Terrestrial Resources

5.3.1 Methods

Natural heritage features within 120 m of the Project Location are described in the Natural Heritage Assessment and Environmental Impact Study Report (AECOM, 2013e), Natural Heritage Assessment and Environmental Impact Study Addendum (AECOM, 2012), Natural Heritage Assessment and Environmental Impact Study Report Second Addendum (AECOM, 2013f) and Natural Heritage Assessment and Environmental Impact Study Report Third Addendum (AECOM, 2013g). A desktop analysis was completed using ArcGIS software to identify natural heritage features considered sensitive to changes in surface water or groundwater levels within the turbine dewatering zones of influence. The following types of natural heritage features were included in this assessment:

- Wetlands (all wetland features were treated as Significant);
- Candidate Significant Wildlife Habitat and Generalized Candidate Significant Wildlife Habitat (GCSWH) Features including:
  - Amphibian Woodland Breeding Habitats;
  - Amphibian Wetland Breeding Habitats;
  - Amphibian Movement Corridors;
  - Seeps and Springs;
  - Turtle Wintering Habitats;
  - Turtle Nesting Habitats;
  - Insect Species of Conservation Concern Habitats;
  - Marsh Bird Breeding Habitats; and
  - Rare Vegetation Communities.

Available background information, including the results of the records review, site investigation surveys and Wetland Characteristics and Ecological Functions Assessments completed for Significant Wetland features (as described in AECOM, 2012, 2013e, 2013f and 2013g) were consulted for Significant Wetland features identified within the turbine dewatering zones of influence. All wetland features were treated as Provincially Significant without going through a full Ontario Wetland Evaluation System (OWES) evaluation.

The results of pre-construction evaluation of significance surveys were consulted for candidate Significant Wildlife Habitat features identified within the turbine dewatering zones of influence (as described in AECOM, 2012, 2013e, 2013f, 2013g and 2014b). Candidate Significant Wildlife Habitat features either confirmed to be significant through pre-construction evaluation of significance (EOS) surveys or treated as significant due to property access limitations were considered as potentially affected by construction dewatering. Where the specific location of sensitive habitat components (i.e., vernal pools or seeps) is available, this information was used to evaluate whether the feature is likely to be affected by construction dewatering.

Natural heritage features (Wetlands and Significant Wildlife Habitat) for which this assessment could not be completed due to a lack of pre-existing available information (i.e., features located more than 120 m from the Project Location or GCSWH features for which an evaluation was not completed to confirm significance) are herein, as a conservative measure, considered to be both Significant and potentially affected by proposed construction dewatering activities, with a commitment to complete a site reconnaissance visit, if possible based on access to private property, to confirm the presence and sensitivity of the feature prior to implementing mitigation measures and monitoring as described below.

5.3.2 Results

Natural heritage features identified within the turbine dewatering zones of influence (ROI) are mapped on **Figure 3** and listed in **Table 6** below. These features were and assessed following the methods described above. A total of seven (7) features are considered potentially affected by construction dewatering at turbines 8 (TWH-06), 10 (WET-072), 54 (AWO-05 and WET-027), 78 (AWO-03), 83 (WET-074 and GCSWH Seep) and 112 (WET-059) (**Table 6**). Insufficient information is available to assess one (1) feature located within the dewatering zone of influence for turbine 83 (GCSWH Seep); a site reconnaissance visit is required to confirm the presence and sensitivity of this feature prior to construction dewatering in excess of the currently permitted limit (50,000 L/day), if possible based on access to private property.

Table 6. Assessment of Impacts to Natural Heritage Features

Turbine ID	Feature(s) Within Radius of Influence (ROI)	Status of Pre-construction Surveys	Significance	Feature Description / Notes	Feature(s) Potentially Affected By Dewatering
4	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
8	Amphibian Woodland Breeding Habitat AWO-17 Turtle Wintering Habitat TWH-06	Evaluation of significance (EOS) surveys completed EOS surveys completed	Not Significant Significant	Two dug ponds; Green Frog (2), American Toad tadpoles (>300) and Northern Leopard Frog (2) recorded during amphibian surveys however feature did not qualify as Significant Wildlife Habitat based on species composition and abundance (AECOM, 2014b). Snapping Turtle (Special Concern species) confirmed present in dug pond during EOS surveys; six months of pre-construction surface water and shallow groundwater level monitoring completed (**Appendix C**).	Yes – pond habitat of TWH-06 present within ROI.
9	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
10	Significant Wetland WET-072	Site investigation completed within ROI	Significant	Deciduous swamp (SWD4-2 and SWD3-2) vegetation communities in Natural Area 263; WET-072 within the ROI is Thedford Swamp Provincially Significant Wetland (PSW); water table encountered at 30 cm below ground surface during site investigation; organic soils over very fine sand observed in soil pit; standing water present; annual spring flooding noted; Spring Peeper and American Toad heard during site investigation; evidence of seeps and springs noted (Skunk Cabbage).	Yes – WET-072 present within dewatering ROI.
32	Seep SS-01	EOS surveys completed	Not Significant	One very shallow seep with a depth of less than 5 cm observed flowing from the middle of a treed slope to a narrow channel and into an agricultural drain that runs through agricultural fields.	No – no significant features present within ROI.
33	No features sensitive to dewatering	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
34	No features sensitive to dewatering	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
51	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
54	Amphibian Woodland Breeding Habitat AWO-05 Significant Wetland WET-027	EOS surveys completed Site investigation completed within ROI	Significant Significant	Vernal pool identified within ROI; Western Chorus Frog (>30), American Toad (13), Spring Peeper (>30), Gray Treefrog (2) and Spotted Salamander egg masses (3) recorded during amphibian surveys. Deciduous swamp (SWD2-2) vegetation communities in Natural Area 113; vernal pools observed during site investigation within dewatering ROI; Western Chorus Frog (>30), American Toad (13), Spring Peeper (>30), Gray Treefrog (2) and Spotted Salamander egg masses (3) recorded during amphibian surveys.	Yes – vernal pool habitat of AWO-05 and WET-027 present within ROI.
78	Amphibian Woodland Breeding Habitat AWO-03	EOS surveys completed	Significant	Vernal pool associated with deciduous swamp (SWD3-3) vegetation community inclusion within dewatering ROI; Wood Frog, Spring Peeper, Western Chorus Frog, American Toad, Blue-spotted Salamander and Spotted Salamander recorded during amphibian surveys.	Yes – AWO-03 present although sensitive components (vernal pools) not observed within ROI.

Turbine ID	Feature(s) Within Radius of Influence (ROI)	Status of Pre-construction Surveys	Significance	Feature Description / Notes	Feature(s) Potentially Affected By Dewatering
79	No features sensitive to dewatering	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
83	Habitat for Insect Species of Conservation Concern SCI-90 Significant Wetland WET-074 GCSWH Seep	EOS surveys completed Site investigation completed within ROI EOS survey not completed	Not Significant Significant Unknown	Dry creek bed with intermittent flow and steep banks surrounded by deciduous forest. Deciduous swamp (SWD3-3), meadow marsh (MAM2-2) and deciduous forest (FOD7-2) vegetation communities in Natural Area 90; mottles observed at 0 cm and 10 cm in MAM2-2 and SWD3-3 soil pits, respectively, and water table encountered at 34 cm in FOD7-2 soil pit during site investigation; evidence of seep observed flowing outside ROI; no rare plants observed. Deciduous forest (FOD5-1) vegetation community in Natural Area 90; seep observed flowing from valley slope to stream outside ROI.	Yes – WET-074 present within ROI, with high water table observed during field investigations. GCSWH Seep within ROI, although presence and sensitivity unconfirmed.
84	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
85	No features sensitive to dewatering	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
89	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
94	Habitat for Insect Species of Conservation Concern SCI-85	EOS surveys completed	Not Significant	Flowing natural creek with 5 m wide riparian corridor dominated by woody and herbaceous species. Riparian corridor is bordered by active agricultural fields.	No – no significant features present within/immediately outside ROI.
96	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
97	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
102	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
103	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
106 (PT1)	None	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
107 (PT2)	No features sensitive to dewatering	Site investigation completed within ROI	Not applicable	Not applicable	No – no significant features present within ROI.
112 (PT11)	Significant Wetland WET-059	Site investigation completed within ROI	Significant	Deciduous swamp (SWD3-3) vegetation community in Natural Area 145; standing water/vernal pool noted outside ROI, no amphibians noted during site investigation; not considered suitable for amphibian breeding habitat; no evidence of seeps or springs observed; no rare plants observed.	Yes – WET-059 present although sensitive components not observed within ROI.

6. Monitoring and Mitigation

Daily records of the timing and volumes of groundwater takings during construction will be maintained by the constructor to ensure compliance with the maximum allowable dewatering rates. Monitoring and mitigation will also include any terms and conditions of the REA approval issued for the Project (MOE, 2014).

Additional monitoring and mitigation measures to address potential effects to private water wells, water body features and natural heritage features are described below.

6.1 Existing Groundwater Users

For those private water wells identified to be located within the 500 m buffer, and with a water well depth of less than 10 m, the well owner will be notified and provided the opportunity to participate in a well monitoring program during construction dewatering activities. Notification letters containing information about the water well monitoring program and a water well survey form with a pre-stamped envelope will be mailed to the property owners. If contact information is available for the property owner a follow up phone call, in a last attempt to conduct a water well survey, will be performed.

If the water well owner requests to be included in the well monitoring program, manual water level measurements from the well will be obtained prior to construction dewatering activities. Daily manual water level measurements will be obtained from the well during dewatering activities.
In the unlikely event that construction dewatering activities are observed to cause a negative impact to the well owners water supply, every effort will be made to rectify the problem or provide a temporary supply of potable water to meet the owners normal requirements until permanent restoration of the affected water supply, as required by the conditions of the Renewable Energy Approval for this project.

6.2 Aquatic Resources

Mitigation measures and monitoring commitments to address potential effects of construction dewatering and discharge were previously described in the Water Assessment and Water Body Report – Jericho Wind Energy Centre (AECOM, 2013c) and Revisions to the Water Assessment and Water Body Report – Jericho Wind Energy Centre (AECOM, 2013d). These are summarized in **Table 7** below.

Due to the volumes of water anticipated, water will be discharged overland at a controlled rate such that erosion and sediment control mitigation measures are effective.

Table 7. Mitigation Measures and Monitoring Plan for Water Body Features Potentially Affected By Proposed Construction Dewatering

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
Increase to surface water temperature from reduced groundwater contribution if dewatering activities are required for excavation of turbine foundations.	• 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. • Restrict taking groundwater and surface water during drought conditions. • Regulate the discharge of water-taking (if required) to ensure that there is no flooding in the downstream area and no soil erosion, or stream channel scouring at the point of discharge. Use a discharge diffuser or other energy dissipation device will be used, if necessary, to mitigate flows which physically alter the stream channel or banks. • Install siltation control measures that are sufficient for the volumes pumped at both the taking location upstream of the construction site and (if necessary) the discharge site. All measures will be taken to properly maintain these control devices throughout the construction period. **Timing Windows** • Schedule construction activities that occur within 30 m of watercourses to avoid periods of critical habitat use (i.e., spawning) to the extent possible. There are generic restricted in-water work timing windows established by DFO. • Specific timing windows for this project may be developed in consultation with MNR. **Dewatering Activities** • Confirm the zone of influence of required dewatering activities prior to construction. • For turbines within the sand and/or gravel deposits, schedule dewatering activities to take place during a seasonally dry time of year where possible. • Limit duration of dewatering to as short a time frame as possible period Implement groundwater cut-offs as required to limit water taking quantities. • Turbines with intersecting radii of influence should not be dewatered simultaneously.	• 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 surface water levels, of which it can be attributed to the dewatering activities, stop dewatering until appropriate site specific mitigation plan has been developed.
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. • Utilize 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. Keep extra erosion and sediment control materials on site (*e.g.*, heavy duty silt fencing, strawbales). • Check that erosion control tools are in good repair and properly functioning prior to conducting daily work and re-install or repair as required prior to commencing daily construction activities. • Keep sediment and erosion control measures in place until disturbed areas have been stabilized (i.e., re-vegetated). **Water Management – See above** **Timing Windows** • Schedule construction activities that occur within 30 m of watercourses to avoid periods of critical habitat use (i.e., spawning) to the extent possible. There are generic restricted in-water work timing windows established by DFO.	• **I**ncreased 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 short term 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 before and during construction. • Collect surface water samples from discharge locations before, during and after construction. Analyze for general chemistry (e.g., temperature, pH, dissolved oxygen, and conductivity), suspended solids, total phosphorus and total metals (e.g., copper, iron, zinc and aluminum). These data will be used to determine background watercourse water quality at discharge locations. The findings of the monitoring program will be reported back to MOE following the

Table 7. Mitigation Measures and Monitoring Plan for Water Body Features Potentially Affected By Proposed Construction Dewatering

Potential Effect	Performance Objectives	Mitigation Strategy	Residual Effects	Monitoring Plan and Contingency Measures
		• Specific timing windows for this project may be developed in consultation with MNR.		completion of dewatering activities. **Contingency Measures:** • Install a temporary storage basin adjacent to foundation area to allow water to infiltrate.
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 mm 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.
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.

6.3 Terrestrial Resources

Mitigation measures and monitoring commitments to address potential effects of construction dewatering and discharge were previously described in the Natural Heritage Assessment and Environmental Impact Study Report (AECOM, 2013e), Natural Heritage Assessment and Environmental Impact Study Addendum (AECOM, 2012), Natural Heritage Assessment and Environmental Impact Study Report Second Addendum (AECOM, 2013f) and the Natural Heritage Assessment and Environmental Impact Study Report Third Addendum (AECOM, 2013g). These are summarized in **Table 8** below. The monitoring plan and contingency measures made reference to the following monitoring plan originally described in Section 5.3.6 of the Natural Heritage Assessment and Environmental Impact Study Report (AECOM, 2013e):

> *For significant natural features within the zone of influence (estimated at 250 m at this time) and potentially affected by dewatering activities, the following Monitoring Plan will be implemented:*
>
> - *Prior to construction, undertake monthly monitoring for a minimum of six months of surface water levels (staff gauge), stream flow (if applicable), vertical hydraulic gradients (mini-piezometers), surface water temperature and vegetation health of the feature within the identified dewatering zone of influence.*
> - *During construction dewatering activities, undertake daily monitoring of surface water levels (staff gauge), stream flow (if applicable), vertical hydraulic gradients (mini-piezometers), surface water temperature and vegetation health of the feature within the identified dewatering zone of influence.*
> - *In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. Implement contingency measures (to be determined in consultation with MNR), if required, including but not limited to rescue of stranded wildlife.*
> - *Following construction, undertake monthly monitoring, for up to one year, of surface water levels (staff gauge), stream flow (if applicable), vertical hydraulic gradients (mini-piezometers), surface water temperature, and vegetation health of the feature within the identified dewatering zone of influence. Monitoring may be terminated prior to one year post-construction if initial monitoring determines that there is no evidence of residual effects and levels have returned to norms established through pre-construction monitoring.*
>
> *In the event that construction dewatering is not required, or if a significant natural feature is confirmed to not be within the zone of influence based on Project-specific geotechnical investigation, no dewatering-related monitoring will be required for that feature. Pre-construction Evaluation of Significance studies will be completed for candidate Significant Wildlife Habitat features as well as Generalized Candidate Significant Wildlife Habitat features located within the confirmed dewatering zone of influence; the mitigation or monitoring related to these features will only be implemented if the features in question are determined to be significant based on the results of pre-construction surveys.*

In fulfillment of the commitment made in the Natural Heritage Assessment and Environmental Impact Study Report (AECOM, 2013d), the dewatering zones of influence were subsequently recalculated based on Project-specific geotechnical conditions and the majority of the natural heritage features listed in **Table 6** above (with the exception of TWH-06) were determined to be outside the recalculated zones of influence (as described in AECOM, 2013h). On this basis, adverse impacts to these features resulting from construction dewatering were not anticipated and it was determined that the monitoring and mitigation measures described in the Natural Heritage Assessment and Environmental Impact Study Report (AECOM, 2013d) were not required (AECOM, 2013h). As a result, six months of pre-construction monitoring data have not been collected for these features, with the exception of TWH-06 (**Appendix C**).

Table 8. Mitigation Measures and Monitoring Plan for Natural Heritage Features Potentially Affected By Construction Dewatering

Potential Effects	Performance Objectives	Mitigation Measures	Likelihood and Significance of Residual Effects	Monitoring Plan and Contingency Measures
Significant Wetlands				
Changes in water levels resulting from short-term construction dewatering.	• Minimize effects on wetland due to dewatering activities.	• Determine the zone of influence of required dewatering activities prior to construction. • Avoid dewatering activities during April 1 to July 31. If this is not possible, MNR will be consulted regarding mitigation measures that may be required. • Limit duration of dewatering to as short a time frame as possible. • Implement groundwater cut-offs as required to limit water taking quantities. • Turbines with intersecting radii of influence should not be dewatered simultaneously. • Set back groundwater discharge locations at least 30 m from significant wetlands. All groundwater discharge will undergo appropriate water quality and temperature controls, as required, and will be directed through a sediment filter (i.e., filter bag), sediment basin or other appropriate device capable of handling the anticipated volumes of water, before being discharged to the environment. The specific locations for directing treated groundwater discharge will be selected in the field at the time of construction, but will generally be limited to grassed areas, existing drainage ditching or agricultural fields.	• Dewatering effects minimized through the application of mitigation measures. • Negligible residual effects.	• Develop and implement a Monitoring Plan to address potential dewatering related effects on significant wetlands within the confirmed zone of influence of dewatering (as described in Section 5.3.6). • **Contingency Measures:** ▪ In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. Implement contingency measures (to be determined in consultation with MNR), if required, including but not limited to rescue of stranded wildlife.
Generalized Candidate Significant Wildlife Habitat (All Types)				
Changes in water levels resulting from short-term construction dewatering.	• Minimize effects on significant wildlife habitat due to dewatering activities.	• Confirm the zone of influence of required dewatering activities prior to construction. • For turbines within the sand and/or gravel deposits, schedule dewatering activities to avoid the sensitive timing window for the Significant Wildlife Habitat(s) present (if determined to be significant) and Generalized Candidate Significant Wildlife Habitat. If this is not possible, MNR will be consulted regarding mitigation measures that may be required. ▪ Amphibian woodland breeding habitat: no dewatering from April 1 to July 31; ▪ Turtle wintering habitat: no dewatering from October 1 to April 30; ▪ Seeps and springs: avoid dewatering from December 1 to March 31, where possible; ▪ Amphibian wetland breeding habitat: no dewatering from April 1 to July 31; ▪ Habitat for insect Species of Conservation Concern: no dewatering from April 1 to July 31; ▪ Marsh bird breeding habitat: no dewatering from April 1 to July 31; and ▪ Rare vegetation community (SWD1-2): no dewatering from April 1 to June 30. • Limit duration of dewatering to as short a time frame as possible. • Implement groundwater cut-offs as required to limit water taking quantities. • Turbines with intersecting radii of influence should not be dewatered simultaneously. • Set back groundwater discharge locations at least 30 m from Generalized Candidate Significant Wildlife Habitat. All groundwater discharge will undergo appropriate water quality and temperature controls, as required, and will be directed through a sediment filter (i.e., filter bag), sediment basin or other	• Dewatering effects minimized through the application of mitigation measures. • Negligible residual effects.	• Develop and implement a Monitoring Plan to address potential dewatering related effects on Generalized Candidate Significant Wildlife Habitat within the confirmed zone of influence of dewatering (as described in Section 5.3.6). • **Contingency Measures:** ▪ In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. Implement contingency measures (to be determined in consultation with MNR), if required, including but not limited to rescue of stranded wildlife.

Potential Effects	Performance Objectives	Mitigation Measures	Likelihood and Significance of Residual Effects	Monitoring Plan and Contingency Measures
		appropriate device capable of handling the anticipated volumes of water, before being discharged to the environment. The specific locations for directing treated groundwater discharge will be selected in the field at the time of construction, but will generally be limited to grassed areas, existing drainage ditching or agricultural fields.		
Turtle Wintering Areas				
Changes in water levels resulting from short-term construction dewatering.	• Minimize effects on significant wildlife habitat due to dewatering activities.	• Confirm the zone of influence of required dewatering activities prior to construction. • Avoid dewatering activities during October 1 to April 30. If this is not possible, MNR will be consulted regarding mitigation measures that may be required. • Limit duration of dewatering to as short a time frame as possible. • Implement groundwater cut-offs as required to limit water taking quantities. • Turbines with intersecting radii of influence should not be dewatered simultaneously. • Set back groundwater discharge locations at least 30 m from significant turtle wintering areas. All groundwater discharge will undergo appropriate water quality and temperature controls, as required, and will be directed through a sediment filter (i.e., filter bag), sediment basin or other appropriate device capable of handling the anticipated volumes of water, before being discharged to the environment. The specific locations for directing treated groundwater discharge will be selected in the field at the time of construction, but will generally be limited to grassed areas, existing drainage ditching or agricultural fields.	• Dewatering effects minimized through the application of mitigation measures. • Negligible residual effects.	• Develop and implement a Monitoring Plan to address potential dewatering related effects on turtle wintering areas (if determined to be significant) within the confirmed zone of influence of dewatering (as described in Section 5.3.6). • **Contingency Measures:** ▪ In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. Implement contingency measures (to be determined in consultation with MNR), if required, including but not limited to rescue of stranded wildlife.
Seeps and Springs				
Changes in water levels resulting from short-term construction dewatering.	• Minimize effects on significant wildlife habitat due to dewatering activities.	• Confirm the zone of influence of required dewatering activities prior to construction. • Avoid dewatering activities during December 1 to March 31, where possible. • Limit duration of dewatering to as short a time frame as possible. • Implement groundwater cut-offs as required to limit water taking quantities. • Turbines with intersecting radii of influence should not be dewatered simultaneously. • Set back groundwater discharge locations at least 30 m from significant seeps and springs. All groundwater discharge will undergo appropriate water quality and temperature controls, as required, and will be directed through a sediment filter (i.e., filter bag), sediment basin or other appropriate device capable of handling the anticipated volumes of water, before being discharged to the environment. The specific locations for directing treated groundwater discharge will be selected in the field at the time of construction, but will generally be limited to grassed areas, existing drainage ditching or agricultural fields.	• Dewatering effects minimized through the application of mitigation measures. • Negligible residual effects.	• Develop and implement a Monitoring Plan to address potential dewatering related effects on SS-01 (if determined to be significant) within the confirmed zone of influence of dewatering (as described in Section 5.3.6). • **Contingency Measures:** ▪ In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. Implement contingency measures (to be determined in consultation with MNR), if required, including but not limited to rescue of stranded wildlife.

Potential Effects	Performance Objectives	Mitigation Measures	Likelihood and Significance of Residual Effects	Monitoring Plan and Contingency Measures
Amphibian Woodland Breeding Habitat				
Changes in water levels resulting from short-term construction dewatering.	• Minimize effects on significant wildlife habitat due to dewatering activities.	• Confirm the zone of influence of required dewatering activities prior to construction. • Avoid dewatering activities during April 1 to July 31. If this is not possible, MNR will be consulted regarding mitigation measures that may be required. • Limit duration of dewatering to as short a time frame as possible. • Implement groundwater cut-offs as required to limit water taking quantities. • Turbines with intersecting radii of influence should not be dewatered simultaneously. • Set back groundwater discharge locations at least 30 m from significant amphibian woodland breeding habitat. All groundwater discharge will undergo appropriate water quality and temperature controls, as required, and will be directed through a sediment filter (i.e., filter bag), sediment basin or other appropriate device capable of handling the anticipated volumes of water, before being discharged to the environment. The specific locations for directing treated groundwater discharge will be selected in the field at the time of construction, but will generally be limited to grassed areas, existing drainage ditching or agricultural fields.	• Dewatering effects minimized through the application of mitigation measures. • Negligible residual effects.	• Develop and implement a Monitoring Plan to address potential dewatering related effects on amphibian breeding habitat (if determined to be significant) within the confirmed zone of influence of dewatering (as described in Section 5.3.6). • **Contingency Measures:** ▪ In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. Implement contingency measures (to be determined in consultation with MNR), if required, including but not limited to rescue of stranded wildlife.

The project is currently under construction and is scheduled to go into commercial operation in September 2014; six months of pre-construction monitoring cannot be accommodated at this time. Furthermore, based on the current construction schedule, adverse effects to Significant Wetlands and Significant Wildlife Habitat Features (i.e., Amphibian Woodland Breeding Habitats, Turtle Wintering Areas, Seeps and Springs) are not anticipated because dewatering in excess of the currently permitted amount (50,000 L/day or 400,000 L/day) will occur outside the sensitive timing windows for these features (as identified in **Table 8** above). As a result, the following alternative monitoring plan will be implemented for natural heritage features potentially affected by construction dewatering, where possible based on access to private property (**Table 9**). As part of this monitoring plan, site reconnaissance visits will be conducted, where possible based on access to private property, prior to construction dewatering in excess of the currently permitted amount (50,000 L/day or 400,000 L/day) in order to confirm the presence and sensitivity of Significant Wetlands and Significant Wildlife Habitat features to construction dewatering.

Where it is not possible to complete site reconnaissance visits and monitoring prior to, during and post-construction due to lack of access to private property, as a conservative measure, the natural heritage feature present within the dewatering zone of influence will be assumed Significant and sensitive to construction dewatering, and the mitigation measures described in **Table 8** above will be implemented.

Table 9. Alternative Monitoring Plan for Natural Heritage Features Potentially Affected by Construction Dewatering

Features	Pre-construction Monitoring	Monitoring During Construction Dewatering	Post-construction Monitoring	Contingency Measures
Significant Wetlands (Turbines 10, 54, 83 and 112)	• Adverse effects are likely to be minimal because dewatering will occur outside April 1 to July 31 therefore six month of pre-construction monitoring not warranted. • Conduct site reconnaissance visit and record surface water level (if present) prior to construction dewatering.	• If surface water is present prior to dewatering, monitor surface water levels daily during construction dewatering.	• Following construction, undertake monthly monitoring for up to one year of surface water levels of the feature within the identified dewatering zone of influence if significant decline recorded during construction dewatering. Monitoring may be terminated prior to one year post-construction if initial monitoring determines that there is no evidence of residual effects and levels have returned to pre-construction condition.	• In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. • Implement contingency measures, if required, including but not limited to rescue of stranded wildlife and/or directing dewatering discharge towards the feature after applying appropriate water quality and temperature controls.
Amphibian Woodland Breeding Habitat (Turbines 54 and 78)	• Adverse effects not anticipated because dewatering will occur outside April 1 to July 31 therefore six month of pre-construction monitoring not warranted. • Conduct site reconnaissance visit and record surface water level (if present) prior to construction dewatering.	• If surface water is present prior to dewatering, monitor surface water levels daily during construction dewatering.	• Following construction, undertake monthly monitoring for up to one year of surface water levels of the feature within the identified dewatering zone of influence if significant decline recorded during construction dewatering. Monitoring may be terminated prior to one year post-construction if initial monitoring determines that there is no evidence of residual effects and levels have returned to pre-construction condition.	• In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. • Implement contingency measures, if required, including but not limited to rescue of stranded wildlife and/or directing dewatering discharge towards the feature after applying appropriate water quality and temperature controls.
Turtle Wintering Habitat (Turbine 8)	• No change to monitoring plan. Pre-construction monitoring completed (**Appendix C**).			

Features	Pre-construction Monitoring	Monitoring During Construction Dewatering	Post-construction Monitoring	Contingency Measures
Generalized Candidate Significant Wildlife Habitat (Seeps) (Turbine 83)	• Adverse effects not anticipated because dewatering will occur outside December 1 to March 31 therefore six month of pre-construction monitoring not warranted. • Conduct site reconnaissance visit and record surface water level (if present) prior to construction dewatering.	• If surface water is present prior to dewatering, monitor surface water levels daily during construction dewatering.	• Following construction, undertake monthly monitoring for up to one year of surface water levels of the feature within the identified dewatering zone of influence if significant decline recorded during construction dewatering. Monitoring may be terminated prior to one year post-construction if initial monitoring determines that there is no evidence of residual effects and levels have returned to pre-construction condition.	• In the event of a decrease in surface water levels which can be attributed to the dewatering activities, stop dewatering until appropriate site-specific mitigation has been implemented. • Implement contingency measures, if required, including but not limited to rescue of stranded wildlife and/or directing dewatering discharge towards the feature after applying appropriate water quality and temperature controls.

Due to the volumes of water anticipated, water will be discharged overland at a controlled rate such that erosion and sediment control mitigation measures are effective.

The results of the monitoring program will be provided to MOE following construction of the project.

7. Closure

This dewatering assessment was completed for the purpose of obtaining approval to increase groundwater dewatering rate allowances as indicated in **Table 4** and apply for a temporary surface water taking allowance of 1,000,000 litres per day at all remaining turbine locations for the Project. Field CPT logs and geotechnical investigations were previously completed by AMEC, and relied upon by AECOM for our assessment. AECOM has assumed that the information provided was factual and accurate. Judgement has been used by AECOM in the interpretation of the field information provided but subsurface physical and chemical characteristics may vary between or beyond borehole locations given the variability in geological conditions.

Generally, with respect to the proposed Project, the significance of anticipated residual effects on private water wells, water body features and/or natural heritage features is predicted to be low provided that the recommended mitigation measures are properly implemented and proactively managed throughout the duration of construction activities.

With respect to the proposed Project, the potential for adverse impacts on Significant Wetlands, Amphibian Woodland Breeding Habitat, Turtle Wintering Habitat, and Generalized Significant Wildlife Habitat (seeps) is predicted to be low, provided the recommended mitigation measures are properly implemented and proactively managed throughout the duration of the construction activities.

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Figures

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