Appendix O
Summary of Current Information Related to Electromagnetic Field Impacts on Fish and LEEDCo Proposed Transmission Cable

501 Avis Drive
Ann Arbor, MI 48108
734.332.1200
www.limno.com

Memorandum

From: Ed Verhamme
Jen Daley, PhD
Greg Peterson

Date: June 29, 2016

Project: LEEDCo

To: Scudder Mackey, PhD, ODNR
Jennifer Norris, ODNR
Jeff Tyson, ODNR

CC: Stuart Siegfried, OPSB
Grant Zeto, OPSB

SUBJECT: Summary of Current Information Related to Electromagnetic Field Impacts on Fish and LEEDCo Proposed Transmission Cable.

Introduction

The Lake Erie Energy Development Corporation (LEEDCo) is proposing to develop the first offshore freshwater wind project in the Great Lakes – planned to be located in Lake Erie offshore of Cleveland. As part of the project, an eight mile long, three-phase, 34.5kV, AC transmission cable will be buried below the sediment surface along the bottom of Lake Erie to transmit electricity from the turbines to the mainland transformer station. During recent discussions regarding the LEEDCo project, the Ohio Department of Natural Resources (ODNR) expressed an interest in the potential impacts of the electric transmission cable on fish in the project area; particularly with respect to electromagnetic field (EMF) impacts. In addition, the ODNR Aquatic Sampling Protocol for Offshore Wind Development requires acoustic telemetry studies to monitor fish behavior and the ODNR has suggested that LEEDCo's study should also include monitoring near the transmission line to evaluate its effects on fish behavior. This memorandum is intended to summarize current research and information regarding the impact of EMFs on fish and provide our assessment of the likely impact to fish in the vicinity of the proposed transmission line.
Based on the current research and existing EMF fish impact studies that have been done in the Great Lakes, the expected EMF to be generated by the LEEDCo electric transmission line will not have an adverse impact on fish behavior and habitat.

Background

When considering the impact of submarine cables on aquatic environments there are two major concerns –the electric field and the magnetic field. The electric field is produced by stationary charges, and the magnetic field is produced by moving charges (currents). Both of these issues are described in more detailbelow.

Electric Field Impacts

Electric fields are caused by electric charges and are associated with the positive and negative electrons in the cable conductors. The electric field impacts are not a concern for the LEEDCo project because the cable conductors are shielded and jacketed with an insulator, which is designed to virtually eliminate any electric field losses outside the cable, thus maximizing the power delivered by the cable to its final destination on shore (Hampton et al., 2007). In addition, the electric field effects of electric transmission cables should not be confused with electric barrier/deterrent system designs. For example, large fish deterrents/barriers, such as those used at the Chicago Ship Canal, are electrical systems designed to transfer as much energy into the water as possible, using exposed bare electrodes in the water to be effective as a fish deterrent. The impact on fish habitat and behavior from electric transmission lines is not comparable to the impact from electric deterrent systems; one system is designed to transfer as much energy as possible into the water, while the other, as is the case for the LEEDCo project, is designed to prevent as much of this energy loss as possible. More information on the Chicago Ship Canal electric barrier can be found at http://www.lrc.usace.army.mil/Missions/CivilWorksProjects/ANSPortal/Barrier.aspx.

Magnetic Field Impacts

The primary concern with submarine cables is the magnetic field that develops around the cable. A magnetic field cannot be contained by the cable shielding and can travel through sediment and water, to some degree. However, studies conducted on magnetic fields created by submarine transmission lines indicate that the magnetic fields are similar to background levels and decrease exponentially with distance from the transmission line. As summarized in Figure 1, Cada et al. (2011, 2012) found that even at 1 meter from the cable, the EMF levels were near background levels (50 micro tesla units (μT)). In a personal communication with Verdant Power Inc., the researchers found that three additional Verdant alternative energy projects had underwater transmission cables that were estimated to generate magnetic fields ranging from 20-100 micro tesla units (μT), one meter away from the surface of the cables. For context, the naturally occurring earth magnetic field is approximately 50 μT in the United States (Bochert and Zettler 2004, Normandeau et al., 2011). Normandeau et al. (2011) evaluated 10 alternating current (AC) projects with standard cable specifications in marine environments. Of the 10 projects the maximum magnetic field at the seabed was estimated to be 18 micro tesla units (μT). The average estimated magnetic field at the seabed for all 10 projects evaluated was found to be 7.8 μT, well below the naturally occurring earth magnetic field. For comparison purposes and as discussed below, the estimated magnetic field from the proposed LEEDCo transmission cable, at 1 meter from the cable, is approximately 2 μT (See Figure 1). Therefore, the estimated magnetic field from the LEEDCo transmission line is much less than background levels and the average magnetic fields measured for other underwater transmission line projects.

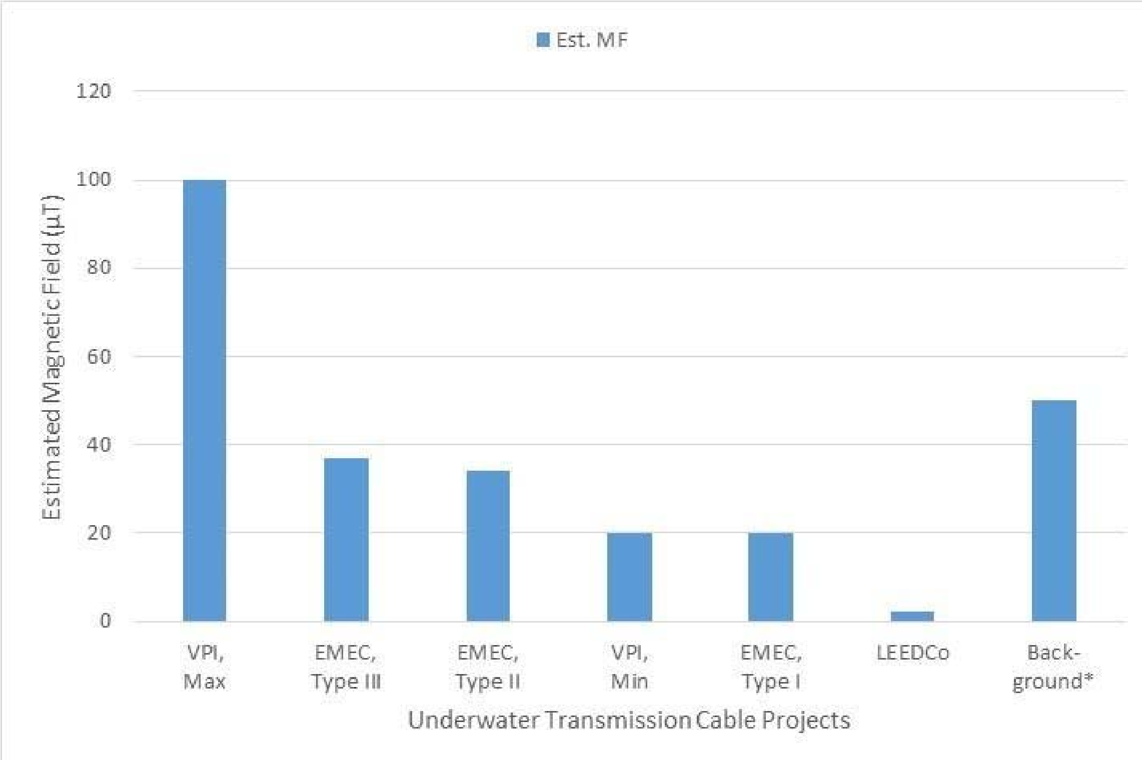

Figure 1. EMF levels for various underwater transmission cable projects (VPI and EMEC) are summarized in Cada et al. (2012). Note for comparison purposes, the insertion of the estimated LEEDCo transmission line EMF at 1m above the buried cable (JDR, 2013) and the inclusion of the naturally occurring earth magnetic field (*) as background.

In addition to demonstrating that the magnetic fields generated by transmission lines are small relative to background, research has also shown that the strength of magnetic field decreased exponentially with distance from the cable center and that burying the cable(s) further diminishes the impacts of magnetic fields (Bevelhimer et al. 2013). For example, a study by Cada et al. (2011, 2012) at the Oak Ridge National Laboratory, found that the strength of the magnetic field decreased as a function of the distance from the source. Based on their calculations, the researchers also found that the strength of the magnetic field decreased exponentially as the distance from the electric transmission cable increased. Using a similar method, Cada et al. (2011) estimated expected magnetic fields based on electric transmission cable characteristics. As part of their experiment, Cada et al. measured the magnetic field at the source of the magnetic field and at several locations away from the source. Even when operating the electromagnet at maximum strength (165,780 µT), they found that the strength of the magnetic field returned to background levels (~100-200 µT) 11 inches away from the source of the field. Preliminary results from ongoing research on in situ cables have corroborated the conclusion that transmission line generated, magnetic fields diminish significantly with distance to near background levels (Bull, 2015; Thomsen, 2015).

LEEDCo Transmission Cable

Figure 2. Example LEEDCo cable cross section

The electric transmission cable specifications chosen by LEEDCo operate at a voltage of 34.5kV, AC, and the cable is made with crosslinked polyethelene (XLPE) insulation. The cable has three inner conductors, and an outer armored steel jacket (Figure 2). For the LEEDCo pilot project the cable will carry a maximum load of 20.7MW (3.45 MW per turbine). This translates to a current of 345 amps. The cable has an approximate total diameter of 100 mm (~4"). The cable will be buried below the surface using a cut and fill approach. Crosslinked polyethylene (XLPE) has become the globally preferred insulation for power cables, both for distribution and transmission system applications. Semiconducting screens are extruded over the three individual conductors and the insulation outer surface to maintain a uniform electric field, and to contain the electric field entirely within the cable jacket (Hampton et al., 2007). The construction of the electric transmission cable for the LEEDCo project is intended to reduce or eliminate any electric field losses outside the jacket of the cable. Any electric fields that escape the jacket decrease the efficiency of the cable and therefore, decrease the amount of power delivered by the cable to its final destination onshore. The proposed LEEDCo cable was specifically chosen to reduce or eliminate electric field losses, and thus reduce or eliminate effects of the electric field to surrounding biota or habitats.

Although a manufacturer has not been chosen, the magnetic field generated by the line is governed by the voltage and current of the transmission cable and not the cable design. Calculation of the estimated magnetic field from the LEEDCo cable was done by one of the transmission cable contractors, JDR Cable Systems in 2013 (JDR, 2013). A maximum magnetic field density of 2 μT was calculated for a load of 379 amps at a distance of 1 meter from the cable center. Note that this calculation was carried out at a slightly higher amperage than the LEEDCo proposed 345 amps. Even at 0.5m above the cable the magnetic field strength is only 8.5 μT, which is considerably less than the earth's magnetic field strength (~50 μT). An estimate of the magnetic field strength at various distances from the cable center is shown below is Figure 3.

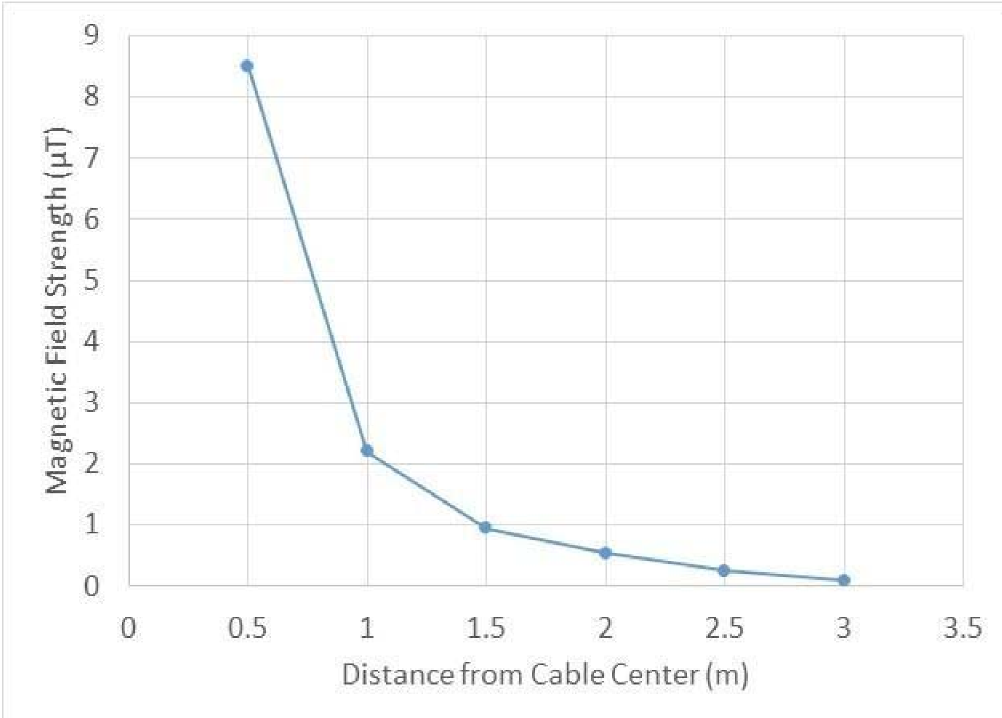

Figure 3. Magnetic field strength at various distances (estimated from JDR, 2013)

Current Research and Information: Electromagnetic Fields and Fish

It is important to understand the spatial scale when assessing the impacts of magnetic and induced electric fields on fish. Although behavioral and physiological effects on fish from electromagnetic fields have been documented in small scale laboratory experiments with embryos, larger scale experiments on juvenile and adult fish, both show little to no impact.

Fish, other aquatic organisms, and even currents can induce electric fields when passing through magnetic fields. The strength of an induced electric field varies depending on the speed and orientation of the object passing through the field. For example, perpendicular movement through a magnetic field will induce an electric field of maximum strength while parallel movement through the same field will not induce an electric field. So induced electric field strength depends on the distance from the field as well as on the speed of the organism (or current) and the orientation of the organism relative to the field. (Gill, 2005; OSPAR, 2009; Normandeau et al., 2011; Bergstrom, 2014; Thomsen et al., 2015; Copping, 2016).

Negative effects related to EMFs have mostly been observed in laboratory settings involving fish embryos exposed directly to EMFs. Increases in mortality due to EMF exposure does not appear to be a major concern (Shultz et al., 2012), but some studies have demonstrated sub-lethal effects. In a recent literature review of EMF experiments on fish embryos, delays in hatching were observed in magnetic fields stronger than 1,000 μT for several species (Krylov et al., 2014). Exposure to even stronger fields (2,000 μT) has been reported to increase the exchange rate between the embryo and the surrounding water (Krylov et al., 2014). However, these effects are not well understood (Thomsen et al., 2015). For example, when zebrafish embryos were exposed to 1,000 μT two hours after fertilization no significant developmental delay was observed, but when similar embryos received the same exposure 48 hours after fertilization a delay was detected (Skauli et al., 2000). Additionally, results from other sets of experiments on freshwater fish suggest that many of the observed effects seen in EMF-exposed embryos were not statistically different from the control groups, even at higher exposure levels (up to 3,000 μT) (Schultz et al., 2012). Although sub-lethal effects were observed in these studies, the levels of magnetic fields were significantly higher than the levels that are estimated to result from the electric transmission cable for the LEEDCo project. Therefore, it is not anticipated that the LEEDCo electric transmission cable will have any adverse impact on fish embryos in Lake Erie.

One study, which saw effects at lower magnetic field strengths, was conducted using Japanese rice fish. When exposing Japanese rice fish embryos to magnetic fields ranging between 15-60 μT, Lee et al. (2014) found that embryos exposed to 60 μT had higher levels of anxiety-like behavior and exhibited changes in morphology. The EMF-exposed embryos also developed faster than the control. Another experiment on roach embryos observed faster development in embryos, and a decrease in yearling size and weight (Chebotareva et al., 2009). Notably, the above studies were all completed with direct exposures of EMF on embryos, which tend to be the most sensitive life stage of a fish.

Cada et al. (2012) performed an experiment to evaluate the impact of magnetic fields generated by an instantaneous AC power source on juvenile freshwater fish. Juvenile paddlefish and juvenile lake sturgeon were placed in a circular tank, and an electromagnet was activated when the fish approached. The experiment was repeated at a variety of electromagnet strengths. The magnetic fields created by the AC electromagnet used in the experiment produced a field at full power of approximately 165,780 μT, whereas the control (background) level was 100-200μT. Even at 1% of the field strength of the maximum value the field was as high as 3,510 μT, which is several folds higher than typical transmission lines (Figure 1). The paddlefish experienced no statistically significant changes in behavior when exposed to the instantaneous magnetic fields. In contrast, lake sturgeon reacted to the magnetic fields at all strengths. Control groups of lake sturgeon also exhibited some altered behavior patterns, but the fish exposed to the magnetic fields displayed longer reaction times. Overall, no long-term changes in sturgeon behavior were observed. A follow up study by Bevelhimer et al. (2013) found that the EMF strength threshold for no behavioral response in lake sturgeon was approximately 1,000-2,000 μT, located about 4 to 8 inches away from the full strength electromagnet producing the EMF. Below this average threshold short-term responses disappeared. Based on the results of this work, researchers suggested burying the cables in order to take advantage of the rapid decay in magnetic field strength and to position cables in a way that would minimize crossings with migratory pathways (Bevelhimer et al. 2013).

An unpublished study by Westerberg and Lagenfelt found that 60 migrating silver eels had significantly slower swimming speeds when in the vicinity of a 130 kV AC transmission cable in the Baltic Sea (Ohman et al., 2007), which Ohman et al. (2007) suggested was a relatively minor impact. Some fish (like eels) are known to be sensitive to EMFs, but this does not necessarily mean that transmission cables will have a significant impact on movement and behavior (Ohman et al., 2007; Bull, 2015; Dunlop et al., 2016). Additionally, as documented earlier, recent lab experiments support the importance of spatial scale in mitigating the ecological impact of electromagnetic fields.

To assess whether EMFs from the LEEDCo transmission line could have an adverse impact on fish species of concern in the Great Lakes, we took a further look at a study involving Lake Sturgeon (*Acipenser fulvescens*). Lake Sturgeon have both shallow and deep water life-history requirements associated with the substrates, and are benthic feeding. Lake Sturgeon are also considered an electro-sensitive species, having developed complex electroreceptors for the purpose of feeding and migration (Map of Life, 2016). Bevelhimer et al. (2013), studied EMF effects on Lake Sturgeon and found that the EMF strength threshold for no behavioral response in Lake Sturgeon was 1,000-2,000 µT, when located about 4 to 8 inches away from the full strength EMF. Figure 4 below shows the threshold level versus estimated EMF levels from Figure 1 above. If Sturgeon are in the vicinity of the LEEDCo transmission line, this large species could be exposed to EMFs however, the LEEDCo transmission cable is planned to be buried below the substrate, at a great enough depth so that any EMF from the transmission line will be well below the strength threshold for no behavioral response in Lake Sturgeon. (See Figure 4). Therefore, EMFs from the LEEDCo transmission cable are not expected to adversely affect Lake Sturgeon.

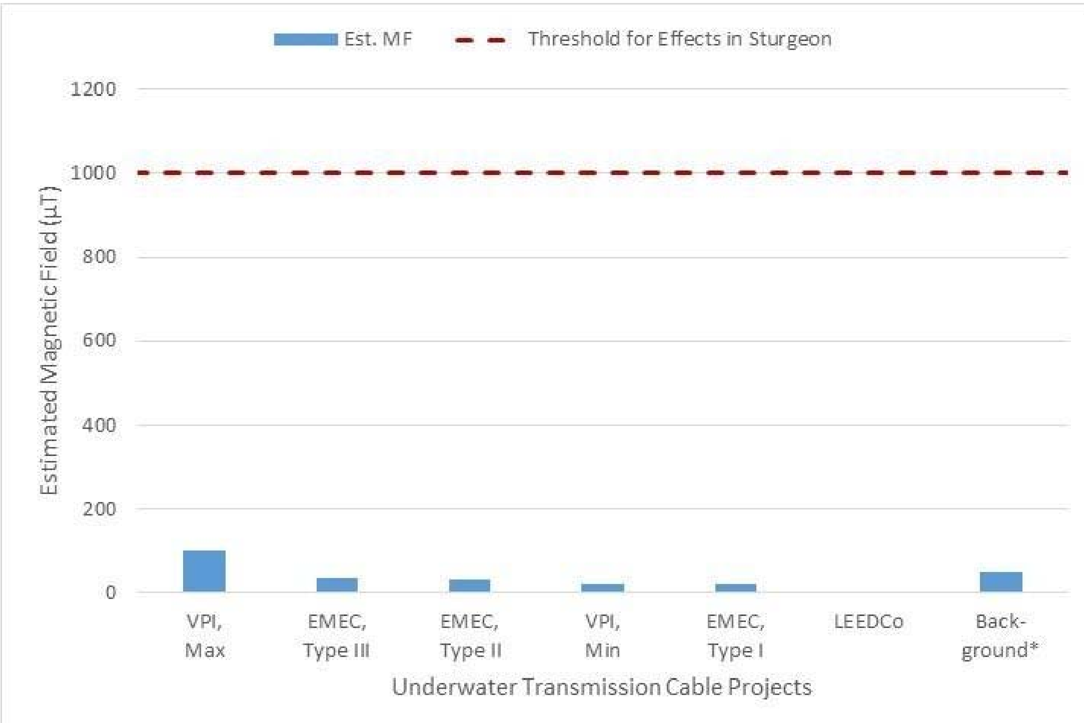

Figure 4. EMF levels (at 1m above buried cables) for various transmission lines (Cada et. al. 2012) and LEEDCo (JDR, 2013) estimate versus Sturgeon effects level.

Magnetic Field Studies

Electric transmission lines within Lake Erie, the Great Lakes or in coastal regions of the United States in general, are not unique and have been permitted and installed for many decades. Several large electric transmission lines are already in place not too far from the project site transiting from Port Clinton to Put-in-Bay, Catawba to South Bass Island, and over 25 miles of electric transmission cable from the Ontario mainland to Pelee Island. Other transmission cables are also in the proposal phase, such as a 73 mile Lake Erie cable, known as the ITC Lake Erie Connector, which will interconnect power grids in Pennsylvania and Ontario.

California Power Cable ObservationStudy

A study just released in June 2016 by the U.S. Department of the Interior, Bureau of Ocean Energy Management, summarized research from 2012 to 2014, which investigated the potential behavior and reaction of electromagnetic-sensitive species to energized and unenergized cables in a corridor on the seafloor in an offshore area of Southern California (Love et al., 2016). All of the cables in the Love et al. study are very similar to the LEEDCo proposed cable (35kV AC cable with similar power loads) except the cables were not buried below the sediment surface (as will be the case for the LEEDCo electric transmission cables). Over the course of the study, average EMF levels were between 73 µT and 91.4 µT, at the sediment surface which are significantly higher than the LEEDCo estimated EMF levels (of no more than 2 µT one meter above the buried cable). The study did not find any biologically significant differences among fish and invertebrate communities between energized cables, pipe, and natural habitat. The authors noted there was not any compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fishes. The Love et al. study also corroborated the findings of previous studies which determined that EMF strength dissipates with distance from the transmission cable and approaches background levels at approximately 1 meter from the cable. Furthermore, Love et al. concluded that, “[i]n this and similar cases, cable burial at sufficient depth would be an adequate tool to prevent EMF emissions from being present at the seafloor.”

Lake Ontario Magnetic Field Study

A recent study conducted within the Great Lakes to monitor for the potential impacts of magnetic fields on fish, Dunlop (2016), concluded “…no detectable effects of the cable on the fish community were found. Local habitat variables, including substrate or depth, were more important in explaining variation in fish density than proximity to the cable”. This project monitored the Wolfe Island wind power project which has a 7.8km buried transmission line running from an island offshore to the mainland. The transmission line carries up to 200MW of power at a maximum of 170kV, which is much larger than the LEEDCo proposed transmission line voltage and power. The study involved nearshore electrofishing surveys and acoustic surveys paired with gill netting. Little difference between fish communities in transects near the cable and reference transects was detected. In the acoustic surveys, researchers did not see significant changes in fish density related to transmission cable proximity either.

Lake Erie Connector Project

The most relevant and nearby project is the ITC Lake Erie Connector project, which is a proposed 1,000MW, 320kV, direct current (DC) transmission cable to link the Ontario Independent Electric System Operator (IESO) with the Pennsylvania PJM Interconnection (PJM). This cable would carry ten times the voltage and almost fifty times the power compared with the LEEDCo proposed transmission cable. More information on the project can be found at http://www.itclakeerieconnector.com/. Although this project does not enter Ohio waters, it is going through a similar permit process with the Province of Ontario, State of Pennsylvania, US Department of Energy, Canada’s National Energy Board, and US Army Corps of Engineers. The cable will span the entire width of Lake Erie and will cross both nearshore and offshore fish habitat areas. Based on personal conversations, we learned that to date, none of the relevant permitting agencies involved have focused on magnetic field concerns. ITC Holdings, LLC, the project owner, reviewed the relevant magnetic field concerns early on in the project and found no significant impacts were expected. Per conversations with project staff, impact concerns have centered on construction methods and shoreline directional drilling rather than magnetic field concerns.

Conclusion

Based on the expected low EMF levels to be generated by the LEEDCO project and the current research regarding EMF impacts on fish behavior and habitat, including some studies that have been completed in the Great Lakes or on Great Lakes species of concern, it is our assessment that additional review or studies of potential EMF impacts from the planned transmission cable proposed by LEEDCo are not necessary. The ODNR required acoustic telemetry studies, as specified in the ODNR Aquatic Sampling Protocol for Offshore Wind Development, to monitor for transmission line effects on fish behavior would be of limited value given the evidence that no measureable EMF impacts are expected from the LEEDCo transmission line project and the abundant current research showing that EMFs from transmission cables similar to the one proposed by LEEDCo do not have a significant effect on fish behavior. Acoustic telemetry research has been widely used across the Great Lakes to understand general fish movement patterns and can be used to monitor local fish behavior within river mouths and channels, but it has limited value to monitor local fish behavior within the open waters of the Great Lakes and should not be a requirement of the pre-, during, and post- construction monitoring.

References

Bergström, Lena, Lena KauTsky, Torleif Malm, RuTger Rosenberg, Magnus Wahlberg, Nastassja Åstrand Capetillo, and Dan Wilhelmsson. 2014. "Effects of Offshore Wind Farms on Marine Wildlife—a Generalized Impact Assessment." *Environmental Research Letters* 9 (3). IOP Publishing: 034012. doi:10.1088/1748-9326/9/3/034012.

Bevelhimer, Mark S., Glenn F. Cada, Allison M. Fortner, Peter E. Schweizer, and Kristina Riemer. 2013. "Behavioral Responses of Representative Freshwater Fish Species to Electromagnetic Fields." *Transactions of the American Fisheries Society* 142 (3). Taylor & Francis Group: 802–13. doi:10.1080/00028487.2013.778901.

Bevelhimer, MS, GF Cada, and C Scherelis. 2015. "Effects of Electromagnetic Fields onBehavior of Largemouth Bass and Pallid Sturgeon in an Experimental Pond Setting." https://info.ornl.gov/sites/publications/Files/Pub59407.pdf.

Bochert, R. and Zettler, M.L., 2004. Long-term exposure of several marine benthic animals to static magnetic fields. Bioelectromagnetics, 25(7),pp.498-502.

Cada, GF, and MS Bevelhimer. 2011. "Effects on Freshwater Organisms of Magnetic Fields Associated with Hydrokinetic Turbines." ORNL/TM-2011/244, Oak Ridge National Laboratory, Oak Ridge, Tennessee. https://www.researchgate.net/profile/Kristina_Riemer/publication/241971469_Effects_on_Freshwater_Organisms_of_Magnetic_Fields_Associated_with_Hydrokinetic_Turbines/links/00b49537fb66cd1a2c000000.pdf.

Cada, GF, and MS Bevelhimer. 2012. "Laboratory Studies of the Effects of Static and Variable Magnetic Fields on Freshwater Fish." ORNL/TM-2012/119. Oak Ridge National Laboratory, Tennessee.http://info.ornl.gov/sites/publications/files/Pub35678.pdf.

Chebotareva, YV, YG Izyumov, and VV Krylov. 2009. "The Effect of an Alternating Electromagnetic Field upon Early Development in Roach (Rutilus Rutilus: Cyprinidae, Cypriniformes)." Journal of Ichthyology. http://link.springer.com/article/10.1134/S0032945209050075.

Copping, A. 2016. "The potential environmental effect of electric and magnetic fields onmarine environment." Pacific Northwest National Laboratory. http://tethys.pnnl.gov/sites/default/files/publications/EMF-One-Pager.pdf

Dunlop, E. S., S. M. Reid, and M. Murrant. 2016. "Limited Influence of a Wind Power Project Submarine Cable on a Laurentian Great Lakes Fish Community." *Journal of Applied Ichthyology* 32 (1): 18–31. doi:10.1111/jai.12940.

Gill, A.B., I. Gloyne-Phillips, K.J. Neal, and J.A. Kimber. 2005. The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms–a review. *Final report*.

Hampton, N., R. Hartlein, H. Lennartsson, H. Orton, and R. Ramachandran. 2007. Long-Life XLPE Insulated Power Cable. Presented at JiCable 2007 (Conference on Power Insulated Cables). Versailles, France. June 24 to 28, 2007.

JDR Cable Systems. 2013. Designed Report. The induced magnetic field in seawater around CAF1556. JDR Document No. D2389. Modified January 24, 2013.

Krylov, VV, and YG Izyumov. 2014. "Magnetic Fields and Fish Behavior." Biology Bulletin Reviews.http://link.springer.com/article/10.1134/S2079086414030049.

Lee, W, and KL Yang. 2014. "Using Medaka Embryos as a Model System to Study Biological Effects of the Electromagnetic Fields on Development and Behavior." Ecotoxicology and Environmental Safety. http://www.sciencedirect.com/science/article/pii/S0147651314002917.

Love, M. S., M. M. Nishimoto, S. Clark, and A. S. Bull. 2016. Renewable Energy in situ Power Cable Observation. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study 2016-008. 86 pp. www.lovelab.id.ucsb.edu.

Map of Life - "Electroreception in fish, amphibians and monotremes", http://www.mapoflife.org/topics/topic_41_electroreception-in-fish-amphibians-and-monotremes/June 15, 2016.

Nordman, E, and DM O'Keefe. 2011. "Offshore wind energy in Michigan: implications for the Great Lakes Environment." MICHU-11-736.

Normandeau Associates, Inc., Exponent, Inc., T. Tricas, and A. Gill. 2011. "Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species: Final Report." DIANE Publishing. https://books.google.com/books?hl=en&lr=&id=FnLSvBMA4B8C&pgis=1.

Ohman, Marcus C., Peter Sigray, and Håkan Westerberg. "Offshore windmills and the effects of electromagnetic fields on fish." AMBIO: A journal of the Human Environment 36.8 (2007): 630-633.

OSPAR. 2009. "Assessment of the Environmental Impacts of Cables." http://www.ospar.org/.

Thomsen, F., A. Gill, M. Kosecka, M. Andersson, M. Andre, S. Degraer, T. Folegot, J. Gabriel, A. Judd, T. Neumann, A. Norro, D. Risch, P. Sigray, D. Wood, and B. Wilson. 2015. "maRVEN—Environmental impacts of noise, vibrations and electromagnetic emissions from marine renewable energy." RTD-KI-NA-27-738-EN-N. https://tethys.pnnl.gov/annex-iv-research/marven-environmental-impacts-noise-vibrations-and-electromagnetic-emissions-marine

Schultz, I. R., W. J Pratt, D.L. Woodruf, G. Roesijadi, and K.E. Marshall. 2010. Effects of Electromagnetic Fields on Fish and Invertebrates. Washington: Pacific Northwest National Laboratory. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19883.pdf.

Skauli, K. S., J.B. Reitan, and B.T. Walther. 2000. Hatching in zebrafish (Danio rerio) embryos exposed to a 50 Hz magnetic field. Bioelectromagnetics, 21(5),407-410.