APPENDIX J

BIOLOGICAL ASSESSMENT: EASTERN SAND DARTER

LAKE ERIE CONNECTOR PROJECT

BIOLOGICAL ASSESSMENT
EASTERN SAND DARTER

Prepared for:
ITC Lake Erie Connector LLC
Novi, Michigan

Prepared by:
HDR Engineering, Inc.
Portland, Maine

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LAKE ERIE CONNECTOR PROJECT
BIOLOGICAL ASSESSMENT

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1.0 INTRODUCTION

ITC Lake Erie Connector LLC (the Applicant) is proposing to construct and operate the Lake Erie Connector Project (Lake Erie Connector or the Project), an approximately 72.4-mile (116.5 km), 1,000-megawatt (MW), +/-320-kilovolt (kV), high-voltage direct current (HVDC), bi-directional electric transmission interconnection to transfer electricity between Canada and the United States (U.S.). For purposes of permits being issued in the U.S., the Project consists of an approximately 42.5-mile (68.4 km) HVDC transmission line that would be buried in the lakebed of Lake Erie from the U.S.- Canada border and be installed underground in Pennsylvania from the Lake Erie shore to a new converter station, called the Erie Converter Station, as well as 2,082 ft (635 m) of underground 345-kV, alternating current (AC) cable between the Erie Converter Station and the nearby existing Penelec Erie West Substation. The converter station will include equipment to change the AC of the existing aboveground transmission network to the direct current (DC) transmitted by the proposed Project, and vice versa.

ITC and its consultants have engaged appropriate federal and state agencies during the planning and siting phase of the Project, including the Pennsylvania Fish and Boat Commission (PFBC). The agencies were informed of the initial Project layout on May 5, 2014 and an updated alignment with more detailed Project information was submitted to each agency on January 23, 2015. In a letter dated September 16, 2014, the PFBC noted the following species of concern may be present within the Lake Segment of the Project: eastern sand darter (*Etheostoma pellucida*), cisco (*Coregonus artedi*), and lake sturgeon (*Acipenser fulvescens*), all of which are state listed endangered species. Via an email dated March 24, 2015, the PFBC requested additional information regarding the impact of HVDC electromagnetic fields on salmonid (steelhead) migration. The PFBC also asked if the HVDC technology interferes with hydro acoustic telemetry tags and receivers. The PFBC requested that this information be provided as a part of the application. The Applicant's consultant provided this information to PFBC on June 4, 2015 in an Environmental Report (drafted to serve as an Applicant Prepared Environmental Assessment), which was submitted to the U.S. Department of Energy on May 29, 2015, as part of the Presidential Permit Application. This information will also be included in the application for Pennsylvania Water Obstruction and Encroachment Permit and U.S. Army Corps of Engineers Rivers and Harbors Act § 10 and Clean Water Act § 404 Permit.

During a conference call between ITC and PFBC representatives on August 28, 2015, PFBC staff stated that they were not concerned about Project construction effects on lake sturgeon and cisco, given PFBC's review of additional information received regarding Project construction activities. However, PFBC asked if in-lake project construction on the U.S. side in water depths less than 20 m could be conducted outside of June and July to protect spawning eastern sand darter. ITC explained that it needed to conduct construction during those months because construction will take about six months during each of two years, that such construction work needs to occur during good weather months on the Lake, and that given Lake weather patterns, June and July were critical parts of the period when suitable construction conditions were available. In response, PFBC indicated that if construction activities need to occur in waters less than 20 m deep in June and July, then ITC should develop and submit a Biological Assessment (which is reflected in this document). The assessment would look at steps to avoid effects, minimize damage, and then mitigate effects to potential eastern sand darter habitat and individuals. The assessment would use the best available science to estimate area of impact and numbers of darters that that would be lethally taken. After review of such an assessment, PFBC would then issue a special take permit with respect to the eastern sand darter.

Consequently, HDR, as ITC's consultant, has developed this Biological Assessment to provide details about the portion of the Lake Erie Connector Project (Project) located in the U.S., and an analysis of the Project's potential effects in Lake Erie on the eastern sand darter.

2.0 PROJECT DESCRIPTION

This section provides a description of the facilities associated with the Project and the proposed construction or installation techniques. The Project has three distinct components: the converter stations, the underground cable systems, and the underwater cable systems. For purposes of this Biological Assessment, the relevant focus is the underwater cable system component in the bed of Lake Erie.

2.1 General Project Description

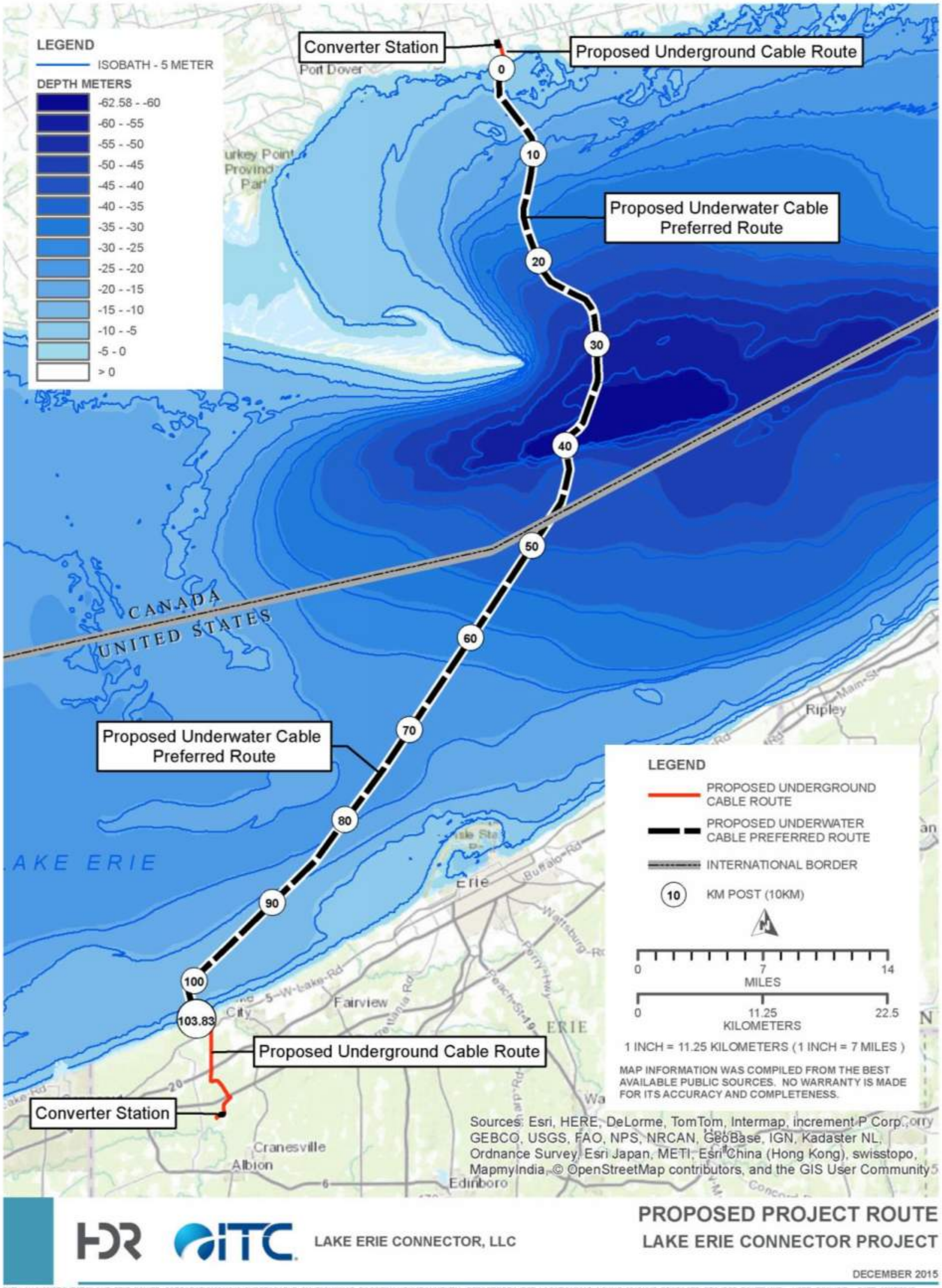
For purposes of permits being issued in the U.S., the Project consists of an approximately 42.5-mile, 1,000-MW, +/-320-kV, HVDC, bi-directional electric transmission interconnection to transfer electricity from the U.S.-Canada border, as well as 2,082 ft of underground, 345-kV, AC cable between the Erie Converter Station and the nearby existing Penelec Erie West Substation (Figure 2.1-1).

An HVDC electric power transmission system uses direct current (DC) for the bulk transmission of electrical power, in contrast with more common alternating current (AC) systems. For underwater cable projects, either high voltage AC (HVAC) or HVDC transmission is possible, each with its advantages and disadvantages, which are heavily dependent on the route length, voltage, and transmission capacity. The main advantage of HVDC transmission over HVAC is the ability to control power flow and lower transmission line losses. In addition, an HVAC cable system needs three cables, whereas an HVDC cable system only needs two. When connecting two different electrical systems, HVDC is typically selected as it is asynchronous and can adapt to almost any rated voltage and frequency.

In the U.S., the Project would consist of one 1,000-MW HVDC transmission line and an HVDC converter station with ancillary aboveground facilities. The HVDC transmission line consists of two transmission cables, one positively charged and the other negatively charged, along with a fiber optic cable for communications between the converter stations. In the U.S., the transmission line elements of the Project consist of:

- HVDC underwater (from the U.S./Canada border to landfall in Erie County) - 35.4 mi (57.0 km)
- HVDC underground (from landfall to the Erie Converter Station) - 7.1 mi (11.4 km)
- HVAC underground (from Erie Converter Station to Erie West Substation) – 2,082 ft (635 m)

Figure 2.1-1 Proposed project route.



The cable would make landfall in Springfield Township in Erie County, Pennsylvania, and the landward segment would be installed primarily along existing roadways to a new HVDC converter station (Erie Converter Station) to be constructed in Conneaut Township in Erie County, Pennsylvania. Limited portions of the underground line will be located on private property. For the underground portions of the HVDC transmission line route, the two cables within the transmission system would typically be installed along with a fiber optic cable in a concrete-encased PVC conduit duct bank with a minimum 3 ft (0.9 m) of cover. In selected areas, low thermal resistivity material, such as well-graded sand, stone dust, or fluidized thermal backfill (controlled density low strength concrete) may be used. Where the duct bank cannot be installed by trenching, such as significant water crossings, railroad crossings, and certain highway crossings, the transmission line conduits will be installed by horizontal directional drill (HDD) or cased auger boring (Jack & Bore).

The Erie Converter Station would convert +/- 320-kV DC power to 345-kV AC power or vice-versa, and connect to a nearby POI at the existing Penelec Erie West Substation that is part of the PJM grid.

The following section provides details concerning the portion of the Project under Lake Erie, which is the focus of concern in relation to potential impacts to the eastern sand darter.

2.2 Underwater Cable Description

2.2.1 General Facility Location and Description, Underwater Cable

The underwater cable route (referred to as Lake Segment or Underwater Segment) for the +/- 320-kV HVDC transmission line would extend approximately 35.4 mi (57.0 km) within Lake Erie from the U.S./Canada border to the proposed landfall location in Erie County (see Figure 2.1-1). A 500 m (1,640 ft) route corridor has been identified for the underwater HVDC cable route (250 m on either side of the centerline shown on Figure 2.1-1). The cable alignment will be refined to approximately a 100-m (328-ft) width in the route corridor through additional in-water surveys that occurred during 2015. As noted in the previous section, the HVDC transmission cables would transition from the landfall location into Lake Erie via borings through bedrock installed by HDD methods. The underwater transmission cables are generally sited to maximize the system's operational reliability while minimizing the costs and potential environmental impacts caused during construction, operation, and maintenance.

The underwater HVDC transmission cables will be solid dielectric extruded insulated HVDC cables (Figure 1.3-1), which will be deployed with a fiber optic cable. An extruded lead moisture barrier with a polyethylene jacket will be used to protect the insulation system. To protect the cable and provide additional strength during installation, an armoring system consisting of one layer of galvanized wires with bedding layers will be installed over the polyethylene jacket. Each cable will be approximately 6 in (15.2 cm) in diameter and weigh approximately 41.9 lb/ft (62.4 kg/m). The two underwater HVDC transmission cables and the fiber optic cable will be bundled together during installation to minimize disturbance and external electrical and magnetic fields.

In most areas the cables will be buried in the lakebed to protect the cables from damage due to shipping traffic, fishing activity, and ice scour. Typical burial depths in jettable material range from 3 ft to 10 ft (1 m to 3 m). No pipeline crossings have been identified for the proposed transmission cable route in the U.S.

A small number of joints will be required in the underwater HVDC transmission cable system. Cable joints for the underwater HVDC transmission cables are slightly larger than the cables. Splices typically cannot be buried and will require protection in the form of articulated concrete mattresses or other means.

2.2.2 Construction Methods, Underwater Cable

Installation engineering and marine route surveys are being performed to evaluate the route position in order to avoid shipwrecks, existing pipelines or other utilities to the extent possible, and to refine construction methods. The general sequence for installing the underwater HVDC transmission cables will be as follows:

- Install HDD conduit;
- Perform pre-lay grapnel run; and
- Install cable.

2.2.2.1 Install HDD Conduit

The shoreline crossings at Lake Erie will also be completed by three separate HDD bores, one bore for each HVDC cable and one bore for the fiber optic cable. It is currently estimated that the HDD will exit the lake in Pennsylvania approximately 2,000 feet (600 meters) from shore, at a water depth of approximately 18 ft (5.4 meters) (while HDD bores can be drilled further than this, there are limitations to how far an underwater cable can be pulled through an HDD bore). It is expected that the distance between bores at the exit will be approximately 33 ft (10 m)(to be verified following detailed survey and engineering).

The rocky and steep nature of the bluffs will require an HDD operation with special attention to preventing fluid releases into the nearshore area. Prior to drilling operations, an offshore sump pit will be excavated (in rock). The pit will be approximately 20 x 10 x 7 feet (6.1 x 3.1 x 2.1 meters) and is designed such that it could contain approximately 10,000 gallons of bentonite if there was an unexpected discharge. Any bentonite that is discharged will be contained at the bottom of the sump (bentonite clay has a specific gravity greater than water). Divers/video cameras will monitor the sump, and should bentonite be discharged, divers will employ a submersible pump to vacuum the bentonite slurry into tanks that are located on the support barge. The use of this system minimizes the amount of disposal required and minimizes potential impacts to water quality from the release of bentonite. The drilling mud will then be returned to shore (in the tanks) for upland disposal.

While the borehole is being completed, the conduit pipe is assembled on land and floated out onto the lake and pulled into the borehole from the water to the land side terminus of the HDD bore. The method used for this installation will depend on topography and geotechnical investigation. If the soils are too hard for forward reaming tools, a method that allows access from both sides may be required.

HDD has the potential for an inadvertent return, which occurs when drilling fluids (i.e. bentonite clay) leak through an unidentified weakness or fissure in the soil. This could cause drilling fluid to become suspended or dispersed in the lake or on the land surface. An Inadvertent Fluid Release Prevention, Monitoring, and Contingency Plan will be developed, describing how to monitor for, identify, contain, and remediate releases of drilling fluid (Appendix A). Descriptions of drilling fluid (e.g., material safety data sheets) will also be included in the plan. Among other elements, the monitoring program will consist of visual observations in the surface water at the targeted drill exit point and monitoring of the drilling fluid volume and pressure within the borehole. Visual observations of drilling fluid on the surface or in nearby water, or excessive loss of volume or pressure in the borehole, would trigger response actions by the HDD operator, including halting drilling activities and initiating recovery of released bentonite clay.

At the land side terminus of the HDD bore, a pit will be excavated to contain any drilling fluids for later pumping out and disposal and to act as a start point for the cable burial. The HDD installation of the 3 bores (2 for the power cables and 1 for the fiber optic cable) will take 3 months. Clear access to the end of the bore is required during the HDD operation, together with calm lake waters and low wind speeds. Therefore, the lake HDD is required to occur during summer (between June and September).

2.2.2.2 Perform Pre-Lay Grapnel Run

The purpose of a pre-lay grapnel run is to locate any immovable obstructions, such as large boulders, and to remove any smaller obstructions such as fishing gear, rocks, or wood. During this process a grapnel chain is towed along the bottom by a self-propelled barge. The grapnel will penetrate the lake bottom to a depth of about 3.3 ft (1 m), depending on sediment type. If an obstacle were encountered, the barge would stop and send a diver to the bottom before the obstacle would be brought to the surface for disposal. Debris would be disposed of at an upland facility. If an object is too large, or not movable, the location would be recorded and the route modified to avoid the obstacle during the cable installation.

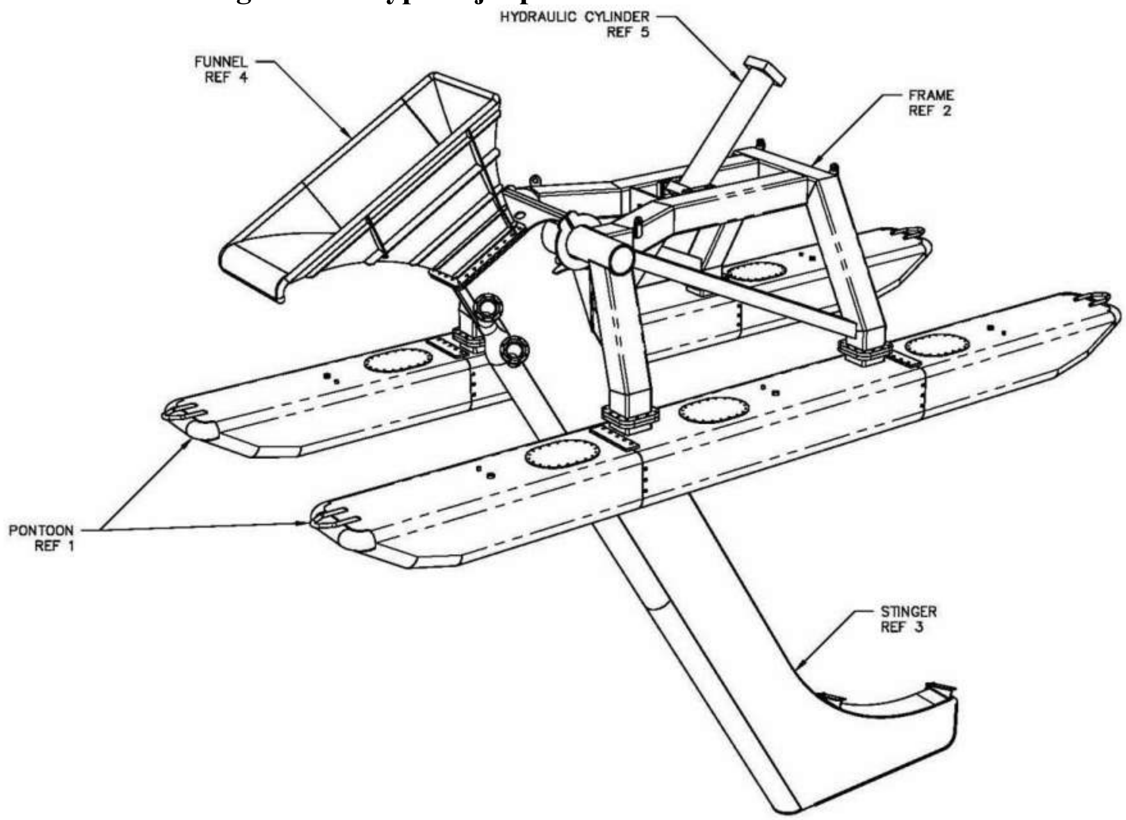
2.2.2.3 Install Cable

At the Erie landfall, bedrock is either exposed or very close to the surface for a substantial distance out to deeper water (about 1.3 miles). In this nearshore area, a trench may be excavated in the bedrock (primarily shale) from the exit of the HDD bore at approximately kilometer post (KP) 103.4 to the softer lakebed material where the sediment overlay is deep enough that jet plow burial can be utilized (approximately KP 102). In installing a trench, any sediment overburden will be excavated and sidecast. A trench would be excavated in the bedrock approximately 6 ft (1.8 m) below the natural top of the bedrock; and, the width would be about 4 ft (1.2 m). It is expected that a barge-mounted drill will drill 4-inch stemmed charge blast holes to a depth of 4 ft below planned excavation grade. Additional blast holes will be required at similar intervals for the offshore sump pits will be excavated in the rock at the exit of the HDD (one bore for each HVDC cable and one bore for the fiber optic cable). Each of the three sump pits will be approximately 20 x 10 x 7 feet (6.1 x 3.1 x 2.1 meters). The holes will be packed with low-level Hydromite emulsion explosive and detonated. The blasted rock will be removed by a barge-mounted excavator and side cast. The trench will be bedded and backfilled with a sand and gravel mixture (originating from an on-land source). Drilled and excavated material will be side cast on the lake bottom. Approximately 20 to 30 stemmed charges arranged in a zig-zag drill pattern over a trench length of 30 to 40 ft (9 to 12 m) will constitute an individual charge or "shot." One shot would occur per day. This pattern would yield an approximate daily advance rate of 40 to 50 ft per day (12 to 15 m per day). Therefore, completion of the blasting portion of the Project, assuming shots would occur on consecutive days, would require approximately 130 days.

Beyond the nearer shore areas underlain by shallow bedrock, installation of the transmission cables will be conducted by the use of a towed jet plow or by water jetting using a remotely operated vehicle (ROV). Jet-plowing is a very common technique for burying submarine cables and uses the combination of a plow share and high pressure water jets to fluidize a trench in the lakebed (see Figures 2.2-1 and 2.2-2). The installation process would be conducted using a dynamically positioned vessel and towed plow device that simultaneously lays and buries the underwater transmission cables in a trench.

Figure 2.2-1 Photograph of a typical jet plow.

Figure 2.2-2 Diagram of a typical jet plow.



Water jetting methods are similar to jet-plow installation methods in that both use water to fluidize sediment within the cable trench to facilitate cable burial. However, the jet-plow is supported on the lake bed by pontoons or skids and pulled along the sediment surface. The very soft sediment in the deeper areas of Lake Erie (approximately between KP 15-55[1]) may not support the weight of the jet-plow. Water jetting tools or ROVs are neutrally buoyant and often self-propelled, moving just above the lake bed and pre-laid cable. Unlike the jet-plow, there is no mechanical force used to pull the plow through the sediment and water jetting relies solely on the weight of the cable to sink through the fluidized sediment to the desired burial depth.

No utility, pipeline, or other submerged infrastructure crossings have been identified along the U.S. portion of the Project's proposed underwater cable corridor.

Cable laying is a continuous procedure. The majority of material required for the cable installation will be transported and stored on the installation vessel; although, it cannot carry enough cable to complete the entire route. Therefore, a cable transport barge will be used to carry the rest of the cable. In the unlikely event the cable installation must be abandoned due to extreme weather conditions, the cable will either be surface laid along the route, or in extreme cases, the will be cut. Following return of appropriate weather conditions, the cable will then be retrieved, spliced as necessary, and the installation process will continue.

[1] The Canada/U.S. border is at KP 47, so water jetting may occur in U.S. waters from approximately KP 47 – 55.

The cable installation in the U.S. and Canadian waters would occur over a 2.5 year period. In the first year, HDD and bedrock trenching would be conducted. During the second year, the pre-lay grapnel run and cable installation would occur, including jet plowing in soft sediments. These activities are expected to occur between May and November each year. Jet plowing will proceed at about 0.9 – 1.2 miles per day (1.5 – 2.0 km/day).

2.3 Transmission System Operating and Design Features

The following sections outline general information about proposed system operation, some of the protective measures included in the cable system design, and information regarding repair measures that will be undertaken if the cable system sustains damage.

2.3.1 System Operation

The Project will be operated in accordance with the established engineering and technical criteria of the IESO and PJM, as well as the mandatory Reliability Standards of the North American Electric Reliability Corporation (NERC). In the U.S., the Project will be placed under the functional control of PJM. Market rules established by these system operators will govern transactions utilizing Project facilities. Coordination between the IESO and PJM will determine the direction and quantity of electricity flow through the Project. Because the Project is a DC facility, PJM can dispatch energy flow over the Project, matching operational and commercial decisions while eliminating the possibility of any unintended power flows.

2.3.2 Electromagnetic Compatibility Limit

The Erie Converter Station will also be designed in accordance with the applicable standards for Electromagnetic Compatibility Limits and will not exceed the design criterion for interference levels. No operational impacts on communication systems would be expected because the transmission cables would not create induced voltages or currents that could impact communications equipment such as marine radios, remote telephones, and cellular telephones. The transmission cables are designed with outer metal layers and would not create an external electric field. Insulated cables do not have corona discharge and are not independent sources of radio, telephone, or television interference.

2.3.3 Relay Protection

Both the AC and HVDC cable systems will be protected by high-speed protection systems at the converter station. Protection of the AC interconnection facilities will be designed in accordance with the requirements of the interconnected utility.

2.3.4 Damage Repair

While it is not expected that the cable would be damaged (e.g., it would be armored and underground/in the lakebed), it is possible that over the expected minimum 30-year lifespan of the Project the transmission cables could be damaged, either by human activity or natural processes. Before operation of the Project begins, an Emergency Repair and Response Plan

(ERRP) would be prepared to identify procedures and contractors necessary to perform maintenance and emergency repairs. The typical procedure for repair of a failure within the underwater portion of the Project route is described as follows:

- Underwater Transmission Cable Repair - In the event underwater cable repair is required, the location of the problem would be identified and crews of qualified repair personnel would be dispatched to the work location. The damaged portion of the cable will first be cut underwater, and a portion of the transmission cable would be raised to the surface. A new cable section would be spliced in place by specialized jointing personnel. Once repairs are completed, the transmission cable would be laid back onto the lakebed and reburied using a water jetting device or covered with concrete mattresses. This repair would result in an additional length of cable that would be placed on the lakebed, with the excess cable forming a U-shaped loop (bight) to the side of the original cable alignment. The additional width of the loop (perpendicular to the original cable alignment) will be approximately equal to the water depth at the repair location.

The time required to repair a damaged cable may vary due to such factors as the nature and the amount of damage, location in the lake, and weather conditions. If the damage occurs when the lake is frozen, an icebreaker may be necessary to move some of the ice, or alternately, it may be necessary to wait for the ice to melt.

2.4 Project Schedule

Project construction is anticipated to begin after receipt of all required construction permits in the second quarter of 2017 and will take approximately 2.5 years to complete, with an anticipated in-service date in the fourth quarter 2019. The project schedule may be adjusted due to market conditions as a result of the competitive solicitation process that will soon be conducted for capacity on the line, and/or the timing of the formal engineering design process, and/or the permitting process.

3.0 SPECIES AND HABITAT DESCRIPTION

The Eastern sand darter is a very long, narrow fish of the Percidae family with other darters and perches, and occurs throughout much of the United States and into southern Canada. This fish has an overall translucent appearance to its body, and there are no obvious differences in coloration between males, females, and young. They have a distinct row of 12-16 dusky spots down the center of their back that split into two rows along the dorsal fins, along with a row of 9-14 oblong dusky spots along their side (ODNR 2015). They are a light yellow or tan color on their back with lighter white or silvery sides and belly. Eastern sand darters are typically 2-3 inches long, sometimes up to 3.5 inches (ODNR 2015). The eastern sand darter mainly eats midge larvae, as well as other dipteran larvae, and mayfly naiads, oligochaetes, and cladocerans. They are apparently a visual feeder, typically concealing itself in sand with only the eyes and snout protruding and darting out to capture prey (NatureServe 2014; ODNR 2015; Pennsylvania Natural Heritage Program [PNHP] 2015).

Eastern sand darters have been reported to be exclusively associated with sand substrates (from studies in streams) and the presence of silt-free sand beds are important to this species (Daniels 1993). In lakes, the eastern sand darter preferred habitat is sandy shoals (Scott and Crossman 1998). They are known to utilize clean sandy shoals along lakeshores, although this species has also been found in depths of 15 m to 20 m and greater in Lake Erie (PFBC 2015, Grandmaison et al. 2014, PFBC unpublished). Spawning in Pennsylvania waters generally occurs during June and July (Criswell 2013), but it may be somewhat later in the Great Lakes (PNHP 2015). Spawning has not been observed in the wild (Adams and Burr 1994), but it has been observed in aquaria where they utilized sandy substrates for mating and egg deposition that is similar to their general habitat preferences. Spawning was observed in aquaria to occur multiple times over the season, with a male and female paired, using their tails to dig in the sand and deposit a single, slightly adhesive, fertilized egg at each spawning location (Adams and Burr 1994). Eggs hatch in less than a week after being laid (NYNHP 2015).

Within Lake Erie, eastern sand darters have been reported along wave protected clean sandy beaches, in shallow bays, and in the island region (PNHP 2015, Van Meter and Trautman 1970). Criswell (2013) reported that eastern sand darter was found in the Pennsylvania portion of Lake Erie on clean, sandy shoals. Langlois (1954) reported it from sandy shoals at the narrows of Middle Bass Island, and noted that some were captured at a beach on South Bass Island in 1952. It occupies unconsolidated, sandy bottom along the shoreline of Presque Isle in waters 1-5 feet in depth (NatureServe 2015). Rob Criswell (pers. comm.) noted the collection of 15 to 20 eastern sand darters in Lake Erie (via trawl) at depths of 12 to 15 meters, circa 1996-1997 (Grandmaison et al 2004).

To aid in development of this Biological Assessment, PFBC reviewed bottom trawl data in the Pennsylvania section of Lake Erie between 1975 and 2013 for records of eastern sand darter. Most of the trawling was conducted in the fall (October and November) for the purpose of evaluating percid (walleye and perch) recruitment. Sampling occurred in water depths of over approximately 40 feet (pers. comm., C. Murray, PFBC, November 10, 2015).

PFBC conducted 366 trawls between 1985 and 2013, and eastern sand darters were collected during 7 of those 26 years (Table 3.1-1).

Table 3.1-1 PFBC bottom trawling effort in Lake Erie and density of eastern sand darters captured, 1985-2013. Source: PFBC unpublished.

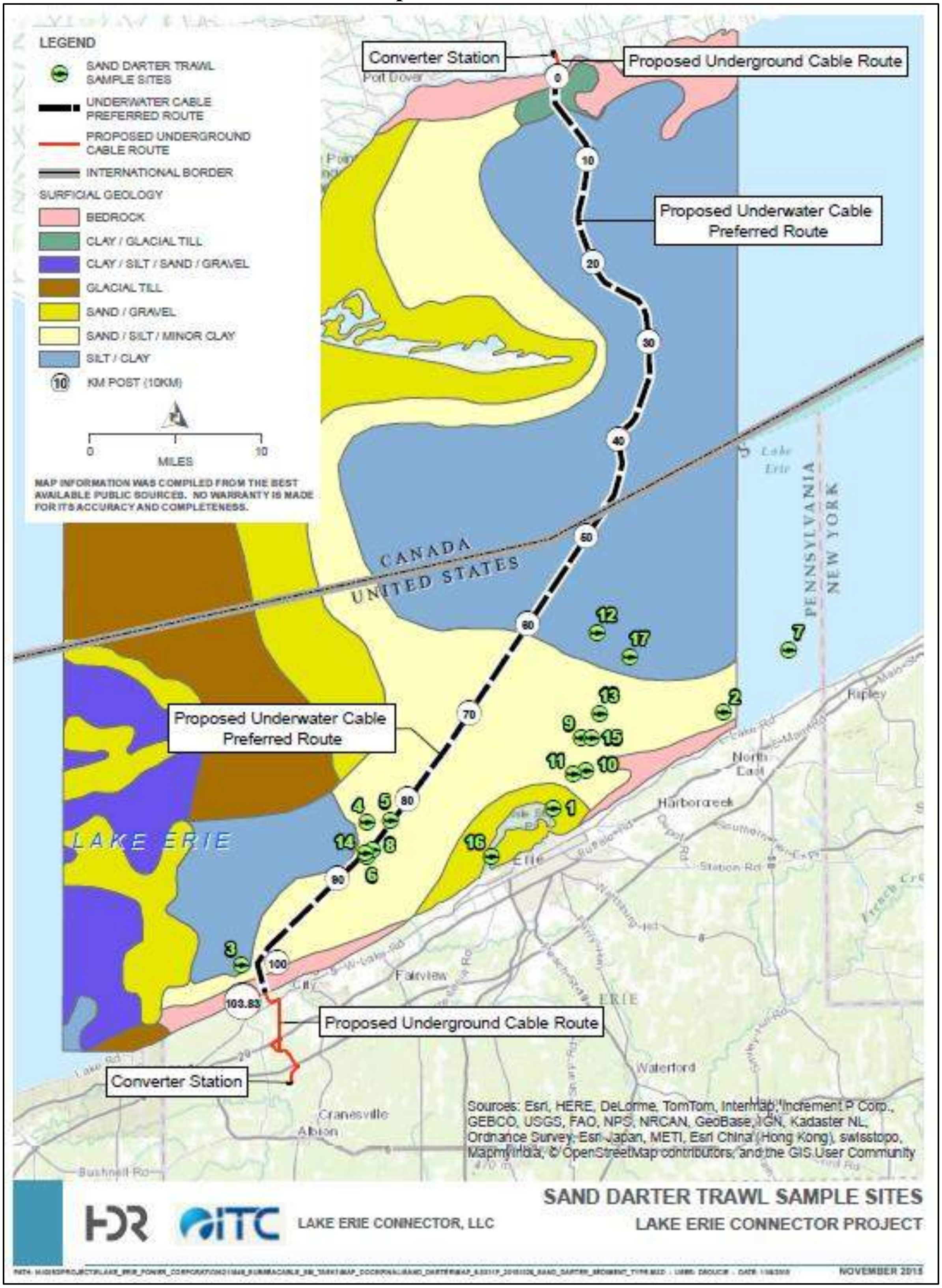
Year	No. trawls	Average e. sand darter/hectare	Year	No. trawls	Average e. sand darter/hectare
1985	13	0.00	1998	22	0.00
1986	17	0.00	1999	15	0.65
1987	28	0.98	2000	15	0.00
1988	17	0.00	2001	8	0.00
1989	13	0.00	2002	21	0.00
1990	9	0.25	2003	13	0.00
1991	15	0.00	2004	8	0.00
1992	16	0.05	2005	11	2.54
1993	9	6.69	2007	12	0.00
1994	15	0.00	2008	5	0.00
1995	19	0.12	2009	11	0.00
1996	16	0.00	2012	26	0.00
1997	2	0.00	2013	10	0.00
			Average	14.1	0.43

In evaluating the trawl data further for trawls in which eastern sand darters were collected, including trawls conducted back to 1975, 62 eastern sand darter were captured during this 39-year period during 17 bottom trawls (PFBC unpublished) (Table 3.1-2 and Figure 3.1-1; the sample site numbers from the table match the sample site numbers on the figure). Contrary to life history information from the literature summarized above, eastern sand darters were collected in deep areas, up to 90 feet. One of the 62 eastern sand darters sampled (1.6%) was captured in June or July, the potential spawning period of interest for this assessment (June 11, 1992, when one sand darter was collected in 66 feet of water over sand/silt/minor clay substrate, approximately 10 miles east of the proposed Project route).While the majority of eastern sand darters (59 of 62; 95.2%) were captured in September to November (PFBC unpublished), it should be noted that trawl sampling was rarely conducted in the spring and summer (pers. comm., C. Murray, PFBC, November 10, 2015).

Table 3.1-2 PFBC trawl sample sites in the Pennsylvania Section of Lake Erie where eastern sand darter were captured, 1975 - 2013. Source: PFBC unpublished.

Sample Location	Number Collected	Date	Entity	Notes (depth in ft)
1	1	10/4/1975	PSU	Lake Erie, Erie Co., at Presque Isle
2	1	11/14/1983	PFBC	Lake Erie, East Basin; Station: NE; Depth: 17.55; 10 min. trawl
3	1	5/21/1987	PFBC	Lake Erie, Central Basin; Station: CROOKED C; Depth: 43; 10 min. trawl
4	1	11/2/1987	PFBC	Lake Erie, Central Basin; Station: WC; Depth: 66; 10 min. trawl
5	1	11/2/1987	PFBC	Lake Erie, Central Basin; Station: WC; Depth: 60; 10 min. trawl
6	5	11/2/1987	PFBC	Lake Erie, Central Basin; Station: WC; Depth: 45; 10 min. trawl
7	4	11/16/1987	PFBC	Lake Erie, East Basin; Station: FREEPORT; Depth: 55; 10 min. trawl
8	1	10/22/1990	PFBC	Lake Erie, Central Basin; Station: WC; Depth: 50; 10 min. trawl
9	1	6/11/1992	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 66; 30 min. trawl
10	8	10/14/1993	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 52; 10 min. trawl
11	18	10/14/1993	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 49; 10 min. trawl
12	1	10/15/1993	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 90; 10 min. trawl
13	1	10/19/1995	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 60; 10 min. trawl
14	4	9/28/1999	PFBC	Lake Erie, Central Basin; Station: WALNUT; Depth: 52; 15 min. trawl
15	2	10/28/1999	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 60; 15 min. trawl
16	1	8/8/2001	PFBC	Lake Erie Drainage: Presque Isle Bay
17	11	10/28/2005	PFBC	Lake Erie, East Basin; Station: NNE; Depth: 96; 10 min. trawl

Figure 3.1-1 Trawl sample sites where eastern sand darter were captured in Pennsylvania. Data source: PFBC unpublished



The PFBC eastern sand darter data was overlain on a surficial geology base map (Figure 3.1-1). As suggested in the literature, most eastern sand darter were associated with sandy substrate (76% found over sand/silt/minor clay), while 21% were found over silt/clay and 2 eastern sand darter (3%) were found over sand/gravel. The surficial geology results of the 2015 geophysical survey (CSR 2015) were similar to what is shown in Figure 3.1-1, with the primary difference being silt/clay, as opposed to sand/silt, was found from KP 61 to 77 and KP 80 to 86 (geophysical panel maps are found in Appendix C).

The majority of years sampled resulted in zero or one eastern sand darter captured. However, during 3 years, eastern sand darter captures were larger with 12 captured in 1987, 27 in 1993, and 11 captured in 2005. Although the eastern sand darter had not been reported in recent years from the Pennsylvania portion of Lake Erie (Criswell 2013, PFBC unpublished), they were collected in 2015 sampling, though results are not yet available (personal communication, Charles Murray, PFBC, November 10, 2015). For the years sampling effort data are available from 1985 to 2014 (a 29-year period, Table 3.1-1), a total of 366 trawl samples (10 minute tows) resulted in the capture of 60 eastern sand darters or an average of one sand darter in six trawl samples. However, distribution was not uniform with only 17 of the 366 trawls capturing eastern sand darters (one in 22 samples) and the remaining 349 of those trawl samples captured none (PFBC unpublished). Using an estimated trawl wingspread of 5.44 meters average annual density estimates varied from 0.0 to 6.69 eastern sand darters per hectare, with a long-term average density of 0.43 eastern sand darters per hectare from 1985 through 2013. Average density estimates of one or more eastern sand darter per hectare occurred in only 3 years: 1987 (0.98/hectare), 1993 (6.69/hectare), and 2005 (2.54/hectare)(Table 3.1-1).

Based on this available data, it would appear that eastern sand darter distribution in Lake Erie is both spatially patchy and persists with a predominantly low recruitment rate with an occasional stronger year class at approximately 10 year intervals on average.

4.0 EFFECTS OF THE PROPOSED ACTION

From a review of literature, as summarized in Section 3, eastern sand darter prefers nearshore or riverine sandy habitat, and utilizes fine sand sediments in areas of moderate flows. Because the nearshore area of Lake Erie along the Project route is primarily bedrock, the presence of eastern sand darter in the nearshore Project area would be expected to be limited. Moreover, in a substantial portion of this nearshore area, cables are to be installed by HDD borings through the bedrock, with no lake bed impacts expected except at the point where the HDD segment transitions to trench installation. For these two reasons, the eastern stand darter would be expected to be minimally affected by construction activities in the nearshore portion of the route.

However, PFBC sampling has found eastern sand darter in deeper water where the predominant substrate is sand/silt, but outside of the spawning season. Given their sampling results, PFBC asked ITC to evaluate Project effects to eastern sand darter during June and July, which is the spawning season. The focus on spawning season reflects concern over the only life stage (egg and incubation) when mobility is reduced and vulnerability to Project construction activities could be increased. This section provides analysis of Project effects to eastern sand darter during their spawning period.

Construction of the proposed Project will cause a direct disturbance to the lake bottom along the Project route of the lake. The proposed Project in U.S. waters will cross primarily silt/clay and sand/silt, though the route crosses approximately 1.3 miles of bedrock near shore (Figure 3.1-1, CSR 2015). Bedrock and shallow surficial sediments are found in near shore waters outward to approximately 1.5 miles from land. The rest of the proposed Project route is located in sediments that allow burial of the cable and are comprised of sand/silt/minor clay and silt/clay.

HDD will be used to avoid impacts on nearshore habitats from the shoreline out to approximately 2,000 ft (609m), at a water depth of approximately 18 ft (5.4 meters). Blasting is being proposed in Lake Erie for a distance of approximately 0.5 to 0.9 miles beyond the lakeward extent of HDD where bedrock is either exposed or very close to the surface, before the bedrock transitions to a sand and silt overburden that is deep enough for a jet plow to be used for the remaining cable installation (water jetting may be used for up to about 14 percent of the U.S. route (8 km) in the deepest portion of the lake, near the Canada/U.S. border).

In the first year of Project construction, HDD and bedrock trenching would require up to 5 months. During the second year, the pre-lay grapnel run and the cable installation would occur, with jet plowing in soft sediments along the lake bottom. Prior to trenching, a grapnel run would occur along the route. The purpose of a grapnel run is to locate any immovable obstructions, such as large boulders, and to remove any smaller obstructions such as abandoned fishing gear, rocks or wood. During this process, a grapnel chain is towed along the bottom by a self-propelled barge. The grapnel will penetrate the lake bottom to a maximum depth of 1 ft (0.3 m), depending on sediment type. If an obstacle were encountered, the barge would stop, drop anchor, and send a diver to the bottom, before the obstacle would be winched to the surface for disposal. Debris would be disposed of at an upland facility. If an object is too large, or not movable, the location would be recorded and the route modified to avoid the obstacle during the cable installation.

The potential temporary impacts effects from construction, operation and maintenance activities to the eastern sand darter include increased turbidity and habitat alteration/disturbance during cable installation from horizontal directional drilling (HDD), trenching/blasting, and jet plowing (or water jetting in the deepest part of the lake), as well as blasting effects from trenching and potential petroleum spills from work vessels. These potential impacts are evaluated in more details below. In addition, operational impacts such as from EMF and maintenance activity are also evaluated below.

4.1 HDD Effects

HDD operations have the potential to release drilling fluids to the surface through inadvertent returns. Such conditions will be addressed via an Inadvertent Returns Plan established and implemented by the drilling contractor. Because drilling fluids consist largely of a bentonite clay-water mixture, they are generally considered non-toxic. While drilling fluid seepage associated with inadvertent returns is most likely to occur near the bore entry and exit points where the drill head is shallow, inadvertent returns infrequently occur at other locations along the directional bore path.

In the event that drilling fluids from the HDD operations are released into the water column, these fluids could become suspended in the lake or disperse. If released into the water column, drilling fluids could result in impacts on the adjacent aquatic resources, including increases in turbidity. Measures to prevent or minimize this potential effect include constructing sump pits at the HDD lake exit point to contain drilling fluids; removal of drilling fluids, and implementing an Inadvertent Fluid Release Prevention, Monitoring, and Contingency Plan.

4.2 Blasting Effects

The cables will be buried in the lakebed by a jet plow or water jetting to protect the cables from damage due to shipping traffic, fishing activity, and ice scour. Typical burial depths in jettable material range from 3 to 10 ft (1 to 3 m). At and near the Erie, Pennsylvania landfall, bedrock under the lake bed is either exposed or very close to the lake bed surface, preventing cable burial via jet plow or water jetting.

As discussed above in Section 2.2.3, due to these geological constraints, a trench will need to be excavated by confined stemmed blasting in the bedrock (primarily shale) for approximately 0.5 to 0.9 miles (800 to 1,500 m) from the exit of the HDD bore (approximately 2,000 ft [600 m] from the shoreline) to softer lake bed material where jet plow burial can be utilized. Stemmed charges will involve explosive materials placed into holes drilled into the substrate.

The stemmed charge approach to blasting, as described in Section 2.2.3, is designed to minimize aquatic impacts. Stemmed charges focus propagation of shock forces into the substrate rather than into the water column, thereby increasing the efficiency of fracturing rock or consolidated materials while minimizing potential impacts to aquatic life and water quality. The trench would have a depth of approximately 6 ft (1.8 m) below the natural top of the bedrock, which includes bedrock and any overlying mud and silt, and would have a width of approximately 4 ft (1.2 m).

This method of blasting was selected to minimize potential impacts to the aquatic community compared to detonations in open water, which would produce both higher amplitude and higher frequency shock waves than contained detonations. The preferred technique of stemming charges has been demonstrated to reduce pressures and lower aquatic organism mortality than the same explosive charge weight detonated in open water (Hempen et al. 2007, Nedwell and Thandavamorthy 1992). The reduced impacts of stemmed charge/subterranean explosions versus mid-water explosions were illustrated by Traxler et al. (1992), who reported no mortalities or observable injuries among largemouth bass (*Micropterus salmoides*), bluegills (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*) held in cages placed directly above and at distances between 7.6 and 91.4 m (25 and 300 ft) from shot holes containing 4.5 and 9.1 kg of dynamite. Their experiments were conducted in a freshwater reservoir in Texas.

The blasting for the Underwater Segment will be conducted as described above in Section 2.2.2.3. Limited fine sediments are expected to be released into the water column following blasting. Large rock material will be side cast along the route. Any increase in turbidity following blasting is expected to be minimal and will settle quickly.

Blasting and bedrock excavation would cause temporary impulse noise and ground-borne vibration. The noise from these activities would potentially have direct effects on nearby eastern sand darter, if present. Blasting can cause fish mortality, physical injury, auditory tissue damage, permanent and temporary threshold shifts, behavioral changes, and decreased egg and larvae viability (Hastings and Popper 2005). The duration of temporary loss varies depending on the nature of the stimulus; however, by definition, there is generally recovery of full hearing over time (Popper and Hastings 2009).

For this Project, the potential for blasting impacts to occur along the portion of the proposed underwater cable route comprised of bedrock was assessed by estimating the extent and duration of the sound pressure level and shock wave associated with the proposed blasting, and comparing these estimates to published guidelines and effects thresholds for fish species that have published criteria. Setback distances specify the distance from the explosive source at which overpressure and particle velocity levels would fall below thresholds at which detrimental impacts on free swimming fishes (overpressure) or fish eggs (particle velocity) are anticipated to occur (Kolden and Aimone-Martin 2013). The resulting setback distance using the proposed charge weights, guidelines outlined in the blasting impact analysis for this Project (Appendix B) are shown in Table 4.2-1.

Table 4.2-1 Setback distance for guideline criteria. Timothy 2013

Criteria	Setback Distance
Overpressure (fish)	63.3 ft
Peak Particle Velocity (eggs)	53.1 ft

Based on the review of existing literature and studies discussed above, the assumptions used to calculate the setback distance for peak particle velocity and pressure for this Project are conservative. Applying this approach to estimating potential impacts on fish takes into consideration the fact that high risk of lethal or permanent injury would be confined to the immediate vicinity of the explosion where compressive forces of the shock wave predominate. Injuries at greater distances are generally caused by negative pressures associated with overshoot of the gas bubble formed by the explosion and reflection of the shock wave from the water's surface (Popper et al. 2014). The 229 to 234 dB re 1 microPascal threshold for mortality recommended by Popper et al. (2014) corresponds to 40 to 70 psi or 276 to 482 kPa. Thus, the overpressure criteria (7.3 psi and 100 kPa) are very conservative. The potential for lethal impacts to fish would be expected to occur in a small footprint (less than 63.3 ft (19.2m) from the blast location) surrounding an individual blast. Blasting can cause mortality, physical injury, auditory tissue damage, permanent and temporary threshold shifts, behavioral changes, and decreased egg and larvae viability. However, based on the setback calculation for this Project, the extent of direct impacts and mortality is expected to be limited to 63.3ft (19.2m). Peak pressures and particle velocities decrease with distance from the detonation and therefore potential impacts are reduced as well, especially when considering the stemming methods proposed and described above.

Blasting will only take place over the bedrock portion of the Project's proposed route near shore, lakeward of the area where the HDD borings will end in pits within the bedrock lake bed. The area of trenching is expected to occur from approximately 0.4 mi (2,000 ft) from the shore, northward to approximately1.3 mi from the shore. Approximately 1.3 mi from the shore, the bedrock transitions to softer sediments.

The best available literature indicates that the eastern sand darter preferred habitat, including spawning habitat in June and July, is clean sand. In evaluating the location of the captured eastern sand darters with mapped lake bed substrates, the eastern sand darters were primarily associated with sand/silt and silt/clay and 2 eastern sand darters (3%) were found over sand/gravel. Trawls were not conducted over the bedrock areas where blasting will occur; however, eastern sand darters are not known to occur over bedrock substrates, especially during the spawning season. Geophysical mapping of the nearshore area conducted for ITC in 2015 detected a thin and variable veneer of sand, gravel, and cobble over much of the bedrock in the reach where blasting will occur, and it is expected that this would not represent suitable spawning habitat for eastern sand darter. However, areas of deeper sand overburden occur over shallow bedrock for about 578 meters of the lakebed where blasting is planned, from approximately KP 102.0 to KP 102.5 and approximately KP 102.6 to KP 102.8 (Appendix C). Literature and PFBC data confirm that this species is found over sand and fine sediment in Lake Erie, not over bedrock, and Project blasting associated with trenching of bedrock not having a sand overburden near shore is not expected to affect eastern sand darter. Blasting could affect eastern sand darter in the areas of sand overburden, and this is discussed further in Section 5.0 below.

4.3 Jet Plow Effects

Following the HDD and trenching/blasting activities associated with the cable installation within the nearshore bedrock area, the next phase of in-lake work would involve installation of the transmission cables by the use of a towed jet plow. This very common technique for burying submarine cables and uses the combination of a plow share and high pressure water jets to cut a trench in the lakebed. Following a grapnel run to clear bottom obstructions, the installation process would be conducted using a dynamically positioned cable ship and towed plow device that simultaneously lays and embeds the underwater transmission cables in a trench. A dynamically positioned cable ship or barge would use thrusters as a propulsion system to tow the plow without the use of anchors. The jet plow itself would be about 15 feet wide, with skids 36 feet long and 2.7 feet wide. The plow share (i.e., width of trench created by the jet plow) is around 12 inches wide. As mentioned in Section 2.2.2.3, for the deepest part of the route, from the Canada/U.S. border at KP 47 to approximately KP 55 (up to about 14 percent of the U.S. Underwater Segment), water jetting using an ROV may be used instead of a jet plow.

Installation of the cable in U.S. waters (both bedrock and in sediment) would result in a temporary disturbance of bottom sediments of approximately 50.0 acres (20.2 hectares). Many of the water quality modeling efforts for similar projects that have undergone regulatory review and gained regulatory approval have used a jet plow or water jetting sediment release fraction of between 25 and 30 percent for similar fine-grained sediments as present in Lake Erie. Because 70 to 75 percent of the sediment in the jet plow or water jetting trench would return to the trench, no fill would be added to the trench. A depression would be expected to occur in the lake bottom over the installed cable, and the contours of the lake bottom would be expected to return to pre-installation conditions through natural deposition to the lakebed. Thus, the only permanent disturbance to the lakebed would be the presence of the two 6-inch cables and the telecommunications cable, which would be buried approximately 3 ft to 10 ft (1 m to 3 m) under the lake bed.

In regard to the effects of these construction activities on the eastern sand darter, jet plowing would disturb sediment and, in areas of soft sediment, temporarily increase turbidity in the water column resulting in a potential temporary, short term impact to these fish along the proposed Project route.[2]

This disturbance would displace the available food sources directly within the footprint of the disturbed areas (50.0 acres, both bedrock and in sediment) and result in a temporary, short-term impact. In general, eastern sand darters are a mobile species and would be able to avoid any direct impacts from construction activities, as well as moving into nearby, unaffected areas of the lake to seek refuge and to feed or spawn. In the deeper waters (greater than 10 m [32.8 ft]) of Lake Erie, where the bottom substrate is dominated by sand, silt, and clay, the jet plow would bury the cable and the trench will begin to backfill immediately with the disturbed sediment resulting in a temporary increase in localized turbidity.

A water quality model has been prepared (Appendix D) evaluating the potential impacts of construction activities on in-lake water quality. That model shows that minimal water quality impacts would be associated with the cable installation in Lake Erie and that such impacts are

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[2] The effects of water jetting are expected to be similar to jet plowing, but this method would only be used from the Canada/U.S. border at KP 47 to approximately KP 55, where the water depths along the route are greatest, and where no eastern sand darters have been collected (Figure 3.1-1). Hence, the water jetting method would not affect eastern sand darter. As noted above, PFBC indicated that it was concerned about effects to eastern sand darter in water depths of 20 meters or less; the water depths where water jetting may occur are approximately 34 to 43 meters in depth.

limited to temporary impacts that would occur locally within a four-hour timeframe after installation occurs. The model calculated that total suspended sediment (TSS) concentration increases would reach a temporary peak concentration at the point of installation and then decrease rapidly. TSS concentration increases due to the cable installation are <3 mg/L above observed background lake TSS levels at a distance of 100 meters from the point of installation and within five to eleven vertical meters of the lake bottom (HDR 2015). These impacts would be temporary and disturbance associated with construction would be minimized at any one location. The grapnel would penetrate the lake bottom to a maximum depth of 3 feet. It would cause a temporary disturbance of the underlying sediments along the transmission line route where the cable installation will occur.

Cable installation in soft sediments will proceed at about 0.9 – 1.2 miles per day (1.5 – 2.0 km/day), and the area of the lake bed disturbed by the trenching activities represents a very small fraction of the available habitat. As such, effects to eastern sand darter habitat will be limited, temporary, and short term. Eastern sand darters are expected to avoid the construction area as a result of startle response, and therefore not be harmed by the slow moving cable installation.

As shown above, eastern sand darters have been found in deeper areas of Lake Erie. Based on available habitat and life history information presented in Section 3.0 above, we are assuming that spawning occurs in the same habitat utilized during the remaining year. Due to the fact that eastern sand darters are expected to avoid the construction area as a result of startle response, and are expected to occur in very low numbers (if at all) in the Project area, no lethal effects on mobile life stages are anticipated as a result of jet plowing, water jetting, or the grapnel run. In conclusion, the jet plow and the grapnel run will have little to no impacts on the adult or mobile juvenile life stages of eastern sand darter in June and July, or the rest of the construction season.

The only potential effect to eastern sand darter would be if the jet plow or grapnel disrupts eastern sand darter eggs, which hatch in less than a week after being laid (NYNHP 2015). The area of lakebed that would be disrupted would be limited in spatial extent at any given time. The effect to eastern sand darter eggs is expected to be insignificant given the small width of the area disrupted by the jet plow and the grapnel compared to the total available similar habitat in Lake Erie, and the short incubation period. If jet plowing and the grapnel should encounter a spawning site with incubating eggs, impact would be expected to be limited since spawning behavior is to lay eggs one at a time over an extended period of time and space (Adams and Burr 2004) suggesting only a small portion of eggs would be encountered.

4.4 Petroleum Spill Effects

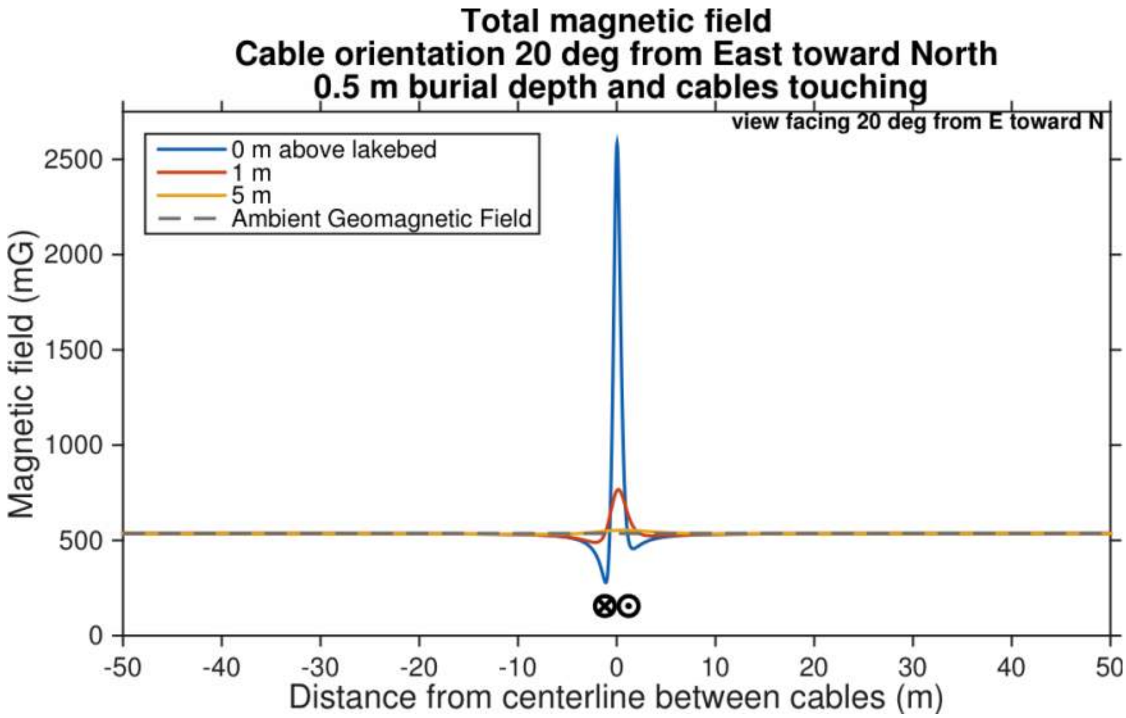
A number of vessels will be involved in Project construction. A comprehensive Spill Prevention Plan designed specifically to prevent spills during lake operations will be developed. Implementation of the plan, should there be a release, will limit effects on eastern sand darter.

4.5 EMF Effects

Electromagnetic fields (EMF) occur in nature and from anthropogenic sources. The earth’s magnetic field, currents traveling through the earth’s geomagnetic field, and different processes (biochemical, physiological, and neurological) within organisms are examples of natural sources of EMF. The geomagnetic field in the Project area is approximately 536 milliGausse (mG) (Exponent 2015*a*). The flow of electric current through transmission lines and power cables also results in the creation of EMF. Some aquatic species are sensitive to EMF and use these fields for detecting prey or migratory navigation.

Unlike AC lines, HVDC technology involves direct currents, which create only static fields. The Project's HVDC cables will be shielded, which will virtually eliminate the static electric fields, leaving only static magnetic fields for consideration of potential impacts for this Project (Intrinsic 2014). The Applicant's consultant, Exponent, modeled the magnetic fields produced by the transmission line in Lake Erie to further evaluate potential effects of magnetic fields produced by the underwater cable system, and evaluated the potential significance for selected fresh water fish species based upon a review of the relevant literature (Exponent 2015*a*, Appendix E). Magnetic fields diminish very rapidly with distance, so it is only in the immediate vicinity of the transmission line that the magnetic field level will be appreciably different than earth's geomagnetic field (Exponent 2015*a*). The modeling for the bedrock trench or jet plow (soft sediments) portions of the transmission line route, assuming a burial depth of 0.5 meters, the peak field deviation (above the ambient geomagnetic field) is 2,047 mG, but drops to a value of -18 mG (3.3% reduction of the geomagnetic field) at a distance of 5 meters from the cable. Beyond 10 meters from the cable, the field deviation is less than 5 mG. This is a conservative estimate, as it is expected that the cable will be buried 1 to 2 meters for the majority of the route. For example, if the burial depth is 1.5 m, magnetic field level at the lakebed would be approximately 10 times lower (Figure 4.5-1) (Exponent 2015*a*).

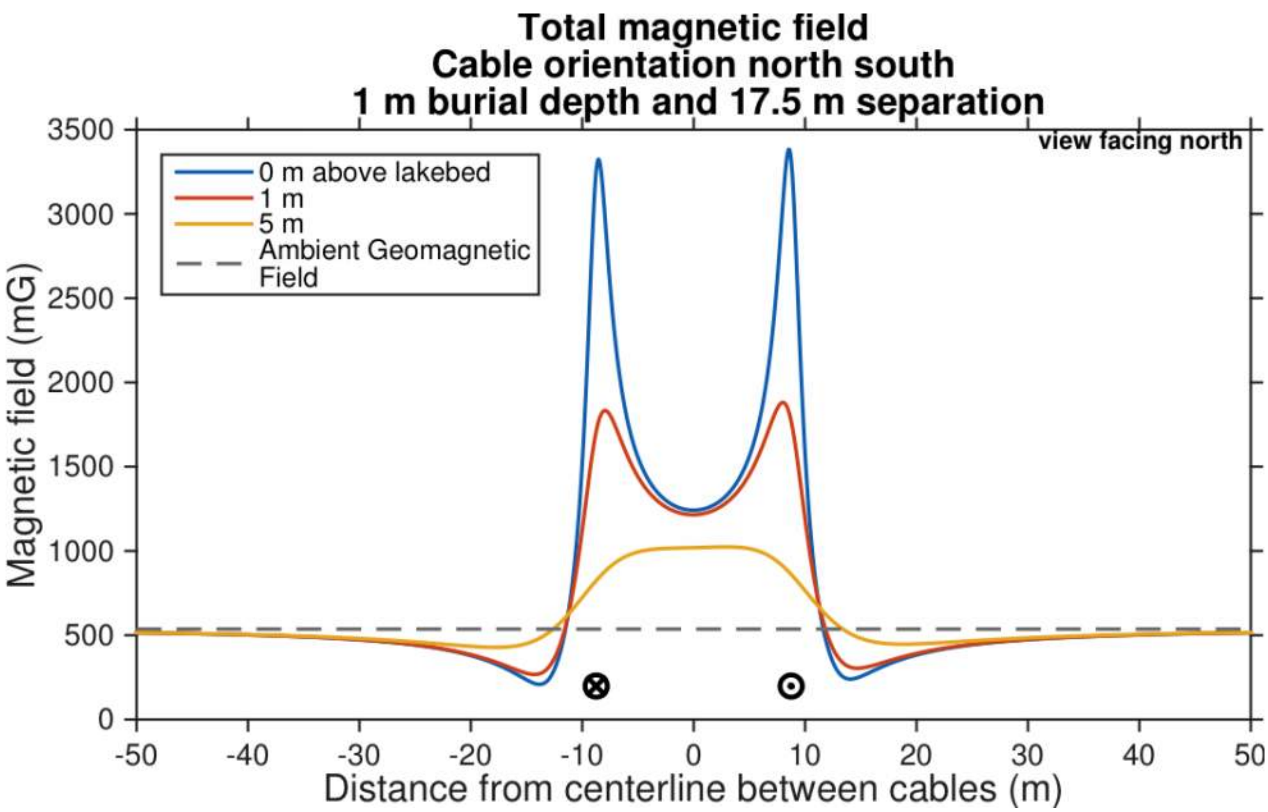
Figure 4.5-1 Calculated magnetic field profile for cables strapped together, laid horizontally and oriented at 20° north of east and buried at a depth of 0.5 m (Exponent 2015*a*).



The HDD portion of the cable (about 0.4 mi) will occur through bedrock areas which are not considered likely habitat for eastern sand darter. In these areas, the EMF model conservatively assumed burial depth of just 1.0 meter. Assuming the cables were just 1.0 meter under the lake surface, the model predicts that magnetic field deviation (above the ambient geomagnetic field) would be 2,846 mG at the lakebed (0 m) directly over the transmission line. This field is approximately 5.3 times larger than the geomagnetic field, but it diminishes quickly with distance. At a distance of 6.25 meters from the cable (15 meters from the centerline between the cables), the field deviation drops to -250 mG, representing a decrease in the total magnetic field to a value approximately 50% relative to the geomagnetic field. The field deviation decreases further still at larger distances and the overall field becomes nearly indistinguishable from the geomagnetic field at distances greater than 30 m from the transmission line.

It should be noted that the EMF model's assumptions for the HDD portion are very conservative. The burial depth in the HDD section will in fact vary from approximately 1 to 30 meters. For a burial depth of just 1 additional meter, the magnetic field level at the lakebed would decrease by a factor of 2; at greater burial depths the magnetic field level would be even lower (Figure 4.5-2)(Exponent 2015a).

Figure 4.5-2 **Calculated magnetic field profile for cables oriented north-south and buried at a depth of 1 m. The cables are separated by 17.5 m (Exponent 2015*a*).**



The changes in the ambient geomagnetic field level will be largely limited to the area in the immediate vicinity of the cable. The highest calculated magnetic field level anywhere along the submarine portion of the route is approximately 3,382 mG (a deviation of approximately 2,846 mG from the ambient) (Exponent 2015*a*). This maximum magnetic field level (calculated on the lakebed, directly over the HDD cables) is approximately 0.08% of the general public exposure limit recommended by ICNIRP (Exponent 2015*a*).

Regarding the potential interaction of the change in the magnetic field with fish, a review was conducted of the maximum post-construction static magnetic-field exposures and the research on the behavioral, migratory, physiological, and early life-stage responses of freshwater fish to static magnetic fields. This analysis included species of concern in Lake Erie, including eastern sand darter, and did not suggest that the Project would sufficiently change the ambient static magnetic field in the very small portion of Lake Erie habitat in the vicinity of the proposed cable, nor threaten the health or performance of this species. Except for one study involving an exposure unlike that associated with the operation of the Project, other studies reported no or very minor reactions to static magnetic fields more than ten-fold greater than those calculated for the LEC when operating at maximum power transfer loads. Regarding potential effects on migration, the change in the magnetic field is not a physical barrier and fish are known to use multiple sensory cues to guide behavior. In the studies reviewed, the responses were readily reversible. As for the electric field induced by fish movement through a static magnetic field, even an assumed high velocity of 1.38 m/s, some 10 times higher than reported, the Project was calculated to induce electric-field levels below the detection threshold of the species of concern in Lake Erie with electrosensory capabilities[3]. In summary, the change in the static magnetic field associated with the operation of the proposed Project is too small to pose a threat to freshwater species of concern in Lake Erie, including eastern sand darters (Exponent 2015*a*).

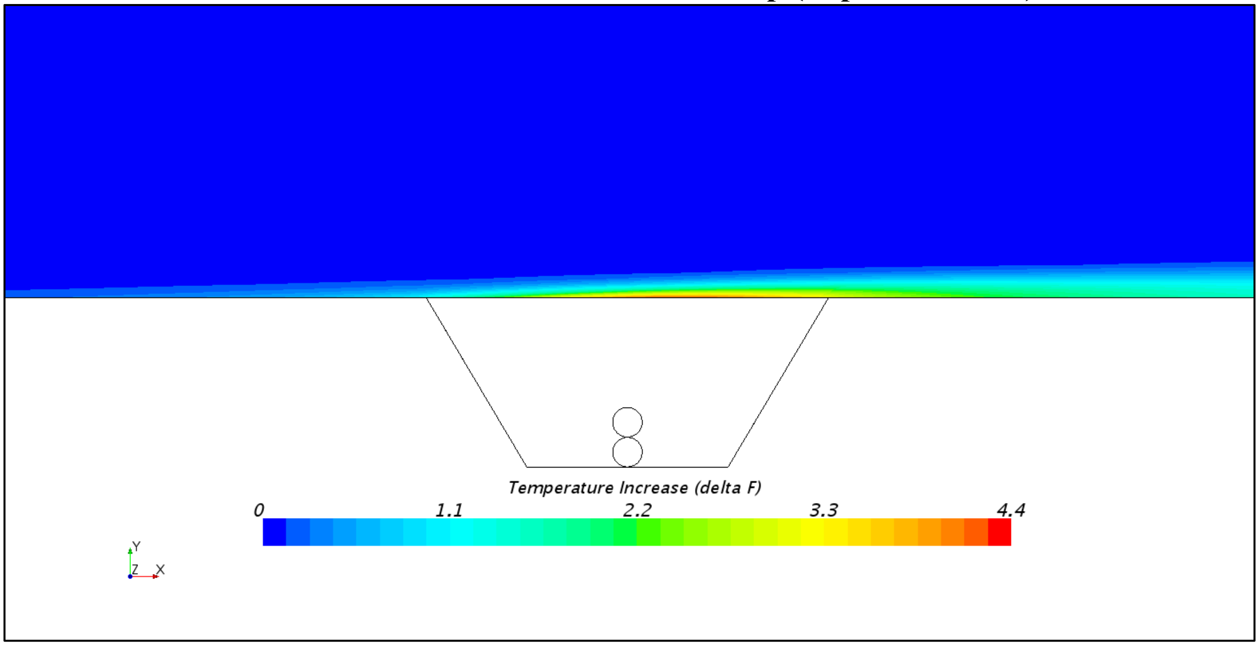
In addition, the calculations presented in the Exponent's modeling study were based on very conservative assumptions selected to yield the highest estimates of the change in the magnetic field. Because calculations presented in the report represent conservative estimates, in more typical conditions, the potential change to the background magnetic field environment is expected to be less than described (Exponent 2015*a*). In addition, the Project is employing mitigation measures that will reduce magnetic field exposure: (1) use of certain types of cables to reduce emission of magnetic fields (e.g., HVDC transmission systems); and (2) burial of cables to reduce exposure on sensitive species (Intrinsik 2014).

4.6 Temperature Effects

Exponent calculated thermal effects to lake water from operation of the Project (Exponent 2015*b*, Appendix F). Using a set of conservative variables in terms of soil thermal properties and water velocity, the largest increase in temperature was found to be approximately 4.4°F (2.4°C) at the water/soil interface on the lakebed. The point of highest temperature increase was found to be approximately 9 inches (23 cm) in the downstream water flow direction from the cables' centerline. As seen in the Figure 4.6-1, the physical extent of this temperature increase is very limited. For example if one were to move vertically by only 4 inches (10 cm) from the point of highest temperature increase on the lakebed, the temperature increase would drop to a mere 0.2°F (0.1°C) (Exponent 2015*b*). The presence and operation of the transmission line would therefore not be expected to cause significant impacts to water temperature.

[3] The Project cables will not directly produce an electric field that would influence aquatic life due to shielding around the conductors. An induced electric field, resulting from movement of charges in water or organisms through the static magnetic field will be produced. The maximum induced electric field is calculated to be approximately 466 µV/m, and diminishes quickly with increasing distance from the cables (Exponent 2015*a*).

Figure 4.6-1 Calculated thermal effects of Project transmission line: bedrock trench shown is 3 ft wide at bottom and 2.5 ft deep (Exponent 2015*b*).



4.7 Cable Maintenance Effects

In the event underwater cable repair is required, the location of the problem would be identified and crews of qualified repair personnel would be dispatched to the work location. The damaged portion of the cable will first be cut underwater, and a portion of the transmission cable would be raised to the surface. A new cable section would be spliced in place by specialized jointing personnel. Once repairs are completed, the transmission cable would be laid back onto the lakebed and reburied using a water jetting device or covered with concrete mattresses. This repair would result in an additional length of cable that would be placed on the lakebed, with the excess cable forming a U-shaped loop (bight) to the side of the original cable alignment. The additional width of the loop (perpendicular to the original cable alignment) will be approximately equal to the water depth at the repair location.

It is not anticipated that these maintenance activities would effect spawning activities of eastern sand darters. These activities will temporarily disturb the lake bed and have a very small foot print. Any sand darters in the area would be startled by the activity and move to other nearby suitable habitat, therefore, no lethal take is anticipated from cable maintenance/repair activities.

5.0 EASTERN SAND DARTER PRESENCE AND ESTIMATED TAKE

In stream studies, Eastern sand darters have been reported to be exclusively associated with sand substrates and the presence of silt-free sand beds are important to this species (Daniels 1993). In lakes, the eastern sand darter preferred habitat is sandy shoals (Scott and Crossman 1998), however, in Lake Erie they have been found in deeper waters over sand and silt (PFBC 2015, PFBC unpublished). Based on available information, we are assuming that spawning habitat is the same habitat used during the remaining year.

The average density of eastern sand darter in Lake Erie, derived from the PFBC trawl surveys is 0.43 fish/hectare (Table 3.1-1). Total temporary disturbance of all in-water activities in the Pennsylvania portion of Lake Erie, including the maximum offset distance for blasting activities (63.3 ft) to either side of the route in the nearshore bedrock area, would result in a temporary disturbance of approximately 23.0 hectares (56.9 acres) and a negligible permanent disturbance, consisting primarily of the footprint of the cables themselves under the lakebed. The number of eastern sand darters that could be expected to occur along the portion of the cable route within this temporary disturbance footprint, based on this calculated density, and with no consideration of spawning season, eastern sand darter preference for sand substrate, or that blasting would occur in increments of 40 to 50 feet (12 to 15 m) per day, would be 10 fish (0.43 fish/hectare x 23.0 hectares). To account for the pre-lay grapnel run, which would occur along the cable route prior to construction, to remove debris, this estimate would be doubled to 20 fish.

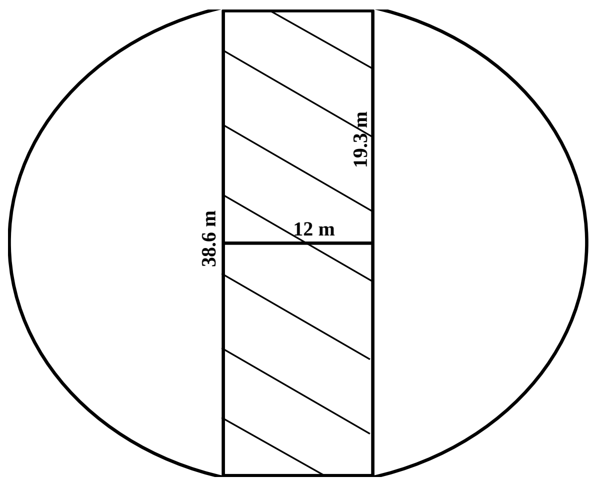
Despite this very low number of eastern sand darters expected to be encountered during construction activities, we evaluated lethal take anticipated during construction (or operation) of the Project. Lethal take was assessed by evaluating the effects described above on eastern sand darters from the Project, with a consideration of the best available science, including habitat preference and species presence information. The take evaluation was focused on the spawning life stage of eastern sand darters, expected to occur in Lake Erie during June and July.

HDD is proposed for the nearest 2,000 ft from the shoreline. The use of HDD methods avoid disturbance of the nearshore area, and no lethal take is expected to result from this method.

Blasting/trenching activities are proposed for approximately 1 mile from the HDD exit to areas of softer substrate where a jet plow can be deployed for burying the cable. Geophysical mapping of the nearshore area conducted for ITC in 2015 detected a thin and variable veneer of sand, gravel, and cobble over much of the bedrock in the reach where blasting will occur; and it is expected that this would not represent suitable spawning habitat for eastern sand darter. However, areas of deeper sand overburden occur over shallow bedrock for about 578 meters of the lakebed where blasting is planned, from approximately KP 102.0 to KP 102.5 and approximately KP 102.6 to KP 102.8 (Appendix C). Literature and PFBC data confirm that this species is found over sand and fine sediment in Lake Erie, not over bedrock, and Project blasting associated with trenching of bedrock not having a sand overburden near shore is not expected to affect eastern sand darter.

Four eastern sand darters could be expected to occur within the offset distance along that portion of the cable route where blasting will occur and where there is an area of sand overburden. This estimate of effects of this temporary disturbance is based on the calculated density, and with no consideration of spawning season. The basis for this estimate is shown in Table 5-1, and is further explained by the following:

- One shot would occur per day. This pattern would yield an approximate minimum daily advance rate of 12 m per day;
- Therefore, 48 shots would be needed in the 578 m of bedrock where there is a sand overburden (578 m/12 m per day);
- For each shot, the area within the overpressure offset distance = (38.6 m x 12 m) + π(19.3 m)^2 = 7.83 hectares (shown in diagram);



- Potential lethal take = 0.43 sand darters/hectare x 7.83 hectares of disturbance = 3.37 sand darters (rounded up to 4).

Table 5-1 Estimated take of eastern sand darter over the length of the cable route where bedrock blasting will occur that has an overburden of sand.

Parameter	Value
Sand darter density (fish/hectare)	0.43
Blasting impact width (ft)	126.6
Blasting impact width (m)(offset distance of 19.3 m x 2)	38.6
Length of blasting impact (m)	578
Length per blast (m; blast 12 to 15 m per day)	12
Impact area per each blast (m^2) – A+B	1,633.4
A. Impact area 1 (rectangle in above diagram) 12 m x offset distance of 38.6 m	463.2
B. Impact area 2 (2 half circles in above diagram) - diameter of 38.6 m on each end of rectangle	1,170.2

Parameter	Value
Number of blasts	48
Area of blasting impact of all 48 blasts (m^2)	78,404
Area of blasting impact of all 48 blasts (hectare)	7.84
Sand darter take (0.43 fish/hectare x 7.84 hectares)	3.37

Once the substrates transition into finer substrates further offshore, jet plowing will be utilized to install the cables. The near shore substrates transition from primarily bedrock into sand, silt and minor clay substrates approximately 1.3 miles off the U.S. shoreline. As shown in Figure 3.1-1 above, eastern sand darters have been collected in the PFBC trawl surveys near the proposed route in this area of finer substrates. However, the last time eastern sand darters were captured via trawling near the proposed route was in 1999, based on the best available data to date. The trawl data provided by PFBC reveals low densities and patchy occurrences of this species. If an area is encountered that has eastern sand darters present during jet plowing or the grapnel run in June and July, it is anticipated that there will be few individuals and they are expected to avoid the slow moving jet plow and the grapnel, since these fish are mobile and can find suitable habitats in the vicinity of the disturbed area to continue spawning activity, feeding, and other normal behavior. Results of the Applicant's water quality model (Appendix D) show that minimal temporary water quality impacts would be associated with the cable installation and are limited to a four-hour timeframe after jet plowing occurs. The model calculated that total suspended sediment (TSS) concentration increases would reach a temporary peak concentration at the point of installation and then decrease rapidly. Therefore, no lethal take is anticipated for the remaining proposed Project route.

The other potential effects evaluated above (i.e., petroleum spills, EMF, and temperature) are negligible, as explained above, and are not anticipated to result in any lethal take of eastern sand darters.

While eastern sand darter spawning (June and July) has not been reported in the wild, general habitat preference in lakes has been reported as clean sandy shoals and beaches, and based on best available information we assume that spawning will occur in the same sandy habitat utilized the remaining year. PFBC trawl survey data shows that eastern sand darters occur over sand and other fine substrates in deeper waters of Lake Erie. Eastern sand darters are not known to utilize habitats consisting of bedrock, so blasting and HDD activities in such near shore bedrock areas should not affect eastern sand darter. HDD, which has the lowest potential for impact to fish species, would be used in the nearshore shallow waters, where the one potential point for impact would be the relatively small boring exit pit.

In summary, both literature and PFBC data confirm that eastern sand darters are found over sand and fine sediment in Lake Erie, not over bedrock. Therefore, eastern sand darters are not expected to occur along the Project route where bedrock trenching will occur, except for the portion of the route that has a sand overburden; and for that portion, it was estimated that 4 eastern sand darters could be killed during project blasting. Jet plowing and the grapnel run would cause a temporary disturbance of the underlying sediments along the transmission line route, resulting from temporarily suspended sediment. However, no lethal effects would occur from jet plowing or the grapnel run. The only potential effect to eastern sand darter would be if the jet plow or grapnel disrupts eastern sand darter eggs. The effect to eastern sand darter eggs is expected to be insignificant given the small width of the area disrupted by the jet plow compared to the available similar habitat in Lake Erie, and the short incubation period. If jet plowing and the grapnel should encounter a spawning site with incubating eggs, impact would be expected to be limited since spawning behavior is to lay eggs one at a time over an extended period of time and space (Adams and Burr 2004), suggesting only a small portion of total eggs would be encountered. The potential effects of ITC's proposed Project installation activities between May and November is insignificant, consisting of potential take of four fish, and the Project is, therefore, not expected to affect eastern sand darter spawning

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APPENDICES

APPENDIX A
INADVERTENT FLUID RELEASE PREVENTION, MONITORING, AND CONTINGENCY PLAN

(SEE ATTACHMENT 1 OF JOINT PERMIT APPLICATION)

APPENDIX B
LAKE ERIE CONNECTOR, BLASTING IMPACT ANALYSIS IN U.S. WATERS

(SEE ATTACHMENT I OF ENVIRONMENTAL ASSESSMENT)

APPENDIX C
2015 GEOPHYSICAL SURVEY, PANEL MAPS

(SEE APPENDIX K OF ENVIRONMENTAL ASSESSMENT)

APPENDIX D
LAKE ERIE WATER QUALITY MODELING REPORT, LAKE ERIE CONNECTOR AND ADDENDUM

(SEE APPENDIX E OF ENVIRONMENTAL ASSESSMENT)

APPENDIX E
ASSESSMENT OF LAKE ERIE CONNECTOR PROJECT: STATIC MAGNETIC FIELD AND SELECTED FISH SPECIES

(SEE APPENDIX F OF ENVIRONMENTAL ASSESSMENT)

APPENDIX F
THERMAL ANALYSIS OF THE ITC LAKE ERIE CONNECTOR HVDC PROJECT

(SEE APPENDIX G OF ENVIRONMENTAL ASSESSMENT)