ENVIRONMENTAL ASSESSMENT
FOR
HYDROPOWER LICENSE

Ludington Pumped Storage Hydroelectric Project

FERC Project No. 2680-113

Michigan

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, DC 20426

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

Alden	Alden Research Laboratory, Inc.
APE	area of potential effect
°C	degrees Celsius
certification	water quality certification
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
Commission	Federal Energy Regulatory Commission
Consumers Energy	Consumers Energy Company
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DTE	DTE Electric Company
DO	dissolved oxygen
EA	environmental assessment
ESA	Endangered Species Act
°F	Fahrenheit
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
fps	feet per second
fph	feet per hour
FWS	United States Fish and Wildlife Service
GLSC	U.S. Geological Survey Great Lakes Science Center
Guidance	Water Quality Guidance for the Great Lakes System
HPMP	historic properties management plan
IGLD 85	International Great Lakes Datum of 1985
ILP	Integrated Licensing Process
Interior	United States Department of the Interior
Michigan DEQ	Michigan Department of Environmental Quality
Michigan DNR	Michigan Department of Natural Resources
Michigan SHPO	Michigan Historic Preservation Officer
MISO	Midcontinent Independent System Operator, Inc.
mg/L	milligrams per liter
MW	megawatt
MWh	megawatt-hours
National Register	National Register of Historic Places
NERC	North American Electric Reliability Council
NGVD 29	National Geodetic Vertical Datum of 1929
NHPA	National Historic Preservation Act
PA	programmatic agreement
PAD	Pre-Application Document

Park Service	National Park Service
PCBs	polychlorinated biphenyls
Pere Marquette	Pere Marquette Charter Township
SAT	Scientific Advisory Team
SD1	Scoping Document 1
U.S.C.	United States Code
USGS	United States Geological Survey

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LUDINGTON PUMPED STORAGE HYDROELECTRIC PROJECT
Project No. 2680-113 - Michigan

1.0 INTRODUCTION

1.1 APPLICATION

On June 28, 2017, Consumers Energy Company and DTE Electric Company (Consumers Energy and DTE Companies) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a new license to continue to operate and maintain the existing Ludington Pumped Storage Hydroelectric Project No. 2680 (Ludington Project, or project). The 1,785-megawatt (MW) project is located on the east shore of Lake Michigan in the townships of Pere Marquette and Summit, Mason County, Michigan, and in Port Sheldon, Ottawa County, Michigan (*see* Figure 1). The Ottawa County portion is a 1.8-acre satellite recreation site, located about 70 miles south of the project. The project does not occupy federal land.

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the Ludington Project is to provide a source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a license to Consumers Energy and DTE Companies for the project and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project will be best adapted to a comprehensive plan for improving or developing the waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, and water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

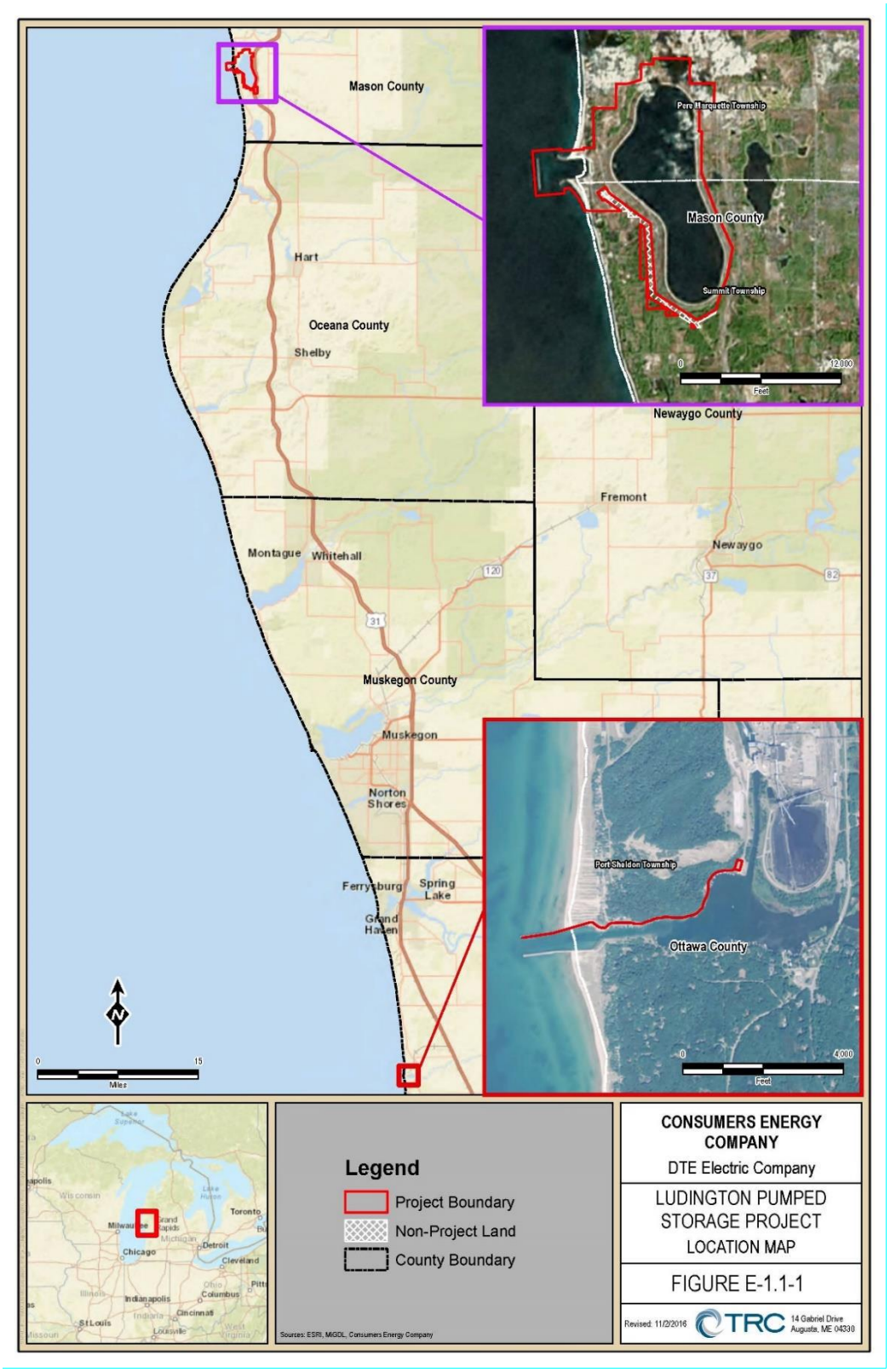

Figure 1. Location of the Ludington Project (Source: Consumers Energy and DTE Companies, 2017a).

This environmental assessment (EA) assesses the effects that would be associated with continued operation of the project, project alternatives, and makes recommendations to the Commission on whether to issue a license, and if so, recommends terms and conditions to become a part of any license issued.

The EA assesses the environmental and economic effects of the following alternatives: (1) operating and maintaining the project as proposed by Consumers and DTE Companies; (2) operating and maintaining the project as proposed by Consumers and DTE Companies, with additional staff recommended measures (staff alternative); and (3) the staff alternative with mandatory conditions. We also consider the effects of a no-action alternative. Under a no-action alternative, the project would continue to operate as it does under the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented. The primary issues associated with relicensing the project are: (1) the effects of project operation on fish entrainment-related mortality; and (2) access to recreational opportunities at the project.

1.2.2 Need for Power

The Ludington Project provides hydroelectric generation to meet daily peak energy and capacity needs. The project's authorized capacity is 1,785 MW which will generate approximatively 2,658,200 megawatt-hours (MWh) when all six unit upgrades are completed in 2019.[1] Project power is sold directly into the Midcontinent Independent System Operator, Inc. (MISO) wholesale market where the project is located. MISO serves as the independent system operator with primary responsibilities to coordinate, monitor, and direct the operations of generating and transmission facilities in the region.

To assess the need for the project's power, we looked at the North American Electric Reliability Corporation's (NERC) MISO assessment area. NERC annually forecasts electrical supply and demand nationally and regionally for a 10-year period. NERC's 2017 Long-Term Reliability Assessment designates summer as the peak season for the planning reserve margin[2] in the MISO assessment area. While the summer peak demand for MISO is projected to increase by 0.3 percent from 2018 to 2027, the anticipated reserve margin is forecasted to decrease from 19.23 percent in 2018 to 14.56 percent in 2027. The MISO assessment area is thus forecast to meet MISO's target

[1] *Consumers Energy Company and Detroit Edison Company*, 139 FERC ¶ 62,101 (2012).

[2] Expressed as a percentage, the reserve margin designates available generating capacity in excess of expected peak demand. MISO's target reserve margin is 15.8 percent.

reserve margin of 15.8 percent through the year 2022, but fall below 15.8 percent beginning in 2023 and continuing through 2027.

We, therefore, conclude that the Ludington Project would help meet the need for power in the MISO assessment area while providing fast start capability, frequency regulation, and spinning and supplemental reserves. The project adds to grid reliability during peak demand and contributes to a diversified generation mix.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

Any new license for the project would be subject to numerous requirements under the FPA and other applicable statutes. The major regulatory and statutory requirements are described below.

1.3.1 Federal Power Act

1.3.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as may be prescribed by the Secretaries of the U.S. Department of Commerce or the U.S. Department of the Interior (Interior). No fishway prescriptions or requests for reservation of authority to prescribe fishways have been filed under section 18 of the FPA.

1.3.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency. No recommendations have been filed pursuant to section 10(j) of the FPA.

1.3.2 Clean Water Act

Under section 401(a)(1) of the Clean Water Act (CWA), 33 U.S.C. § 1341(a)(1), a license applicant must obtain either water quality certification (certification) from the appropriate state pollution control agency verifying that any discharge from a project would comply with applicable provisions of the CWA, or a waiver of certification by the

appropriate state agency. A waiver occurs if the state agency does not act on a request for certification within a reasonable period of time, not to exceed one year after receipt of such request.

On June 28, 2017, Consumers Energy and DTE Companies applied to the Michigan Department of Environmental Quality (Michigan DEQ) for certification for the project. Michigan DEQ received the request for certification on July 3, 2017,[3] and issued a certification on June 6, 2018. The conditions of the certification are described under section 2.3, *Modifications to Applicant's Proposal – Mandatory Conditions*.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA), 16 U.S.C. § 1536, requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of endangered or threatened species, or result in the destruction or adverse modification of the critical habitat of such species. Review of the United States Fish and Wildlife Service's (FWS) Information for Planning and Conservation (IPaC) system in July 2018 indicated that eight federally listed species have the potential to occur in Mason and Ottawa Counties, including the Indiana bat, northern long-eared bat, eastern massasauga, piping plover, red knot, Karner blue butterfly, Pitcher's thistle, and whooping crane. Our analysis of project effects on threatened and endangered species is presented in section 3.3.3, *Threatened and Endangered Species*, and our recommendations are included in section 5.1, *Comprehensive Development and Recommended Alternative*.

We conclude that relicensing the project would have no effect on the eastern massasauga, piping plover, red knot, Karner blue butterfly, Pitcher's thistle, and whooping crane because: (1) continued project operation and maintenance would not affect these species respective habitats; and (2) wildlife and botanical surveys conducted in 2015 indicate the probable absence of these species at the project.

FWS's IPaC system indicates that the federally listed Indiana bat and northern long-eared bat occur within the counties of the project. Approximately 190 acres of woodlands occur at the project which are subject to Consumers Energy and DTE Companies' periodic timber sales. On average, 68 trees are removed per year, with the most recent timber sale in 2017 removing 460 predominantly mature, hardwood trees. Such mature, hardwood trees can provide roosting habitat to the Indiana and northern

[3] *See* Michigan DEQ's email dated July 7, 2017, from Amira Oun (Michigan DEQ, Environmental Engineer) to David Mcintosh (Consumers, Senior Licensing Manager) included in Attachment 1 to Consumers Energy and DTE Companies' July 17, 2018, filing.

long-eared bats. As discussed in section 3.3.4.2, *Environmental Effects, Recreation and Land Use*, staff determined that approximately 155 acres of forested lands that serve no project purpose should be removed from the project boundary. However, tree removal in the remaining 35 acres resulting from Consumers Energy and DTE Companies' intermittent timber harvests has the potential to disturb roosting bats and their newly born pups during a sensitive period of their life cycle. Therefore, we conclude that with a seasonal restriction to tree clearing in place from June 1 to July 31, continued project operation and maintenance may affect, but is not likely to adversely affect the Indiana bat. In addition, because tree removal that may result from the Consumers Energy and DTE Companies' timber harvests does not occur within 0.25 miles of a known northern long-eared bat hibernacula, or within 150 feet of a known maternity roost, we conclude that that continued operation and maintenance of the project may affect the northern long-eared bat, but any incidental take that may result is not prohibited per the final 4(d) rule.

1.3.4 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) of 1972, as amended, requires review of the project's consistency with a state's Coastal Management Program for projects within or affecting the coastal zone. Under section 307(c)(3)(A) of the CZMA, 16 U.S.C. § 1456(c)(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state's CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA Program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

In a letter dated September 29, 2017,[4] Michigan DEQ states that portions of the project will affect areas located within Michigan's coastal management boundary and, therefore, are subject to the state's consistency review. Michigan DEQ states that a determination of consistency with the Michigan Coastal Management Program requires an evaluation of a project to determine if it will have an adverse impact on coastal land, water uses, or coastal resources. Michigan DEQ further states that projects are evaluated using the permitting criteria contained in the regulatory statutes administered by Michigan DEQ, which constitute the enforceable policies of the Coastal Management Program. Michigan DEQ, therefore, has concluded that because the water quality certification will largely embody these requirements, no adverse effects to coastal resources are anticipated from relicensing the project, provided Consumers Energy and DTE Companies comply with all conditions of the water quality certification.

[4] *See* Enclosure 2 of Consumers Energy and DTE Companies' December 20, 2017, filing.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA), 54 U.S.C. § 306108, requires federal agencies to "take into account" how each of its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register or historic properties).

On March 20, 2014, Commission staff designated Consumers Energy and DTE Companies as its non-federal representative for the purposes of conducting section 106 consultation with the Michigan State Historic Preservation Officer (Michigan SHPO), under section 106 of the NHPA. As the Commission's designated non-federal representative, Consumers Energy and DTE Companies consulted with the Michigan SHPO and Saginaw Tribe to identify historic properties, determine the National Register-eligibility of the projects, and assess potential adverse effects on historic properties within the project's area of potential effects (APE).

These consultations and other investigations concluded that within the project's APE, the Ludington Pumped Storage Hydroelectric Facility is eligible for listing in the National Register and two post-contact archaeological sites (20MN324 and 20MN329) are potentially eligible for listing in the National Register.

To meet the requirements of section 106 of the NHPA, the Commission intends to execute a Programmatic Agreement (PA) with the Michigan SHPO. The PA would contain principals and procedures for the protection of historic properties from the effects of the operation and maintenance of the project. The terms of the PA would ensure that Consumers Energy and DTE Companies addresses and treats all historic properties identified within the project's APE through implementation of a Historic Properties Management Plan (HPMP). Consumers Energy and DTE Companies filed an HPMP on June 28, 2017, and the Michigan SHPO concurred on May 5, 2017.

1.4 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 C.F.R. §§ 5.1 to 5.16) require applicants to consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, the ESA, the NHPA, and other federal statutes. Pre-filing consultation must be completed and documented according to the Commission's regulations.

Relicensing of the project was formally initiated on January 21, 2014, when Consumers Energy and DTE Companies filed with the Commission a Pre-Application

Document (PAD) and a Notice of Intent to license the project using the Integrated Licensing Process (ILP). The Commission issued a Notice of Commencement of Proceeding on March 20, 2014.

1.4.1 Scoping

Before preparing this EA, staff conducted scoping to determine what issues and alternatives should be addressed. During the pre-filing consultation process, scoping meetings were held to determine what issues and alternatives should be addressed in the EA. Scoping Document 1 (SD1) was issued on March 20, 2014. Scoping meetings were held in Pentwater, Michigan on April 17, 2014, to request comments on the project. A court reporter recorded all comments and statements made at the scoping meetings, and these are part of the Commission's public record for the project. An environmental site review was held on July 30, 2014.

In addition to comments provided at the scoping meetings, the following entities provided written comments pertaining to SD1, the PAD, and additional study needs:

Commenting Entity	Date Filed
Pere Marquette Township	May 08, 2014
Mason County Parks and Recreation Commission	May 19, 2014
Little River Band of Ottawa Indians	May 20, 2014
Michigan Department of Natural Resources; Michigan Attorney General, U.S. Fish and Wildlife Service; Grand Traverse Band of Ottawa; Chippewa Indians; Little Traverse Bay Bands of Odawa Indians; National Wildlife Federation; Michigan United Conservation Clubs, and; Little Traverse Bay Bands of Odawa Indians	May 21, 2014

1.4.2 Interventions

On February 8, 2018, the Commission issued a notice accepting the application and setting April 9, 2018, as the deadline for filing protests and motions to intervene. The Michigan Department of Natural Resources (Michigan DNR) filed a notice of intervention on April 9, 2018. No entities filed in opposition to issuance of a license.

1.4.3 Comments on the Application

On February 8, 2018, the Commission issued a notice setting April 9, 2018 as the deadline for filing comments, recommendations, terms and conditions, and prescriptions. The following entities commented:

Commenting Entity	Date Filed
Pere Marquette Charter Township	April 3, 2018
Michigan DNR	April 9, 2018
Interior	April 9, 2018
National Park Service (Park Service)	April 11, 2018

1.4.4 Settlement Agreement

On November 13, 2017, Consumers Energy and DTE Companies filed a Fish Entrainment Settlement Agreement (Settlement Agreement) for the project. The Settlement Agreement was signed by Consumers Energy and DTE Companies; Attorney General for the State of Michigan; Michigan DNR; Interior, on behalf of the FWS and as Trustee for Indian tribes, bands, or communities with reserved treaty rights in the Michigan waters of Lake Michigan; Grand Traverse Band of Ottawa and Chippewa Indians; Little River Band of Ottawa Indians; Little Traverse Bay Bands of Odawa Indians; Michigan United Conservation Clubs; and National Wildlife Federation (Settling Parties). The Settlement Agreement resolves among the Settling Parties all issues associated with issuance of a new license for the project regarding fish entrainment and requests a 50-year license term.[5] The Settling Parties request that the Commission accept and incorporate the agreed-upon measures into any new license that may be issued for the project. These measures are included as Appendix B to this EA. We consider the Settlement Agreement to represent the Applicant's Proposed Action regarding fish entrainment issues.

On November 14, 2017, the Commission issued a Notice of Settlement Agreement. That notice set December 4, 2017, as the deadline for filing comments, and December 14, 2017, as the deadline to file reply comments. On December 4, 2017, the Settling Parties, with the exception of Consumers Energy and DTE Companies, filed a joint comment letter in support of the Settlement Agreement and the applicant's request

[5] Accompanying the Settlement Agreement filed on November 13, 2017, was a separate request from Consumers and DTE Companies for a 50-year license term.

for a 50-year license term. On December 12, 2017, Interior filed a letter stating that it did not have any comments on the Settlement Agreement.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 NO ACTION ALTERNATIVE

Under the no-action alternative, the project would continue to operate under the terms and conditions of the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented. We use this alternative to establish baseline environmental conditions for comparison with other alternatives.

2.1.1 Existing Project Facilities

The Ludington Project consists of: an 842-acre reservoir (upper reservoir) with a gross storage capacity of 82,300 acre-feet at an elevation of 942 feet National Geodetic Vertical Datum 29 (NGVD 29) with a maximum drawdown of 67 feet; a concrete intake structure located in the upper reservoir; six, 1,300-foot-long steel penstocks varying in diameter from 28.5 feet at the intake to 24 feet at the powerhouse; a concrete powerhouse consisting of six bays that house the six pump-turbine/motor-generator units; two 1,600-foot-long jetties forming the project's U-shaped tailrace from which Lake Michigan water is withdrawn; an approximately 1,850-foot-long breakwater located about 2,700 feet from the Lake Michigan shoreline; a seasonal barrier net approximately 12,850 feet in length; and several appurtenant facilities. A satellite recreation site (Pigeon Lake North Pier), located about 70 miles south in Port Sheldon Township, is also part of the project. The facility includes a parking area and a 4,600-foot-long boardwalk. *See* Figure 2 and Figure 3.

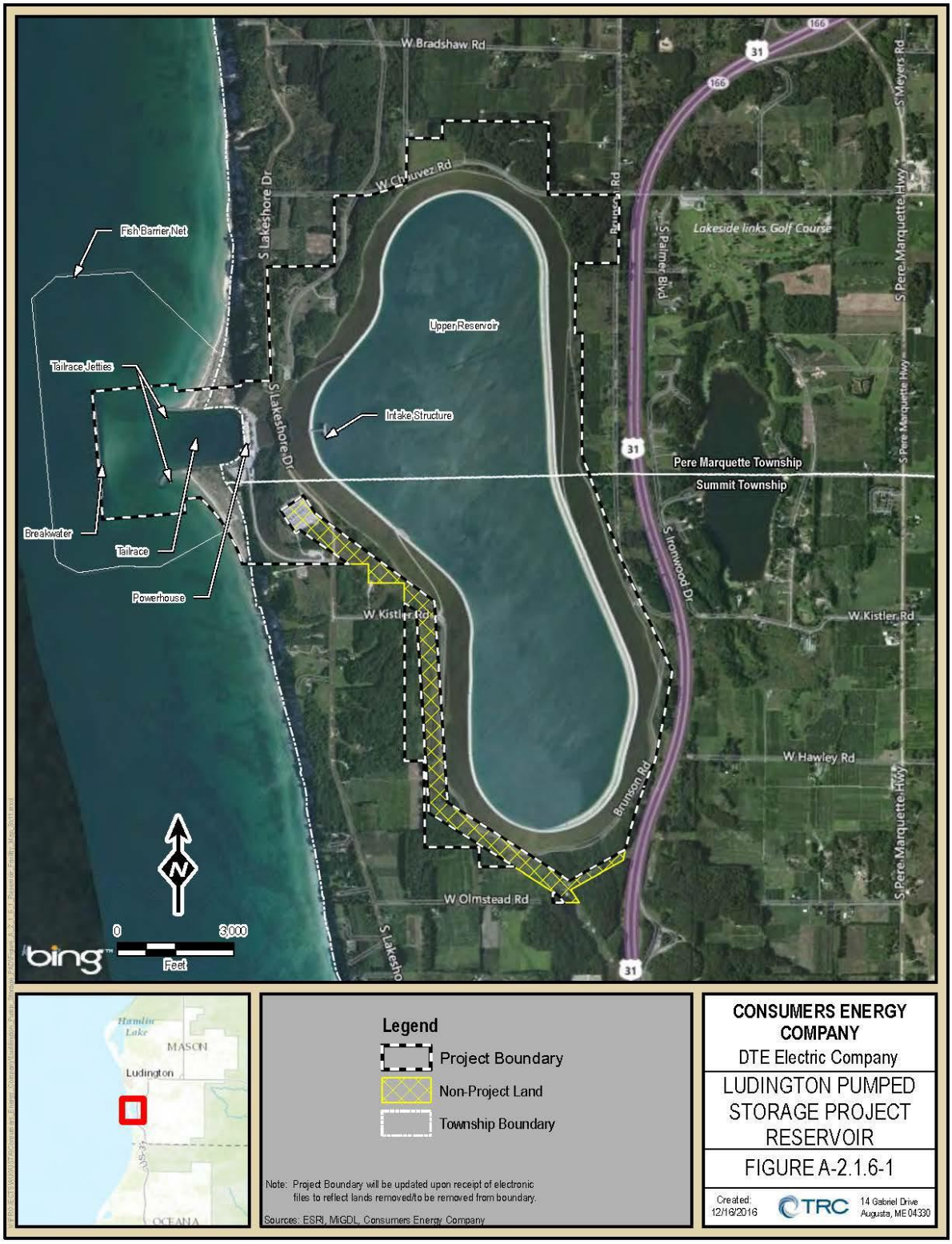

Figure 2. Ludington Project site plan (Source: Consumers Energy and DTE Companies, 2017a).

Figure 3. Pigeon Lake North Pier (Source: Consumers Energy and DTE Companies, 2017a).

The Ludington Project generates during peak demand periods. Generation usually occurs during the day with the upper reservoir partially replenished at night during pumping.

Consumers and DTE Companies operate and maintain six recreational facilities at the project: Mason County Campground, Hull Field, Mason County Day Use and Picnic Area, Reservoir Overlook, Lake Michigan Overlook, and a satellite recreation site (Pigeon Lake North Pier), located about 70 miles south of the project.

2.1.2 Current and Proposed Project Boundary

The current project boundary for the Ludington Project encompasses approximately 1,700 acres and includes the upper reservoir, lands associated with the penstocks, powerhouse, generator lead lines, recreation facilities, a portion of Lake Michigan containing the tailrace, the two jetties and the breakwater, and appurtenant facilities. The project boundary also encloses the Pigeon Lake North Pier recreation area. The Ludington Switchyard and the lands associated with the three 345 kV transmission lines extending east and south of the Ludington Switchyard were excluded from the project boundary by Commission order issued on February 9, 2001.[6]

The barrier net, which extends from the lake bottom to the water surface, is installed seasonally from approximately mid-April to mid-October outside of the tailrace structures. Under the current license, the barrier net is not considered a project facility and is not located within the existing project boundary. Consumers and DTE Companies do not propose any changes to the existing project boundary.

2.1.3 Project Safety

The Ludington Project has been operating for more than 48 years under an existing license. During this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance.

As part of the relicensing process, the Commission staff would evaluate the continued adequacy of the project's facilities under a new license. Special articles would be included in any license issued, as appropriate. Commission staff would continue to inspect the project during the term of the new license to assure continued adherence to Commission-approved plans and specifications, special license articles relating to

[6] *Consumers Energy Company and Detroit Edison Company*, 94 FERC ¶62,158 (2001).

construction (if any), operation and maintenance, and accepted engineering practices and procedures.

2.1.4 Current Project Operation

On a day-to-day basis, the project generally begins each week on Monday morning with the upper reservoir at or near full pool (i.e., water elevation of 942 feet NGVD 29). Generation usually occurs during the day with the upper reservoir replenished at night during pumping to meet the next day's forecast load. Generation and pumping operations throughout the course of the week generally result in the upper reservoir being at or near minimum pool (i.e., water elevation of 875 feet NGVD 29) by late Friday evening. The upper reservoir water level is then brought to full pool over the weekend to be ready for the start of the next week's operating cycle. Following completion of the ongoing unit upgrades, the project can generate at maximum capacity for approximately 7 hours, starting with a full upper reservoir. Refilling the upper reservoir requires approximately 10 hours of pumping at maximum capacity.

The Ludington Project is not affected by low, normal, or flood flows and does not affect the flows of any stream. The upper reservoir is filled using water from Lake Michigan and has no contributory drainage area other than the catchment area of the 842-acre upper reservoir itself.

2.1.5 Current Environmental Measures

On January 23, 1996, the Commission approved a Settlement Agreement (i.e., 1995 Settlement Agreement) resolving issues concerning fish mortality resulting from operation of the project.[7] In accordance with the 1995 Settlement Agreement, Consumers Energy and DTE Companies are required, in part, to: (1) annually install and maintain (from April 15 through October 15) a fish barrier net around the project jetties and breakwater to minimize fish entrainment and mortality during pumping operation; (2) fund studies to monitor the effectiveness of the fish barrier net (on an annual basis) against established biological standards and provide annual reports on the results to the Commission and the signatories to the 1995 Settlement Agreement; and (3) conduct fish entrainment abatement technology reviews every five years to determine if any new technologies are technically and economically practicable for use at the project. The 1995 Settlement Agreement also established a Scientific Advisory Team (SAT), comprising representatives of Consumers Energy and DTE Companies, Interior,

[7] *See Consumers Energy Company and Detroit Edison Company*, Order Approving Settlement Agreement Regarding Fishery Issues, 74 FERC ¶ 61,055, January 23, 1996. The same entities are signatories to both the 1995 Settlement Agreement and the Settlement Agreement filed on November 13, 2017.

Michigan DNR, National Wildlife Federation, Michigan United Conservation Clubs, Michigan State University-Department of Fisheries and Wildlife, and tribal parties, for the purposes of evaluating the data and information upon which the settlement is based and advising on issues related to fish protection at the project.

In addition to the approved Settlement Agreement, Article 39 of the current license requires Consumers Energy and DTE Companies to minimize any disturbance to the scenic values of the area caused by construction and or maintenance of the project.

2.2 APPLICANTS' PROPOSAL

2.2.1 Proposed Project Facilities

Consumers Energy and DTE Companies are not proposing any changes to the project's generating facilities. Consumers Energy and DTE Companies are in the process of completing unit upgrades that were approved by the Commission on May 7, 2012. These unit upgrades involve turbine-pump runner replacement and generator-motor-stator replacement including new windings, with the final unit upgrade scheduled for completion by the end of 2019.

2.2.2 Proposed Project Operation and Environmental Measures

Consumers Energy and DTE Companies are not proposing changes to how the project currently operates, which is described under section 2.1.4, *Current Project Operation*.

The Settlement Agreement includes five proposed articles (sections V.A through V.E) for inclusion in any new license issued for the project that address measures to minimize fish mortality at the project. Sections V.F, V.H, and VII of the Settlement Agreement are administrative matters and include descriptions of the Settlement Agreement's general provisions and dispute resolution procedures, and a summary of the matters[8] for which the Settling Parties seek Commission approval. Section V.G. of the Settlement Agreement is also an administrative matter and includes a request by the Settling Parties for the Commission to grant a 50-year license for the project. The Settlement Agreement also includes an off-license agreement among the Settling Parties

[8] The Settling Parties request that the Commission approve and incorporate into any new license issued for the project, all terms of section V of the Settlement Agreement and all relevant and appropriate terms of section VII (General Provisions) of the Settlement Agreement, except subsections VII.E and VII.G.

that was filed for informational purposes only (i.e., this off-license agreement is not filed for Commission approval).[9]

Consumers Energy and DTE Companies propose the following environmental measures described in its license application, as modified by the Settlement Agreement, to protect or enhance environmental resources at the project.

- Continue to fund the SAT[10] for the purposes of evaluating data and information relevant to the Settlement Agreement and the scientific activities proposed in the Settlement Agreement, including: (1) the seasonal fish barrier net monitoring program; (2) the Adaptive Management Process; and (3) the fish entrainment abatement technology reviews. The SAT would also have technical oversight over any proposed improvements and/or modifications to the barrier net during the term of any new license issued for the project (section V.E of the Settlement Agreement).[11]

[9] Section VI of the Settlement Agreement includes provisions for Consumers and DTE Companies to annually compensate the State of Michigan, including Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indian, and Little Traverse Bay Bands of Odawa Indians, for unavoidable project-related fish mortality that would occur during the term of any new license issued for the project. However, because this compensation is proposed as an off-license measure, it is not analyzed in this EA as part of the relicensing proposal.

[10] The Settlement Agreement specifies the SAT would be co-chaired by Michigan DNR and a representative of the licensees, and include the following representatives: (1) a designee of the Secretary of the Interior; (2) Michigan DNR; (3) Michigan United Conservation Clubs; (4) National Wildlife Federation; (4) Consumers; (5) DTE; (6) Chippewa-Ottawa Resource Authority or its successors or assigns; (7) Grand Traverse Band of Ottawa and Chippewa Indians; (8) Little River Band of Ottawa Indians; (9) Little Traverse Bay Bands of Odawa Indians; and (10) one member chosen by mutual agreement of Michigan DNR, Michigan United Conservation Clubs, and the National Wildlife Federation.

[11] Sections E.1.E and E.1.F of the Settlement Agreement also include provisions for the SAT to have technical oversight over the following off-license measures: (1) determining the annual compensation for fish mortality that occurs during the term of any new license issued for the project; and (2) review of and recommendations to the Great Lakes Fishery Trust regarding funding proposals submitted to it for fishery

- Continue to annually install and maintain the fish barrier net at the project for the longest practicable period each year during the ice-free season to minimize fish entrainment (section V.A of the Settlement Agreement).[12]
    - Procure, maintain, and make available additional fish barrier net replacement panels, anchors, buoys, lines, and other equipment and materials necessary to maintain the net on a continuous basis during the ice-free season and to allow for the replacement of all elements of the net system in the event of an extraordinary storm or other event that may damage the net system (section V.A.2 of the Settlement Agreement).
    - Continue to fund studies to monitor the effectiveness of the fish barrier net on an annual basis (section V.A.3 of the Settlement Agreement).
    - Maintain an annual fish barrier net effectiveness target of 80 percent[13] for all fish equal to or greater than 5 inches in length. If 80 percent effectiveness is not achieved for two consecutive years, initiate discussions with the SAT in accordance with the procedures proposed under the Adaptive Management Process (as discussed below) to improve net performance (section V.A.1 of the Settlement Agreement).[14]

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research, habitat improvements, or other projects to enhance Great Lakes fishery resources and public access to them.

[12] Consumers and DTE Companies propose in the Settlement Agreement that, at a minimum, the fish barrier net would be installed from April 15 to October 15 on an annual basis.

[13] The current annual performance standards for the fish barrier net established under the 1995 Settlement Agreement are: (1) 80 percent effectiveness for game fish (salmonids and yellow perch combined) over five inches in length; and (2) 85 percent effectiveness for large forage fish (alewife and smelt combined) over five inches in length.

[14] Consumers and DTE Companies propose in the Settlement Agreement that conformance with the 80 percent annual barrier net effectiveness target would be determined by using a three year rolling average of the annual barrier net effectiveness percentage. Consumers and DTE Companies further propose in the Settlement Agreement that during the initial three years of any new license, if issued for the project, the rolling average would be calculated using barrier net effectiveness percentages from the relevant years predating issuance of any new license.

- Continue to provide annual reports to the Commission and Settling Parties that describe: (1) the actions taken by Consumers Energy and DTE Companies to evaluate and improve both the effectiveness of the fish barrier net and the methodology employed to measure barrier net effectiveness; and (2) the measures taken by Consumers Energy and DTE Companies to maintain the proper replacement capacity of the fish barrier net during the ice-free season (section V.A.4 of the Settlement Agreement).

- Implement an Adaptive Management Process (included as Appendix B to the Settlement Agreement) that includes the following measures to further minimize fish entrainment mortality at the project (section V.C of the Settlement Agreement):
  - Develop a plan, in consultation with the SAT, for the installation of additional floatation and anchor pilings, and stronger net materials in targeted areas of the fish barrier net to improve net effectiveness and file the plan for Commission approval (section V.B of the Settlement Agreement).
  - Develop a plan, in consultation with the SAT, to monitor the effectiveness of any measures implemented to enhance the performance of the fish barrier net (Appendix B of the Settlement Agreement).
  - Develop, in consultation with the SAT, and implement additional studies to support the decision making process for any additional optimizations of the fish barrier net or ancillary fixtures of the entrainment abatement system (Appendix B of the Settlement Agreement).
  - Develop, in consultation with the SAT, and implement studies to characterize the fish community near the project to ensure barrier net effectiveness targets remain biologically relevant during the term of any new license issued for the project (Appendix B of the Settlement Agreement).
  - After five years of implementing the Adaptive Management Process, file a report with the Commission that summarizes the efforts undertaken during the first five years of this process (Appendix B of the Settlement Agreement).
  - Beginning in year six of any new license issued for the project and continuing for the duration of the license, provide funding to the SAT to enable the continuation of studies under the Adaptive Management Process (Appendix B of the Settlement Agreement).

- Continue to review fish entrainment abatement technologies at least once every ten years for the purpose of determining if any new technologies are practicable for use at the project either in conjunction with or in lieu of the existing fish barrier net to reduce fish mortality at the project (section V.D of the Settlement Agreement).[15]
    - Continue to develop a fish entrainment abatement technology review study plan, in consultation with the SAT, prior to implementing each review. Upon completion of each review, provide a report to the Commission, SAT, and Settling Parties that describes the conclusions and recommendations concerning the feasibility, biological effectiveness, and costs associated with implementing any new fish entrainment abatement technologies at the project (section V.D of the Settlement Agreement).

- Minimize foot traffic and restrict the use of vehicular equipment in the spring and summer to ensure the protection of piping plover nests and Pitcher's thistle.
- Restrict the cutting of trees at the project during periods when northern long-eared bats may be making use of forested habitat.
- Implement the Recreation Plan, which includes measures to continue to operate and maintain existing project recreation facilities and monitor recreation use for the term of the license.
- Consult with Mason County on an annual basis on the maintenance and facility management of the Mason County Day Use/Picnic area and Mason County Campground.
- Implement the Historic Properties Management Plan (HPMP), filed on June 28, 2017.

[15] Under the 1995 Settlement Agreement, Consumers and DTE Companies are required to undertake an evaluation of fish entrainment abatement technologies every five years and report the results, including conclusions and recommendations concerning the feasibility of utilizing new entrainment abatement technologies at the project, to the Commission. Reviews were conducted in 2001, 2006, and 2011. The fish and aquatic resource studies conducted in 2015 and 2016 as part of Consumers and DTE Companies' relicensing process were, in essence, a review of current fish entrainment abatement technologies and satisfied the requirements of the review which was scheduled to occur in 2016.

2.3 MODIFICATIONS TO APPLICANT'S PROPOSAL – MANDATORY CONDITIONS

The following mandatory conditions have been provided and are summarized below.

2.3.1 Water Quality Certification Conditions

The Michigan DEQ certification includes 15 conditions (*see* Appendix C). Conditions 1.2, 2.3, and 4 through 10 are administrative or legal in nature, and are not analyzed in the EA.

The following conditions are analyzed in this EA.

- Condition 1.1 requires that the project operate as an open loop system.

- Condition 2.1 requires that project operation must not warm Lake Michigan to temperatures in degrees Fahrenheit (°F) higher than the following monthly maximum temperatures. Condition 2.1 applies when the natural water temperatures of Lake Michigan exceed the below monthly maximum water temperature values. In such cases, water releases from the project's man-made impoundment shall not raise the water temperatures of Lake Michigan by more than 3°F.

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
40°F	40°F	40°F	50°F	55°F	70°F	75°F	75°F	75°F	65°F	60°F	45°F

- Condition 2.2 requires that the compliance point for the water temperature monitoring required by condition 2.1 be at a representative location in Lake Michigan and approved by Michigan DEQ.

- Condition 3.1 requires that Consumers Energy and DTE Companies monitor water temperatures adjacent to the project at the compliance point on an hourly basis from June 1 through October 31 after any new license is issued. Consumers Energy and DTE Companies may request approval from Michigan DEQ for a reduced monitoring schedule if the daily average value consistently meets the limits specified by condition 2.1 after one year of continuous monitoring.

- Condition 3.2 requires that after issuance of any new license and every five years thereafter, Consumers Energy and DTE Companies provide fish samples collected from the project area to Michigan DEQ for monitoring of the edible portion of fish for mercury, polychlorinated biphenyls (PCB), dioxin/furans, and dioxin-like PCBs. The sample shall consist of ten legal-size (> 15 inches total length) lake trout in a range of sizes (if possible). These fish can be collected in Lake Michigan, in the project area, during the routine gill net surveys inside and outside of the barrier net. Fish shall be frozen and provided to the Michigan DEQ for individual analysis at the state laboratory. Other fish tissue data of adequate quality less than five-years old from the project area may be substituted upon approval of the Michigan DEQ.

- Condition 3.3 requires that Consumers Energy and DTE Companies submit a plan for Michigan DEQ approval that provides details on the water quality and fish tissue monitoring required by certification conditions 3.1 and 3.2. This condition also requires that Consumers Energy and DTE Companies provide an annual report to Michigan DEQ that contains the results of all sampling results related to certification conditions 3.1 and 3.2.

2.4 STAFF ALTERNATIVE

Under the staff alternative, the project would be operated as proposed by Consumers Energy and DTE Companies and includes all but four of Consumers Energy and DTE Companies' proposed measures (discussed below). The staff alternative also includes the certification's requirement that the project operate as an open loop system (condition 1.1), but it does not include three certification conditions (discussed below). Under the staff alternative, the project would include the following modifications of and additions to Consumers Energy and DTE Companies' proposed measures:

- Develop a plan that guides the proposed fish community studies and includes provisions for: (1) a description of the sampling methodologies, study area, and the anticipated timing and frequency of all fish sampling; (2) an implementation schedule; and (3) a protocol for providing the study results to the Commission.

- Develop a plan that guides the proposed fish entrainment abatement technology reviews and includes provisions for: (1) a description of the consultation process that would be used to determine the need for and frequency of the reviews, which at a minimum must occur every ten years for the term of the license; (2) detailed study plans to be developed prior to implementing each fish entrainment abatement technology review; (3) an

implementation schedule; and (4) a protocol for providing the results of each fish entrainment abatement technology review to the Commission.

- Remove from the project boundary approximately 155 acres of forested land that surrounds the embankment around the transmission corridor in the southwest corner.
- Expand the project boundary to include the fish seasonal fish barrier net.
- Implement bald eagle protection measures to minimize adverse project maintenance effects on nesting eagles within the project boundary.
- Avoid cutting trees between June 1 and July 31 to protect roosting Indiana and northern long-eared bats.
- Develop an invasive species monitoring plan that includes provisions for monitoring autumn olive and other invasive plants within the project boundary.
- Execute a PA to protect historic properties.

Settlement Agreement Measures

The Commission encourages parties to cooperatively resolve disputes. While we have no objection to Consumers Energy and DTE Companies' proposal to continue funding the SAT to allow for the continued existence of a group that would advise on issues related to fish protection at the project, the Commission only has authority over its licensees and cannot impose or enforce such provisions on or against third parties, like the members proposed to compose the SAT. Therefore, because a license condition requiring the establishment of the SAT would serve no useful purpose, we do not recommend it be included as a requirement in any new license that may be issued.

We do not recommend those provisions of the Adaptive Management Process that contemplate as-yet unidentified and uncertain studies because we are unable to determine the needs and benefits associated with the studies or whether the studies would have a connection to a specific project effect and/or fulfill a project-related purpose. Absent such information, we are unable to make a public interest finding with respect to these studies. For similar reasons to those cited above, we also do not recommend Consumers Energy and DTE Companies' proposals to provide funding to third party entities (i.e., the Great Lakes Fishery Trust and SAT) under the Adaptive Management Process because there are no specific measures associated with the funding and the Commission only has authority over its licensees.

Upon completion of the installation of additional floatation, additional anchor pilings, and stronger net materials to the fish barrier net, Consumers Energy and DTE Companies propose to develop and implement a plan to monitor the effectiveness of these specific measures at improving the performance of the net. Information gathered as

a result of implementing such a plan would be redundant with the information that would be provided through Consumers Energy and DTE Companies' proposal to monitor the overall biological effectiveness of the barrier net on an annual basis. Therefore, because a license condition requiring such a plan would be unnecessary, we do not recommend it be included as a requirement in any new license, if issued.

Water Quality Certification Conditions

We do not recommend Michigan DEQ certification condition 2.1, which would require that Consumers and DTE Companies operate the project in such a manner as to adhere to state water quality standards for water temperature in Lake Michigan. We also do not recommend Michigan DEQ certification conditions 2.2, 3.1, and 3.3, which would require that Michigan DEQ develop a plan to continuously monitor water temperature in Lake Michigan (from June 1 through October 31) to verify project-related effects on water temperature. We do not recommend these measures because data collected by Consumers Energy and DTE Companies indicate that water temperature in the project area is consistent with values specified by Michigan state water quality standards. Further, based on water quality data collected by Consumers Energy and DTE Companies, there does not appear to be any discernable correlation between project operation and water quality in Lake Michigan. Therefore, because we expect water temperatures in Lake Michigan under the proposed action to be similar to current conditions, we have no justification for recommending a license requirement for Consumers Energy and DTE Companies to develop a plan to conduct post-license water temperature monitoring in Lake Michigan.

We do not recommend Michigan DEQ certification condition 3.2, which would require that Consumers Energy and DTE Companies conduct (at five year intervals) contaminant monitoring (i.e., mercury, PCBs, dioxin/furans, and dioxin-like PCBs) of the edible portion of fish collected from within the project vicinity. We do not recommend this measure because the sources of bioaccumulative contaminates entering Lake Michigan are not project related. Therefore, there would be no project-related benefit to monitoring the level of contaminants in fish collected from within the project vicinity.

Piping Plover and Pitcher's Thistle

We do not recommend Consumers Energy and DTE Companies proposal to minimize foot traffic and prohibit the use of vehicular equipment during the piping plover active nesting period to ensure nests are not destroyed. There is no evidence the Pitcher's thistle and piping plover currently make use of project lands. Therefore, with no clear nexus of the project's effects to the Pitcher's thistle and piping plover, there is no need to require specific protection or mitigation measures for these species at the project.

2.5 STAFF ALTERNATIVE WITH MANDATORY CONDITIONS

We recognize that the Commission is required to include all conditions required by the certification in any new license issued for the project. Therefore, the staff alternative with mandatory conditions includes all the measures in the staff alternative with the addition of the certification conditions not included in the staff alternative, as discussed above in section 2.4, *Staff Alternative*.

2.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

We considered several alternatives to Consumers Energy and DTE Companies' proposal, but eliminated them from further analysis because they are not reasonable in the circumstances of this case. These include: (1) issuing a non-power license, (2) Federal Government takeover of the project, and (3) retiring the project.

2.6.1 Issuing Non-power License

A non-power license is a temporary license that the Commission would terminate when it determines that another governmental agency will assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to do so. No party has sought a non-power license for the project and we have no basis for concluding that the project should no longer be used to produce power. Thus, we do not consider issuing non-power licenses as a realistic alternative to relicensing the project in this circumstance.

2.6.2 Federal Government Takeover of the Project

We do not consider federal takeover to be a reasonable alternative. Federal takeover and operation of the project would require Congressional approval. While that fact alone would not preclude further consideration of this alternative, there is currently no evidence to indicate that federal takeover should be recommended to Congress. No party has suggested federal takeover would be appropriate, and no federal agency has expressed an interest in operating the project.

2.6.3 Retiring the Project

As the Commission has previously held, decommissioning is not a reasonable alternative to relicensing a project in most cases, when appropriate protection, mitigation and enhancement measures are available.[16] The Commission does not speculate about possible decommissioning measures at the time of relicensing, but rather waits until an applicant actually proposes to decommission a project, or there are serious resource concerns that cannot be addressed with appropriate license measures, making decommissioning a reasonable alternative to relicensing.[17] This is consistent with NEPA and the Commission's obligation under section 10(a) of the FPA to issue licenses that balance developmental and environmental interests.

Project retirement would require denying the relicense application and surrender or termination of the existing license with appropriate conditions.

No participant has suggested that project retirement would be appropriate in this case, and we have no basis for recommending it. The power and ancillary services provided by the Ludington Project are important resources that would be lost if the project was retired, and there would be significant costs involved with retiring the project and or removing any project facilities. Thus, we do not consider project retirement a reasonable alternative to relicensing the project with appropriate protection, mitigation, and enhancement measures.

3.0 ENVIRONMENTAL ANALYSIS

In this section, we present: (1) a general description of the project vicinity; (2) an explanation of the scope of our cumulative effects analysis; and (3) our analysis of the proposed action and recommended environmental measures. Sections are organized by resource area (aquatics, recreation, *etc*.). Historic and current conditions are described first under each resource area. The existing condition is the baseline against which the

[16] *See, e.g., Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 67 (2015); *Public Utility District No. 1 of Pend Oreille County*, 112 FERC ¶ 61,055, at P 82 (2005); *Midwest Hydro, Inc.*, 111 FERC ¶ 61,327, at PP 35-38 (2005).

[17] *See generally Project Decommissioning at Relicensing; Policy Statement,* FERC Stats. & Regs., Regulations Preambles (1991-1996), ¶ 31,011 (1994); *see also City of Tacoma, Washington*, 110 FERC ¶ 61,140 (2005) (finding that unless and until the Commission has a specific decommissioning proposal, any further environmental analysis of the effects of project decommissioning would be both premature and speculative).

environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of proposed protection, mitigation, and enhancement measures, and any potential cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.1, *Comprehensive Development and Recommended Alternative*, of this EA.[18]

3.1 GENERAL DESCRIPTION OF THE PROJECT AREA

The project is located along the eastern shoreline of Lake Michigan near Ludington, Michigan, and is within the Lake Michigan Basin.[19] The project pumps water from Lake Michigan to the upper reservoir, a man-made structure constructed solely for project operation. There are no rivers, streams, or other means of inflow to the project other than direct precipitation and the water that is pumped from Lake Michigan during project operation.

The project area is characterized by rolling hills and dunes that have been generated by lake-driven winds. Topography in the project area ranges from less than 600 feet NGVD 29 along the shore of Lake Michigan to over 950 feet NGVD 29 along the project's upper reservoir.

The project area experiences a moderate climate with well-defined seasons. The average monthly maximum air temperatures in the region range from 29.8 degrees Fahrenheit (°F) in January to 80.0°F in July. The average monthly minimum air temperatures in the region range from 17.1°F in January to 59.8°F in July. The average annual snowfall for Ludington, Michigan is 66.8 inches and the average annual precipitation (rainfall) is 16.7 inches.

Because the project's watershed is associated with Lake Michigan and not a river or stream, the major water uses associated with Lake Michigan near the project include recreational, industrial, and commercial. Major land uses in the project vicinity include industrial, commercial, agricultural, and residential. The land adjacent to the project is

[18] Unless otherwise indicated, the sources of our information are the final license application filed by Consumers and DTE Companies on June 28, 2017 (Consumers and DTE Companies, 2017a), the responses to requests for additional information filed on September, 25, 2017, October 18, 2017, October 24, 2017, and February 7, 2018 (Consumers and DTE Companies, 2017c, 2017e, 2017d, and 2018), and the Settlement Agreement filed on November 13, 2017 (Consumers and DTE Companies, 2017e).

[19] A 1.8 acre satellite project recreation facility, Pigeon Lake North Pier, is located in Port Sheldon Township, Michigan, approximately 70 miles south of the powerhouse and reservoir, further discussed in section 3.3.4, *Recreation and Land Use*.

primarily wooded and agricultural with some residential use primarily along the Lake Michigan shoreline. More concentrated residential, industrial, and commercial land uses are found in the communities close to the project, including the City of Ludington.

3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (40 CFR § 1508.7), a cumulative effect is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions (40 C.F.R. § 1508.7). Cumulative effects can result from individually minor but collectively significant actions taking place over time, including hydropower and other land and water development activities.

Based on our review of the license application and agency and public comments, we have not identified any resources that may be cumulatively affected by the continued operation of the project.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section, we discuss the effects of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure effects. We then discuss and analyze the site-specific environmental effects.

Only the resources that would be affected, or about which comments have been received, are addressed in detail in this EA. Based on this, we have determined that fisheries, terrestrial resources, threatened and endangered species, recreation and land use, and cultural resources may be affected by the proposed action and action alternatives. We have not identified any substantive issues related to geology and soils, aesthetic resources, or socioeconomics associated with the proposed action; therefore, these resources are not assessed in this EA. We present our recommendations in section 5.1, *Comprehensive Development and Recommended Alternative*.

3.3.1 Aquatic Resources

3.3.1.1 Affected Environment

Water Resources

Water Quantity

Consumers Energy and DTE Companies currently operate the project, configured with six reversible pump-turbine/motor generating units and accompanying penstocks, by pumping water from Lake Michigan into the upper reservoir during periods of low electrical demand. When energy is needed during periods of high electrical demand, water is released from the upper reservoir through the penstocks to the powerhouse. All discharge from the project is released back into Lake Michigan.

On May 7, 2012, Consumers Energy and DTE Companies received authorization under the existing license to upgrade and overhaul the project's pump-turbine/motor generating units for the purposes of improving the project's efficiency and enhancing its ability to support system energy needs during times of peak demand. The Commission's Order Amending License approved Consumers Energy and DTE Companies' proposal to upgrade and overhaul all six reversible pump-turbine/motor generating units at the project, one unit at a time between the years 2013 and 2019.[20] Upon completion, the overhaul will increase: (1) the authorized installed capacity of the project from 1,657.5 MW to 1,785 MW; (2) the hydraulic capacity of the project from 66,600 cubic feet per second (cfs) to 76,290 cfs (approximately 14.5 percent); and (3) the pumping discharge rate by approximately 22.2 percent.[21] After the upgrades are complete, the estimated hydraulic capacity during pumping would increase from 10,200 to 12,464 cfs per unit or approximately 22.2 percent overall to allow the project to store more energy within the limited timeframe of low electricity demand.

[20] Rehabilitation of Unit Nos. 2, 4, 5, and 6 were completed on March 12, 2015. May 25, 2016, April 9, 2017, and May 18, 2018, respectively. Rehabilitation of Unit No. 1 began on May 21, 2018, and is expected to be completed in May 2019. Rehabilitation of the final unit will commence upon completion of the rehabilitation of Unit No. 1.

[21] The generating and hydraulic capacities provided correspond to best gate opening and average head or "mid-pond." Because the level of Lake Michigan does not vary because of project operation, average head occurs when the upper reservoir is at mid-pond level or 908.5 feet NGVD 29.

Upper Reservoir

The upper reservoir has a perimeter of 5.7 miles, a surface area of 842 acres, and a storage capacity of 82,300 acre-feet (approximately 26.8 billion gallons) at a maximum water surface elevation of 942 feet NGVD 29. The mean depth of the upper reservoir is 98 feet, with depth ranging from approximately 97 feet at the south end of the reservoir to approximately 112 feet at the north end. The usable volume is 54,000 acre-feet (approximately 17.5 billion gallons) with a maximum drawdown of 67 feet, which corresponds to a minimum water surface elevation of 875 feet NGVD 29. During normal project operation, the water surface elevation of the upper reservoir rises or falls approximately 1 foot per hour per generating unit and can generate at maximum capacity for about 8 hours. Upon completion of the reversible pump-turbine/motor generating unit upgrades, the maximum drawdown rate of the upper reservoir will be approximately 10 feet per hour with all six units in operation.

The embankment forming the perimeter of the upper reservoir does not allow for inflow or outflow from the reservoir other than through project facilities. Therefore, the project's upper reservoir has no contributory drainage area (i.e., there is no geographical area which provides run-off other than the inside slope of the reservoir itself). Consequently, the project is unaffected by low, normal, or high flows from any waterbody in the project area.

Lake Michigan

The Lake Michigan Basin has a total drainage area of about 45,600 square miles. Lake Michigan itself has a surface area of approximately 22,300 square miles and a mean depth of 279 feet. From 1918 to 2012, the long-term average water surface elevation of Lake Michigan, as measured at Harbor Beach, Michigan, is 578.8 feet International Great Lakes Datum of 1985 (IGLD 85). The record low level of 576.1 IGLD 85 was established in January 2013.

Water Use

Because the project's watershed is associated with Lake Michigan, and not a river or stream, the major water uses are associated with use of Lake Michigan near the project. Major water uses of Lake Michigan include recreational, industrial, and commercial uses. Lake Michigan has a long history of providing an area to pursue many forms of water-based recreation (e.g. fishing, boating, and swimming) and, as such, the area is a popular tourist destination.

Consumptive use of water does not occur at the project, as project use of water is for generation purposes only. Water is stored in the upper reservoir only for a relatively short time period. Based on a total impoundment volume of 82,300 acre-feet and an

average weekly pumping rate of 200,000 acre-feet, the weekly turnover rate is approximately 2.4.

The project currently holds a National Pollution Discharge Elimination permit (Permit No. M10035912) that covers eight monitored outfalls. These reflect non-contact cooling water discharges for each unit (outfalls 1-6), the oil/water separator discharge (outfall 7), and the dewatering sump pump discharge (outfall 8). Outfalls 1 through 6 and 8 (the dewatering sump pump discharge is used to drain draft tubes for periodic outage work) are free of pollutant loads with monitoring consisting of daily visual observations and reporting of daily flow. Similar monitoring is required for outfall 7, with the addition of a monthly grab sample collected for oil and grease analysis. Outfall 9 consists of uncontaminated groundwater drainage from the upper reservoir slopes and non-regulated storm water from the penstock upper encasement area.

Water Quality

Section 401 of the Clean Water Act (CWA) provides the federal water quality standards applicable to the project. Further, Water Quality Guidance for the Great Lakes System (Guidance) is provided in 40 CFR Part 132. The Guidance identifies minimum water quality standards, anti-degradation policies, and implementation procedures for the Great Lakes System to protect human health, aquatic life, and wildlife.

Michigan DEQ implements the requirements of the CWA on behalf of the federal government. Michigan DEQ administers federal and state surface water quality standards for wastewater, non-point source pollution, seepage and National Pollutant Discharge Elimination System permits. The State of Michigan's Part 4 Rules, Water Quality Standards (of Part 31, Water Resources Protection, of Act 451 of 1994), specify water quality standards which shall be met in all waters of the state. Michigan's Part 4 Water Quality Standards require that all designated uses of the receiving water be protected. Designated uses include: agriculture, navigation, industrial water supply, public water supply at the point of water intake, warmwater or coldwater fish, other indigenous aquatic life and wildlife, fish consumption, partial body contact recreation, and total body contact recreation from May 1 to October 31. According to the Michigan Surface Water Information Management System (MiSWIMS, 2018), the surface waters in the project boundary do not support its designated use for "fish consumption." The Michigan Surface Water Information Management System (2018) also indicates that surface waters within the project boundary have not been assessed to determine whether other applicable designated uses are being met in the project area.

Water temperature and dissolved oxygen are water quality parameters that could be affected by project operation. State of Michigan water quality standards for these parameters, as provided in Michigan Act 451 Part 4, are as follows:

- Dissolved oxygen

- Rule 64 – A minimum of 7 milligrams per liter (mg/L) of dissolved oxygen shall be maintained in all Great Lakes and connecting waterways.

- Water temperature
  - Rule 70 – The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone more than 3°F above the existing natural water temperature.
  - Rule 70 – The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures in degrees °F higher than the following monthly maximum temperatures.

Jan.	**Feb.**	**Mar.**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
40°F 4.4°C	40°F 4.4°C	40°F 4.4°C	50°F 10°C	55°F 12.8°C	70°F 21°C	75°F 23.9°C	75°F 23.9°C	75°F 23.9°C	65°F 18.3°C	60°F 15.6°C	45°F 7.2°C

Prior to the filing of the Pre-Application Document and Notice of Intent to seek a new license for the project on January 21, 2014, Consumers Energy and DTE Companies monitored water quality in Lake Michigan and the project's upper reservoir during the summer and early fall of 2013 in order to supplement existing water quality data from the 1970s (Liston et al., 1976) with more recent data. The location and water depths of the water quality monitoring sites from within Lake Michigan and the upper reservoir are listed in Table 1. The location of all water quality monitoring sites from within Lake Michigan and the project's upper reservoir are also shown in Figure 4 and Figure 5, respectively.

Table 1. Water quality sampling sites (Source: Consumers Energy and DTE Companies, 2017e).

Station	Location	Water Depth (in feet)[a]
Lake Michigan		
1 (control area)	3 miles south of breakwater	45
2	1 mile SSE of south jetty	19
3	0.5 mile south of breakwater	36
4	1.5 miles west of breakwater	62
5	0.5 mile NNW of breakwater	37
6	1 mile north of north jetty	20
Lake Michigan NW, minisonde	0.5 mile NNW of breakwater	36
Lake Michigan SW, minisonde	0.5 mile south of breakwater	36
Upper Reservoir		
Reservoir 1R, minisonde	1.4 miles SSE of upper reservoir's intake	66
Reservoir 2R	1 mile SE of upper reservoir's intake	65
Reservoir 3R	0.75 mile NE of upper reservoir's intake	81

a For water quality monitoring sites located within Lake Michigan (station nos. 1 through 6) and the upper reservoir (reservoir 1R, 2R, and 3R), water depth is an average based on the maximum depth measured during profile monitoring. For the minisonde sites, water depth is based on one measurement taken during minisonde deployment.

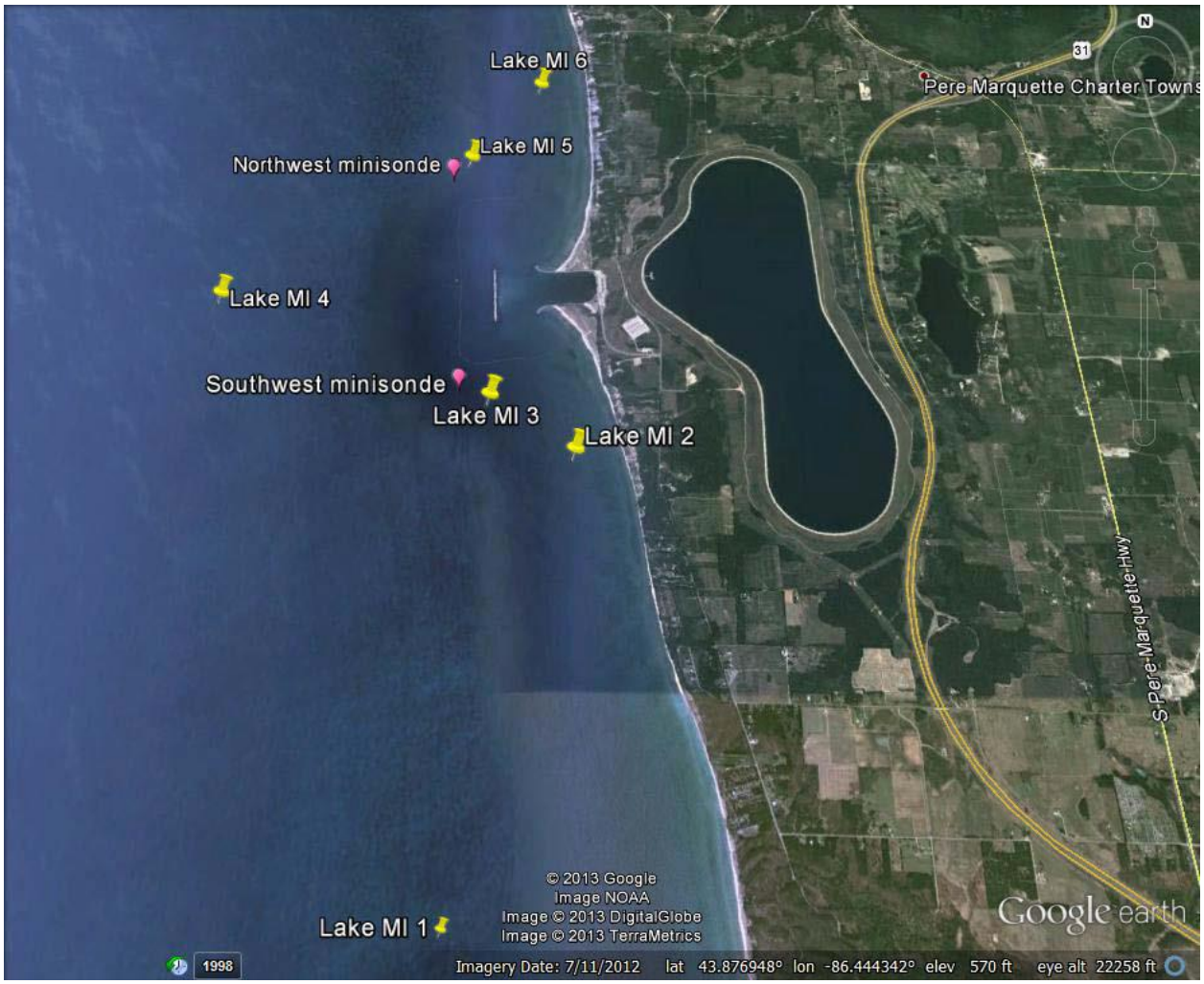


Figure 4. Lake Michigan water quality sampling sites (Source: Consumers Energy and DTE Companies, 2017a).

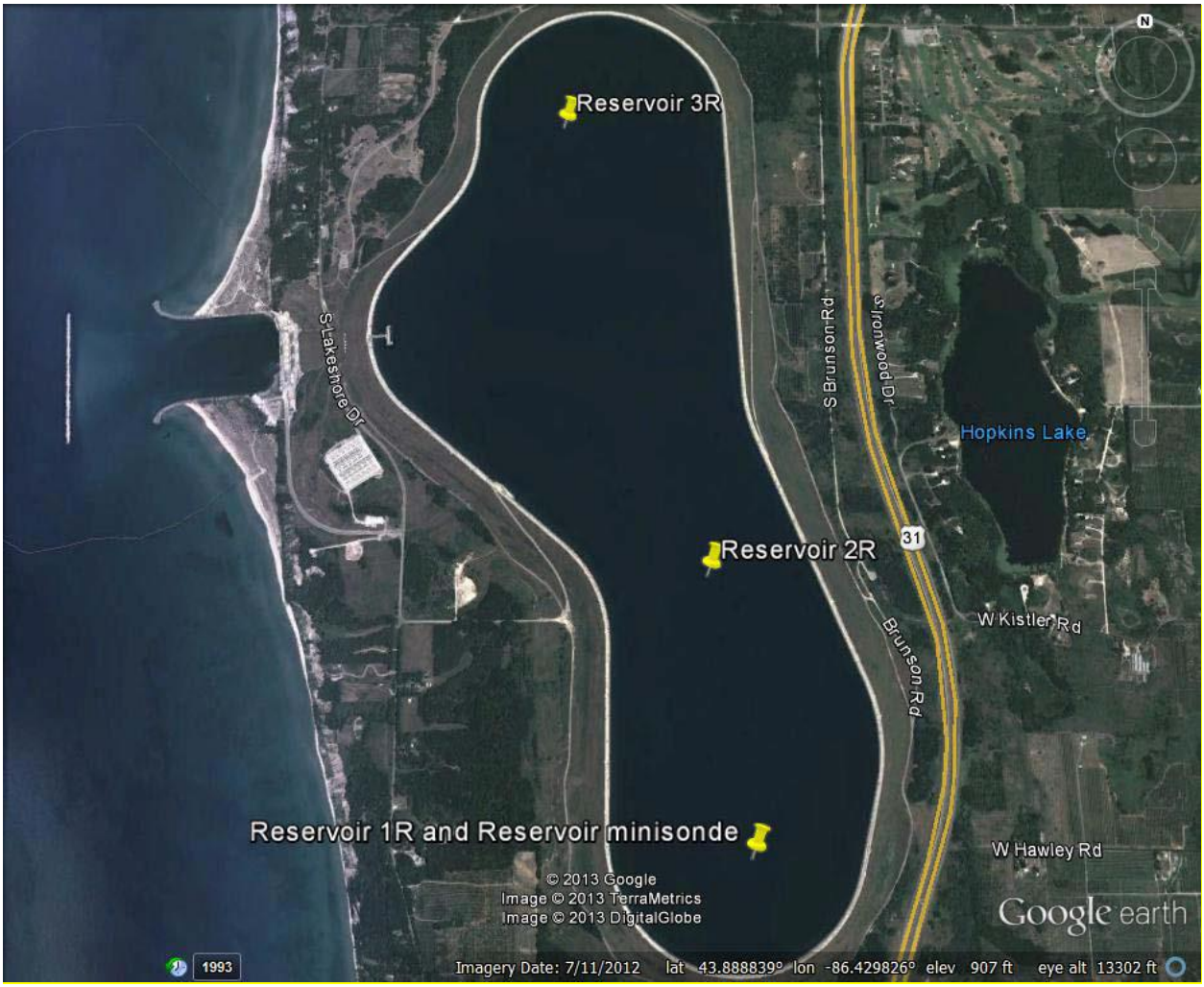


Figure 5. Upper reservoir water quality sampling sites (Source: Consumers Energy and DTE Companies, 2017a).

Water Temperature and Dissolved Oxygen Profile Data

Water temperature and dissolved oxygen profile data were collected twice per month from June 20th to October 11th at the sites highlighted (in gray) in Table 1. Profile data were collected at 3.3-foot increments from the water surface to the bottom at each site to determine if stratification occurred.[22] Water temperatures ranged from 51.8 to 70.9°F in the upper reservoir and from 41.4 to 73.0°F in Lake Michigan. Within the upper reservoir, monitoring indicated that site 1R showed stratification once over the

[22] Consumers and DTE Companies defined stratification as a 1.8°F or greater temperature change within a 3.3-foot interval (Wetzel, 1983).

study period, while sites 2R and 3R did not stratify. Within Lake Michigan, the following instances of stratification were observed: (1) Lake Michigan sites 1 and 4 in seven out of nine visits; (2) Lake Michigan site 5 in five out of nine visits; (3) Lake Michigan sites 2 and 3 in four out of nine visits; and (4) Lake Michigan site 6 in three out of nine visits. The mean differences between surface and bottom water temperatures at each of the six water quality monitoring stations in Lake Michigan are shown in Figure 6.

Over the study period, dissolved oxygen ranged from 8.2 to 11.7 mg/L in the upper reservoir and from 8.2 to 12.8 mg/L in Lake Michigan. Mean dissolved oxygen values over the study period were slightly lower in the upper reservoir (9.5 mg/L) than in Lake Michigan (9.8 mg/L).

A summary of the average dissolved oxygen and water temperature profile data from each monitoring site is shown in Table 2.

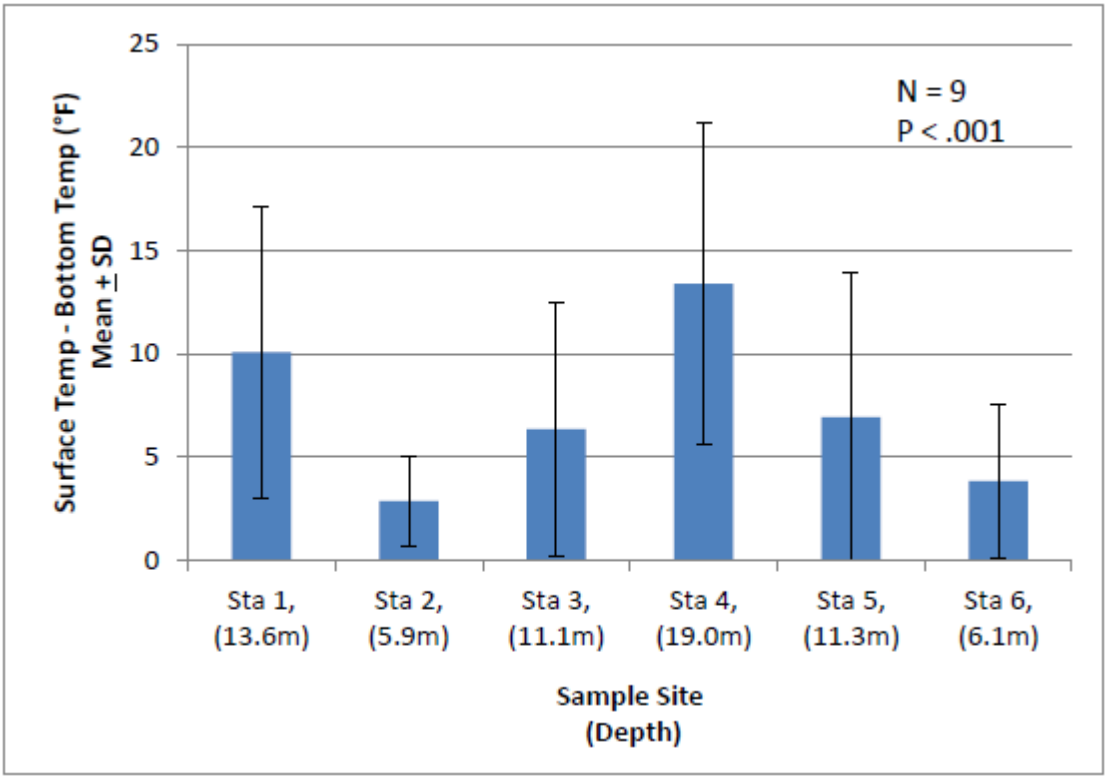


Figure 6. Mean difference between surface and bottom water temperatures at each Lake Michigan sampling station (Source: Consumers Energy and DTE Companies, 2017a).

Table 2. Summary of average dissolved oxygen and water temperature profile data from Consumers Energy and DTE Companies' 2013 water quality study (Source: Consumers Energy and DTE Companies, 2017a).

Monitoring Site No.	Number of Water Temperature Readings	Average Water Temperate (°F)	Average Dissolved Oxygen Concentration (mg/L)
Lake Michigan Station 1 (control)	130	58.9	9.9
Lake Michigan Station 2	62	60.8	9.7
Lake Michigan Station 3	110	59.6	9.8[a]
Lake Michigan Station 4	181	57.6	10
Lake Michigan Station 5	110	60.0	9.8[a]
Lake Michigan Station 6	65	60.6	9.7
Reservoir 1R	194	60.7	9.5
Reservoir 2R	185	60.7	9.5
Reservoir 3R	229	60.4	9.5

a Lake Michigan station nos. 3 and 5 were located closest to discharge from the powerhouse.

Continuous Monitoring of Water Temperature and Dissolved Oxygen

Continuous water quality monitors (i.e., minisondes) were also deployed in the project area to monitor water temperature and dissolved oxygen on an hourly basis. Two minisondes were located in Lake Michigan near the northwest and southwest corners of the seasonal fish barrier net and a third minisonde was located at the southern-most water quality monitoring site in the upper reservoir (Figure 4 and Figure 5). Generally, water temperatures in the upper reservoir were similar to those in Lake Michigan, except when the project was not pumping or generating (Figure 7). Water temperatures in the upper

reservoir also did not vary as much as those observed within Lake Michigan. As an inverse function of water temperature,[23] the average daily dissolved oxygen values exhibited a similar pattern of agreement with temporal offset between lake and reservoir changes and smaller excursions in the reservoir (Figure 8).

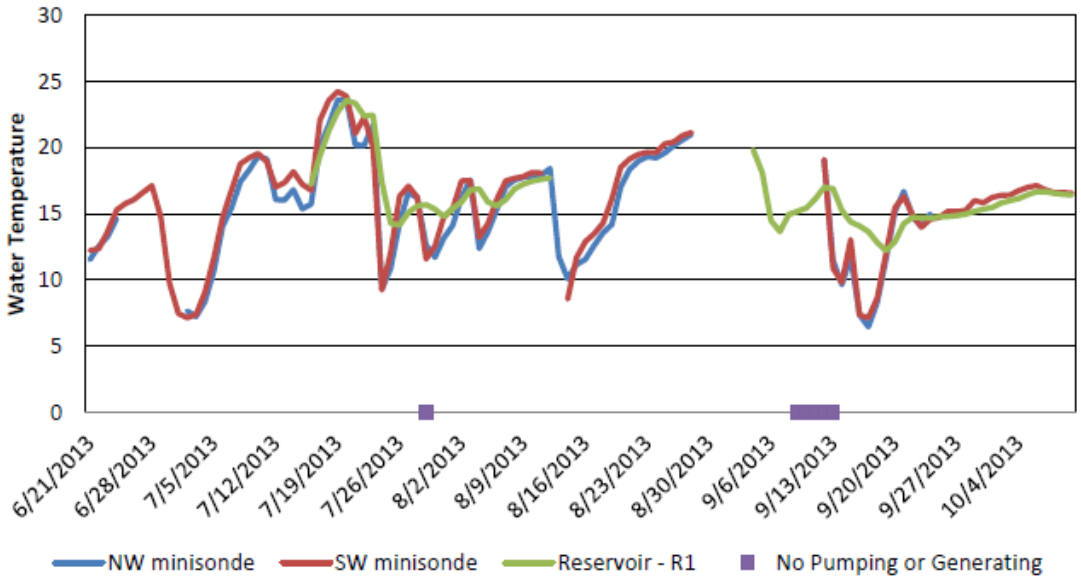


Figure 7. Continuous minisonde water temperature data (in °C) from Consumers Energy and DTE Companies' 2013 water quality study (Source: Consumers Energy and DTE Companies, 2017a).

[23] Dissolved oxygen saturation concentrations have an inverse relationship with water temperature meaning, as water temperature increases less dissolved oxygen is contained in the water.

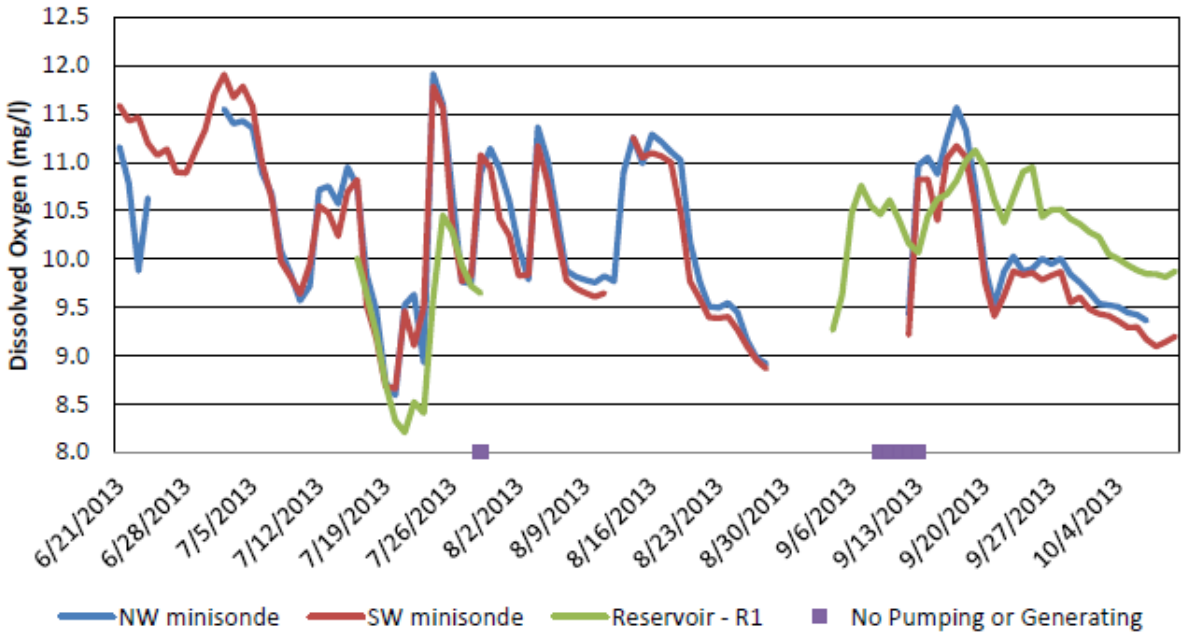


Figure 8. Continuous minisonde dissolved oxygen data (in mg/L) from Consumers Energy and DTE Companies' 2013 water quality study (Source: Consumers Energy and DTE Companies, 2017a).

Fishery Resources

Aquatic Habitat

The inshore waters of Lake Michigan near the project contain a variety of aquatic habitats that are influenced daily by the strong multi-directional currents resulting from project operation. The shoreline is characterized by high clay bluffs and sandy beaches. The lake bottom slopes gradually and consists mainly of fine gravel and sand, with clay and large rocks occurring at water depths exceeding 40 feet. Jetties and breakwaters near the project intake area provide rocky habitat for fish and other aquatic organisms. Between the jetties, bottom substrates consist mostly of clay, with depths between the jetties averaging about 24 feet. Sand deposits occur outside the jetties, where current velocities are lower than inside the jetties.

Overall aquatic habitat conditions within the upper reservoir are marginal to poor. The bottom of the upper reservoir is lined with compacted clay and contains an asphalt-concrete liner that covers the interior sloped sides of the upper 75 feet of the reservoir embankment. Adjacent to the intake structure, the reservoir bottom is lined with riprap to protect the clay liner from scour caused by the strong currents during pumping. Other than riprap, little structural habitat for fish is present within the upper reservoir.

Fish Community

Lake Michigan

Lake Michigan supports a rich assemblage of game and non-game freshwater fish that includes over 78 species and 22 families (FERC, 1995). The Lake Michigan fishery and forage base have been and continue to be dramatically influenced by the numerous non-native aquatic invasive species that have entered the Great Lakes via the St. Lawrence Seaway.[24] It is estimated that more than 180 non-native aquatic invasive species have entered the Great Lakes, including several that have had major economic and ecological effects (Kornis and Zanden, 2010; Atkinson and Domske, 2015).

Several fish species native to Lake Michigan, including lake trout, lake whitefish, yellow perch, and lake herring (also known as cisco), formerly supported large commercial fisheries on Lake Michigan but stocks were depleted by the parasitic sea lamprey in the 1950s. Burbot, along with lake trout, represent the top native predators in Lake Michigan and the decline of burbot in the 1950s is also attributed to sea lamprey predation (USGS, 2017). The most prolific forage species in Lake Michigan is the alewife, a non-native species, which like the sea lamprey, gained access to the upper Great Lakes through the Welland Canal.[25] Introduced into Lake Michigan in 1949, growing alewife populations eventually replaced lake herring as the principal forage species in Lake Michigan (FERC, 1995). Intense management of salmonid stocks, in particular, introductions of Pacific salmon species (including Chinook and coho salmon) and reintroduction of lake trout in the mid- to late-1960s, helped control alewife populations. The introduction of Pacific salmon also created a successful and valuable sport fishery. Rainbow smelt, introduced to the Great Lakes in the early 1900s, have also played an important role in the forage base for sport fish and are an economically viable commercial and sport fish.

In 1988, Stone and Webster Engineering Company conducted a study to identify and evaluate fish protection concepts for application at the project. The information included in Stone and Webster Engineering Company's study (1988) was developed from a number of fishery resource studies (e.g., Gulvas, 1976; Brazo and Liston, 1979; Liston, 1979) that were conducted in the vicinity of the project from the early 1970s through the early 1980s. Overall, these fishery resource studies provided information on relative

[24] The St. Lawrence Seaway is a 2,342-mile-long system of locks, canals, and channels that was opened in 1959 to connect the Great Lakes with the Atlantic Ocean.

[25] The Welland Canal is a ship canal in Ontario, Canada, which connects Lake Ontario and Lake Erie.

abundance and temporal presences of species and life stages that occurred near the project. Stone and Webster Engineering Company (1988) concluded that alewife, rainbow smelt, johnny darter, ninespine stickleback, sculpin species, yellow perch, and spottail shiner were the most abundant species in the project area. Chinook salmon, coho salmon, and lake, brown, and rainbow trout were identified as important sport fish that occurred in relatively low abundances. Specific results from gill net sampling in the project vicinity conducted by Brazo and Liston (1979) from 1972 through 1977 are shown in Table 3.

More recent gill net sampling data collected at the project from 1993 through 2017 as part of Consumers Energy and DTE Companies' annual barrier net effectiveness monitoring program, as discussed below, is summarized in Table 4. As shown in Table 4, the most abundant species collected at the project over the past five years (2013 through 2017) of data collection are alewife (n=18,474), yellow perch (n=1,857), lake herring (n=1,241), round goby (n=1,221), spottail shiner (n=1,030), and brown trout (n=793). A comparison of the two datasets shown in Table 3 and Table 4 illustrate the similarities and differences in both the abundance and composition of the near-shore fish community at the project over time.

Table 3 shows that for all sampling years combined (1972 through 1977), yellow perch were the dominant species collected during sampling in the 1970s at 47 percent relative abundance, followed by alewife (19 percent relative abundance), which exhibited an overall increase in relative abundance during sampling in the 1970s, and spottail shiner (8 percent relative abundance). Table 4 shows that for all sampling years combined (1993 through 2017), alewife were the dominant species collected (73.6 percent relative abundance), followed by spottail shiner (7.1 percent relative abundance), and yellow perch (5.5 percent relative abundance).[26] Table 4 also illustrates the reduced abundance of some species in the project area since barrier net effectiveness monitoring began (e.g., yellow perch and alewife) and the increased abundance of other species (e.g., round goby and lake herring).

The U.S. Geological Survey Great Lakes Science Center (GLSC) has conducted lake-wide surveys of the Lake Michigan fish community each fall since 1973 using

[26] Differences in sampling gear may account for the greater abundances of alewife in sampling conducted at the project from 1993 through 2017. Though similar in length and experimental graduated mesh, gill nets used during the 1970s fished only the bottom 6 feet at predominantly deeper stations, while gill nets used for more recent barrier net effectiveness monitoring cover the entire water column.

bottom trawl nets.[27] GLSC uses the data collected (i.e., relative abundance, size and age structure, biomass estimates, and condition of individual fishes) to estimate various population parameters that are used by local state and tribal agencies to manage Lake Michigan fish stocks (USGS, 2017). The GLSC provides relative abundance and biomass estimates for forage fish populations (e.g., alewives, rainbow smelt, round goby, bloater, etc.), burbot, and yellow perch.[28] As shown in Figure 9, total forage fish biomass in Lake Michigan has trended downward since 1989, primarily as a result of the dramatic decrease in bloater biomass since 1992, intensified predation of alewives by salmonids during the 2000s and 2010s, and the effects of increased zebra and quagga mussel populations within Lake Michigan (USGS, 2017).

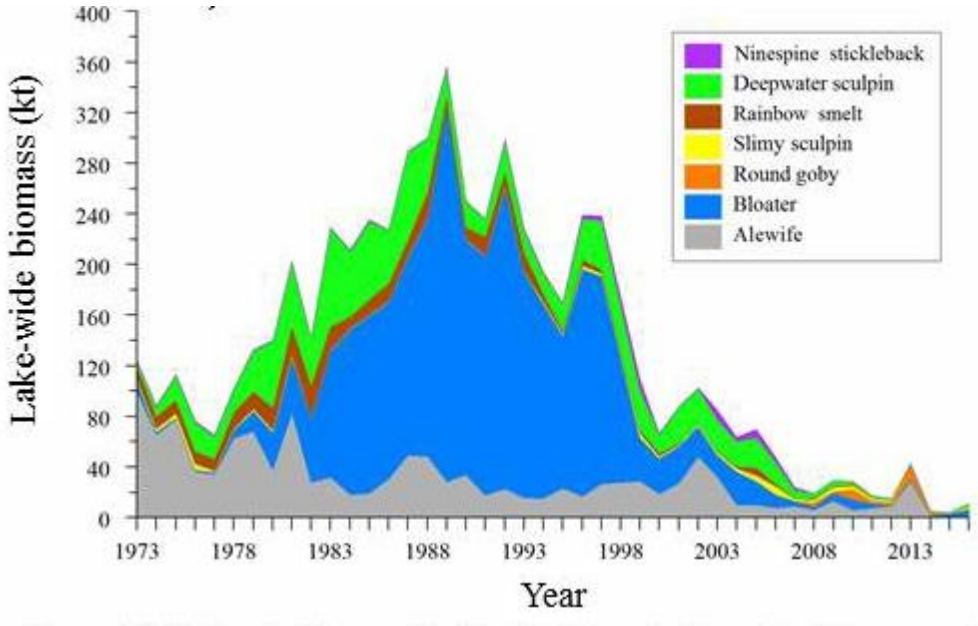


Figure 9. Estimated lake-wide biomass of prey fishes in Lake Michigan from 1973 through 2016 (Source: USGS, 2017).

[27] The mission of the GLSC is to advance scientific knowledge and provide scientific information for restoring, enhancing, managing, and protecting living resources and their habitats in the Great Lakes basin ecosystem.

[28] From 1999 through 2015, the GLSC's lake-wide surveys also sorted, weighed, and reported the biomass for non-native dreissenid mussels (i.e., zebra mussels and quagga mussels); however, these efforts were discontinued in 2016.

Table 3. Total number and relative abundance (percent of catch) of fish collected with bottom gill nets in Lake Michigan from 1972 through 1977 (Source: Brazo and Liston, 1979).

	1972 (n=15)		1973 (n=126)		1974 (n=120)		1975 (n=157)		1976 (n=119)		1977 (n=138)		Years 1972-1977 Combined	
Species	**Total No.**	**Relative Abundance (%)**	**Total No.**	**Relative Abundance (%)**	**Total No.**	**Relative Abundance (%)**	**Total No.**	**Relative Abundance (%)**	**Total No.**	**Relative Abundance (%)**	**Total No.**	**Relative Abundance (%)**	**Total No.**	**Relative Abundance (%)**
YP	6,857	50.7	6,214	58.3	5,748	56.8	4,761	44	4,376	39.9	3,228	31.2	31,184	0.47
AW	2,071	15.3	1,126	10.6	990	9.8	1,397	12.9	3,556	32.4	3,207	31	12,347	0.19
STSH	1,323	9.8	849	8	1,110	11	972	9	314	2.9	728	7	5,296	0.08
LNS	889	6.6	345	3.2	396	3.9	445	4.1	351	3.2	591	5.7	3,017	0.05
WS	850	6.3	628	5.9	701	6.9	812	7.5	372	3.4	547	5.3	3,910	0.06
RSM	435	3.2	927	8.7	311	3.1	926	8.6	912	8.3	392	3.8	3,903	0.06
LT	430	3.2	267	2.5	314	3.1	584	5.4	325	3	587	5.7	2,507	0.04
RWF	374	2.8	193	1.8	346	3.4	583	5.4	534	4.9	791	7.7	2,821	0.04
Other[a]	304	2.2	110	1.0	205	2.0	332	3.1	226	2.1	268	2.6	1,445	0.02
TOTAL	**13,533**		**10,659**		**10,121**		**10,812**		**10,966**		**10,339**		**66,430**	

Species abbreviations: AW, alewife; LT, lake trout; LNS, longnose sucker; RSM, rainbow smelt; RWF, round whitefish; STSH, spottail shiner; WS, white sucker; YP, yellow perch.

a "Other species" include the following individual species whose relative abundances were less than 1 percent for each of the respective years they were captured: lake whitefish, bloater, burbot, trout-perch, lake chub, Chinook salmon, brown trout, rainbow trout, shorthead redhorse, coho salmon, lake sturgeon, carp, northern pike, walleye, longnose dace, lake herring, sea lamprey, gizzard shad, ninespine stickleback, slimy sculpin, northern hogsucker, smallmouth bass, and brook trout.

Table 4. Number of target and non-target fish species collected inside and outside the fish barrier net from 1993 through 2017 during Consumers Energy and DTE Companies' barrier net effectiveness monitoring (Source: Consumers Energy and DTE Companies, 2017a and 2017b).

	TARGET SPECIES										NON-TARGET SPECIES OF CONCERN			
Year	**BNT**	**CHIN**	**COHO**	**LT**	**RBT**	**YP**	**AW**	**RSM**	**CHUB**		**LKH**	**LW**	**LS**	
1993	316	298	186	292	40	8,006	23,368	520	78		0	22	3	
1994	445	417	146	206	75	3,822	37,661	1,159	14		0	2	2	
1995	192	386	67	202	36	2,809	34,878	388	0		2	0	3	
1996	516	421	69	342	178	3,472	34,342	215	1		0	0	3	
1997	398	675	120	106	85	929	17,805	209	8		1	0	1	
1998	194	261	62	143	17	193	28,206	162	20		1	0	4	
1999	151	286	64	338	24	956	10,469	141	3		0	0	5	
2000	132	401	111	176	6	68	34,178	21	3		0	0	1	
2001	118	271	26	154	11	43	16,076	49	10		0	0	4	
2002	80	205	246	76	8	18	7,848	13	8		0	2	4	
2003	95	198	9	199	16	70	4,736	12	0		23	1	0	
2004	84	424	22	288	15	37	16,188	10	0		29	9	3	
2005	64	316	21	228	4	40	9,310	20	16		0	0	1	
2006	56	265	20	118	8	911	9,025	3	0		0	66	4	
2007	77	165	16	202	8	175	3,512	1	13		0	9	2	
2008	65	201	12	416	13	212	7,030	13	360		0	28	2	
2009	152	214	15	435	15	130	7,188	14	89		0	40	7	
2010	124	62	21	279	4	50	2,218	2	14		1	7	5	
2011	92	218	34	567	12	725	6,953	1	0		16	14	7	
2012	113	79	43	143	12	532	7,781	2	4		10	4	7	
2013	125	169	12	148	20	1,250	4,081	3	3		68	7	1	
2014	192	129	16	88	34	187	1,550	0	0		41	0	1	
2015	255	154	26	219	30	25	2,419	7	0		120	21	5	
2016	159	35	17	112	20	96	3,619	8	0		254	123	10	
2017	62	184	81	114	7	299	6,805	11	0		758	77	9	
TOTAL	**4,257**	**6,434**	**1,462**	**5,591**	**698**	**25,055**	**337,246**	**2,984**	**644**		**1,324**	**432**	**95**	
R.A.[a]	**0.9**	**1.4**	**0.3**	**1.2**	**0.2**	**5.5**	**73.6**	**0.7**	**0.1**		**0.3**	**0.1**	**0**	

TABLE CONTINUED BELOW

OTHER NON-TARGET SPECIES [b]														
Year	**BURB**	**CP**	**FD**	**GSD**	**LNS**	**REDH**	**RGY**	**RWF**	**SMB**	**STSH**	**TPER**	**WEYE**	**WS**	**TOTAL**
1993	109	33	224	473	165	204	0	750	8	3,136	5	150	1,039	39,425
1994	89	40	322	791	63	279	0	537	8	1,572	0	190	993	48,833
1995	28	49	597	1,588	42	262	0	504	36	2,340	3	179	767	45,356
1996	19	39	310	714	27	201	0	665	8	6,270	2	98	669	48,583
1997	19	40	350	261	26	117	0	1,188	3	2,715	12	137	520	25,724
1998	15	60	406	787	11	184	0	833	15	2,314	2	238	455	34,583
1999	13	21	408	249	5	110	0	659	17	7,712	3	171	190	21,996
2000	4	29	377	145	8	191	0	477	4	724	10	140	232	37,438
2001	5	6	313	55	8	145	0	351	7	288	6	168	268	18,382
2002	2	7	291	182	6	165	0	382	3	689	25	197	261	10,718
2003	1	8	199	25	5	100	13	192	0	464	13	92	111	6,582
2004	0	18	304	213	5	61	65	241	5	943	60	124	121	19,269
2005	0	2	161	180	3	75	44	116	4	250	0	156	98	11,109
2006	3	17	234	226	0	92	127	19	5	677	0	126	34	12,036
2007	1	16	202	224	0	90	135	96	0	81	0	126	17	5,168
2008	0	9	278	40	4	59	246	82	2	67	0	149	34	9,322
2009	2	20	123	34	3	59	186	128	2	171	0	99	47	9,173
2010	1	3	177	89	1	69	415	122	8	280	0	86	42	4,081
2011	0	7	172	15	3	28	864	329	3	446	0	95	126	10,727
2012	0	3	82	86	0	33	535	203	14	308	0	44	73	10,110
2013	2	3	184	14	0	46	682	182	10	508	0	76	20	7,614
2014	1	9	101	2	1	26	167	80	1	70	0	37	48	2,781
2015	1	20	120	6	0	44	37	128	4	145	0	63	74	3,893
2016	2	20	158	392	12	46	297	63	4	133	0	86	67	5,733
2017	0	19	227	225	1	36	38	46	2	174	0	90	57	9,379[c]
TOTAL	**317**	**498**	**6,320**	**7,016**	**399**	**2,722**	**3,851**	**8,373**	**173**	**32,477**	**141**	**3,117**	**6,363**	**457,989**
R.A.[a]	**0.1**	**0.1**	**1.4**	**1.5**	**0.1**	**0.6**	**0.8**	**1.8**	**0**	**7.1**	**0**	**0.7**	**1.4**	

Species abbreviations: BNT, brown trout; CHIN, Chinook salmon; COHO, coho salmon; LT, lake trout; RBT, rainbow trout; YP, yellow perch; AW, alewife; RSM, rainbow smelt; CHUB, chub (bloater); LKH, lake herring; LW, lake whitefish; LS, lake sturgeon; BURB, burbot; CP, common carp; FD, freshwater drum; GSD, gizzard shad; LNS longnose sucker; REDH, redhorse spp.; RGY, round goby; RWF, round whitefish; SMB, smallmouth bass; STSH, spottail shiner; TPER, trout perch; WEYE, walleye; WS, white sucker.

a R.A. = relative abundance (percent catch).

b "Other non-target species," (i.e., species other than lake herring, lake whitefish, and lake sturgeon) only include species for which more than 100 fish were collected (all size groups combined) over the entire 25-year sampling period.

c Consumers Energy and DTE Companies' 2017 Annual Report of Barrier Net Operation also reported that the following species were captured in 2017: black bullhead (n=1), channel catfish (n=24), pink salmon (n=1), longnose gar (n=2), rock bass (n=2), and white perch (n=27).

Upper Reservoir

Although habitat for fishery resources within the upper reservoir is limited, fish present within the inshore waters of Lake Michigan are regularly pumped into the upper reservoir during project operation (FERC, 1995). Fish surviving passage through the reversible pump-turbine units reside in the reservoir for a period of time ranging from hours to several days or weeks before exiting through the intakes during generation. Patterns of species abundance within the upper reservoir have been shown to generally correspond with seasonal fisheries abundance trends in inshore waters (FERC, 1995). Fisheries sampling conducted within the upper reservoir from 1973 to 1977 demonstrated that the most abundant fish species within the upper reservoir at that time were alewife, rainbow smelt, and spottail shiner (Gulvas, 1976; Brazo and Liston, 1979). These studies also concluded that although most fish species do not reproduce in the reservoir's unstable environment, some species such as alewife, johnny darter, and sculpin (*Cottus* sp.) may successfully spawn there (Brazo and Liston, 1979; Liston et al., 1981). More recent data collected by Consumers Energy and DTE Companies suggest that the most abundant fish species currently present within the reservoir are alewife, bloater, smelt, and yellow perch (Table 5) (Consumers Energy and DTE Companies, 2017b). Consumers Energy and DTE Companies have also recently suggested that the presence of a self-sustaining population of round whitefish may also inhabit the upper reservoir (Consumers Energy and DTE Companies, 2016).

Table 5. Fish species composition of the upper reservoir during 2017 sampling (Source: Consumers Energy and DTE Companies, 2017b).

Species	Number of Fish Collected	Relative Abundance
Alewife	389	60.9
Lake herring	165	25.8
Yellow perch	27	4.2
Lake trout	5	0.8
Round goby	5	0.8
Brown trout	4	0.6
Chinook salmon	4	0.6
Freshwater drum	3	0.5
Spottail shiner	2	0.3
Coho salmon	1	0.2
Walleye	1	0.2
Total	**639**	**100**

a Sampling occurred using 21 gill nets set overnight for 15 days. Gill nets were installed in the south (5 nets) and north (16 nets) ends of the upper reservoir at 24-foot (16 nets) and 6-foot (5 nets) depths.

Settlement Agreements

In 1995, Consumers Energy and DTE Companies entered into two separate settlement agreements with interested stakeholders. One of those settlement agreements was filed with the Commission on February 28, 1995, and subsequently approved on January 23, 1996 (i.e., 1995 Settlement Agreement).[29] The 1995 Settlement Agreement resolved issues concerning fish mortality resulting from operation of the project and required Consumers Energy and DTE Companies, in part, to: (1) annually install and maintain (from April 15 through October 15)[30] the fish barrier net around the project

[29] *See Consumers Energy Company and Detroit Edison Company*, Order Approving Settlement Agreement Regarding Fishery Issues, 74 FERC ¶ 61,055, January 23, 1996. Signatories to this settlement included Consumers Energy, DTE, Attorney General for the State of Michigan, Michigan DNR, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Band of Odawa Indians, Michigan United Conservation Clubs, National Wildlife Federation, and Interior.

[30] Actual installation and removal dates of the barrier net have varied depending on weather and lake conditions in a given year.

jetties and breakwater to minimize fish entrainment and mortality during pumping operation; (2) fund studies to monitor the effectiveness of the barrier net against established biological standards; and (3) review current fish entrainment abatement technologies every five years and report the results, including conclusions and recommendations concerning the feasibility of utilizing new entrainment abatement technologies at the project, to the Commission.[31]

The other settlement agreement (i.e., State Settlement Agreement) was an off-license agreement that covered non-FERC matters and included the same signatories as the 1995 Settlement Agreement. The State Settlement Agreement provided for the establishment of the Great Lakes Fishery Trust, which is administered by a Board of Trustees. The purpose of the Great Lakes Fishery Trust is to mitigate Lake Michigan fishery resources forgone as a result of project operation. Initial formation of the Great Lakes Fishery Trust included a cash payment of 5 million dollars from Consumers Energy and DTE Companies, and the transfer of 10,800 acres of company properties. Annual funding for the Great Lakes Fishery Trust is also provided by Consumers Energy and DTE Companies through compensation payments for unavoidable fish entrainment-related losses occurring at the project. Compensation payments are calculated using plant operation data (i.e., volume of water used for pumping) and annual barrier net effectiveness monitoring results. The payments from Consumers Energy and DTE Companies to the Great Lakes Fishery Trust are its sole funding source. About 70 million dollars in grants having been awarded from the Great Lakes Fishery Trust to various nonprofit organizations, educational institutions, and government agencies to enhance, protect, and rehabilitate Great Lakes fishery resources.

Both the 1995 and State Settlement Agreements contained provisions for the creation of a SAT to oversee elements of both settlement agreements.[32] The SAT not only serves in an advisory role, but it also has some independent responsibilities with

[31] Reviews were conducted in 2001, 2006, and 2011. The fish and aquatic resource studies conducted in 2015 and 2016 as part of Consumers Energy and DTE Companies' relicensing process were, in essence, a review of current fish entrainment abatement technologies and satisfied the requirements of the review which was scheduled to occur in 2016. None of the five-year reviews have resulted in additional or alternative entrainment abatement measures being proposed for implementation at the project.

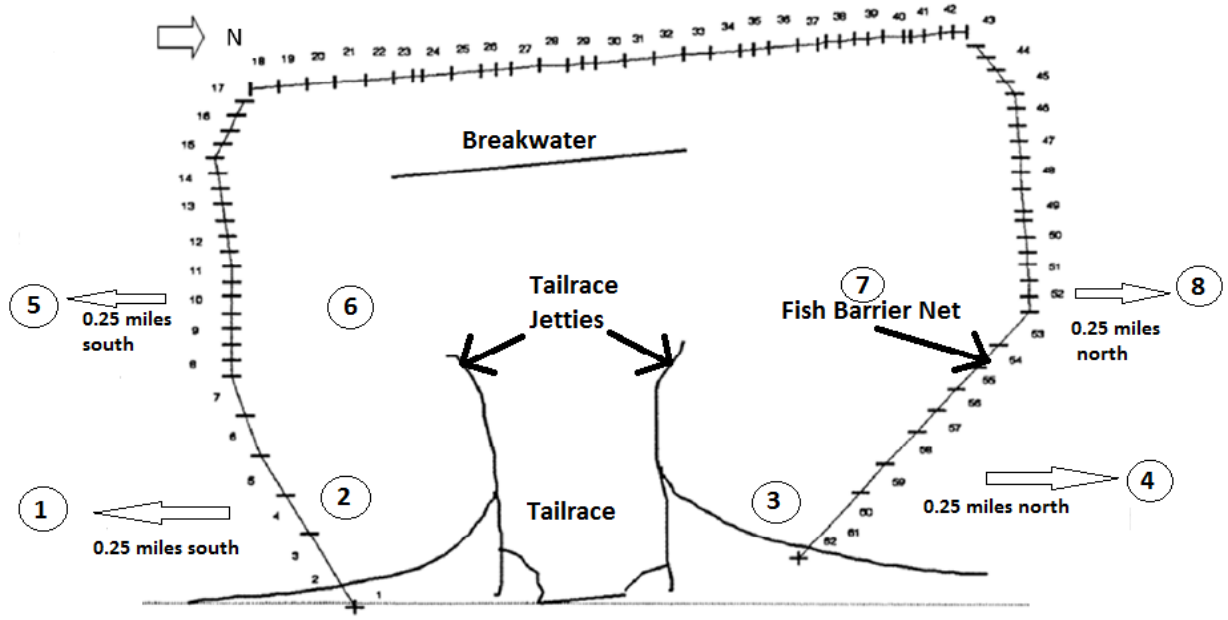
[32] The following entities currently serve on the SAT: Consumers Energy, DTE, Chippewa-Ottawa Treaty Fishery Management Authority, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Band of Odawa Indians, Michigan Department of Natural Resources, Michigan State University-Department of Fisheries and Wildlife, Michigan United Conservation Clubs, National Wildlife Federation, and the U.S. Department of Interior.

respect to overseeing certain technical provisions related to the project's license requirements. For example, the SAT evaluates and oversees the barrier net effectiveness monitoring data and proposals submitted to the Great Lakes Fishery Trust.

Seasonal Barrier Net

Specifications

As shown in Figure 10



, the seasonal barrier net currently installed at the project has a total length of approximately 12,850 feet. The 62 panel barrier net is composed of 51 panels that are 200 feet long, 2 panels that are 175 feet long, 2 panels that are 100 feet long, and 7 panels that are 300 feet long. The barrier net is anchored in place using a series of permanent bottom anchor piles that are generally spaced approximately 100 feet apart. An anchor chain is attached from each anchor pile to the barrier net panel's lead line at each of the permanent bottom anchors, distributing the stress from the anchor points to the rest of the barrier net panels. Each panel, except for panel numbers 1 and 62, have a bottom skirt affixed to the main net bottom border line and a top skirt attached to the top border line.[33] These skirts act to maintain the integrity of the area protected by the net during high discharge rates and/or turbulent lake conditions.

[33] Barrier net panel numbers 1 and 62 are located entirely on shore to provide protection during periods of higher Lake Michigan water levels or stormy conditions.

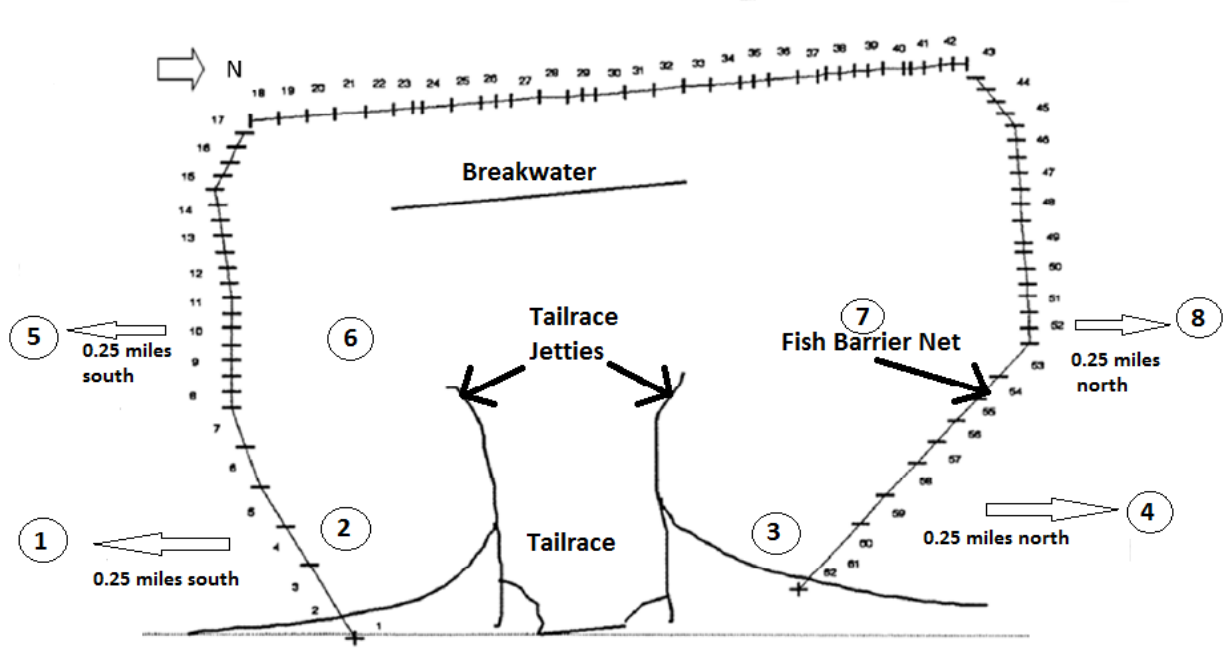
The first 1,175 feet of the barrier net from the shoreline, in both the north and south wings (panels 1 through 5 and 58 through 62), is made of 0.5-inch bar mesh (1-inch stretch mesh), while the remainder of the net (panels 6 through 57) is constructed with 0.75-inch bar mesh (1.5-inch stretch mesh).[34] The purpose of using the 0.5-inch bar mesh near shore is to improve the net's effectiveness at excluding smaller fish, which typically inhabit shallow, near-shore waters during the spring and early summer months. Each net panel is completely encompassed by border lines and the main net is diamond hung, meaning that when in a vertical position, the mesh is oriented in a diamond shape rather than a square shape. This allows the net material to stretch and flex both horizontally and vertically, which provides a stronger net as a result of the uniform distribution of forces.

Seasonal Barrier Net Effectiveness Monitoring

Consumers Energy and DTE Companies began installing and monitoring the effectiveness of a seasonal fish barrier net at the project in 1989 as part of a developmental program to minimize fish losses at the project. The barrier net effectiveness monitoring program currently undertaken by Consumers Energy and DTE Companies consists of setting gill nets[35] twice weekly at eight sampling stations; four nets are set inside the barrier net and four nets are set outside the barrier net, as shown in Figure 10

[34] Bar mesh is the length between two knots measured from the inside of one knot to the outside of the second knot. Stretch mesh is the inside diagonal distance between two knots on opposite sides of the stretched square mesh.

[35] The gill nets are designed to primarily capture fish greater than 4 inches in length, whereas the current barrier net effectiveness standards assess the protection of fish greater than 5 inches.



. Monitoring stations are paired on both sides of the barrier net at the same depths with the assumption that the catches should be the same in the absence of the barrier net. Barrier net effectiveness (expressed as a percent) is calculated by comparing the relative fish abundance from gill net sample collections inside the barrier net to outside the barrier net. Differences in catch abundance and species composition between sample stations inside and outside the net are attributed to the presence of the barrier net.

Gill nets used at nearshore locations (monitoring stations 1, 2, 3, and 4) are 6 feet deep and offshore locations (monitoring stations 5, 6, 7, and 8) are 24 feet deep, which are the approximate water depths at each location. Each gill net has 11, 30-foot-long panels with 11 different stretch mesh sizes ranging from 1 to 7 inches. Gill net data from the four sample locations outside the barrier net are considered to be representative of those fish species susceptible to gill nets and their relative abundance in the vicinity of the project. Fish collected inside the perimeter of the barrier net are indicative of the net's ability to prevent those fish from entering the inside area and represent those species and life stages subject to entrainment during pumping operation. It is assumed that fish that pass through the barrier net are entrained into the upper reservoir during pumping operation.

As shown in Table 4, since 1993, Consumers Energy and DTE Companies have collected a total of approximately 458,000 fish during the barrier net effectiveness monitoring program. Several target species (and size groups) were identified in the 1995 Settlement Agreement as species of primary interest with respect to barrier net effectiveness and for which barrier net effectiveness standards are applied annually (

Table 6). The 1995 Settlement Agreement also established the following biological performance standards for the barrier net with respect to designated target species and size groups: 80 percent effectiveness for game fish (salmonids and yellow perch combined over five inches in length) and 85 percent effectiveness for large forage fish (alewife and smelt combined over five inches in length). For the period 1993 through 2017, mean annual barrier net effectiveness for all target gamefish species greater than 5 inches long was 83.4 percent (ranging from 70.1 to 96.3 percent) and for all target forage fish species greater than 5 inches long, mean annual barrier net effectiveness was 93.3 percent (ranging from 72 to 98.9 percent) (Table 7). Mean annual barrier net effectiveness was 85.7 percent for all species combined, 88.9 percent for all target species combined, and 69.4 percent for all non-target species combined (Table 8). Table 9 provides barrier net effectiveness data for individual fish species by year for the period of record (i.e., 1993 through 2017).

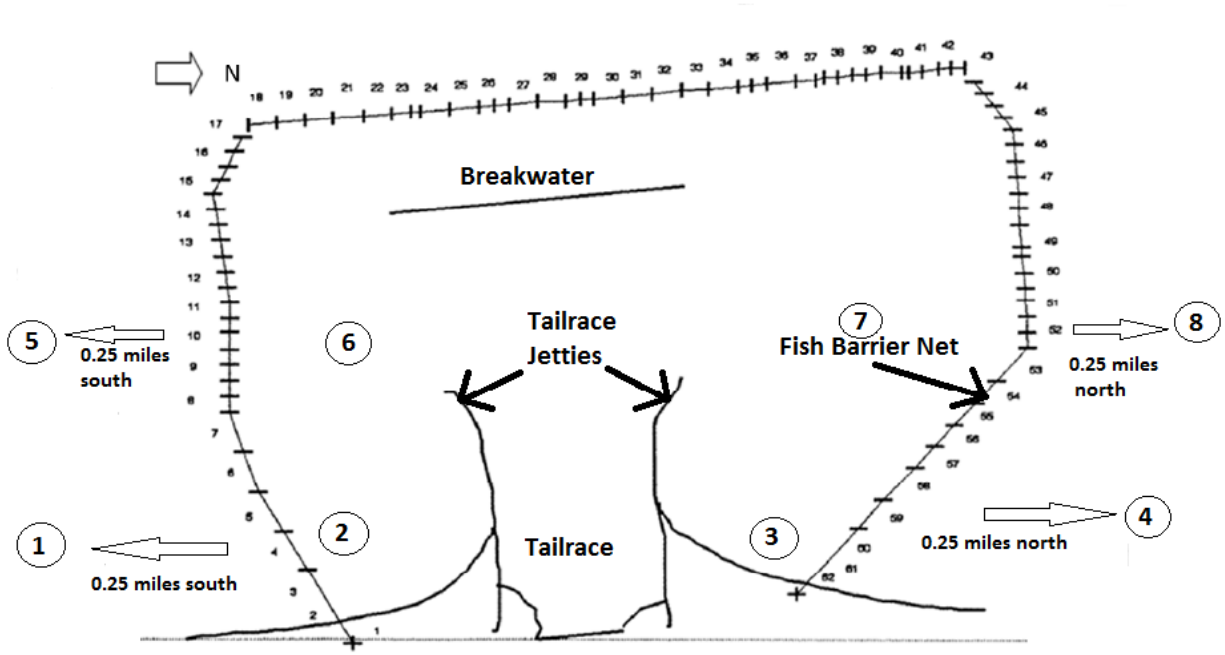


Figure 10. Overview of the primary barrier net sections and gill net installment locations (represented by circle nos. 1 through 8) as part of the barrier net effectiveness monitoring program at the project (Source: Consumers Energy and DTE Companies, 2017a).

Table 6. Designated target species and size groups that are the focus of Consumers Energy and DTE Companies' annual barrier net effectiveness monitoring (Source: Consumers Energy and DTE Companies, 2017a).

Category	Species	Size Groups[a] (inches)
Game Fish	Chinook salmon	>4-5, 5-12, 12-20, >20
	coho salmon	>4-5, 5-12, >12
	lake trout	>4-5, 5-12, >12
	rainbow trout	>4-5, 5-12, >12
	brown trout	>4-5, 5-12, >12
	yellow perch	>4-5, >5
Forage fish	rainbow smelt	>4-5, >5
	alewife	>4-5, >5
Other	Bloater (chub)	>4-5, >5

a Biological performance standards apply to gamefish and forage fish greater than 5 inches in length.

Table 7. Annual barrier net effectiveness (in percent) for target game and forage fish greater than 5 inches in length for the period of record (i.e., 1993 through 2017) (Source: Consumers Energy and DTE Companies, 2017a and 2017b).

Year	All Target Game Fish (> 5 inches)	All Target Forage Fish (> 5 inches)
1993	76.6	80.7
1994	90.7	90.3
1995	96.3	96.3
1996	91.6	97.2
1997	83.1	97.5
1998	89.3	96.7
1999	94.3	98.9
2000	86.7	96.4
2001	81.1	97.2
2002	85	90.8
2003	80	98.2
2004	70.1	95.4
2005	90.3	92.6
2006	79.8	89.5
2007	80.4	94.3

Year	All Target Game Fish (> 5 inches)	All Target Forage Fish (> 5 inches)
2008	82.7	92.2
2009	77.1	97.0
2010	78.9	94.5
2011	82.1	96.2
2012	76.5	95.2
2013	91.4	94.1
2014	78.7	97.3
2015	87.1	96.6
2016	70.4	86.3
2017	85	72
Mean	83.4	93.3
Max	96.3	98.9
Min	70.1	72
Years Below Target[a]	8	2
Years Above Target	17	23

a Established biological performance standards are 80 percent for game fish and 85 percent for forage fish.

Table 8. Annual, mean, and range of barrier net effectiveness (in percent) for all species combined, all target species combined, all-non target species combined, and target game and forage species greater than 5 inches in length. (Source: Consumers Energy and DTE Companies, 2017a and 2017b).

				Game Fish > 5 inches				Forage Fish > 5 inches		
Year	**All Species[a]**	**All Target Species**	**All Non-Target Species**	**Salmonids**	**Yellow Perch**	**Walleye[b]**	**All Game Fish**	**Alewife**	**Rainbow Smelt**	**All Forage Fish**
1993	77.5	80.4	60.1	80.1	76.1	95.8	76.6	80.7	77	80.7
1994	89.4	90.6	77.5	74.3	95.1	93.3	90.7	90.2	91	90.3
1995	93.1	95.4	76.8	86.2	99.3	96.5	96.3	96.3	93.1	96.3
1996	89.1	95.6	47.7	74	98.5	94.6	91.6	97.4	78.3	97.2
1997	90.5	95.8	64.5	72.4	96.4	95.4	83.1	97.6	87.6	97.5
1998	92.7	96.3	67.8	86.1	99	95.6	89.3	96.8	90.5	96.7
1999	82.5	96	58.5	89.3	99.6	97.6	94.3	99.2	78.4	98.9
2000	85.7	86.5	71.9	86.3	90.3	99.3	86.7	96.4	100	96.4
2001	95.6	96.5	84.4	79.3	100	98.8	81.1	97.2	80.5	97.2
2002	87	90.9	69.5	84.5	100	98.5	85	90.8	-	90.8
2003	91	93.9	76.8	78.9	100	96.6	80	98.3	-	98.2
2004	91.6	93.9	69.3	69.6	80	95.8	70.1	95.5	-	95.4
2005	91.4	92.1	85	89.8	100	96.7	90.3	92.6	88.9	92.6
2006	76.9	78.3	67.7	74.2	95.4	92.3	79.8	89.5	-	89.5
2007	91.2	91.9	88.7	80.5	80	88.5	80.4	94.3	-	94.3
2008	88.1	88.5	85.4	81.7	86.1	96.5	82.7	92.2	-	92.2
2009	89.3	91.4	65.6	75.1	89.3	73.1	77.1	97	-	97
2010	82.2	89.2	64.4	77.4	100	89.7	78.9	94.5	-	94.5
2011	79.5	81.7	69.4	77.3	92.6	92	82.1	96.2	-	96.2
2012	76.4	77.8	67	70.7	81.1	58.1	76.5	95.3	-	95.2

				Game Fish > 5 inches				Forage Fish > 5 inches		
Year	**All Species[a]**	**All Target Species**	**All Non-Target Species**	**Salmonids**	**Yellow Perch**	**Walleye[b]**	**All Game Fish**	**Alewife**	**Rainbow Smelt**	**All Forage Fish**
2013	78.4	81.2	68.6	76.6	96.2	94.4	91.4	94.3	-	94.1
2014	88.6	92.1	73.3	71.9	92.9	87.9	78.7	97.3	-	97.3
2015	90.2	93.1	77.1	86.6	100	78.8	86.5	96.7	-	96.6
2016	70.4	74.1	47.2	67.8	93.1	80.6	72.5	86.2	-	86.3
2017	74.6	79.0	52.0	86.1	82.2	88.9	84.9	71.4	-	71.6
Mean	**85.7**	**88.9**	**69.4**	**79.1**	**92.9**	**91.0**	**83.2**	**93.4**	**86.5**	**93.3**
Range	**70.4-95.6**	**74.1-96.5**	**47.2-88.7**	**67.8-89.8**	**76.1-100.0**	**58.1-99.3**	**70.1-96.3**	**71.4-99.2**	**77.0-100.0**	**71.6-98.9**

Key: "-" indicate instances whereby less than 20 fish were collected in a given year and annual effectiveness estimates were not calculated.

a "For all species," all size groups are combined.

b Walleye have been included as a game fish species of special interest for purposes related to the State Settlement Agreement (i.e., walleye have been used to calculate compensation for fish lost to entrainment during pumping operation), but are not a target species for barrier net effectiveness monitoring as identified in the 1995 Settlement Agreement. Walleye estimates include all fish greater than 4 inches in length.

Table 9. Barrier net effectiveness (in percent) for target species, non-target species of concern, and non-target species for which more than 1,000 total fish were collected over all sample years (catches inside and outside the barrier net combined) (Source: Consumers Energy and DTE Companies, 2017a and 2017b).

	TARGET SPECIES [a,b]										**NON-TARGET SEPCIES OF CONCERN**			**TABLE CONTINUED BELOW**
Year	**BNT**	**CHIN**	**COHO**	**LT**	**RBT**	**AW**	**RSM**	**YP**	**CHUB**		**LS**	**LW**	**LKH**	
1993	71.5	82.2	85.2	85.5	0	82.1	96.5	76.2	0		-	90	-	
1994	69.5	81.2	62.3	83	61.1	90.6	91	94.7	-		-	-	-	
1995	76.9	81.6	90.2	95.9	87.5	96	93.1	90.5	-		-	-	-	
1996	82.5	73.6	64.7	86.8	0	97.3	78.5	86.9	-		-	-	-	
1997	89.4	62.2	44.2	91.8	58.3	97.5	87.6	92.2	-		-	-	-	
1998	72.4	84	100	94.1	-	96.6	90.5	99	0		-	-	-	
1999	93.7	86.1	87.7	92	50	97.3	78.4	89.6	-		-	-	-	
2000	82.1	89.5	76.7	87.2	-	86.5	100	90.3	-		-	-	-	
2001	80.8	74	70	85.9	-	97.2	80.5	100	-		-	-	-	
2002	68.9	75.8	93.5	84.8	-	91.4	-	100	-		-	-	-	
2003	82.7	71.4	-	86.9	-	95.5	-	90.6	-		-	-	72.2	
2004	83.3	53.3	16.7	85.7	-	95	-	80.6	-		-	-	29.4	
2005	81.5	89.1	68.8	93	-	92.3	88.9	94.7	-		-	-	-	
2006	72.7	72.6	0	87.6	-	77.9	-	83.7	-		-	0	-	
2007	88.4	63.6	-	90.2	-	94.2	-	75	-		-	-	-	
2008	72.5	66.9	-	88.2	-	91.2	-	82.2	33.3		-	100	-	
2009	73.3	79.8	-	75	-	94.4	-	83.9	0		-	94.7	-	
2010	73.5	22.9	0	90.2	-	91.7	-	78	-		-	-	-	
2011	54	54.7	78.6	87.1	-	84.2	-	60.6	-		-	-	-	
2012	67.1	58.9	46.4	85.6	-	78.2	-	77.4	-		-	-	-	
2013	81	60.3	-	91.2	18.2	77.3	-	94	-		-	-	82.8	
2014	75.3	64.2	-	84.2	45.5	96.9	-	92.5	-		-	-	63.3	
2015	80.3	79.7	70	96.2	75	95.2	-	100	-		-	76.5	76.3	
2016	52.8	84	-	93.3	0	74.3	-	93.1	-		-	50	0	
2017	89.3	77.2	90.5	93.5	83.3	81.9	100	82.2			-	39.6	0	
Mean	**76.6**	**71.6**	**63.6**	**88.6**	**43.5**	**90.1**	**89.5**	**87.5**	**8.3**		**-**	**64.4**	**46**	

Range	**52.8-93.7**	**22.9-89.5**	**0-100**	**75.0-96.2**	**0-87.5**	**74.3-97.5**	**76.5-100**	**60.6-100**	**0-33.3**		**-**	**0-100**	**0-82.8**	
N (all years)	**4,257**	**6,434**	**1,462**	**5,591**	**698**	**337,246**	**2,984**	**25,055**	**644**		**95**	**432**	**1,324**	
Percent Collected	**0.9**	**1.4**	**0.3**	**1.2**	**0.2**	**73.6**	**0.7**	**5.5**	**0.1**		**0**	**0.1**	**0.3**	

Non-Target (>1,000 fish collected over all years)								
Year	**FD**	**GSD**	**REDH**	**RGY**	**RWF**	**STSH**	**WEYE**	**WS**
1993	75.6	91	82.1	-	43.4	26.7	95.8	97.9
1994	91.9	80.5	91	-	22.8	66.2	93.3	95.6
1995	98.5	95.5	91.7	-	57.2	38.5	96.5	96.5
1996	97.4	76.9	91.4	-	4.4	30.6	94.6	95.3
1997	97.7	93.9	98.3	-	27.8	54.7	95.4	94.1
1998	96.7	90.2	89.8	-	6.3	52	95.6	96.6
1999	99.5	100	99.1	-	0	53	97.6	99.5
2000	99.5	84	99.5	-	62.1	10	99.3	97.8
2001	96.7	47.2	97.9	-	81.8	33.5	98.8	96.9
2002	89.4	96	96.9	-	12.7	32.8	98.5	96.8
2003	99.5	95.8	93.6	-	90.9	28.1	96.6	97.2
2004	96.9	96.6	87	72.5	59.1	34.3	95.8	95.7
2005	98.7	87.5	84.6	81.1	85.1	58.8	96.7	94.6
2006	99.6	88.7	96.6	70.4	-	28.6	92.3	97
2007	100	87.4	96.6	86.6	82.9	52.7	88.5	-
2008	97.8	100	94.6	74.5	82.9	0	96.5	93.8
2009	95.8	90.3	90.7	59.1	35.9	1.2	73.1	85.4
2010	98.3	0	74.5	69.9	87	14.6	89.7	60
2011	98.8	-	35.3	79.7	50.5	46.7	92	22.5
2012	93.5	100	73.1	78.4	76.2	0	58.1	67.3
2013	97.2	-	90.5	81.6	28.3	24.8	94.4	-
2014	99	-	76.2	84	40	0	87.9	82.9
2015	100	-	95.2	97.2	70.7	29.4	78.8	87.9
2016	94.7	55.7	87.8	84.6	0	22.7	80.6	60.4
2017	95.4	96.8	61.5	73.3	0	37.4	88.9	57.5

Non-Target (>1,000 fish collected over all years)								
Year	**FD**	**GSD**	**REDH**	**RGY**	**RWF**	**STSH**	**WEYE**	**WS**
Mean	**97.4**	**82.9**	**86.6**	**78.1**	**49.0**	**29.3**	**90.2**	**83.4**
Range	**75.6-100**	**0-100**	**35.5-99.5**	**59.1-97.2**	**0-90.9**	**0-66.2**	**58.1-99.3**	**22.5-99.5**
N (all years)	**6,320**	**7,016**	**2,722**	**3,851**	**8,373**	**32,477**	**3,117**	**6,363**
Percent Collected	**1.4**	**1.5**	**0.6**	**0.8**	**1.8**	**7.1**	**0.7**	**1.4**

Species abbreviations: BNT, brown trout; CHIN, Chinook salmon; COHO, coho salmon; LT, lake trout; RBT, rainbow trout; AW, alewife; RSM, rainbow smelt; YP, yellow perch; CHUB, chub (bloater); LS, lake sturgeon; LW, lake whitefish; LKH, lake herring; FD, freshwater drum; GSD, gizzard shad; REDH, redhorse spp.; RGY, round goby; RWF, round whitefish; STSH, spottail shiner; WEYE, walleye; WS, white sucker.

a For all species, all size groups are combined and annual effectiveness was not calculated if less than 20 fish were collected in any given year (indicated by dashes).

b Effectiveness estimates of 0 percent indicate more fish were caught inside the barrier net than outside the net.

Fish Entrainment Abatement Technologies and Engineering Alternatives Study

Pursuant to the Commission-approved study plan,[36] Consumers Energy and DTE Companies conducted a desktop study that was based on existing information to assess fish entrainment abatement measures and engineering alternatives that could potentially be applied at the project. The objectives of the study were to evaluate existing technologies available to protect fish from entrainment mortality and consider their applicability, feasibility, effectiveness, and total cost (capital and annual operating and maintenance costs). The study was completed in three phases:

Phase 1 compiled a comprehensive list of available fish protection technologies and species of fish that may be affected by the project (Alden, 2015a).

Phase 2 provided an assessment of entrainment abatement technologies that could potentially be implemented at project; these were technologies that did not require substantial structural changes to the project intake (Alden, 2015b).

Phase 3 provided an assessment of engineering alternatives that could potentially be implemented at the project to reduce fish entrainment; these alternatives were more substantive options that required civil or structural changes to the project (Alden, 2016).

A brief summary of each study phase is provided below. Additional information regarding each phase of the study, including methodologies and results, are contained in Alden (2015a, 2015b, and 2016).

Phase 1

Phase 1 included an extensive search for existing information on the Lake Michigan fishery as well as information on all available entrainment abatement technologies and engineering alternatives (both existing and in development). As a result, 53 different fish species were identified as having the potential to be exposed to entrainment at the project (Alden 2015a). The resulting list of entrainment abatement technologies and engineering alternatives subsequently evaluated in the Phase 2 and Phase 3 studies is provided in Table 10.

Phase 2

Phase 2 evaluated the entrainment abatement technologies identified during Phase 1 of the study for their applicability at the project, as well as the design and operation of the existing fish barrier net. The first step was to develop a thorough understanding of the biological and life history parameters for affected fish species

[36] *See* Study Plan Determination letter issued December 1, 2014.

(Alden 2015b). This included using Phase 1 information to identify what species and life stages are present in the vicinity of the project intake on Lake Michigan and when these fish would likely be at risk to entrainment (i.e., diurnal, monthly, and seasonal presence). Phase 2 included a matrix that identified entrainment risk, biological information, and data for the species and life stages present in the vicinity of the project intake on Lake Michigan (Alden, 2015b).

Assessment of the entrainment abatement technologies identified in Table 10 followed a three-step process: preliminary screening, feasibility assessment, and detailed assessment of selected technologies. Each step in the process evaluated the technologies against selected criteria. Those deemed as being potentially viable for application at the project in a given step were then evaluated in the subsequent step. The screening criteria used to evaluate Entrainment Abatement Technologies (Phase 2) and Engineering Alternatives (Phase 3) were developed in consultation with a panel of experts[37] and the SAT, and included the following: (1) proven biological effectiveness; (2) seasonal performance; (3) comparison to the existing fish barrier net; (4) commercial availability; (5) design performance; (6) regulatory approval; and (7) space requirement (Alden, 2015b).

Results of Phase 2 identified four potential entrainment abatement options that could be implemented at the project, in addition to the existing barrier net. Option 1 included modifying the existing fish barrier net to improve the integrity of the net and reduce submergence events (e.g., additional floatation, changes to the bottom skirt and anchors, etc.). Option 2 included modifying the existing barrier net with the physical modifications from Option 1 and also including an ultrasonic anti-fouling system to reduce biogrowth on the net. Options 1 and 2 also contemplated implementing net modifications on an incremental basis, based on barrier net effectiveness data, as part of an adaptive management process. Option 3 included utilizing a larger, 3.3-mile-long fish barrier net configuration with smaller mesh (0.5-inch bar mesh) to better distribute flows passing through the net and provide greater protection to fish less than 4 inches in length. Option 4 included utilizing a full-scale ultrasonic deterrent system to be used in conjunction with the existing fish barrier net to reduce the entrainment of juvenile and adult alewife, which is the most abundant species in the project area.

Phase 3

The Phase 3 report considered engineering alternatives identified in Phase 1. Similar to the Phase 2 process, each engineering alternative was evaluated in a stepwise

[37] A panel of experts (comprised of a fisheries biologist, a hydropower engineer, and a fish protection engineer) was created to provide expertise during the conduct of the study and provide expert opinions with regard to study results.

approach against established criteria (Alden, 2016). Based on the screening of engineering alternatives, the following six alternatives were selected for a detailed evaluation in Phase 3 (Alden, 2016): (1) offshore intakes with tunnels and velocity caps; (2) an extended tailrace with deep submerged intakes; (3) an extended tailrace with deep submerged intakes and intake tunnels; (4) offshore intakes with an acoustic barrier; (5) additional structures to better distribute flow at the existing barrier net; and (6) breakwater modifications to better distribute flow at the existing barrier net.

Based on the comprehensive results of the Phase 1, 2, and 3 studies, Consumers Energy and DTE Companies concluded that the existing barrier net remains the most feasible and proven fish protection measure available for the dynamic environmental and hydraulic conditions present at the project.

Table 10. Fish protection technologies considered for application at the project (Source: Alden, 2015).

Mode of Protection	Technology	
Entrainment Abatement Technologies		
Behavioral deterrence/guidance	Sound (infrasonic, sonic, ultrasonic, impulsive/high impact)	Hanging chains
	Light (strobe, continuous)	Visual keys
	Chemicals	Multi-technology behavioral system
	Electric barriers	Modified flow systems (current inducers; FVES™)
	Air bubble curtain	
	Water jet curtain	
Physical barrier/guidance	Barrier net	Aquatic filter barrier
Engineering Alternatives		
Behavioral deterrence/guidance	Velocity Cap	Veneer Intake
Mechanized physical barrier w/collection	Modified (Ristroph) traveling screens	Beaudrey Water Intake Protection Screen
	Bilfinger Multi-Disc™ Screening System	Fish Pumps
	Hydrolox ™ Screens	
Mechanized physical barrier	Standard traveling water screens (without fish collection)	Rotary drum screens
Physical barrier	Fixed screens	Porous dike
	Narrow-spaced bar racks	Filtrex filter system
	Infiltration intakes	Perforated pipe screens
	Cylindrical wedgewire screens	
Physical diversion	Angled louvers and bar racks	Eicher screen
	Angled screens (fixed or traveling)	Modular inclined screen
	Angled rotary drum screens	Submerged traveling screens
	Inclined-plane screens	
Physical barrier and/or diversion	Multi-technology physical system	

Invasive Mussels

Lake Michigan dreissenid mussels include two non-native species, the zebra mussel and the quagga mussel. Zebra mussels were first introduced into Lake Michigan beginning in the late 1980's, while quagga mussels are a more recent invader of Lake Michigan. These mussels pose a serious threat to the native Lake Michigan ecosystem because of their rapid proliferation and ability to filter enormous amounts of organic particulate matter from the water, thereby competing with other filterers and enhancing primary production through increased water clarity.

Special Status Aquatic Species

No federally listed fish species have been documented in the project area. However, several state-listed fish species may occur within Ottawa and Mason Counties and/or the adjacent waters of Lake Michigan according to the Michigan Natural Features Inventory website (Table 11).

The Upper Great Lakes population of Kiyi is believed to be extirpated from Lake Michigan as it was last recorded in Lake Michigan in 1974 (Fisheries and Oceans Canada, 2017). Similarly, although shortjaw cisco was once a common chub species in Lake Michigan, it too is considered extirpated from Lake Michigan (Gorman and Todd, 2005). Although native to Lake Michigan, sauger have recently only been recorded in the St. Clair River and Lake St. Clair within the State of Michigan (Michigan DNR, 2004). No collections of Kiyi, shortjaw cisco, or sauger could be found in the gill net data associated with Consumers Energy and DTE Companies' barrier net effectiveness monitoring.

Table 11. Special status fish species reported to occur in the project vicinity (Source: MNFI, 2017a).

Species	Status	County
Bigmouth shiner	State special concern	Ottawa[a]
Lake herring (cisco)	State threatened	Mason[b] and Ottawa
Kiyi	State special concern	Ottawa
Lake sturgeon	State threatened	Mason[b]
River redhorse	State threatened	Ottawa
Sauger	State threatened	Ottawa
Shortjaw cisco	State threatened	Ottawa

a A small satellite recreation area is located in Port Sheldon Township (Ottawa County), approximately 70 miles south of the powerhouse and reservoir.

b Lake herring and lake sturgeon are not listed as occurring in Mason County by the Michigan Natural Features Inventory (MNFI, 2017a); however, both lake herring and lake sturgeon have been collected during fish barrier net effectiveness monitoring conducted by Consumers and DTE Companies.

Bigmouth Shiner

Bigmouth shiner are a small minnow, attaining a maximum length of three inches. Spawning occurs from late-May through mid-August. The bigmouth shiner prefers flowing water in streams less than three feet deep, but is occasionally found in larger rivers (MNFI, 2017b). King and MacGregor Environmental, Inc. (2016) concluded that there is the potential for bigmouth shiner habitat within the Pigeon River and Lake Michigan immediately adjacent to the Port Sheldon recreation site. No collections of bigmouth shiner were found in the gill net data associated with Consumers Energy and DTE Companies' barrier net effectiveness monitoring.

River Redhorse

The river redhorse is one of the largest redhorse species and can reach a length of 30 inches and a weight of 10 pounds. River redhorse prefer medium to large rocky rivers with moderate to strong currents and are most often associated with long, deep run habitats between 1 and 10 feet deep. This species requires clear, unpolluted waters and is intolerant of silt and turbidity (MNFI, 2017c). King and MacGregor Environmental, Inc. (2016) concluded that there is the potential for bigmouth shiner habitat within the Pigeon River and Lake Michigan immediately adjacent to the Port Sheldon recreation site. No

collections of river redhorse were found in the gill net data associated with Consumers Energy and DTE Companies' barrier net effectiveness monitoring.

Lake Herring (Cisco)

Lake herring, a native salmonid species, prefer deep water habitats of the Great Lakes and high quality inland lakes. As water temperature drops in the fall, lake herring form spawning schools (Michigan DNR, 2017b). They may be found in shallower depths (3 to 10 feet deep) when spawning, which occurs from late-September through early-December, although spawning may occur at much greater depths (Michigan DNR, 2017b; MNFI, 2017d). Lake herring are heavily preyed upon by lake trout, northern pike, yellow perch, and walleye, and are an important part of the Great Lakes ecosystem. During the 19th and early 20th centuries, lake herring were a significant part of the Great Lakes commercial fishery, but since that time their population has dropped drastically (Michigan DNR, 2017b).

Gill net collections at the project from 1972 through 1977 documented no lake herring; however, this species has become more common in the project vicinity in recent years. During Consumers Energy and DTE Companies' fish barrier net monitoring from 1993 through 2017, a total of 1,324 lake herring were collected, with the majority of these being collected in the last several years (1,132 lake herring were collected in the past three years) (Table 4). King and MacGregor Environmental, Inc. (2016) concluded that there is also the potential for lake herring habitat within the Pigeon River and Lake Michigan immediately adjacent to the Port Sheldon recreation site.

Lake Sturgeon

Lake sturgeon are the longest lived fish species in Michigan, attaining ages of up to 150 years old. Lake sturgeon can grow to over 8 feet in length and weigh up to 800 pounds. Male lake sturgeon reach sexual readiness between 8 and 12 years of age, though it can take up to 22 years, and spawn every 2 to 7 years. Female lake sturgeon reach sexual maturity between 14 and 33 years of age, though most often between the ages of 24 and 26 years, and spawn every 4 to 9 years. Spawning typically takes place between April and June when water temperature reaches 53 to 64 $^{\circ}$F. Lake sturgeon exhibit homing behavior in which adult fish return to the streams in which they were born, often migrating great distances up rivers during the spring months (Great Lakes Inform, 2017). These life history characteristics have hindered the recovery of the lake sturgeon, which have been designated as a threatened species in Michigan.

Gill net collections at the project from 1972 through 1977 documented 1 lake sturgeon (in 1972) and an entrainment mortality study conducted from 1979 through 1980 collected an additional lake sturgeon at the project (Liston et al., 1981). A total of 95 lake sturgeon, ranging from 0 to 10 individual fish annually, have been collected at the project since fish barrier net monitoring began (Table 4).

The fish barrier net monitoring procedures require that all lake sturgeon collected be processed in accordance with FWS protocol. This involves tagging the fish with Passive Integrated Transponder tags (if not previously tagged), recording of length and girth, and collection of a small amount of fin tissue. Consumers Energy and DTE Companies provide all lake sturgeon sampling data to a prescribed list of researchers and to the SAT in monthly reports. Consumers Energy and DTE Companies state that all lake sturgeon collected to date have been released in good condition and nearly all sturgeon processed have not been previously tagged.

3.3.1.2 Environmental Effects

Water Quality

Releasing water through the powerhouse during generation has the potential to affect water temperature and dissolved oxygen concentrations in Lake Michigan. These altered conditions in Lake Michigan could in turn affect fish and other aquatic species.

Consumers Energy and DTE Companies propose to continue operating the project as it does under the existing license (*see* section 2.2.2, *Proposed Project Operation and Environmental Measures*) and do not propose any protection, mitigation, or enhancement measures related to water quality.

Michigan DEQ certification condition 2.1 would require that Consumers Energy and DTE Companies operate the project in such a manner as to adhere to state water quality standards for water temperature in Lake Michigan. Specifically, certification condition 2.1 would require that project operation not cause the waters of Lake Michigan to exceed the following state standard monthly average temperatures:

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
40°F	40°F	40°F	50°F	55°F	70°F	75°F	75°F	75°F	65°F	60°F	45°F
4.4°C	4.4°C	4.4°C	10°C	12.8°C	21°C	23.9°C	23.9°C	23.9°C	18.3°C	15.6°C	7.2°C

Michigan DEQ states, however, that deviations from the above water temperature standards would be acceptable when the natural water temperature of Lake Michigan exceeds these specified monthly average temperature values. In these instances, Michigan DEQ certification condition 2.1 would require that water released from the project not raise the water temperature of Lake Michigan by more than 3°F.

To verify project-related effects on water temperature, Michigan DEQ certification condition 3.1 would require that Consumers Energy and DTE Companies monitor Lake Michigan water temperature on an hourly basis from June 1 through October 31,

beginning the first year after license issuance, for a minimum of one year. Michigan DEQ certification condition 2.2 would require that the compliance point for water temperature monitoring be located at a representative location in Lake Michigan that is approved by Michigan DEQ. After one year of continuous monitoring, Michigan DEQ specifies in certification condition 3.1 that Consumers Energy and DTE Companies may request Michigan DEQ approval for a reduced monitoring schedule if the observed daily average water temperature values consistently meet state standards.

Michigan DEQ certification condition 3.3 would require that: (1) the water quality monitoring required by certification conditions 3.1 and 3.2 (discussed below under the *Fish Tissue Sampling* section) be formalized in a water quality plan that would be submitted (within six months of license issuance) to Michigan DEQ for approval, and (2) annual reports detailing all water quality monitoring required by the certification be provided to Michigan DEQ within three months of the completion of all sampling.

Our Analysis

Water quality monitoring conducted by Consumers Energy and DTE Companies indicate that water temperature and dissolved oxygen concentrations in the project's upper reservoir and in vicinity of the project tailrace on Lake Michigan are consistent with Michigan state water quality standards. Water quality within the upper reservoir exhibits slightly warmer water temperatures and lower dissolved oxygen concentrations than Lake Michigan waters within the project vicinity. As shown in Table 2, the average combined water temperature for the monitoring sites in the upper reservoir and Lake Michigan during sampling were 60.6°F and 59.6°F, respectively. These warmer water temperatures within the upper reservoir are also likely responsible for the slightly lower average dissolved oxygen concentrations observed at the sites in the upper reservoir (9.5 mg/L) as compared to the sites in Lake Michigan (9.8 mg/L) (Table 2).

As shown in Figure 7 and Figure 8, water temperature and dissolved oxygen concentrations within the project's upper reservoir generally mimic water quality conditions within Lake Michigan. However, unlike Lake Michigan, the upper reservoir does not regularly stratify. Water temperature and dissolved oxygen concentrations within the upper reservoir are relatively uniform throughout the water column, which is likely a result of the mixing that occurs during pumping operation and the relatively high turnover rate of the upper reservoir pool.[38] This mixing reduces the potential for any negative effects to water quality in Lake Michigan that could otherwise occur if the upper

[38] Based on a total impoundment volume of 82,300 acre-feet and an average weekly pumping rate of 200,000 acre-feet the weekly turnover rate is approximately 2.4 (Consumers Energy and DTE Companies, 2017a).

reservoir were to stratify (e.g., project discharges with lower dissolved oxygen concentrations).

Overall, there does not appear to be any discernable correlation between project operation and water quality in Lake Michigan. Water quality in Lake Michigan appears to be primarily driven by environmental conditions and natural processes (e.g., weather, water depth, etc.) that are unrelated to project operation. For example, Figure 6 shows that water temperature profiles and thermal stratification in Lake Michigan are primarily dependent upon water depth. Because wind forces are usually strong enough to mix water in shallow areas from the water surface to the bottom, stratification was shown to occur less often at the shallowest monitoring sites (2, 3, and 6), as compared to the deepest monitoring sites (1 and 4). The colder water temperatures observed at the deeper monitoring sites in Lake Michigan are also likely responsible for the overall average water temperatures being colder in Lake Michigan than the upper reservoir.

Michigan DEQ's certification would require that Consumers Energy and DTE Companies develop a plan to conduct additional water temperature monitoring in Lake Michigan to ensure that outflow from the project into Lake Michigan meets state water quality standards. Consumers Energy and DTE Companies are proposing no changes to existing project operation and the results from the 2013 water quality study show that existing project operation has no effect on water temperatures in Lake Michigan. Therefore, under the proposed action, we would expect that water quality in the vicinity of the project tailrace would likely be similar to conditions that currently exist and water temperatures would be consistent with those values specified by Michigan's state water quality standards. For these reasons, we find that there would be no project-related benefit to developing a plan to conduct post-license water temperature monitoring in Lake Michigan.

Fish Impingement and Entrainment

Fish residing within the vicinity of the project intake on Lake Michigan would continue to be susceptible to entrainment-related injury and mortality if unable to escape water flowing into the project during pumping operation. For any fish entrained through the project's reversible pump-turbine units during pumping operation, a certain number may be initially killed by turbine-induced mortality (*e.g.*, turbine blade strikes), pressure changes, or shear forces. Similarly, any fish present within the upper reservoir, including those that previously survived entrainment during pumping operation, would also be subject to entrainment through the project's turbines if unable to escape water flowing into the project during generation. As discussed below, smaller fish have the greatest potential for entrainment at the project because smaller fish have poorer swimming abilities than larger fish and the existing barrier net is less effective at excluding smaller fish (i.e., particularly fish less than 4 inches in length) from the tailrace. The existing barrier net is designed to be more effective at excluding larger fish (i.e., particularly fish

greater than 5 inches in length), which also have stronger swimming capabilities than smaller fish and are generally better able to avoid entrainment.

The project trashracks in front of the draft tubes in Lake Michigan have 12-inch by 23-inch openings to protect the turbines from drifting ice and large debris during pumping operation. As a result of the large openings, the trashracks do not exclude fish during pumping operation or result in fish impingement on the trashracks themselves. However, fish do have the potential to become impinged against the fish barrier net if unable to overcome approach velocities along the net during pumping operation.[39]

Pursuant to section V.A of the Settlement Agreement, Consumers Energy and DTE Companies propose to continue with the annual installation and maintenance of the fish barrier net around the project jetties and breakwater to minimize fish entrainment related to continued project operation. Under this proposal, the barrier net would continue to be installed for the longest practicable period each year during the ice-free season, and, at a minimum, from April 15 through October 15. Although the Settlement Agreement did not contain specific details in regard to Consumers Energy and DTE Companies' proposals for barrier net maintenance, staff assumes that Consumers and DTE Companies would continue with the existing fish barrier net maintenance procedures as described in the final license application, unless otherwise modified by the Adaptive Management Process described below. Currently, maintenance of the barrier net includes: (1) cleaning the net panels in-situ once per month or as practical (i.e., areas of higher debris accumulation may necessitate a more frequent cleaning schedule); (2) weekly in-situ inspections of the net to identify and repair net damage, as necessary; and (3) repairing and replacing net panels, lines, and other associated components of the net, as needed, in the off-season (i.e., when the net is not installed).

Pursuant to section V.A.2 of the Settlement Agreement, Consumers Energy and DTE Companies propose to procure, maintain, and make available additional fish barrier net replacement panels, anchors, buoys, lines, and other equipment and materials necessary to maintain the net on a continuous basis during the ice-free season and to allow for the replacement of all elements of the net system in the event of an extraordinary storm or other event that may damage the net system in its entirety.

Pursuant to section V.A.3 of the Settlement Agreement, Consumers Energy and DTE Companies propose to continue funding studies to monitor the effectiveness of the fish barrier net. Consumers and DTE Companies also propose in section V.A.4 of the Settlement Agreement to continue providing annual reports to the Commission and

[39] The first 1,175 feet of the barrier net from the shoreline, in both the north and south wings, is made of 0.5-inch bar mesh (1-inch stretch mesh). The remainder of the net is constructed with 0.75-inch bar mesh (1.5-inch stretch mesh).

Settling Parties that describe: (1) the actions taken by Consumers Energy and DTE Companies to evaluate and improve both the effectiveness of the fish barrier net and the methodology employed to measure barrier net effectiveness, and (2) the measures taken by Consumers Energy and DTE Companies to maintain the proper replacement capacity of the fish barrier net during the ice-free season. Although the Settlement Agreement did not contain specific details in regard to Consumers Energy and DTE Companies' proposals for barrier net effectiveness monitoring, staff assumes that Consumers Energy and DTE Companies would continue with the existing monitoring program as described in the final license application, unless otherwise modified by the Adaptive Management Process described below. The existing effectiveness monitoring program includes conducting overnight gill net sampling twice per week during the period the fish barrier net is installed. Differences in catch abundance and species composition between sampling stations located inside and outside the barrier net are then attributed to the presence of the barrier net and are used to calculate net effectiveness.

Pursuant to section V.A.1 of the Settlement Agreement, Consumers Energy and DTE Companies propose to maintain an annual fish barrier net effectiveness target of 80 percent for all fish equal to or greater than 5 inches in length. Consumers Energy and DTE Companies further propose in section V.A.1 of the Settlement Agreement that if 80 percent net effectiveness is not achieved for two consecutive years, Consumers Energy and DTE Companies would initiate discussions with the SAT in accordance with the procedures proposed under the Adaptive Management Process, as discussed below, to improve net performance. Section V.A.1 of the Settlement Agreement also describes how conformance with net effectiveness would be measured. Specifically, Consumers Energy and DTE Companies propose to: (1) use a three year rolling average of the annual barrier net effectiveness percentage to calculate the proposed effectiveness target of 80 percent for a given year, and (2) calculate net effectiveness during the first three years of any new license issued for the project by using a rolling average of net effectiveness calculated from the relevant years predating the issuance of any new license. Although not explicitly stated in the Settlement Agreement, staff assumes that Consumers Energy and DTE Companies would continue to calculate the effectiveness of the net using the following existing formula, where T_o is the total catch outside the barrier net and T_i is the total catch inside the barrier net: $[(T_o - T_i)]/ T_o \times 100$.

As evidenced by their execution of the Settlement Agreement and joint comment letter filed on December 4, 2017, in support of the Settlement Agreement, the Attorney General for the State of Michigan, Michigan DNR, Interior, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, Michigan United Conservation Clubs, and National Wildlife Federation support Consumers Energy and DTE Companies' proposed measures regarding the annual installation, maintenance, and effectiveness monitoring of the fish barrier net.

Our Analysis

The ability of various fish species to avoid impingement and entrainment is based largely on swimming ability, which is strongly influenced by fish size, form, and behavior, and the physical characteristics of the project (e.g., trash rack bar spacing, approach velocity, and intake location). Swimming ability has been categorized into several basic modes: (1) sustained speed; (2) prolonged speed; and (3) burst speed. Sustained speed can be maintained for long periods of time, typically on the order of hours. Prolonged speed, often listed as critical speed, can be maintained for only a brief and specific period of time before fatigue sets in, usually on the order of minutes or seconds. Burst speed is the fastest speed a fish can attain, usually only for a few seconds, and is typically exhibited to escape danger or capture prey.

Impingement

In 2011, Alden Research Laboratory, Inc. (Alden) conducted an evaluation of the potential effects of operational flow increases at the project on the existing fish barrier net (Alden, 2011). Specifically, the operational flow increases evaluated as part of this study were associated with the reversible pump-turbine unit upgrades that were subsequently proposed by Consumers Energy and DTE Companies in a license amendment and authorized by the Commission.[40] As part of this evaluation, a computational fluid dynamics (CFD) model was used to gain an understanding of water velocities through the fish barrier net under existing and proposed pumping conditions at a 0, 20, and 50 percent reduction in net porosity (i.e., clogging).[41] Alden (2011) concluded that under existing conditions (i.e., the project without the proposed reversible pump-turbine unit upgrades), maximum water velocities through the barrier net during pumping operation were low, ranging from 0.2 to 0.5 feet per second (fps) and dependent upon several factors (e.g., net porosity, location of an individual panel within the overall net configuration, etc.). Under the increased hydraulic capacities associated with the proposed reversible pump-turbine unit upgrades, Alden (2011) concluded that water velocities through the barrier net would

[40] *See Consumers Energy Company and Detroit Edison Company*, Order Amending License, 139 FERC ¶ 62,101, May 7, 2012.

[41] Flow capacity values used for "existing pumping conditions" under the CFD simulations were chosen to match those used in previous physical modeling at the project (66,630 cfs for pumping and 77,400 cfs for generating). Simulations for the "proposed pumping conditions" were chosen to represent the maximum flow capacities that would occur under the upgraded reversible pump-turbine units (84,096 cfs for pumping and 89,670 cfs for generating) and did not account for variations in head or throttling of the wicket gates for maximum efficiency.

range from 0.2 to 0.7 fps depending upon the same factors identified above. These water velocities modeled by Alden provide an estimation of the hydraulic conditions that would occur at the project during the term of any new license issued for the project, once the reversible pump-turbine unit upgrades have been completed.[42]

Prolonged or critical swimming speeds for select fish species known to reside in the project area (lake trout, lake whitefish, rainbow smelt, alewife, brown trout, and rainbow trout) and a surrogate species (Atlantic salmon)[43] were collected by Alden for comparison to modeled water velocities at the barrier net. This comparison was used to determine if resident fish would be capable of overcoming the approach velocities along the barrier net under the increased hydraulic capacities associated with the reversible pump-turbine unit upgrades and, thus, avoid impingement on the net. All seven of the fish species cited in Alden (2011) had critical swimming speeds that ranged from 0.7 to 1.3 fps for juveniles and 1 to 3 fps for adults. Alden (2011) also conducted a comprehensive literature review of the swimming capabilities of freshwater, estuarine, and marine fish based upon the results of EPRI (2000). These results showed that the expected maximum average water velocities through the barrier net upon completion of the upgrades would be below the critical swimming speeds of the vast majority fish species cited in EPRI (2000), particularly for fish approximately 10 centimeters (4 inches) in length or greater (Figure 11). These results suggest that the burst speeds, or the highest speed a fish can attain over a very short period of time to support sprints or fast starts for purposes such as avoiding predators, high water velocities, or behavioral barriers (e.g., the barrier net) (Katopodis and Gervais, 2016), would be somewhat greater than the critical swimming speeds presented in Alden (2011). This would be especially true for adult fish (i.e., those fish potentially large enough to impinge on the barrier net), indicating there would be minimal susceptibility for impingement on the barrier net under the proposed action. These conclusions are also supported by Consumers Energy and DTE Companies' assertions in the final license application that fish impingement on the barrier net has not been observed during pumping operation.

[42] The reversible pump-turbine unit upgrades are scheduled for completion during the third quarter of 2019.

[43] Surrogate species are species that are similar in body shape and size (often of the same genus or family) to resident species and oftentimes have better data available than for resident species. Surrogate species are also typically assumed to have comparable swimming abilities as resident species. In this study, Atlantic salmon were most likely used as a surrogate for other, more abundant salmonid species present in the project area.

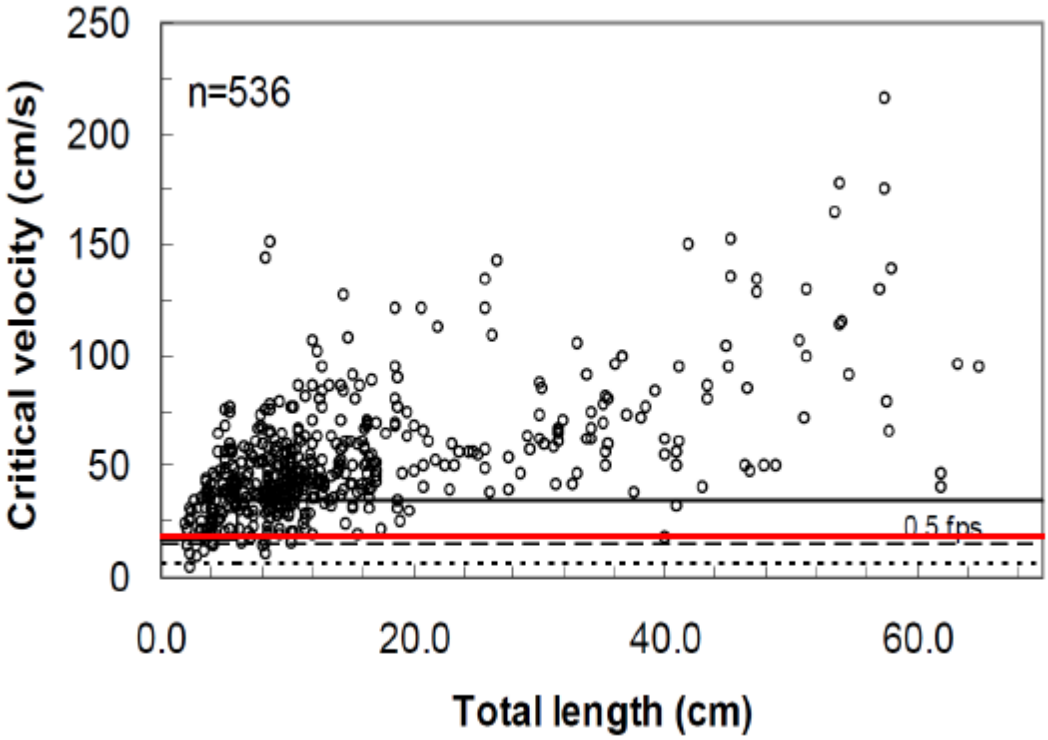


Figure 11. Critical swimming speeds for freshwater, estuarine, and marine fish as summarized in EPRI (2000). The red line indicates the highest estimated through-net velocity anticipated upon completion of the reversible pump-turbine unit upgrades at the project.

Entrainment

No project-specific turbine entrainment or mortality studies were conducted by Consumers Energy and DTE Companies during the relicensing process. The unique physical dimensions and high water velocities at the project have historically precluded the effective use of full-flow intake/tailrace netting and other direct counting techniques typically used at more conventional hydropower projects to estimate fish entrainment and mortality (FERC, 1995). However, prior to the annual installment of the fish barrier net beginning in 1989, several entrainment studies were conducted at the project in the 1970s and 1980s using a variety of alternative methods, including desktop-type analyses (Serchuk, 1976; Liston, 1979; Liston et al., 1981).[44] Several notable conclusions from Liston et al. (1981) included: (1) annual mortality at the project is approximately 532 million fish; (2) juvenile fish account for more than 99 percent of all fish mortality at

[44] *See* FERC (1995) for additional information pertaining to entrainment studies conducted at the project in the 1970s and 1980s, including study methodologies and results.

the project (alewife and johnny darter accounted for 73 percent of total losses), while adult fish, including salmonids, account for the remaining 1 percent of fish mortality; (3) entrainment into and out of the upper reservoir peaks in late-July and August, corresponding with the peak inshore abundance of alewife; (4) fish abundance decreases significantly in the project area during the winter months; and (5) peak mortality for large fish (i.e., greater than 7.9 inches in length), mostly salmonids, suckers, burbot, and whitefish, occurs from September through November. Liston et al. (1981) also concluded that the annual losses of fish may vary substantially as Lake Michigan fish population levels and climatic conditions fluctuate from year to year.

Historic entrainment analyses such as those conducted by Liston et al. (1981) are useful to help provide an understanding of seasonal and annual entrainment patterns, and the factors potentially influencing these patterns at the project. However, conclusions drawn in these historic studies regarding specific entrainment and entrainment-related mortality estimates should not be used as a definitive determination of existing entrainment rates at the project. It has been well documented that the composition, abundance, and population attributes of the resident fishery within Lake Michigan have changed substantially since 1970 (Eck and Wells, 1987; Madenjian et al., 2002), calling into question the relevance of some of the results presented in entrainment studies conducted at the project nearly 40 years ago. Further, in 1989, Consumers Energy and DTE Companies began annually installing a barrier net around the project jetties and breakwater in an effort to reduce fish entrainment and entrainment-related mortality during pumping operation. As discussed below, the barrier net has proven effective at minimizing fish entrainment at the project for species such as alewife, which Liston et al. (1981) concluded was the species most susceptible to entrainment-related mortality during project operation at that time. In 1980 alone, the entrainment of alewife during pumping and generation combined was estimated at 111 million fish, which suffered an estimated mortality rate of 84.2 percent (Liston et al., 1981).

As required by the 1995 Settlement Agreement, Consumers Energy and DTE Companies have annually monitored the effectiveness of the barrier net with respect to the designated target species and size groups identified in

Table 6. Based on current biological effectiveness targets,[45] the barrier net has been shown to be effective at reducing fish entrainment and mortality during pumping operation. As shown in Table 8, the average annual barrier net effectiveness (for species

[45] The current annual performance standards for the fish barrier net established under the 1995 Settlement Agreement are: (1) 80 percent effectiveness for game fish (salmonids and yellow perch combined) over five inches in length, and (2) 85 percent effectiveness for large forage fish (alewife and smelt combined) over five inches in length.

greater than 5 inches in length) is 85.7 percent (ranging from 70.4 to 95.6 percent) for all species combined, 88.9 percent (ranging from 74.1 to 96.5 percent) for all target species, and 69.4 percent (ranging from 47.2 to 88.7 percent) for all non-target species. For all target gamefish greater than 5 inches in length (salmonids and yellow perch combined) and target forage fish greater than 5 inches in length (alewife and rainbow melt), the average annual barrier net effectiveness is 83.2 percent (ranging from 70.1 to 96.3 percent) and 93.3 percent (ranging from 71.6 to 98.9 percent), respectively (Table 8). Overall, the barrier net has attained the biological effectiveness targets required by the 1995 Settlement Agreement in 17 out of 25 years for all target game fish greater than 5 inches in length and 23 out of 25 years for all target forage fish greater than 5 inches in length (Table 7).

Consumers Energy and DTE Companies' proposal acknowledges that while a good faith effort would be made to deploy the barrier net in Lake Michigan for the longest practicable period each year to reduce fish entrainment, winter conditions in the project area preclude the use of the net on a year-round basis. Therefore, Consumers and DTE Energy and DTE Companies propose that, at a minimum, the barrier net would continue to be installed from April 15 through October 15 each year. During the late-fall through spring, no mitigation measures would be in place to reduce fish entrainment at the project. However, based upon the findings of Liston et al. (1981), entrainment and entrainment-related mortality during the late-fall through spring period are reported to be substantially less than the period when the net is installed and mostly limited to larger species undergoing spawning migrations (e.g., salmonids, suckers, and burbot) through inshore waters in the project area. Recent weekly gill net data from Consumers Energy and DTE Companies' barrier net effectiveness monitoring help to support these conclusions made by Liston et al. (1981). Staff reviewed the five most recent annual barrier net operation reports on the project record from 2013 through 2017. Figure 12, which illustrates gill net data from a single year (2016), is an accurate characterization of recent data provided by Consumers Energy and DTE Companies in their annual barrier net effectiveness reports (Consumers Energy and DTE Companies, 2016). Figure 12 demonstrates that based upon gill net data from 2016, peak fish abundance in the project area occurs during the months of June through August, with smaller numbers of fish present in the project area prior to (April and May) and after (September and October) this period of peak abundance.

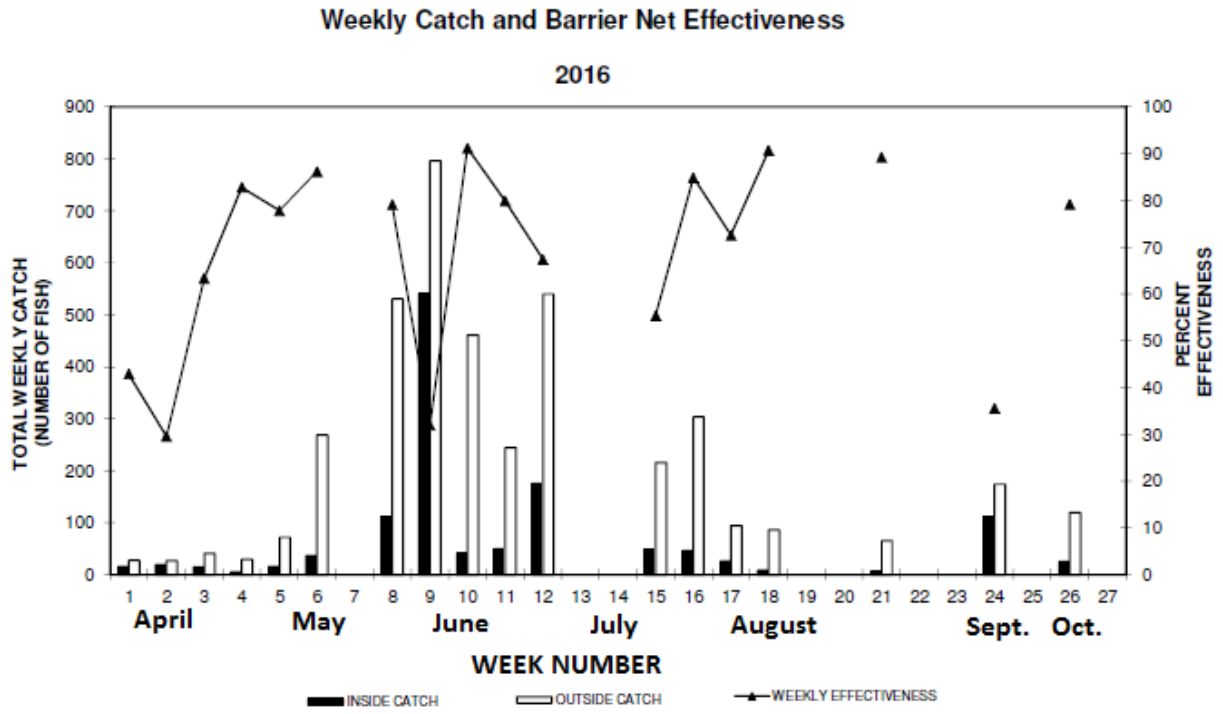


Figure 12. Weekly catch and barrier net effectiveness data (in percent) from Consumers Energy and DTE Companies' 2016 Annual Report of Barrier Net Operation (Source: Consumers Energy and DTE Companies, 2016).

Consumers Energy and DTE Companies' proposal to continue funding the existing fish barrier net effectiveness monitoring program would provide a means to assess whether the barrier net meets the proposed biological effectiveness targets during the term of any new license issued for the project. This information would help to verify whether the barrier net is functioning as designed and actively excluding Lake Michigan fish from the tailrace, thereby preventing their entrainment through the reversible pump-turbine units during pumping operation. Barrier net effectiveness monitoring results could also be used by Consumers Energy and DTE Companies to help inform decisions made during the implementation of the proposed Adaptive Management Process, as further discussed below.

In recent years, the effectiveness of the barrier net at meeting the current annual performance standards has generally been reduced, as compared to the barrier net's documented effectiveness in the 1990s (Table 7). In the first 11 years of barrier net effectiveness monitoring, only once (in 1993) did the barrier net not meet the 80 percent effectiveness target for target game fish over five inches in length. However, in the past 14 years of barrier net effectiveness monitoring, there have been seven years where the barrier net did not meet the 80 percent effectiveness target for target game fish over five inches in length. Similarly, two out of the three years that did not achieve the 85 percent

effectiveness target for target forage fish over five inches in length have occurred in the past two years (in 2016 and 2017). Consumers Energy and DTE Companies have attributed reduced barrier net effectiveness in recent years to several non-project-related factors. For example, Consumers Energy and DTE Companies stated the following factors influenced the reduced barrier net effectiveness rates observed in 2016: (1) a record minimum number of game fish**,** including a scarcity of yellow perch, the formerly dominant species and a species well protected by the barrier net (mean barrier net effectiveness for the period of record is 87.5 percent for yellow perch), comprised only 8 percent of the 2016 game fish collection; (2) an abundance of smaller alewife; and (3) a smaller than average size of fish in the non-target species group (Consumers Energy and DTE Companies, 2016). These results from the 2016 Annual Report of Barrier Net Operation support Consumers Energy and DTE Companies' assertions in the final license application that recent changes to the Lake Michigan fish community and the substantial declines in overall fish abundance in the project area have skewed current net effectiveness measurements. In the license application, Consumers Energy and DTE Companies contemplated the need to potentially develop new biological standards or "groupings" to more adequately assess barrier net effectiveness. Consumers Energy and DTE Companies' proposal in the Settlement Agreement appears to address this issue by combining the current two groupings and proposing the following single new grouping: maintain an annual fish barrier net effectiveness target of 80 percent for all fish equal to or greater than 5 inches in length. This proposal would ensure a greater number of fish are available to calculate an overall effectiveness of the barrier net. This proposal would also be a reasonable approach to eliminate the current small sample size biases associated with the existing "All Target Game Fish" grouping and better allow Consumers Energy and DTE Companies to more accurately measure and report on the effectiveness of the barrier net based on the actual composition of the existing fish community in the project area.[46]

Consumers Energy and DTE Companies' proposal to continue with the existing fish barrier net maintenance practices would ensure that the net is inspected, cleaned, and repaired on a regular basis, which would be essential to ensuring the net continues to function properly and as designed. Under existing conditions, the frequency of net cleaning and general net maintenance varies and is somewhat dependent upon a variety of factors. For example, the amount of algae accumulated on the barrier net at any given time is a function of various factors such as temperature, light and nutrient levels, and storm events, all of which are not influenced by the project and, in turn, dictate the frequency of net cleaning. Further, given the well documented proliferation of quagga

[46] Consumers and DTE Companies' proposal regarding implementation of the proposed Adaptive Management Process upon failing to achieve an 80 percent barrier net effectiveness for two consecutive years is discussed below in the *Adaptive Management Process* section.

mussels within Lake Michigan in recent years and their ability to currently accumulate on the barrier net, it is likely that the barrier net will require more frequent cleaning in the future to ensure it remains effective. Overall, Consumers Energy and DTE Companies' proposal for regularly inspecting the barrier net would be a continuation of existing procedures employed at the project and would provide a mechanism for Consumers Energy and DTE Companies to evaluate the need for more frequent inspections or cleanings in the future based on any identified causes (e.g., quagga mussels, algae, etc.). Continued regular inspections and cleanings of the barrier net would also be particularly important under any new license issued given the increase in net submergence and net lifting events that are anticipated to occur upon completion of the upgrades to the project's reversible pump-turbine units (Alden, 2011). Regular net inspections, in combination with barrier net effectiveness monitoring results, would also provide data which Consumers Energy and DTE Companies could use to help inform the need for structural modifications to the barrier net (e.g., additional floatation or alternations to the bottom skirt or anchors) or changes to other project facilities or operation to reduce net submergence or lifting events in the future. This would help to ensure the biological effectiveness of the net is maintained during the term of any new license issued for the project.

Consumers Energy and DTE Companies' proposal to procure, maintain, and make available additional fish barrier net replacement panels, anchors, buoys, lines, and other equipment and materials necessary to maintain the entirety of the net on a continuous basis would ensure that the appropriate materials and equipment are readily available for deployment in the event the barrier net becomes damaged during the term of any new license issued for the project. In the event of a partial or full net breach, Consumers Energy and DTE Companies' proposal would also facilitate net repairs being made in a timely manner. This would minimize the time period fish could potential gain access to the tailrace and become subject to entrainment through the project's reversible pump-turbine units during pumping operation.

As evidenced by their execution of the Settlement Agreement and joint comment letter filed on December 4, 2017, in support of the Settlement Agreement, the Settling Parties support Consumers Energy and DTE Companies' proposed measures regarding the continued installation of the fish barrier net and no other entities recommended an alternative to the fish entrainment abatement measures currently in place at the project. Although the existing barrier net has been shown to be an effective technology at reducing project-related entrainment, which may be further reduced under Consumers Energy and DTE Companies' proposed Adaptive Management Process (as discussed below), thousands of fish will undoubtedly continue to be entrained and killed at the project on an annual basis. Based upon historic entrainment studies and more recent annual barrier net effectiveness data, entrainment at the project would likely consist of mostly larval fish and fish smaller than 4 or 5 inches in length that are able to pass through the barrier net from mid-April to mid-October. During the fall and winter

months when the barrier net is not installed, larger species undergoing spawning migrations in the project area (e.g., salmonids) are likely to comprise the majority of project-related entrainment during this period. However, as discussed above, a number of changes to the Lake Michigan ecosystem as a whole have been well documented by researchers over past 40 years. These changes have been attributed to a number of different factors including, establishment and proliferation of various invasive species, fisheries management decisions, and reduced nutrient loading. These findings suggests that operation of the project has not been the primary cause of the population-level declines or shifts in the composition of the fishery that have been documented in the project area. Therefore, Consumers Energy and DTE Companies' proposal to continue operating the project with the seasonal installation of the barrier net would not have a discernable effect on fish populations within Lake Michigan despite the project's known unavoidable adverse effects.

Upon removal of the barrier net from Lake Michigan and once barrier net effectiveness data from the previous year has been analyzed, Consumers Energy and DTE Companies currently file annual reports with the Commission. Each annual report describes barrier net operation and effectiveness monitoring results from the previous year. The annual reports also contain a description of potential actions that could be implemented in the future to maintain or improve barrier net design and performance, and effectiveness monitoring. Consumers Energy and DTE Companies' proposal to continue filing these reports with the Commission (and providing them to the Settling Parties) on an annual basis would ensure that the Commission can effectively administer the requirements of any new license issued for the project. The annual reports would also provide valuable information that could help inform decisions regarding the effectiveness of the barrier net and the associated monitoring procedures, and the need for any necessary modifications to the barrier net or the methodologies employed to monitor its effectiveness during the term of any new license issued for the project.

We note that any proposal by Consumers Energy and DTE Companies to modify project facilities (i.e., the fish barrier net) or project operation for the purposes of reducing fish entrainment may not be implemented without prior Commission authorization.

Adaptive Management Process

Pursuant to section V.C of the Settlement Agreement, Consumers Energy and DTE Companies propose to implement an Adaptive Management Process[47] to increase

[47] Consumers and DTE Companies' proposed Adaptive Management Process For Fish Entrainment Abatement Technologies is included as Appendix B to the Settlement Agreement.

the barrier net's effectiveness or otherwise reduce fish entrainment at the project. Consumers Energy and DTE Companies propose that the Adaptive Management Process include the following measures during the first five years of the process, which would commence upon issuance of any new license issued for the project:

(1) Develop a plan, in consultation with the SAT, for the installation of additional floatation, additional anchor pilings, and stronger net materials in targeted areas of the fish barrier net to improve net effectiveness and file the plan for Commission approval (section V.B of the Settlement Agreement).
(2) Develop a plan, in consultation with the SAT, to monitor the effectiveness of any measures implemented to enhance the performance of the fish barrier net (e.g., additional anchor pilings) (Appendix B of the Settlement Agreement).
(3) Develop, in consultation with the SAT, and implement additional studies to support the decision making process for any additional optimizations of the fish barrier net or ancillary fixtures of the entrainment abatement system (Appendix B of the Settlement Agreement).
(4) Develop, in consultation with the SAT, and implement studies to characterize the fish community near the project. The purpose of these studies would be to ensure barrier net effectiveness targets remain biologically relevant during the term of any new license issued for the project and to provide information on the feasibility of implementing future potential fish entrainment abatement technologies at the project (Appendix B of the Settlement Agreement).
(5) After five years of implementing the Adaptive Management Process, file a report with the Commission that summarizes the efforts implemented under this process to date (Appendix B of the Settlement Agreement).

In Appendix B of the Settlement Agreement, Consumers Energy and DTE Companies propose that, based on the results of any of the above studies, the SAT may recommend to Consumers Energy and DTE Companies that a barrier net improvement or optimization be implemented only if it is: (1) shown in the applicable study to be likely to further reduce entrainment beyond the then-existing fish barrier net; and (2) reasonable, financially prudent, and maintains acceptable generation at the project. Any disagreement between Consumers Energy and DTE Companies, and the SAT regarding a proposed management action would trigger the Settlement Agreement's dispute resolution process.[48] Lastly, Consumers Energy and DTE Companies propose

[48] *See* section V.F. of the Settlement Agreement for a description of the dispute resolution process.

that after the implementation of any measures to enhance barrier net effectiveness, the implementation of any new method to monitor or evaluate barrier net effectiveness, or any change in an existing monitoring program, Consumers Energy and DTE Companies, and the SAT would collaboratively evaluate the results and subsequently consider whether any further barrier net-related improvements should be developed or implemented at the project. Consumers Energy and DTE Companies propose that any particular management action agreed upon by Consumers Energy and DTE Companies, and the SAT would first be submitted to the Commission, for approval, prior to implementation.

In Appendix B of the Settlement Agreement, Consumers Energy and DTE Companies propose to fund the Adaptive Management Process at a minimum of $3,450,000 over the first five years. Consumers Energy and DTE Companies propose that $1,450,000 would be dedicated to the installation of increased net floatation and additional permanent pile net anchors in high flow areas and $2,000,000 would be dedicated to studies and/or incremental net improvements. Consumers Energy and DTE Companies also propose that if it determines, in consultation with the SAT, that no additional optimizations would provide beneficial outcomes for management objectives to minimize fish mortality, any funds remaining from the $1,450,000 could, at the SAT's discretion, be deposited into the Great Lakes Fishery Trust's corpus.[49]

To support the continued implementation of studies under the Adaptive Management Process, Consumers Energy and DTE Companies propose in Appendix B of the Settlement Agreement to create a "Study Fund" by providing $500,000 to the SAT in year six of any new license issued for the project. Every ten years thereafter, Consumers Energy and DTE Companies propose to provide sufficient funds to increase the Study Fund to $500,000, as adjusted for inflation, except for the last payment, which would increase the Study Fund balance to $250,000.[50] Consumers Energy and DTE Companies also propose that any funds remaining from the $2,000,000 dedicated to studies and/or incremental net improvements could be used to reduce Consumers Energy and DTE Companies' obligation to the Study Fund in year six of any new license issued. For

[49] *See* section 3.3.1.1, *Affected Environment – Settlement Agreements*, for a description of the Great Lakes Fishery Trust.

[50] Consumers Energy and DTE Companies propose that if the balance of the Study Fund is at $500,000, as adjusted for inflation, at the time when a payment is scheduled to be made, there would be no obligation for it to provide additional funds. Consumers Energy and DTE Companies also propose that any unused funds at the expiration of any new license issued for the project would revert back to Consumers Energy and DTE Companies.

example, if there were $200,000 of undedicated funds left of the $2,000,000, then Consumers Energy and DTE Companies would only be required to provide $300,000 to the Study Fund in year six. Similarly, if Consumers Energy and DTE Companies spend more than $2,000,000 to conduct studies and/or make incremental net improvements during the initial five years of any new license issued, Consumers Energy and DTE Companies propose that any expenditures above $2,000,000 could be used to reduce its obligation to the Study Fund. For example, if $2,200,000 is spent during the first five years for studies and/or incremental net improvements, Consumers Energy and DTE Companies only be required to only provide $300,000 to the Study Fund in year six of any new license issued.[51]

As evidenced by their execution of the Settlement Agreement and joint comment letter filed on December 4, 2017, in support of the Settlement Agreement, the Attorney General for the State of Michigan, Michigan DNR, Interior, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, Michigan United Conservation Clubs, and National Wildlife Federation support Consumers Energy and DTE Companies' proposed Adaptive Management Process.

Our Analysis

Although there are no data directly correlating barrier net submergence or net lifting events with net effectiveness (Alden, 2016), both lifting and submergence of the net have the potential to reduce its effectiveness. Net submergence and net lifting would provide an opportunity for fish that are otherwise excluded by the net to pass over or under the net and gain access to the tailrace where they could become susceptible to entrainment. In the 2017 Annual Report of Barrier Net Operation, Consumers Energy and DTE Companies concluded that submergence (both during pumping and when the project was not operating) of the near-shore barrier net panels was, in part, likely related to the relatively poor performance of the barrier net observed in 2017 (Consumers Energy and DTE Companies, 2017b). Currently, submergence of the barrier net occurs on a regular basis and net lifting, while less likely to be observed than net submergence, has also been observed by divers while performing net maintenance. Barrier net submergence has been shown to mostly occur during generation and is influenced by several known factors, including the amount of debris accumulated on the barrier net, which is the primary factor responsible for net submergence, the location of individual net panels within the overall net configuration, the combination of reversible pump-

[51] Section VIII of Appendix B to the Settlement Agreement also describes the protocols to be followed in the event additional funding from Consumers Energy and DTE Companies is requested by the SAT.

turbine units in operation, quantity of discharge from the project, and ambient lake conditions (Alden, 2011).[52] Typically, barrier net submergence occurs most often in the northwest and southwest corners of the net, which are areas that receive the project's high-velocity flows during project generation.

Consumers Energy and DTE Companies' proposal to develop a plan for the installation of specific physical improvements (i.e., additional floatation, additional anchor pilings, and stronger net materials) to the fish barrier net would likely help to reduce net submergence and net lifting events. This proposal would essentially continue the efforts implemented by Consumers Energy and DTE Companies under the existing license to improve the structural integrity of the net to increase its effectiveness.[53] Additionally, Consumers Energy and DTE Companies are currently in the process of upgrading and overhauling all six reversible pump-turbine/motor generating units, which will result in increased flows when the project is generating. Alden (2011) concluded that as generation flows increase under these upgrades, the frequency and magnitude of barrier net submergence and net lifting events are likely to increase. Therefore, developing a plan to reduce net submergence and net lifting events would be particularly important given the frequency and magnitude of these events are expected to increase as the reversible pump-turbine unit upgrades are completed.

As part of Consumers Energy and DTE Companies' Fish Entrainment Abatement Technologies and Engineering Alternatives Study (Phase 2) conducted during relicensing, Alden analyzed the benefits and risks associated with making structural modifications to the existing barrier net (Alden, 2015b). Alden (2015b) noted the potential benefits associated with making structural modifications to the existing barrier net but also cautioned that some modifications could in turn have negative effects on the overall structural integrity of the net. For example, while improving net buoyancy may reduce net submergence events, this would also increase stresses on the net support system and anchors, potentially resulting in more frequent net lifting events and, therefore, a reduction in the net's overall structural integrity. Consumers Energy and DTE Companies' proposal to monitor the effectiveness of any measures implemented to enhance the performance of the fish barrier net would provide a mechanism for Consumers Energy and DTE Companies to adaptively manage structural modifications to the net through ongoing monitoring and evaluation of the monitoring results.

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[52] From 2008 through 2010, a total of 258 net submergence events were documented (Alden, 2011).

[53] The netting material, the manner in which the net is hung, and the addition of skirting are examples of the types of adaptations implemented by Consumers Energy and DTE Companies over the course of the barrier net's deployment history to improve its structural integrity.

Specifically, Consumers Energy and DTE Companies' proposal would allow for the effectiveness of these measures at improving the net's overall structural integrity to be assessed and help inform the need for additional or alternative modifications to the net to further improve the net's structural integrity, if necessary. This proposal would also provide Consumers Energy and DTE Companies with useful information on whether other non-project-related factors (e.g., algae, dreissenid mussels, etc.) are potentially responsible for any observed barrier net submergence and net lifting events.

Consumers Energy and DTE Companies propose to initiate discussions with the SAT in accordance with the procedures proposed under the Adaptive Management Process if an 80 percent net effectiveness target is not achieved for two consecutive years. This proposal would establish a proactive approach to addressing future potential reductions in barrier net effectiveness by ensuring reasonable measures and procedures are in place, should the net fail to meet the proposed effectiveness targets for two consecutive years. This proposal would also provide an opportunity for Consumers Energy and DTE Companies to discuss options to increase barrier net effectiveness with the SAT, while taking into consideration the respective member's expertise relative to fisheries and fish protection technologies (*see* discussion in SAT section below). For example, such discussions could focus on the potential need for additional or alternative structural modifications to the barrier net, if the information gathered through annual barrier net effectiveness monitoring and maintenance (*see* discussion in *Entrainment* section above) establishes a direct relationship between project-related net submergence or lifting events and observed decreases in net effectiveness.

Overall, Consumers Energy and DTE Companies' proposal to develop a plan for the installation of additional floatation, additional anchor pilings, and stronger net materials in targeted areas of the fish barrier net would reduce net submergence and net lifting events, and improve the structural integrity of the existing barrier net, which would be especially important given the frequency and magnitude of these types of net breaches are expected to increase in the future. This in turn may help to improve the biological effectiveness of the net during the term of any new license issued for the project. Filing the plan for Commission approval prior to implementation would enable the Commission to ensure that the objectives of the plan are achieved and facilitate Commission oversight of the license. However, Consumers Energy and DTE Companies' proposal to develop and implement a plan to monitor the effectiveness of these specific barrier net enhancements at improving the performance of the net would be redundant with the information that would be gathered through Consumers Energy and DTE Companies' proposal to continue monitoring the overall biological effectiveness of the barrier net on an annual basis. Therefore, a license condition requiring such a plan would be unnecessary.

As part of the proposed Adaptive Management Process, Consumers Energy and DTE Companies would develop and implement additional studies to support the decision

making process for additional potential optimizations of the fish barrier net or ancillary fixtures of the fish entrainment abatement system. Further, Consumers Energy and DTE Companies, in consultation with the SAT, would collaboratively identify feasible study needs and methodologies, and determine whether a particular study should be implemented by using the Settlement Agreement's dispute resolution process. Studies such as those contemplated by Consumers Energy and DTE Companies in section V.3 of the Adaptive Management Process could benefit fishery resources in the project vicinity by providing information which could help inform the need for additional measures to reduce fish entrainment and mortality losses during pumping.[54] Although Consumers Energy and DTE Companies' proposal appears to be a reasonable approach to determine the need for additional studies, the proposal does not identify specific studies at this time, but rather provides examples of the types of studies that could be implemented under the Adaptive Management Process. The Commission in its Policy Statement on Hydropower Licensing Settlements (Settlement Policy Statement)[55] notes that it prefers specific protection, mitigation, and enhancement measures that have a clear nexus to the project (i.e., a relationship between project effects or purposes and a proposed measure should be established). Therefore, because Consumers Energy and DTE Companies are proposing as-yet unidentified and uncertain studies, we have insufficient information at this time to assess the needs and benefits of the studies or the relationship of these studies to specific project effects or project-related purposes.

Changes in fish composition and abundance in the project vicinity over the past 45 years have been well documented in the literature and in Consumers Energy and DTE Companies' barrier net effectiveness monitoring data. The effects of these changes on the ability of the barrier net to meet the current biological performance standards with respect to designated target species and size groups have also been well documented (*see* discussion in *Entrainment* section above). Given that Lake Michigan's fish community is likely to continue to change in the future, conducting Consumers Energy and DTE Companies' proposed fish community characterization studies would help to ensure the proposed barrier net effectiveness targets remain biologically relevant over the term of any new license issued for the project. For example, since barrier net effectiveness monitoring began, alewife have been the most abundant species collected and a species effectively excluded from the tailrace through the use of the barrier net. Overall barrier

[54] Consumers and DTE Companies state that potential studies for consideration may include: (1) a study to determine if flow magnitude and direction during generation influences the concentration of small fish proximal to the fish barrier net, and/or (2) a study to determine if there are populations of resident fish within the upper reservoir that could affect the results of barrier net effectiveness monitoring.

[55] *See* the Commission's Policy Statement on Hydropower Licensing Settlements. 116 FERC ¶ 61,207 (2006).

net effectiveness for alewife is approximately 90 percent for all sizes combined (Table 9). However, if populations and the size distribution of certain fish species trend smaller during the course of any new license issued, similar to what has been observed for alewife since the barrier net monitoring program began (Consumers Energy and DTE Companies, 2017b), the ability of the barrier net to meet the proposed biological effectiveness standards may be reduced. Identifying changes such as these to fish populations in the project area would be important to help determine the cause of any reductions in barrier net effectiveness and whether the causes are project-related or otherwise (e.g., environmental). Further, the results of these fish community characterization studies, in combination with the results from Consumers Energy and DTE Companies' proposed barrier net effectiveness monitoring, would provide information which could help inform the need for additional measures, such as smaller bar mesh to reduce fish entrainment and mortality losses during pumping. However, Consumers Energy and DTE Companies' proposal to develop these studies lacks detail and specificity, and does not provide for any oversight by the Commission. Preparing a detailed plan for the proposed fish community studies would enable the Commission to ensure that the objectives of the studies are achieved and facilitate Commission oversight of any license, if issued. Lastly, we note that any specific measures developed in the future as a result of implementing the Adaptive Management Process (e.g., modifications to the fish barrier net for the purposes of reducing fish entrainment) may not be implemented without prior Commission authorization.

The proposed Adaptive Management Process contains a detailed description of the estimated funding amounts that would be required to implement the various provisions of the process. During the first five years of the process, Consumers Energy and DTE Companies propose to fund the Adaptive Management Process at a minimum of $3,450,000, with $1,450,000 dedicated to the installation of increased net floatation and additional permanent pile net anchors in high flow areas and $2,000,000 dedicated to the studies and/or incremental net improvements as described above. Consumers Energy and DTE Companies' proposal in regard to funding appears to be provided for informational purposes and the Adaptive Management Process acknowledges Commission policy in regard to "cost caps."[56] To clarify, the Commission in its Settlement Policy Statement notes that if a specific measure has been determined to meet the Federal Power Act's comprehensive development standard, the financial obligation of the licensee to provide the measure should not be limited by a particular dollar amount.[57] For example, in the event that any new license issued for the project required Consumers Energy and DTE

[56] *See* section VII of Appendix B to the Settlement Agreement.

[57] *See* Va. Elec. Power Co., 110 FERC ¶ 61,241 (2005) and Portland Gen. Elec. Co. and Confederated Tribes of the Warm Springs Reservation of Or., 111 FERC ¶ 61,450 (2005). *See* also Settlement Policy Statement, 116 FERC ¶ 61,270, at P 21 (2006).

Companies to develop a plan to reduce net submergence and net lifting events, and the costs associated with implementing the plan exceeded $1,450,000, Consumers Energy and DTE Companies' obligation would nevertheless be to complete the installation of all structural modifications required by the Commission-approved plan. Consumers Energy and DTE Companies' obligation would not be limited to the estimated dollar amount provided in the Adaptive Management Process.

If Consumers Energy and DTE Companies determine, in consultation with the SAT, that there are no additional optimizations that would provide beneficial outcomes for management objectives to minimize fish mortality, Consumers Energy and DTE Companies propose that any funds remaining from the estimated $1,450,000 could, at the SAT's discretion, be deposited into the Great Lakes Fishery Trust's corpus. The Commission noted in its Settlement Policy Statement that measures must have a nexus to project-related effects and that it prefers measures that are within the scope of its jurisdiction. The Commission has no authority over any party (e.g., Great Lakes Fishery Trust) to a hydroelectric licensing proceeding other than the licensee, and a licensee cannot satisfy the obligation to perform certain tasks by making a simple payment to another party. In general, when funds are proposed to be paid to a non-licensee entity for a measure, staff would analyze the actual measure itself to determine whether the measure addresses an identified project effect or would enhance a resource affected by the project. However, in this case, Consumers Energy and DTE Companies' proposal in regard to potential funding commitments to the Great Lakes Fishery Trust does not include any specific measures. Without specific measures, we cannot determine what benefits would accrue under the funds, the location of the measures in relation to the project, or the nexus between the measures and project effects or purposes.

Similarly, Consumers Energy and DTE Companies' proposal in regard to creating and maintaining a "Study Fund" for the SAT beginning in year six of any new license does not identify the specific studies that would be implemented and portions of this proposal also appear to contemplate cost caps when certain funding limits are met. Further, because the funds would be provided to a third party (i.e., the SAT), the licensee would not retain sufficient control over how the funds would potentially be used and there is no assurance that studies funded under this proposal would be conducted within the project vicinity or tied to project effects or purposes. Therefore, an evaluation of how the funds would benefit fishery resources in the project in any meaningful and measurable way are not possible.

Scientific Advisory Team

Pursuant to section V.E of the Settlement Agreement, Consumers Energy and DTE Companies propose to continue funding the SAT that was established under the 1995 Settlement Agreement. The Settlement Agreement states that the purpose of the SAT is to evaluate data and information relevant to the Settlement Agreement and the

scientific activities established or authorized in the Settlement Agreement, including, but not limited to, technical oversight of the following proposed measures: (1) the annual fish barrier net monitoring program, including all improvements and modifications to the net; (2) the Adaptive Management Process; and (3) the fish entrainment abatement technology reviews.[58] The Settlement Agreement further states that the SAT would be co-chaired by the Michigan DNR and a representative from either Consumers Energy and DTE Companies, and include the following members: (1) Interior; (2) Michigan DNR; (3) Michigan United Conservation Clubs; (4) National Wildlife Federation; (4) Consumers Energy; (5) DTE; (6) Chippewa-Ottawa Resource Authority or its successors or assigns; (7) Grand Traverse Band of Ottawa and Chippewa Indians; (8) Little River Band of Ottawa Indians; (9) Little Traverse Bay Bands of Odawa Indians; and (10) one member chosen by mutual agreement of Michigan DNR, Michigan United Conservation Clubs, and the National Wildlife Federation.

As evidenced by their execution of the Settlement Agreement, the Attorney General for the State of Michigan, Michigan DNR, Interior, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, Michigan United Conservation Clubs, and National Wildlife Federation support Consumers Energy and DTE Companies' proposal to continue funding the SAT.

Our Analysis

Consumers Energy and DTE Companies' proposal would essentially maintain its role as a participating member of the SAT and the current primary function of the SAT, which is to serve in an advisory role to Consumers Energy and DTE Companies. This proposal would also maintain the established processes for technical review of all information related to fish protection at the project and ensure appropriate consultation occurs among the relevant stakeholders. More specifically, Consumers Energy and DTE Companies' proposal would ensure an effective forum is in place for interpreting ongoing study results and evaluating the effectiveness of the fish barrier net at reducing fish entrainment at the project. Future decisions regarding the need for additional or

[58] Sections E.1.E and E.1.F of the Settlement Agreement also include provisions for the SAT to have technical oversight over the following off-license measures: (1) determining the amount of annual compensation that Consumers and DTE Companies will provide to the State of Michigan, including the Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, for fish mortality associated with project operation that occurs during the term of any new license issued, and (2) funding proposals submitted to the Great Lakes Fishery Trust for fishery research, habitat improvements, or other projects to enhance Great Lakes fishery resources and public access to them.

alternative entrainment abatement measures at the project and modifications to the methodologies for monitoring barrier net effectiveness would also benefit from SAT involvement and the collaborative approach proposed by Consumers Energy and DTE Companies.

Although the establishment of technical advisory groups can facilitate consultation among interested stakeholders and resolve disputes, the Commission only has authority over its licensees and cannot impose or enforce such provisions on or against third parties, like the members proposed to compose the SAT. Therefore, a license condition requiring the establishment of the SAT would serve no useful purpose. Nevertheless, Consumers Energy and DTE Companies would be free to consult with any or all members of the proposed SAT for technical expertise that in its view, would be needed to comply with the environmental requirements of any license issued for the project.[59]

Effects of Continued Project Operation on State-listed Species

Continued operation and maintenance of the satellite recreation facilities (i.e., a 4,600-mile-long boardwalk, fishing areas, and parking lot) in Ottawa County would not result in any in-water disturbance, including disturbance to nearby aquatic habitat, which may support populations of state-listed fish species (Table 11). As a result, the proposed action would have no effect on the following state-listed fish species: bigmouth shiner, Kiyi, river redhorse, sauger, and shortjaw cisco.

Potential effects of the proposed action on state-listed fish species would be limited to the entrainment of those state-listed species (i.e., lake herring and lake sturgeon) reported to occur within Mason County. Specifically, any lake herring or lake sturgeon present within the vicinity of the project intake on Lake Michigan during pumping operation would potentially become susceptible to entrainment.

Lake Herring

As shown in Table 3 and Table 4, few lake herring (n=83) were collected during annual gill net sampling conducted by Consumers Energy and DTE Companies at the project prior to 2012, as this species comprised less than 1 percent of the total number of fish collected each year from 1972 through 1977, and 1993 through 2012. However, since 2013, lake herring have become increasingly more abundant during annual gill net

[59] Although Consumers Energy and DTE Companies would be free to consult with the members of the SAT, doing so would not relieve Consumers Energy and DTE Companies of any required deadlines for filing related plans and other materials as stipulated by any new license issued.

sampling with a total of 1,241 collected, including 758 collected in 2017, which represents the most lake herring collected since sampling began (Table 4). In 2016 and 2017, lake herring comprised 4.4 and 8.1 percent, respectively, of the total number of fish collected during those years (Table 4).

In terms of the effectiveness of the existing fish barrier net at excluding lake herring from the tailrace, barrier net effectiveness has averaged 46 percent (ranging from 0 to 83 percent) since effectiveness monitoring began at the project (Table 9). In 2016 and 2017, which represent the years with the most lake herring collected (n=254 in 2016 and n=758 in 2017) since barrier net effectiveness monitoring began at the project, effectiveness was 0 percent in both years (Table 9).[60] Consumers Energy and DTE Companies speculate that these low effectiveness rates may be attributable to small fish passing through the barrier net or the possibility that fish were entrained before the net was deployed and then later discharged behind the net after the net was deployed (Consumers Energy and DTE Companies, 2016 and 2017b).

Lake herring spawning is known to occur in late-fall to early-winter in shallow water areas located along the Lake Michigan shoreline (Latta, 1995). Therefore, during the period when the barrier net is not installed (i.e., mid-October through mid-April), lake herring may inhabit the project intake area in greater numbers than otherwise may occur during periods when the barrier net is installed and lake herring are generally present at deeper depths within Lake Michigan. Given the shallow-water spawning habitat requirements of this species during the period when the net is not installed, some unknown level of entrainment-related mortality of lake herring would be inevitable as a result of continued project operation. Consumers Energy and DTE Companies' barrier net effectiveness studies have shown that at times the barrier net can be effective at preventing this species from accessing the tailrace from April 15 through October 15 (e.g., 83 percent effectiveness rate in 2013). Alternatively, during years when net effectiveness has been less than average to poor (e.g., 2016 and 2017), lake herring have continued to maintain a relatively low abundance in the project area, indicating entrainment and turbine mortality of this species is likely minimal. Overall, fish entrainment-related mortality does not appear to be adversely affecting lake herring on a population level, as evidenced by the results of Consumers Energy and DTE Companies' barrier net effectiveness studies. These data have shown an increase in lake herring abundance at the project in recent years, which is consistent with other recent data

[60] A barrier net effectiveness estimate of 0 percent indicates more fish were caught inside the barrier net than outside the barrier net. Consumers and DTE Companies concluded in the 2016 Annual Report of Barrier Net Operation that most of the lake herring collected during gill net sampling in 2016 were in the 5 to 6-inch range and, thus, potentially able to pass through the 0.75-inch mesh barrier net (Consumers and DTE Companies, 2016).

suggesting lake herring populations are currently rebounding in portions of Lake Michigan (Derosier et al., 2015). Therefore, continued operation of the project would likely have little to no adverse effect on lake herring populations in Lake Michigan.

Lake Sturgeon

The swimming performance of sturgeon varies greatly across sizes, populations, species, life stages, and water temperatures (Harvey, 2015). Generally, however, sturgeon have lower swimming performances relative to other fish species and a relatively limited capacity for high-speed swimming as a result of high profile drag (Webb, 1986) and poor aerobic capacity (Peake et al., 1997). Peake et al. *(*1997) found that the swimming performance of lake sturgeon, relative to body length, is inferior to that of most salmonids, particularly at burst speeds.[61] Peake et al. (1997) also found that lake sturgeon 9 to 22 inches in total length and 42 to 52 inches in total length are capable of burst speeds of 3 fps and 5.9 fps, respectively (at a test temperature of 14 degrees Celsius).

As further discussed in the *Impingement* section above, Alden (2011) conducted an evaluation of the potential effects of operational flow increases at the project on the fish barrier net. Specifically, the operational flow increases evaluated as part of this study were associated with the reversible pump-turbine unit upgrades that were proposed by Consumers Energy and DTE Companies in a license amendment and subsequently authorized by the Commission.[62] As part of this evaluation, a CFD model was developed that estimated the existing (i.e., the project without the proposed reversible pump-turbine unit upgrades) and proposed (i.e., the project with the proposed reversible pump-turbine unit upgrades) velocity conditions in the tailrace during pumping operation. Figure 13 illustrates the results of the CFD model and provides an estimation of the hydraulic conditions that would occur at the project during the term of any new license issued for the project, once the reversible pump-turbine unit upgrades have been completed. Based on the CFD model results, the estimated maximum intake velocities expected to occur during pumping are approximately 9 fps immediately adjacent to the project intake. These model results suggest that lake sturgeon present within the maximum velocity fields nearest the intake on Lake Michigan may not be able to avoid entrainment because of known burst speeds that are less than the maximum intake velocities that would be

[61] Burst speed is the highest speed a fish can maintain (for less than 20 seconds at a time) and is used for prey capture and predator avoidance (Peake et al., 1997).

[62] *See Consumers Energy Company and Detroit Edison Company*, Order Amending License, 139 FERC ¶ 62,101, May 7, 2012.

expected during pumping operation. However, for the reasons discussed below, lake sturgeon exposure to these maximum intake velocities would be limited.

A total of 95 lake sturgeon have been collected at the project since barrier net effectiveness monitoring began (Table 4). Annual net effectiveness estimates for sturgeon were not provided by Consumers Energy and DTE Companies in the final license application because annual catches of lake sturgeon were considered too low to provide reliable estimates. However, a review of the annual reports on barrier net operation that have been filed with the Commission specify whether lake sturgeon have been captured inside or outside of the barrier net during the respective monitoring years. This data provides useful information on the overall effectiveness of the existing barrier net at excluding lake sturgeon from the tailrace. A total of 8 lake sturgeon have been collected inside the barrier net during barrier net effectiveness monitoring and an additional 5 lake sturgeon have been collected inside the barrier net during separate monitoring not associated with barrier net effectiveness monitoring (Table 12). Although the reliability of the results from each given year are not particularly strong given the small sample sizes, which range from 0 to 10 lake sturgeon collected each year during barrier net effectiveness monitoring, the overall data suggest that the barrier net has been effective at excluding lake sturgeon from the tailrace.

Little data is available regarding seasonal lake sturgeon habitat preferences and annual migration patterns within the Lake Michigan watershed. Similarly, other than spawning migrations, information on the seasonal movement patterns and wintering behavior of lake sturgeon in other watersheds is limited and not well defined (Galarowicz, 2003; Smith and King, 2005). Some studies have shown that lake sturgeon move randomly within an established home range of 6 to 9 miles, while other studies have shown some individuals make longer unidirectional movements indicative of emigration (Peterson et al., 2007). During spawning, however, it has been well documented that lake sturgeon can migrate long distances (up to 175 miles) when returning to their natal streams for spawning purposes (Auer, 1999). The Muskegon and Manistee Rivers, located about 60 miles south and 20 miles north of the project, respectively, represent the only known sturgeon spawning habitat in the vicinity of the project. According to Peterson et al. (2007), lake sturgeon populations within these two rivers exhibit a "one-step" migration pattern, whereby migration occurs in spring with spawning taking place within a few days once natal spawning grounds are reached. After spawning has concluded, adult lake sturgeon quickly move downstream, eventually returning to a larger river or lake (e.g., Lake Michigan) to distinct foraging areas to replenish energy stores over the next several years before the next spawning cycle begins. Because foraging often occurs in shallow waters with sand or mud substrates (Kerr et al., 2010), this behavior may result in some lake sturgeon occupying near-shore areas in proximity to the project, which predominantly consist of sand and gravel substrates.

The majority of the available literature on lake sturgeon wintering habitat is not specific to large bodies of water or unique watersheds such as the Lake Michigan basin, but rather riverine systems. Nonetheless, these data generally show that adult lake sturgeon tend to be found in aggregations and display sedentary behavior during non-spawning or winter periods (Fortin et al., 1993; Kerr et al., 2010; Thayner et al., 2017). Lake sturgeon have also been shown to overwinter in deep-water areas with low water velocities prior to commencing migration to spawning areas (McKinley et al., 1998; Threader et al., 1998). The high water velocities (relative to ambient conditions) in the tailrace associated with project operation and the lack of deep water habitat in the tailrace suggest that few lake sturgeon are likely to occur in the project area from mid-October through mid-April, the period when the barrier net would not be installed under Consumers Energy and DTE Companies' proposal.

Lastly, lake sturgeon are considered a benthic species, feeding primarily on benthic invertebrates (Peterson et al., 2007). In general, CFD model results showed that the greatest velocities associated with pumping operation occurred at depths between 50 and 70 percent below the surface of the individual fish barrier net panels. These model results suggest that during pumping, lake sturgeon present within the tailrace are unlikely to be subjected to the maximum velocity magnitudes shown in Figure 13, which occur higher in the water column and outside the areas benthic lake sturgeon would be expected to typically inhabit.

The existing fish barrier net has proven effective at excluding lake sturgeon from the tailrace from mid-April through mid-October, which coincides with the period lake sturgeon would most likely be present in near-shore areas of Lake Michigan, including the project area, for migration or foraging purposes. During the period when the barrier net is not installed, the project tailrace area exhibits characteristics (e.g., shallow, high water velocities, etc.) that are not consistent with those the literature has identified as being favorable for lake sturgeon winter habitat. Continued project operation is, however, likely to continue to entrain an unknown number of lake sturgeon as the barrier net is not completely effective at excluding lake sturgeon from the tailrace and it remains possible that lake sturgeon may migrate through the tailrace when the barrier net is not installed. However, nothing in the project record suggests that lake sturgeon entrainment and turbine mortality are currently having such adverse effects on lake sturgeon populations as downward trending abundances and recruitment that could lead to an inability of the population to replenish itself. To the contrary, lake sturgeon populations within Lake Michigan, including the Manistee and Muskegon River populations, have recently been characterized as stable or increasing (Michigan DNR, 2012; Michigan DNR, 2017a). Further, as discussed in the *Adaptive Management Process* section above, Consumers Energy and DTE Companies' proposal to develop a plan for the installation of specific physical improvements (e.g., anchor pilings) to the fish barrier net would likely help to reduce net lifting events during the term of any new license issued for the project. This proposal may benefit benthic fauna such as lake sturgeon in particular,

which are more likely than pelagic species to encounter breaches along the bottom of the net and gain access to the tailrace. Thus, by shoring up the integrity of the net bottom, this could potentially reduce current levels of sturgeon entrainment at the project during the term of any new license issued. Overall, continued operation of the project with Consumers Energy and DTE Companies' proposed measures to improve barrier net effectiveness, including the implementation of physical improvements to the net itself to reduce lifting events, would likely result in modest beneficial effects on lake sturgeon populations within Lake Michigan relative to existing conditions.

Table 12. Lake sturgeon statistics, including fish barrier net effectiveness (in percent), for those years in which lake sturgeon have been collected inside the barrier net (Source: Staff, 2017).

	Lake Sturgeon Collected During Annual Barrier Net Effectiveness Monitoring			**Lake Sturgeon Collected Outside of Annual Barrier Net Effectiveness Monitoring[a]**	
Sample Year	**Total No. of Lake Sturgeon Collected**	**Total No. of Lake Sturgeon Collected Inside Barrier Net**	**Barrier Net Effectiveness (in percent)**	**Total No. of Lake Sturgeon Collected Inside Barrier Net**	**Total No. of Lake Sturgeon Collected Outside Barrier Net**
2017	9	1	89	0	1[a]
2016	10	2	80	2[b]	1 (recapture)
2015	5	0	100	2[c]	0
2014	1	0	100	1	2
2013	1	1	0	0	0
2011	7	1	86	0	0
2010	5	1	80	0	0
2008	2	1	50	0	0
2001	4	1	75	0	0
Total	44	8	82	5	4

a Sampling required by the State Settlement Agreement during a plant outage in 2017 (i.e., not for effectiveness monitoring) collected one additional lake sturgeon on the outside of the barrier net.

b Sampling required by the State Settlement Agreement during a plant outage in 2016 (i.e., not for effectiveness monitoring) collected two additional lake sturgeon on the inside of the barrier net and one outside (i.e., recapture). The recaptured lake sturgeon was previously collected outside the barrier net in 2016 during barrier net effectiveness monitoring.

c Two additional lake sturgeon were found on the inside of the net during a plant shutdown in 2015.

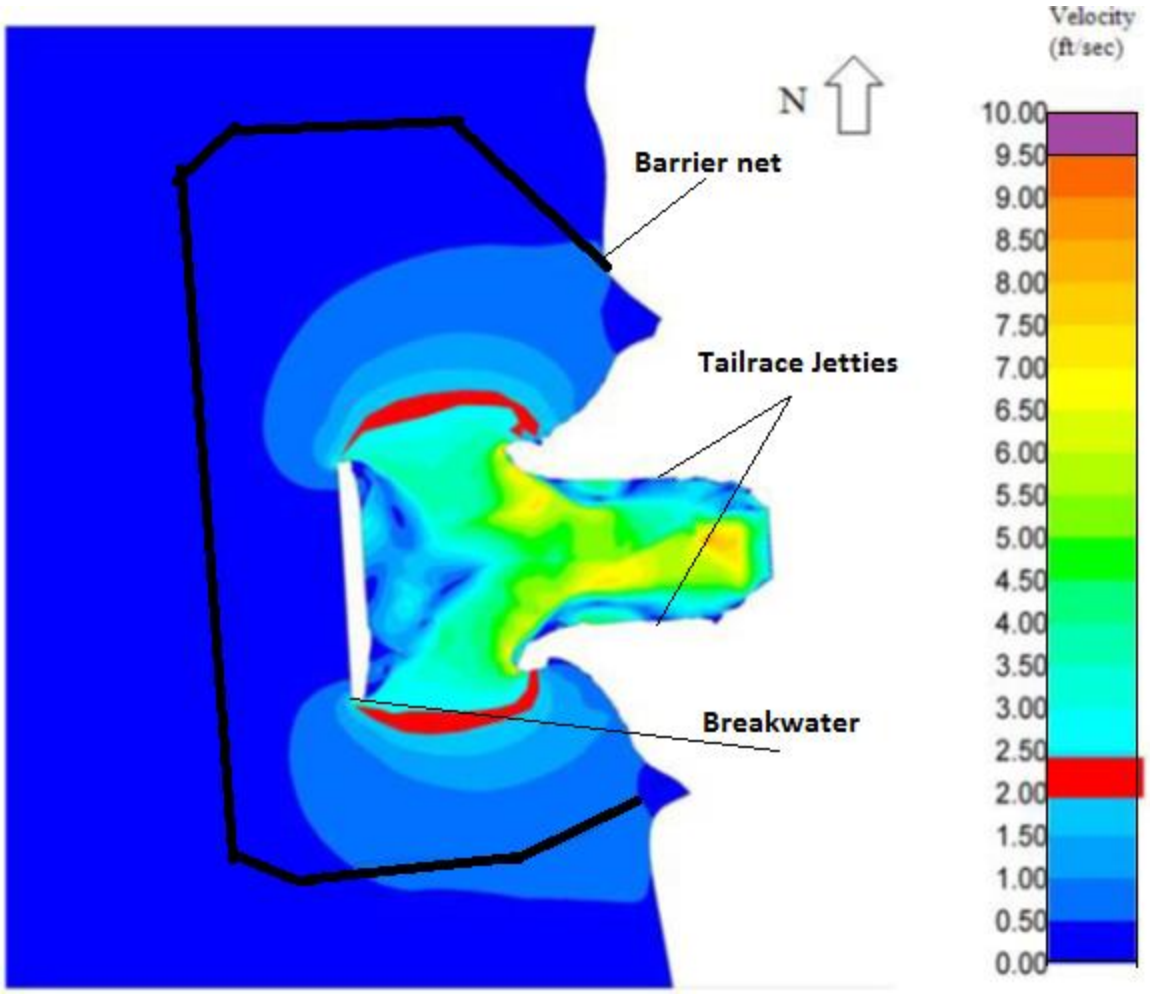

Figure 13. CFD model-estimated tailrace velocity conditions at the project with all six turbine-generator units pumping at upgraded capacity. Model results assume a Lake Michigan lake level of 575 feet NGVD 29 (Source: Alden, 2011).

Fish Entrainment Abatement Technology Reviews

Pursuant to section V.D of the Settlement Agreement, Consumers Energy and DTE Companies propose to continue reviewing fish entrainment abatement technologies to determine if any new fish entrainment abatement technologies become available in the future and are technically and economically practicable for use at the project. These technologies could either be used in conjunction with or in lieu of the existing fish barrier net to substantively reduce fish entrainment relative to the existing fish barrier net. Consumers Energy and DTE Companies propose that the reviews would be conducted at

least once every ten years after the execution of the Settlement Agreement, or more frequently if recommended by the SAT and there is reasonable basis for such a recommendation. Consumers Energy and DTE Companies also propose to continue: (1) developing fish entrainment abatement technology review study plans in consultation with the SAT, prior to implementing each review, and (2) providing a detailed report on the study results, including conclusions and recommendations concerning the feasibility, biological effectiveness, and costs of implementing any new fish entrainment abatement technologies at the project, to the Commission, SAT, and Settling Parties.

As evidenced by their execution of the Settlement Agreement and joint comment letter filed on December 4, 2017, in support of the Settlement Agreement, the Attorney General for the State of Michigan, Michigan DNR, Interior, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, Michigan United Conservation Clubs, and National Wildlife Federation support Consumers Energy and DTE Companies' proposal for fish entrainment abatement technology reviews.

Our Analysis

Under the 1995 Settlement Agreement, Consumers Energy and DTE Companies are required to undertake an evaluation of fish entrainment abatement technologies every five years and report the results to the Commission. The reports provide a review of evolving fish entrainment abatement technologies and contain conclusions and recommendations concerning the feasibility of installing new abatement technologies at the project to substantively reduce fish entrainment relative to the existing fish barrier net.[63] Currently, each five-year report is first provided to the SAT for review and comment, prior to it being filed with the Commission. In the 2011 report,[64] Consumers Energy and DTE Companies concluded that most of the fish abatement technologies that were first evaluated in 1988 for deployment at the project have not evolved further. Consumers Energy and DTE Companies further concluded that the rationale that eliminated certain physical and behavioral technologies in 1988, including lack of or unproven biological effectiveness, no engineering advantage over other alternatives, not

[63] Reviews were conducted in 2001, 2006, and 2011. The fish and aquatic resource studies conducted in 2015 and 2016 as part of Consumers Energy and DTE Companies' relicensing process were, in essence, a review of current fish entrainment abatement technologies and satisfied the requirements of the review which was scheduled to occur in 2016.

[64] The most recent report, entitled *Evaluation of Recently Evolved Abatement Technologies for Application at the Ludington Pumped Storage Project*, was filed by Consumers Energy and DTE Companies on April 12, 2011.

practical for application at the project, or some combination of these reasons, remained valid in 2011. These conclusions are also consistent with Consumers Energy and DTE Companies' findings in the Fish Entrainment Abatement Technologies and Engineering Alternatives Study conducted during the relicensing process (Alden 2015a, 2015b, and 2016).

Consumers Energy and DTE Companies' proposal to continue reviewing existing fish entrainment abatement technologies would provide an effective mechanism to identify and evaluate the feasibility of any new technologies or as-yet unidentified measures that may become available in the future to potentially further reduce fish entrainment at the project relative to the existing fish barrier net. Because none of the five-year reviews to date have resulted in recommendations or proposals for additional or alternative entrainment abatement measures at the project, Consumers Energy and DTE Companies' proposal to conduct the reviews on a less frequent basis is a reasonable approach and would continue to ensure that any future entrainment abatement technologies are evaluated for potential application at the project during the term of any new license issued for the project. However, this proposal also does not provide any details on the consultation process that would be implemented by Consumers Energy and DTE Companies to determine the need for and frequency of the reviews, which at a minimum would occur every ten years for the term of the license. Filing reports with the Commission, as proposed by Consumers Energy and DTE Companies, would make the study results available to other stakeholders and help ensure compliance with the terms of any new license issued for the project.

Developing fish entrainment abatement technology review study plans in consultation with FWS and Michigan DNR, prior to implementing each review, would be important to ensure the collective expertise of the resource agencies are considered. For example, this consultation would help to ensure that all fish protection technologies available for review are identified and given full consideration prior to commencing with each review.

Including a requirement in any new license issued for the project for Consumers Energy and DTE Companies to develop a detailed plan for these proposed reviews would facilitate Commission oversight of the license. To address the issues discussed above, it would be particularly important that the plan contain specific details regarding the consultation process that will used to determine the need for and frequency of the reviews. Lastly, as noted in section V.E.4 of the Settlement Agreement, any proposal by Consumers Energy and DTE Companies to modify project facilities (i.e., the fish barrier net) or project operation for the purposes of reducing fish entrainment may not be implemented without prior Commission authorization.

Fish Tissue Sampling

Michigan DEQ certification condition 3.2 would require that Consumers Energy and DTE Companies provide frozen fish samples to Michigan DEQ for analysis after issuance of any new license for the project and every five years thereafter. The edible portion of each fish sample would be analyzed for mercury, polychlorinated biphenyls (PCBs), dioxin/furans, and dioxin-like PCBs. This condition would require that samples consist of ten legal-size (> 15 inches total length) lake trout[65] in a range of sizes (if possible) and that these fish be collected from the project area as part of Consumers Energy and DTE Companies' annual barrier net effectiveness monitoring program.

Michigan DEQ certification condition 3.3 would require that: (1) the fish tissue sampling required by condition 3.2 be formalized in a water quality plan that would be submitted (within six months of license issuance) to Michigan DEQ for approval, and (2) annual reports detailing all water quality monitoring required by the certification (including fish tissue sampling results) be provided to Michigan DEQ within three months of the completion of all sampling.

Our Analysis

Mercury in air emissions are a by-product of coal combustion (such as in power plants), metal smelting, and solid waste incineration. Mercury is deposited from the atmosphere primarily as inorganic mercury. Methylation is the conversion of inorganic mercury to organic methylmercury, which greatly increases the toxicity and potential for accumulation in aquatic biota, and is the principal form of mercury in freshwater fish (Bloom, 1992; NRC, 2000). The primary route of human exposure to methylmercury, generally over 95 percent, has been through the ingestion of mercury contaminated fish (NRC, 2000). PCBs,[66] dioxins, and furans[67] are similar in structure and are classes of organic chemicals that are persistent, bioaccumulative, and toxic. They can be produced intentionally, or as by-products of industrial processes, and can remain in the environment for many years and move between water, air, soil, and sediments. With the

[65] Other fish tissue data of adequate quality less than five-years old from the project area may be substituted upon approval of the Michigan DEQ.

[66] PCBs are a class of chemical compounds introduced in the late 1940's for uses in electrical equipment, hydraulic systems, flame retardants, immersion oils, paints, carbonless copy paper, and in a host of other applications.

[67] Dioxins and furans are the common names associated with polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, which are compounds that are formed as an unintended byproduct during combustion of organic compounds in the presence of chloride.

ability to move between these media, they threaten the food chain and can accumulate in animals and humans. Higher detection levels are typically reported from fish tissue and sediment (parts per billion) than water (parts per trillion or quadrillion) because of the hydrophobic nature of these contaminants (Washington State Department of Ecology, 2010).

All the Great Lakes and their connecting waters are currently under advisories for one or more contaminants (EPA, 2011). Lake Michigan is currently under advisories for mercury, PCBs, dioxins, chlordane, and DDT (EPA, 2011). Since 1980, Michigan DEQ has monitored bioaccumulative contaminants in fish tissue samples to help support the development of the Michigan Department of Community Health's *Michigan Eat Safe Fish Guide* (Michigan Department of Health and Human Services, 2018). The purpose of the guide is to issue general and specific consumption advisories for sportfish caught in Michigan waters. Consumption advisories in the project area exist for the following species: burbot, carp, largemouth bass, smallmouth bass, suckers, walleye, smelt, yellow perch, and numerous salmonid species (Michigan Department of Health and Human Services, 2018).

In some cases, large fluctuations in water levels or mobilization of substrate caused by hydroelectric project operation can activate mercury from sediments into the water column. However, Consumers Energy and DTE Companies do not propose any new construction, major modifications to existing project facilities, or changes to existing project operation. We also note that the project's upper reservoir is a man-made impoundment that pumps water directly from Lake Michigan. Further, other than direct precipitation and water pumped directly from Lake Michigan, there are no rivers, streams, or other means of inflow to the project that serve as a source of contaminated sediment. As discussed above, elevated levels of bioaccumulative contaminates in fish tissue have been reported throughout the Lake Michigan basin and have often been linked to numerous natural (including geologic and atmospheric conditions) and anthropogenic sources. Periodically providing fish tissue samples to Michigan DEQ for bioaccumulative contaminate sampling would assist state agencies in monitoring bioaccumulative contaminant levels in sportfish in the project area over time. Presumably, this data could then be used by the Michigan Department of Community Health to support the development of new or modified fish consumption advisories in the project area. However, because the sources of bioaccumulative contaminates entering Lake Michigan are not project related, and because the proposed action would not include any activities that would disturb potentially contaminated sediments, we do not expect any changes to bioaccumulative contaminant levels in sportfish as a result of continued project operations. For these reasons, we find that there would be no project-related benefit to monitoring the level of contaminants in fish collected from the project vicinity.

3.3.2 Terrestrial Resources

3.3.2.1 Affected Environment

The project is within the Southern Michigan / Northern Indiana drift plains ecoregion. The ecoregion is characterized by many lakes and marshes as well as an assortment of landforms, nutrient rich soils, and land uses. Broad till plains with thick and complex deposits of drift, paleobeach ridges, relict dunes, morainal hills and meltwater channels are common features in the region. Historically, oak-hickory forests, northern swamp forests and beech forests were typical; agriculture, woodlots, quarries and urban-industrial areas are now common (EPA, 2013).

The area surrounding the project is a mix of forest, agricultural, residential, and industrial lands. Lands abutting the project boundary are primarily agricultural with scattered residential areas. Agricultural uses include fruit orchards and row crops. Cover types surrounding the reservoir contain primarily sloped meadow and mature forest, with a lesser abundance of shrub thickets and low-dune beaches. Woodlands within the project boundary include a mix of young and mature forest; common species observed in studies conducted as part of licensing activities include sugar maple, American beech and white ash. Additionally, the downstream slope around the upper reservoir contains a mix of native and non-native grasses and shrubs.

The beach and low dune areas along the Lake Michigan shoreline contains low rolling dunes at the base of the steep bluff, extending to the beach. The 2,544-foot-long shoreline contains beach grass, dune reed, beach wormwood, common milkweed and willows. Annual installation and removal of the barrier net along the project shoreline occurs by April 15 and October 15, respectively. The barrier net is seasonally installed to reduce fish entrainment and mortality during the pumping operation of the project.

Cover types in the vicinity of the Pigeon Lake North Pier consist of manicured lawn, beaches and low dunes that transition to wooded dunes. The recreational area also provides access roads to marines and boat docks to the adjacent Pigeon River. Vegetation endemic to the satellite site include sassafras, red oak, and common milkweed.

Approximately 190 acres of woodlands occur within project boundary, which are subject to periodic timber sales. Timber sales have occurred in 2004, 2008 and 2017. On average, 68 trees are removed per year, with the most recent timber sale removing 460 primarily mature hardwood trees. Tree cutting is intermittent and Consumers Energy and DTE Companies state that harvesting is dependent on the availability and market value of the trees to be removed.

Invasive Plant Species

Terrestrial plant surveys conducted by Consumers Energy and DTE Companies in 2016 identified 16 invasive species within the project boundary, including reed canary grass, Japanese barberry, and autumn olive. The most abundant invasive plant invasive plant species is autumn olive; approximately twelve acres of autumn olive are found within the project area, located primarily in woodlands abutting the reservoir. The invasive species in the project area are not actively managed at the project; however, Consumers Energy and DTE Companies conducts maintenance activities including mowing which incidentally suppresses the growth of invasive herbaceous and woody plants.

Wetlands

Wetlands provide a variety of ecological functions, including groundwater recharge, flood-flow alteration, fish and wildlife habitat, toxicant sequestration, and shoreline stabilization. Riparian and littoral habitats within the project boundary are sparse and primarily located near shore areas of Lake Michigan. The National Wetlands Inventory classifies Lake Michigan and the upper reservoir as lacustrine, limnetic deepwater habitat. Although the 842 acre reservoir holds water, it is a man-made structure with an asphaltic-concrete lined earthen embankment, which provides no soil interface between reservoir water and land. The reservoir thus does not contain hydric soils or obligate wetland vegetation, and does not function as a natural wetland.

During the wildlife survey, the presence of a small stream and associated 1-acre wetland were observed near the shoreline of Lake Michigan. The 725-foot-long stream is fed by groundwater and contains saw grass, sedge species and various woody plants. Groundwater flow is a result of springs located near the powerhouse and pumping relief wells, contributing 30 and 200 gallons per minutes, respectively.

Wildlife and Species of Concern

Wildlife within the project area is characteristic of the Northern Lower Peninsula and Southern Lower Peninsula of Michigan. A 2015 field survey conducted by Consumers Energy and DTE Companies recorded the presence of the eastern chipmunk, eastern coyote, meadow vole, striped skunk, white-tailed deer and eastern garter snake within the project boundary. Non-migratory bird species observed at the project include the northern cardinal, ruffed grouse, and wild turkey.

Migratory Birds

A variety of waterbirds and passerines that make use of project shoreline and forest habitat during their migratory periods were observed at the project. Migratory bird

species observed at the project include the common tern, Caspian tern, double-crested cormorant, eastern bluebird, house wren, and mallard duck, among others.

Bald eagle

Bald eagles *(Haliaeetus leucocephalus)* are common in the great lakes region and have been documented in the project area. Bald eagles migrate throughout North America and commonly nest near large open bodies of water where tall trees and cliffs are available. Nests are easily visible, span 6-10 feet in diameter, and weigh as much as 1000 pounds. In Michigan, bald eagles frequently nest in live white pine, red pine, maple, oak and aspen trees, tree species found within the project boundary (Michigan NFI, 2009). An immature bald eagle was observed flying over the reservoir during the wildlife survey, although no nests were observed.

Historically, bald eagles have experienced declines in populations due to habitat loss and degradation, anthropogenic persecution, and toxic pollutants. In recent years, bald eagle populations have recovered and have been subsequently removed from the federal list of threatened and endangered species. The bald eagle, however, is still protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act, which prohibit the "take" of bald eagle eggs, nests, and offspring, except as permitted by regulation. Bald eagles are adept at adapting to low levels of disturbance, and in recent years have expanded their range into areas of higher human occupancy. Human activities are still the most influential variable in bald eagle populations (Michigan NFI, 2009).

Marsh wren

The marsh wren *(Cistothorus palustris)* is a small songbird, approximately 10 cm in length, and possessing shades of cinnamon brown and black plumage. The marsh wren is found throughout most of North America but is restricted to emergent cattail or bulrush marsh habitat. The breeding season for the marsh wren in Michigan occurs between mid-May through late July. The marsh wren remains a common species in many marshes in Michigan; however, concerns over possible population declines and habitat destruction led to the marsh wren's categorization as a state-listed species of concern (Michigan NFI, 2006).

Eastern box turtle

The Eastern box turtle *(Terrapene carolina carolina)* is a small brown or black terrestrial turtle with variable yellow markings on a high-domed carapace, ranging 5-6 inches in length. The irises of the male eastern box turtle eye are red, while female eye color is brown. Box turtles are active in Michigan between April through October, with egg laying occurring from early June through mid-July. Habitat for the Eastern box turtle

includes meadows and woodlands with sandy soils adjacent to wetlands and other waterbodies. The Eastern box turtle is a species of concern within Michigan, with declines in populations attributed to nest predation, habitat destruction and degradation, road mortality, and illegal collection (Michigan NFI, 2004).

American Ginseng

American ginseng *(Panax quinquefolius)* is an herbaceous perennial plant native to deciduous forests of the eastern United States and Canada. American ginseng grows 6 to 18 inches in length, typically bears 3 to 5 leaflets, and thrives in shaded, moist soils. American ginseng root grows slowly and has strong commercial value; consequently, over-harvesting has led to the root's decline. Wild American ginseng is a threatened species in Michigan (Michigan DARD, 2018).

Double-Crested Cormorant

The double-crested cormorant *(Phalacrocorax auritus)* is a goose-sized waterbird and possesses gray or black plumage and hooked bill. The cormorant is usually found in flocks along coast and inland lakes and is a common resident of the Great Lakes region. Cormorants have a mostly fish-based diet; adults consume an average of one pound of fish per day. Accordingly, the large quantities of fish necessary to sustain Cormorant colonies can adversely affect aquaculture facilities and has created conflicting interactions between commercial and recreational fishermen (FWS, 2017a).

The breakwater structure, located 2,700 offshore from the project and 1,700 feet in length, provides ideal nesting habitat for a double-crested cormorant colony. In September 2016, Consumers Energy and DTE Companies surveyed the colony and identified 500-1000 individuals located at the project breakwater.

3.3.2.2 Environmental Effects

Invasive Plant Species

Terrestrial plant mapping surveys were conducted within the project boundary in 2015. The surveys identified 72 emergent or upland plant species, 16 of which are considered invasive by the state of Michigan. Autumn olive is the most prominent invasive plant species occurring with the project boundary, and was identified covering an estimated 12 acres in lands adjacent the reservoir.

Consumers Energy and DTE Companies conduct scheduled maintenance activities (e.g., mowing) along roadways, recreational areas, and for dam safety security purposes within the project boundary. Limited brush removal and herbicide treatments are regularly conducted on the upper reservoir embankment.

Michigan DNR recommends a comprehensive plan that addresses exotic and invasive species at the project.

Our Analysis

As noted above, 16 invasive plant species are known to occur within the project boundary. Invasive plants are able to out-compete and displace native species, thereby reducing biodiversity and altering compositions of existing native plant and animal communities. Autumn olive is the most abundant terrestrial invasive plant species within the project boundary, covering approximately 12 acres. Autumn olive out-competes and displaces native plant species by creating a dense canopy, hindering the growth of plants that require an abundance of sunlight. Individually, an autumn olive can produce up to 200,000 seeds per year, which are spatially distributed by wildlife. Consumers Energy and DTE Companies state they perform grounds maintenance of project land, which suppresses the growth of invasive herbaceous and woody plants. However, it is unclear how many individual plants exist within each population, and how invasive plant populations have responded to routine grounds maintenance (e.g., mowing), which incidentally suppresses invasive plants, including autumn olive.

An invasive species monitoring plan, as recommended by Michigan DNR, would protect native vegetation, wildlife habitat, and recreational resources by minimizing adverse effects associated with the proliferation of autumn olive and other invasive plants within the project boundary. However, Michigan DNR has not provided any details on specific measures of the proposed plan. An effective invasive species monitoring plan implemented to manage the expansion of autumn olive and other invasive plants within project lands would typically contain: (1) a description of the proposed monitoring methods; (2) the proposed frequency of monitoring; (3) the proposed criteria to be used to determine when control measures will be implemented; and (4) a reporting mechanism. Implementing a plan with criteria to enact control measures to address autumn olive within project-affected lands would reduce the likelihood of adverse effects to local plant communities by limiting invasive plant expansion and reducing the likelihood of their transmission to other adjacent property.

Wetlands

As stated above, the upper reservoir is an asphaltic-concrete lined earthen embankment and does not function as a natural wetland. Consequently, there are no wetlands abutting the reservoir for water level fluctuations to have an effect. Additionally, because the stream and associated wetland observed during the wildlife study are sustained by groundwater and independent of reservoir fluctuations, continued project operation and maintenance are unlikely to deleteriously affect the hydrology or biota of wetlands in the vicinity of the project.

Wildlife and Species of Concern

The eastern box turtle and the marsh wren both make use of wetland habitat for foraging and reproduction. However, with the exception of the isolated wetland mentioned above, there are few wetlands and their associated obligate plant biota at the project. Additionally, American ginseng was not observed during botanical surveys. Therefore, continued project operation and maintenance is unlikely to affect the marsh wren, American ginseng or the eastern box turtle.

Migratory Birds

As stated above, a variety of migratory birds make seasonal use of shoreline and woodland habitat at the project. Maintenance actions that occur in the summer months, such as the clearing trees, can remove nesting habitat during sensitive periods of migratory bird reproduction.

FWS recommends that scheduled maintenance activities, such as mowing and the removal of other nesting structures, occur between April 15 through August 15 (at the avoidance of the summer months) to minimize potential effects to migratory birds.

Our Analysis

Consumers Energy and DTE Companies mow grassland communities as part of regularly scheduled maintenance. Mowing project land is conducted for security purposes and maintains the aesthetic features of the landscape, as well as suppresses the growth of invasive plant species within the project boundary. Therefore, restricting mowing during the summer months when vegetative growth is the greatest would be impractical. Additionally, FWS did not provide any evidence that migratory bird species would favor meadow or prairie grasslands over other habitats within the project boundary.

Migratory birds may use woodlands within the project boundary during the summer months as nesting habitat, however. Suspending tree clearing for the northern long-eared bat and Indiana bat during June and July would similarly benefit migratory birds that make use of trees for nesting habitat.

Double-Crested Cormorant

Although almost driven to extinction due to the ubiquitous application of DDT between 1940 and 1970, double-crested cormorant populations have rapidly rebounded and are now considered a nuisance species by many state resource agencies. Double-breasted cormorants can also negatively affect commercial and recreational fisheries

because of their predation of game fish (United States Department of Agriculture (USDA), 2011).

Double-crested cormorants are currently protected under the Migratory Bird Treaty Act. However, in 2003, FWS authorized state fish and wildlife agencies to remove double-crested cormorants without a federal permit.

Consumers Energy and DTE Companies have historically provided logistical support to the USDA for the purposes of managing the colony of double-crested cormorants using the project breakwater as nesting habitat. Specifically, Consumers Energy and DTE Companies have escorted USDA staff on-site during double-crested cormorant removal operations and secured approval for the transportation of firearms on project land. Currently, it is unclear whether agencies are conducting removal operations for the double-crested cormorant at the Ludington breakwater site.

Our Analysis

Double-crested cormorants use of the project breakwater as a summer nesting site is not project-related. Double-crested cormorants nest along the shorelines at numerous other locations throughout Lake Michigan, and project operation does not encourage the nesting at the project (USDA, 2011). Therefore, a license condition requiring the establishment of the cormorant mitigation or removal would serve no useful purpose. Nevertheless, Consumers Energy and DTE Companies would be free to continue to cooperate with USDA if it conducts future control efforts.

Bald Eagle

As mentioned above, an immature bald eagle was observed during the wildlife survey, and hardwood trees conducive to nesting habitat occur within the project boundary. Consumers Energy and DTE Companies have not proposed any measures for the protection of bald eagles at the project.

FWS recommends that bald eagles should not be disturbed, and any unavoidable take should be permitted by FWS.

Our Analysis

The operation of machinery during maintenance of the project has the potential to disturb bald eagles during nest building, incubation, and fledging phases of their reproductive cycle. Loud and disruptive activities, such as those originating from Consumers Energy and DTE Companies' periodic timber harvests, may result in eagles engaged in nest building, incubating, or other reproductive behaviors to abandon the nest. Therefore, implementing the following measures in accordance with the National Bald

Eagle Management Guidelines (FWS, 2007a) would be sufficient to prevent project-related effects to bald eagles and ensure the protection of bald eagle nesting habitat within project-affected lands: (1) restrict clear cutting or removal of overstory trees within 330 feet of a nest at any time; (2) restrict timber harvesting operations, including road construction, chain saw and yarding operations, during the breeding season (January through August) within 660 feet of a nest; and (3) maintain landscape buffers that screen project activity from the nest.

3.3.3 Threatened and Endangered Species

3.3.3.1 Affected Environment

FWS's IPaC system indicates eight federally listed threatened and endangered species known to potentially occur in Mason and Ottawa Counties: the Indiana bat, northern long-eared bat, eastern massasauga, piping plover, red knot, Karner blue butterfly, Pitcher's thistle, and whooping crane (FWS, 2018a). No critical habitat for any federally listed threatened and endangered species occurs within project-affected lands.

Indiana Bat

The Indiana bat *(Myotis sodalist)* is federally listed as endangered. The Indiana bat is a migratory species found throughout much of the mid-western United States, hibernating colonially in caves, mines, and other underground areas (hibernacula) through the winter. Forage species include a variety of flying insects found along rivers, lakes and in uplands. The non-hibernation season includes spring emergence and migration, summer reproduction in maternity roosts, and fall migration, swarming, and mating. Summer habitat requirements include: (1) dead or live trees and snags with peeling or exfoliating bark, split tree trunks or braches, or cavities that may be used as maternity roost areas; (2) live trees such as shagbark hickory and oaks that have exfoliating bark, or other hardwoods that are dead, or have dead branches with loose bark, which provide crawl spaces for the bats between the bark and the trunk or branches of the tree; and (3) stream corridors, riparian areas, and upland woodlots which provide forage sites (FWS, 2013).

Parturition[68] occurs in June or early July; pups then become able to fly 3-5 weeks after birth. Maternity roosts can be described as "primary" or "alternate" based on the proportion of bats a colony occupying that tree. Maternity colonies typically use 10-20 different trees each year but only 1-3 of these are primary roosts used by the majority of the bats for the summer (FWS, 2007b). The primary roots serve as the bats main roosts for the summer while the alternate roosts provide the bats safe resting areas and

[68] The act of giving birth to young.

protection from inclement weather. The loss of a primary tree is a natural phenomenon that the species is adapted to address through the use of alternate sites. However, if a roost tree does not have alternates available, or if those alternates are also lost, severe reproductive consequences may occur. Trees that may provide habitat for the Indiana bat occur within 190 acres of wooded lands adjacent to the reservoir and within the project boundary. Threats to Indiana bats include human disturbance in hibernacula, such as gates or other structures that exclude people from caves and mines, and summer habitat loss and degradation (FWS, 2013).

The Indiana bat was not observed during wildlife surveys conducted by Consumers Energy and DTE Companies in July 2015.

Northern Long-Eared Bat

The northern long-eared bat *(Myotis septentrionalis)* is federally listed as threatened. The northern long-eared bat is a medium-sized nocturnal bat ranging from 3 to 3.7 inches in length and possessing shades of brown fur. The northern long-eared bat's historical range includes 37 states, encompassing most of the central and eastern United States. Northern long-eared bats forage almost exclusively in the understory of forested areas, feeding on moths, flies and other insects using echolocation. The northern long-eared bat uses habitat similar to the Indiana bat for summer roosting, however, the northern long-eared bat is more opportunistic and may also roost in man-made structures as well as mature hardwoods. Both dead and live trees greater than 3 inches in diameter at breast height provide a necessary reproductive component for the bat; the northern long-eared bat primarily uses the crawl spaces between dead and exfoliating bark for roosting in the summer months. Parturition occurs in mid-May through July, with pups becoming able to fly within 3-5 weeks after birth. Trees that may provide habitat for the northern long-eared bat occur within 190 acres of wooded lands adjacent to the reservoir and within the project boundary. The decline in northern long-eared bat populations has been attributed to the emergence of white-nose syndrome; there has been a 99-percent reduction of northern long-eared bats in recent years as a result of white-nose syndrome in the Northeast United States. White-nose syndrome is expected to spread throughout the rest of United States in the foreseeable future (FWS, 2015a).[69]

The northern long-eared bat was not observed during wildlife surveys conducted by Consumers Energy and DTE Companies in July 2015. In addition, as of 2016, there

[69] White-nose syndrome is an emerging disease which has led to the death of more than 5.7 million bats in North America. The fungal infection agitates hibernating bats, causing them to rouse prematurely from their hibernation and to burn essential fat reserves. Mortality results from bats evacuating their roosts during the winter when no food is available, and consequently starve or die to exposure (FWS, 2015a).

are no known northern long-eared bat hibernacula or maternity roost trees in Mason or Ottawa Counties (FWS, 2016b).

Eastern Massasauga

The eastern massasauga *(Sistrurus catenatus)* is federally listed as threatened. The eastern massasauga is a gray or light brown small rattlesnake, about 2 feet in length, and possessing light-edged chocolate brown blotches on its back and sides. Massasaugas live in wet prairies, marshes and low areas along rivers and lakes. The diet for the Eastern massasauga includes species that make use of wetlands, including small rodents, amphibians and other snakes. The home range for the eastern massasauga includes the upper Midwest and Northeast, extending from central New York to eastern Iowa. Massasaugas are dependent on wetlands as habitat; consequently, the decline eastern massasauga populations has been attributed to habitat degradation and destruction resulting from the extensive draining of wetlands for agriculture purposes and urban expansion (FWS, 2016a).

The eastern massasauga was not observed during wildlife surveys conducted by Consumers Energy and DTE Companies in July 2015.

Piping Plover

The piping plover *(Charadrius melodus)* is federally listed as endangered. The piping plover is a small, stocky shorebird, possessing sand-colored plumage and orange legs. Adults are approximately 7 inches long, with a 15 inch wingspan. During the breeding season, adults have a black forehead, a black breast hand and an orange bill. Piping plovers use broad, sandy beaches with low vegetative cover as nesting habitat. Piping plovers are migratory and arrive at shoreline breeding sites at the Great Lakes in April and early May. Egg-laying often begins the second or third week in May, with female piping plovers laying three to five eggs, with an incubation period that lasts about a month. Young chicks are precocial and leave the nest almost immediately, though many adult males will stay with the chicks until they fledge, about 28 days later. Departure from breeding sites by both adults and young is typically complete by early August. Although the specific diet and foraging habits of piping plovers is largely unknown, based on available information, piping plovers likely consume littoral dwelling invertebrates, including crustaceans, mollusks and marine worms. The decline in piping plover populations has been attributed to habitat loss and degradation, nest disturbance, and predation; coastal beaches traditionally used by piping plovers for nesting have been lost to commercial, residential and recreational developments (FWS, 2018b).

The piping plover was not observed during wildlife surveys conducted by Consumers Energy and DTE Companies in July 2015.

Rufa Red Knot

The rufa red knot *(Calidris canutus rufa)* is federally listed as threatened. The rufa red knot is a small shorebird, about 9 inches long with a 20-inch wingspan. Plumage alternates between a mottled gray during the winter months to a cinnamon color during the summer breeding season. Though the majority of the red knot population uses the Atlantic flyway during its migration northward,[70] some migrants are known to forage along shoreline tributaries to the Mississippi River and the Great Lakes. Each year the rufa subspecies population migrates from its winter habitat in Terra del Fuego, the Caribbean, and from the southern reaches of the United States to the northern reaches of the Canadian arctic, making its migration route one of the longest in the western hemisphere. Prior to its migration, the red knot incurs dramatic physiological changes, which include an enlargement of its flight muscles and a decrease in the size of its stomach and gizzard. Forage for the species commonly consists of clams, mussels, snails and other macroinvertebrates. The red knot is unusual in that it possess the capacity to consume shellfish whole while feeding at its summer and winter habitats. During its 9,300-mile-long migration, its diet is comprised of more readily digestible foods such as insects and horseshoe crab eggs, with the horseshoe crab eggs becoming an essential component for providing staple nourishment during its long migration. The rapid decline of the rufa red knot has been associated with loss of habitat from increased coastal development, and more recently, from a loss of its important food source caused by increased commercial overharvesting of horseshoe crabs in Delaware Bay (FWS, 2005).

The rufa red knot was not observed during wildlife surveys conducted by Consumers Energy and DTE Companies in July 2015.

Karner Blue Butterfly

The Karner blue butterfly *(Lycaeides Melissa samuelis)* is federally listed as endangered. The butterfly has a 1-inch wingspan and is sexually dimorphic; the dorsal surface in male's wings are silvery or dark blue, while the dorsal surface of female's wings are a grayish-brown. The butterfly usually has two generations per year, hatching in April and July. Adult butterflies feed on the nectar of flowering plants; however, Karner blue caterpillars feed exclusively on the leaves of the wild lupine plant. Karner blue butterflies are found in the northern part of the wild lupine's range, including northern states in the Great Lakes region. Decline in Karner blue butterfly populations has been attributed to habitat loss and degradation, as well as the absence of disturbance

[70] About 80 percent of the North American red knot population migrates through the Delaware Bay each year (New Jersey Department of Environmental Protection, 2009).

(e.g. wildfire) to established vegetation communities, which would promote early-successional species like the wild lupine (FWS, 2008).

In wildlife surveys conducted in July 2015 by Consumers Energy and DTE Companies, the Karner blue butterfly was not observed within the project boundary, nor its obligate plant species, the wild lupine.

Pitcher's Thistle

The Pitcher's thistle *(Cirsium pitcheri)* is federally listed as threatened. The plant is gray-green in appearance, up to 3 feet in height with a 6 foot tap root, and covered in dense, silvery hairs. These hairs cover both the stems and leaves of the plant allow the plant to retain water and are an adaptation to sandy-soil habitats. The Pitcher's thistle blooms once during its lifetime, after a 5 to 8 year non-flowering period. The flower is pink in appearance and pollinated by insects. The thistle commonly colonizes open beaches and grassland dunes along the great lakes with low plant cover. The decline in Pitcher's thistle populations are attributed to habitat loss and fragmentation associated with shoreline development and recreation.

In botanical surveys conducted in August 2015 by Consumers Energy and DTE Companies, the Pitcher's thistle was not observed within the project boundary.

Whooping Crane

The endangered whooping crane *(Grus americana)* is endemic to North America, with a historic distribution that ranged from the Rocky Mountains to the East Coast; it extended as far north as Canada, and as far south as Mexico. Whooping cranes are one of the largest birds in North America, with an average height of 5 feet when standing erect, and a wingspan that measures 7 feet across. Habitat requirements for whooping cranes include nesting in marshy areas amongst bulrushes, cattails, and sedges, as well as in sloughs and along lake margins. Whooping cranes often feed and roost in wetlands as well as in upland grain fields, where they consume insects, minnows, mollusks, crustaceans, frogs, rodents, small birds and berries (FWS, 2007). Only one non-experimental population of 431 cranes exists in the wild: the Aransas-Wood Buffalo National Park Population, which migrates from the Wood Buffalo National Park in northern Canada, to the Aransas National Wildlife Refuge on the Texas coast (FWS, 2017b).

The whooping crane was not observed during wildlife surveys conducted by Consumers Energy and DTE Companies in July 2015.

3.3.3.2 Environmental Effects

Consumers Energy and DTE Companies do not propose any changes to project operation, and do not propose any new construction.

Eastern Massasauga

Habitat for the massasauga at the project is generally restricted to the 725-foot-long stream and associated 1-acre wetland observed during the 2015 wildlife survey. The stream is sustained by groundwater flow originating near the powerhouse and pumping relief wells. Project maintenance does not occur along the stream and project operation would not disrupt groundwater flows necessary for sustaining the stream. Additionally, the eastern massasauga was not observed during wildlife surveys. Therefore, continued operation and maintenance of the project would have no effect on the Eastern massasauga.

Karner Blue Butterfly

The Karner blue caterpillars feed exclusively on the leaves of the wild lupine plant. No wild lupine was identified at the project during botanical surveys. Additionally, the project occurs at the northern-most extent of the Karner blue butterfly's historic range in Michigan, rendering the likelihood of encountering an adult Karner blue butterfly remote. Therefore, continued operation and maintenance of the project would have no effect on the Karner blue butterfly.

Whooping Crane

As mentioned above, the only non-experimental population of the whooping crane uses a well-documented corridor between northern Canada and the Texas coast, approximately 700 miles west of the project. In the summer of 2000, two whooping cranes from an experimental population in Florida migrated more than 1,000 miles to rural Michigan. This dispersal is thought to be an isolated instance and has been attributed to a severe drought in Florida which made their home marshes unsuitable for breeding (FWS, 2015b). Due to the absence of suitable habitat within the project boundary and remote likelihood of a whooping crane making use of this habitat, continued operation and maintenance of the project would have no effect on the whooping crane.

Indiana Bat and Northern Long-Eared Bat

As described in section 3.3.2, *Terrestrial Resources*, Consumers Energy and DTE Companies conduct intermittent tree harvests of woodlands within the project boundary. Approximately 190 acres of woodlands occur within project boundary which are subject to periodic timber sales. On average, 68 trees are removed per year, with the most recent

timber sale in 2017 removing 460 predominantly mature, hardwood trees. Consumers Energy and DTE Companies propose to only clear trees while the bats are hibernating, but does not specify the months in which trees will not be cut.

FWS recommends that tree clearing at the project be conducted outside the months of June and July.

Our Analysis

Deciduous, mature forest that may provide roosting habitat to the Indiana and northern long-eared bat exists within the project boundary. Both the Indiana bat and northern long-eared bat use trees with similar features for roosting and reproduction. The Indiana bat and northern long-eared bat both make use of more than 33 species of trees, primarily mature hardwoods with exfoliating bark (FWS, 2014). The botanical survey conducted by Consumers Energy and DTE Companies identified trees with exfoliating bark within the project boundary, including sassafras, sugar maple, and white ash. These trees represent potential habitat for the Indiana bat and northern long-eared bat and are subject to Consumers Energy and DTE Companies' tree harvests. Tree removal resulting from Consumers Energy and DTE Companies' intermittent tree harvests has the potential to disturb roosting bats and their newly born pups.

There is no known documentation of Indiana or northern-long eared bats or maternity roosts occurring within the project; however, FWS's IPaC system indicates both species have the potential to occur within the counties of the project. Undocumented roosts may occur within the 190 acres of forest habitat within the project boundary. Avoiding tree removal in June and July would reduce the likelihood of disturbance to roosting bats and their pups. Implementing a seasonal clearing restriction would ensure that any negative effects resulting from tree removal to the Indiana or northern long-eared bat residing in undocumented roosts would be minimized. In addition, as discussed in section 3.3.4, *Recreation and Land Use*, land within the project boundary for the Ludington Project that is not needed for a project purpose should be removed from the project boundary. These lands would include approximately 155 acres of forested land that could serve as potential Indiana bat and northern long-eared bat roosting habitat. Therefore, with consideration to the removal of these lands and with the seasonal restriction to tree clearing in place, continued project operation and maintenance may affect, but is not likely to adversely affect the Indiana bat. In addition, because tree removal that may result from Consumers Energy and DTE Companies' timber harvests does not occur within 0.25 miles of a known northern long-eared bat hibernacula, or within 150 feet of a known maternity roost, continued operation and maintenance of the project may affect the northern long-eared bat, but any incidental take that may result is not prohibited per the final 4(d) rule.

Piping Plover, Rufa Red Knot, and Pitcher's Thistle

As described in section 3.3.1, *Aquatic Resources*, Consumers Energy and DTE Companies conduct an annual installation and removal of the barrier net along the project shoreline by April 15 and October 15, respectively. Consumers Energy and DTE Companies have not proposed any other scheduled maintenance or activities associated with project operation along the 2544-foot-long shoreline within the project boundary.

FWS recommends that Consumers Energy and DTE Companies provide access to the project area to periodically survey for piping plover nests, and that Consumers Energy and DTE Companies provide a 100-foot buffer around any future nest site and prohibit the use of vehicular equipment to minimize human disturbance to nesting plovers. With respect to the Pitcher's thistle, FWS recommends that if the Pitcher's thistle colonizes shoreline habitat within the project boundary in the future, vehicular use be restricted and foot traffic minimized.

Consumers Energy and DTE Companies propose to minimize foot traffic and prohibit the use of vehicular equipment during the piping plover active nesting period to ensure nests are not destroyed.

Our Analysis

Extensive shorelines along Lake Michigan occur within the project boundary and provide potential habitat for the Pitcher's thistle, piping plover, and rufa red knot. All three species use sparsely vegetated shorelines with sandy soils, characteristics similar to those found at the project, as habitat. Foot traffic and motorized vehicles associated with the installation and removal of the barrier net could potentially disturb or otherwise disrupt shoreline habitat. However, these activities are confined to times of the year when the piping plover and rufa red knot are unlikely to occupy project land, and when the Pitcher's thistle is outside its growing season. Additionally, wildlife and botanical surveys conducted in 2015 indicate the probable absence of these species at the project. Therefore, continued operation and maintenance of the project would have no effect on the Pitcher's thistle, piping plover, or rufa red knot.

As stated above, there is no evidence the Pitcher's thistle, piping plover, and rufa red knot currently make use of project lands. Therefore, there is no need to require specific protection or mitigation measures for these species at the project. If unforeseen or unanticipated adverse project effects to these species are observed, however, FWS could petition the Commission to reopen the license to consider protective measures pursuant to Standard Article 15 of Form L-10. The Commission's standard license reopener polices would provide a mechanism to review potential project effects and protective measures at that time. If Consumers Energy and DTE Companies elect to provide access to the project for the purposes of surveying threatened or endangered

species, or develop additional measures for the protection of these species, they may do so under an off-license agreement with FWS.

3.3.4 Recreation and Land Use

3.3.4.1 Affected Environment

Regional Recreation Resources

Located on the east shore of Lake Michigan, recreation opportunities in the region surrounding the project are abundant and include hunting, fishing, camping, hiking, biking, cross-country skiing, swimming, picnicking, wildlife viewing, and boating.

Both national and state parks nearby provide a variety of recreational opportunities. The U.S. Forest Service manages the Huron-Manistee National Forest, located approximately 8 miles east of the project and the Nordhouse Dunes Wilderness Area, situated directly north of Ludington State Park. Ludington State Park is located just 6.5 miles north of the project. The park consists of approximately 5,300 acres of scenic sand dunes, shoreline vistas, ponds, marshlands, and forests and miles of beach access to Lake Michigan. The state park also includes three campgrounds that include 355 campsites and three mini-cabins.

The City of Ludington operates Stearns Park, Waterfront Park, Cartier Park, Copeyon Park, and Loomis Street Boat Launch approximately 4 to 5 miles north of the project. The parks' amenities include playgrounds, a skate park, shuffle board, mini golf, public boat launches, picnic areas, a campground, and beach access.

The Pere Marquette Charter Township provides several recreation opportunities within its township. Located 2 miles north of the project, Buttersville Beach and Campground provides camping at 55 campsites and a public access swimming beach on Lake Michigan. Buttersville Beach has served as the swimming beach for the campground for many years. Pere Marquette Township is in the final stages of acquiring a 316-acre natural property located adjacent to Buttersville Beach site, which has been designated as the Pere Marquette Conservation Park. On the east side of the property is an area known locally as the Twin Bridges site. The site is located at the mouth of the Pere Marquette National Scenic River and State Natural River, approximately 2.7 miles northeast of the project. Anglers are attracted to the Twin Bridges site because of the steelhead and salmon migration in the spring and fall.

The Father Marquette Shrine, also located 2 miles north of the project, includes 400 feet of frontage on the Pere Marquette Lake and a boat launch that provides access to Pere Marquette Lake and Lake Michigan. There are no developed facilities at Pere Marquette Lake, but it is a popular fishing spot with anglers for Lake Michigan

salmonids and other species. Anglers park along the Pere Marquette Highway (old US-31) to access the lake.

The Pere Marquette River is located approximately 2 miles north of the project and has been designated as a scenic river under the Wild and Scenic River program in the State of Michigan. The river offers several recreation opportunities such as boating, fishing, and wildlife viewing. Located along the south fork of the Pere Marquette River is the 34-acre riverfront park, Suttons Landing. The park includes approximately 425 feet of river frontage, a small boat launch facility, a boardwalk along the riverbank, restrooms, a pavilion, and parking.

Summit Township operates Summit Township Park approximately 2 miles south of the Ludington Project. The park includes a tennis court, ball fields, a picnic area and pavilion, and beach access on Lake Michigan.

The Lake Michigan Water Trail planned route extends along the lake, stopping north of the project near Butterville Park and starting up again south of the project. The anticipated 1,600-mile-route is planned to be the longest continuous-loop water trail in the world. The first 75 miles of the water trail from Chicago, Illinois to New Buffalo, Michigan is designated as a National Recreation Trail by the Park Service. However, the rest of the water trail is still under development.

Existing Project Recreation Facilities

The Ludington Project offers a variety of recreational opportunities within the project boundary, including fishing, camping, picnicking, hiking, snowshoeing, disc golfing, and flying model aircrafts. There are six formal project recreation sites located at the project (Figure 14 and Figure 15): Mason County Campground; Hull Field; Mason County Day Use/Picnic Area; Reservoir Overlook; Lake Michigan Overlook; and Pigeon Lake North Pier. Although the sites are closed and not maintained during the winter, the area remains open to the public to allow for informal winter recreation opportunities.

Mason County Campground

The Mason County Campground is owned by Consumers Energy and DTE Companies and managed by Mason County. The site provides opportunities to camp and picnic on a seasonal basis (i.e., Memorial Day weekend to Labor Day weekend). The site also includes 56 campsites, four cabins, an accessible restroom/shower facility, a picnic shelter with eight tables, a playground, three benches, an interpretive display, and a footpath to Hull Field.

Hull Field

Hull Field, located adjacent to the Mason County Campground, is a model airplane field owned by Consumers Energy and DTE Companies, managed by Mason County, and operated by the Twisted Sticks Radio Control Club. The site includes 18 parking spots, portable toilets, two benches, five picnic tables, a pavilion, 14 airplane platforms, and a large mowed field. Although the site is open to the public, those who wish to fly a radio controlled plane must have a current Academy of Model Aeronautics card.

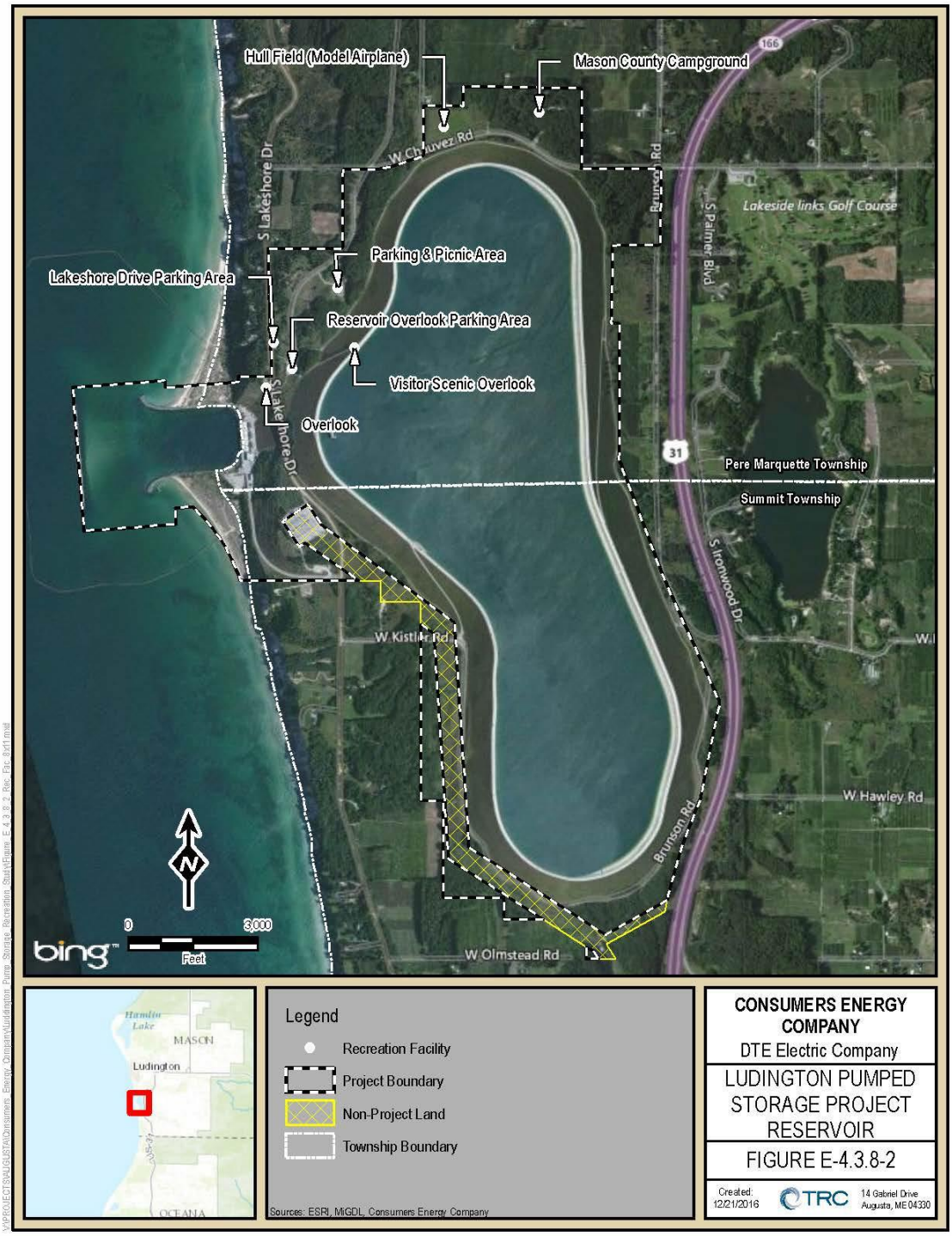

Figure 14. Ludington Project Recreation Facilities Location Map (Source: Consumers Energy and DTE Companies, 2017a).

Figure 15. Pigeon Lake North Pier (Source: Consumers Energy and DTE Companies, 2017a).

Mason County Day Use/Picnic Area

The Mason County Day Use/Picnic Area is owned by Consumers Energy and DTE Companies and managed by Mason County. The site includes 62 parking spots, a picnic pavilion with 34 tables, accessible restrooms, a 72-goal dis golf course, and a playground. The site also includes a designated snowshoe trail loop that follows a pathway used by disc golfers in warmer months.

Reservoir Overlook

The Reservoir Overlook, both owned and managed by Consumers Energy and DTE Companies, is located on the northwest side of the upper reservoir embankment and provides views of the reservoir and Lake Michigan. The site includes 83 parking spots, portable toilets (one standard and one accessible), a pagoda shelter and interpretive display, and nine benches located along a steep footpath to the pagoda.

Lake Michigan Overlook

The Lake Michigan Overlook, both owned and managed by Consumers Energy and DTE Companies, is located north of the powerhouse along the eastern shore of Lake Michigan. The site includes a footbridge, multiple interpretive displays, and parking located just north of the overlook.

Pigeon Lake North Pier

Pigeon Lake North Pier, both owned and managed by Consumers Energy and DTE Companies, is located approximately 70 miles south of the project's upper reservoir. The site includes 18 parking spots, two fishing platforms, eight benches, and a boardwalk that leads to the Pigeon Lake North Pier. The pier itself extends 700 feet west into Lake Michigan and provides opportunities to walk, jog, and fish. Although a warm water discharge pipe at the end of the pier would provide for Great Lake species winter fishing, safe public access is not possible during the winter due to heavy ice build-up on the pier and the often-hazardous Lake Michigan winter weather conditions.

Recreation Use

The Michigan Department of Natural Resources (MDNR) has a statewide responsibility for assisting local, state, and federal agencies in planning, acquiring, and developing recreational resources in the state. Through evaluating ongoing and emerging outdoor recreation trends, needs, and issues, Michigan's Statewide Comprehensive Outdoor Recreation Plan (SCORP) is a five-year strategic plan that shapes investment by the State of Michigan and local communities in priority outdoor recreation infrastructure

and programming. The most current version of the plan covers 2018-2022 and published on a web site for public use (Michigan Parks and Recreation, 2018).[71]

With year-round outdoor recreation opportunities, outdoor recreation rates have increased in Michigan and outdoor recreation continues to be an important activity for residents and out-of-state visitors. Between 2014 and 2016, the Michigan SCORP reported that park visits increased by 41 percent and camping increased approximately 20 percent. However, hunting appeared to decline by 10 percent based on the number of hunting licenses purchased. The Michigan SCORP also identified relaxing outdoors, visiting parks, swimming, picnicking, and fishing as the top recreation activities as the most popular outdoor recreation opportunities in Michigan.

Project Recreation Use

In order to identify existing and future recreation use at the Ludington Project, Consumers Energy and DTE Companies conducted a recreation use study and user survey at the six project recreation sites described above to understand use patterns and preferences in the project area. The study characterized types of use, capacity, conditions of project facilities, and assessed future needs based on the information collected and population trends as identified in the Michigan SCORP. Survey results indicate that visitors' primary purpose for visiting the project for recreation is camping (27.4%), followed closely by disc golfing (27.1%) and sightseeing (21.3%). Only 1.4% of recreation users surveyed or observed were anglers. Consequently, the highest amount of use occurred at the Mason County Day Use/Picnic Area (14,044 recreation days) and the Mason County Campground (13,667 recreation days). Both Hull Field and the Reservoir Overlook had the lowest amount of recreation use out of the six project recreation sites. Total annual recreation use in 2015 was estimated at 49,876 recreation days[72] at the project.

Land Use

The project encompasses approximately 982 acres of open water (Lake Michigan) and 687 acres of land. The majority of land within the project boundary is developed, consisting of public land designated for recreational use (144 acres) or non-public lands primarily associated with the project powerhouse, dike, and other project structures (410 acres). Undeveloped land makes up 19% of lands within the project boundary (133

[71] This plan is an update to the Michigan Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2008-2012, which is on the Commission's List of Comprehensive Plans.

[72] A recreation day is defined as each visit by a person to a development for recreational purposes during any portion of a 24-hour period.

acres). All project lands are owned by Consumers Energy and DTE Companies with the exception of the portion extending into Lake Michigan. The bottom of Lake Michigan is owned by the State of Michigan.

About 190 acres of land within the project boundary is forested. Approximately 35 acres of forested land are located in the northeast corner of the project boundary, near the disc golf course, and are open to the public (Consumers and DTE Companies, 2018). Additionally, forested land surrounds the embankment around the transmission corridor in the southwest corner. However, there is no public access to this land nor is it used for project purposes. While timber cutting occurs periodically on forest lands within the project boundary, the frequency depends on the number, type, and market price of trees.

3.3.4.2 Environmental Effects

Project Recreation Plan

To manage project recreation facilities, Consumers Energy and DTE Companies propose a Recreation Plan that includes measures to:

- continue to operate and maintain the following FERC-licensed project recreation sites and facilities: (1) Mason County Campground; (2) Hull Field; (3) Mason county Day Use/Picnic Area; (4) Reservoir Overlook; (5) Lake Michigan Overlook; and (6) Pigeon Lake North Pier.
- consult with Mason County on an annual basis to discuss continued operation of Mason County Campground and Mason County Day/Use Picnic Area; and
- conduct periodic recreation use monitoring every six years over the term of the new license and report the data collected in the FERC Form 80[73] and file it with the Commission.

Our Analysis

Implementing the proposed Recreation Plan for the project would help to ensure project recreation facilities are operated and maintained over the term of a new license and that existing and future recreation needs are met. Including consultation with Mason County on Mason County-owned recreation sites and monitoring recreation use at the project over the term of the new license would help Consumers Energy and DTE Companies determine if facility improvements or modifications to the Recreation Plan are necessary. Additionally, conducting periodic recreation use monitoring over the term

[73] The FERC Form-80 describes a project's recreation facilities and the level of public use.

of any new license would help Consumers Energy and DTE Companies determine whether facility improvements or modifications to the Recreation Plan are necessary.

Recreation Enhancement Plan

Pere Marquette states in its comments that there is a need for more recreational access at the Ludington Project. Pere Marquette also states there is currently no fishing or swimming beach access at the project and there are no suitable lands associated with the project where a beach development could be located. Pere Marquette further states that the Pigeon Lake North Pier site is not serving its purpose because anglers cannot access the facility in the winter when fishing is preferred at that site. Both Pere Marquette and the Park Service state that the project not only lacks beach and fishing access, but is an impediment to the development of the Lake Michigan Water Trail. The Park Service states that the project creates significant safety issues for paddlers in the open water area around the project intake.

To mitigate for the lost opportunity of beach and fishing access at the Ludington Project, the lack of quality fishing at the Pigeon Lake North Pier, and the absence of portage around the project for boaters who want to access the Lake Michigan Water Trail, Pere Marquette and the Park Service recommend the development of a Recreation Enhancement Plan. The Recreation Enhancement Plan would include an angler access facility at the Twin Bridges site to address the need for public access to shoreline and small boat fishing opportunities for Lake Michigan fish species, and a portage facility at the Buttersville Beach site to provide portage around the project for boaters accessing the Lake Michigan Water Trail. The Park Service recommends the development of the Buttersville Beach site portage facility, including an access trail, restrooms, parking, signage, kayak racks, and transport service to assist kayakers with their portage. The Park Service states that the plan should be developed in consultation with Pere Marquette, the Park Service, Michigan DNR, and FWS in conjunction with the Pere Marquette projects currently being planned (i.e., Pere Marquette Conservation Park and additional projects at Buttersville Beach and Twin Bridges site). Additionally, both Pere Marquette and the Park Service state the plan should include a schedule for completion of the projects and financial support in an amount not to exceed $800,000.

Michigan DNR recommends that Consumers Energy and DTE Companies participate with Pere Marquette and their partners to develop the Twin Bridges and Buttersville Beach sites to provide additional recreational opportunities in the vicinity of the project because there would be a greater need for recreational access opportunities in Michigan over the term of any new license, and the topography directly adjacent to the project does not provide for additional waterfront development.

Our Analysis

Although the recommendation for a Recreation Enhancement Plan would increase recreation opportunities at the Twin Bridges and Buttersville Beach sites, Pere Marquette and the Park Service have not established a need for additional recreational access at the Ludington Project. Pere Marquette and the Park Service state there is a demonstrated need for public access to shoreline and small boat fishing opportunities for Lake Michigan fish species at the project because the Pigeon Lake North Pier site is not serving its purpose due to the lack of quality fishing. However, public access to shoreline and boat fishing opportunities already exist at several sites within two to three miles of the project (i.e., Pere Marquette Lake, Summit Township Park, Father Marquette Shrine, and City of Ludington Stearns, Waterfront, and Copeyon parks and Loomis Street Boat Launch). Furthermore, in its comments filed on April 3, 2018, Pere Marquette included Michigan DNR's Fisheries Survey Analysis of Pere Marquette Lake and the Pere Marquette River Mouth that states Pere Marquette Lake provides exceptional fishing opportunities due to the outstanding naturally reproducing populations of salmon and steelhead in the Pere Marquette River. While the Twin Bridges and Buttersville Beach sites would add additional public beach and shoreline fishing access to Lake Michigan, the two recreation sites are located approximately three miles north of the project, are not affected by project operation or maintenance, and do not provide access to project land or water. Further, because Pere Marquette owns and manages both the Twin Bridges and Buttersville Beach sites and the adjacent Pere Marquette Conservation Park, there is no reason to believe that Pere Marquette would not continue to operate and maintain these facilities over the term of a new license. Although Michigan DNR recommends, at a minimum, that Consumers Energy and DTE Companies participate with Pere Marquette and their partners to develop both of these sites to provide additional recreational opportunities in the vicinity of the project, as stated above the Twin Bridges and Buttersville Beach sites have no nexus to the project and several similar recreational opportunities already exist within the project vicinity.

In addition to beach and fishing access to Lake Michigan, both the Park Service and Pere Marquette recommend that Consumers Energy and DTE Companies provide a portage facility at the Buttersville Beach site and transportation to and from Lake Michigan for boaters because the project is an impediment to the development of the Lake Michigan Water Trail. Boaters are strongly discouraged by Consumers Energy and DTE Companies from traversing around the facilities' safety barrier and are prohibited from crossing into the safety zone altogether. However, the Lake Michigan Water Trail is still in the early development stages and the only section of the trail designated by the Park Service is roughly 200 miles south the project. Further, pick-up zones for boaters on Lake Michigan are already available 2.7 miles north of the project at Buttersville Beach and 2 miles south of the project at Summit Township Park. As noted above, there is no reason to believe that the townships that manage these sites would not continue to operate and maintain these facilities over the term of any new license.

Land Use

Project Boundary

Commission regulations require that all lands necessary for the operation and maintenance of the project be included in the project boundary.[74] Staff propose the removal of approximately 155 acres of forested lands that surround the embankment around the transmission corridor in the southwest corner of the existing project boundary. The lands were included in the original license for potential future recreation development. However, only 35 acres of these lands (near the disc golf course) are currently being used for project purposes. The 155 acres of forested lands surrounding the embankment around the transmission corridor do not provide public access to project recreation opportunities nor are they needed for project operation or maintenance. Therefore, there is no need to include these lands within the project boundary.

As discussed in section 2.1.2, *Current and Proposed Project Boundary*, the barrier net is not included in the existing project boundary. However, the barrier net is installed seasonally to prevent losses of fish at the project due to project operation (see section 3.3.1, *Aquatic Resources*. Because the barrier net serves a project purpose by mitigating the effects of project operation on fish, it should be considered a project facility and located within the project boundary.

3.3.5 Cultural Resources

3.3.5.1 Affected Environment

Area of Potential Effects

Under section 106 of the National Historic Preservation Act of 1966, as amended, the Commission must take into account whether any historic property within the project's APE could be affected by the project. The Advisory Council on Historic Preservation defines an APE as the geographic area or areas in which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist (36 C.F.R. § 800.16(d)). The APE for the Ludington Project includes all lands enclosed by the project boundary, including both the Mason County and Ottawa County recreation sites.

[74] *See* 18 C.F.R. 4.41(h)(2) (2017).

Regional History

The precontact occupation of Michigan is generally divided into three broad periods: Paleo-Indian, Achaic and Woodland, defined primarily by changes in subsistence strategies, cultural developments, and technology. The Paleo-Indian period encompasses the cultural remains of the earliest recorded occupations of the region, after approximately 12,000 Before Present. Paleo-Indians were nomadic, seasonally following large herds of migrating game. Later in the period, hunting activity shifted from large-scale expeditions to smaller but more regular hunting within a more localized territory. The beginning of the Archaic period is marked by the retreat of the Great Lakes and decreasing populations mega-fauna. In response, the broad seasonal migration patterns of the previous period shifted towards more localized seasonal settlement and subsistence patterns. By the end of this period, interaction among settlements and trade across regions of North America indicates larger and more permanent occupations. During the Woodland period, the innovation of ceramic technology and the emergence of cultigens in agriculture were accompanied by a shift towards sedentary, agrarian communities with increased cultural complexity and traditions.

The first permanent European settlement in Michigan was established in 1668 by Father Jacques Marquette, a Jesuit missionary and explorer. Father Jacques Marquette is a significant historical figure in Michigan, and his death is memorialized by the Father Marquette Shrine on South Lakeshore Drive on the Pere Marquette Lake in Mason County. The City of Ludington was originally called Pere Marquette, later renamed Ludington after the successful 19th-century industrialist James Ludington, who was instrumental in developing the city and the early lumber industry in the area.

Early settlers came to the area to hunt, fish and trade with the Indians. In the mid-19th century a number of sawmills were constructed, including James Ludington's mill at the end of Pere Marquette Lake, acquired in 1859. In 1873 the village of Pere Marquette became the incorporated City of Ludington, and in the late-19th century the city developed as a major Great Lakes shipping and transportation center, establishing the Flint and Pere Marquette Railroad in 1874. As the lumber boom declined in the early 20th century, agriculture gained prominence in Mason County, followed by an increase in year-round recreation and upscale development in the last decades of the 19th century.

Archaeological and Historic Resources

In May of 2015, Consumers Energy and DTE Companies initiated a Phase I archeological and historic resources study to identify any archaeological or historic resources they could be affected by the project. The archaeological survey identified seventeen previously recorded archaeological sites and fifteen unrecorded archaeological sites. Of the previously unrecorded sites, thirteen were determined to be ineligible for listing on the National Register. Two historic farmstead/orchard sites (20MN324 and

20MN329) exhibit many factors associated with significant farmstead archaeological sites in Michigan and were determined to be potentially eligible for listing on the National Register under Criterion D: *Information Potential.*

One historic site, the Ludington Project, was found to be eligible for listing on the National Register under Criteria A, C, and D. Although historic resources less than 50 years old, such as the Ludington Pumped Storage Hydroelectric Facility (built between 1969 and 1973), are not typically considered eligible for listing on the National Register, they may be eligible if they are considered exceptionally important. The Ludington Project is Michigan's first and only hydroelectric pumped storage facility. At the time it was constructed, it had the largest generating capacity in the world for pumped storage facilities, and remains the third largest pumped storage facility in the world and second largest in the United States. Due to this significant history, Consumers Energy and DTE Companies voluntarily conducted a National Register-eligibility study in 2011, prior to pump-turbine/motor-generator unit upgrades. The study determined that the project is eligible for listing on the National Register. The Michigan SHPO concurred in a letter filed February 21, 2012, that the proposed pump-turbine/motor-generator upgrades would not adversely affect the eligibility of the Ludington Pumped Storage Hydroelectric Facility.

On March 4, 2016 Consumers Energy and DTE Companies submitted to the Michigan SHPO and Saginaw Tribe a copy of the Phase I historical and archaeological resources study report, concluding that the project would have no adverse effects on historic and cultural resources. On March 6, 2017 Consumers Energy and DTE Companies also submitted a copy of a draft Historic Properties Management Plan (HPMP) to the Michigan SHPO and Saginaw Tribe, following up by email on May 5, 2017. On May 5, 2017, the Michigan SHPO concurred by email with the findings and effects determinations of the 2015 Phase I historical and archaeological resources study report and draft HPMP.

3.3.5.2 Environmental Effects

Although Consumers Energy and DTE Companies do not propose any new construction, ground disturbing activities or changes to the project, continued operation and maintenance of the project may affect identified and unidentified historic properties within the project's APE. To address potential effects, Consumers Energy and DTE Companies propose to implement an HPMP, developed in consultation with the Michigan SHPO and Saginaw Tribe, filed with the license application on June 28, 2017. The HPMP contains procedures and requirements for: (1) treatment and mitigation measures for unavoidable adverse effects; (2) treatment and mitigation measures for unexpected adverse effects, including erosion, vandalism, unanticipated discoveries and human remains, treatment of historic properties during emergencies, and counter-terrorism measures; and (3) implementation procedures, including periodic reporting and periodic

review and revision of the HPMP, and actions requiring consultation with the Michigan SHPO and tribes. The Michigan SHPO stated by email on May 5, 2017, that the HPMP is accepted without comment or recommendation.

Our Analysis

Consumers Energy and DTE Companies do not propose any ground disturbing activities as part of relicensing; therefore, continued operation and maintenance of the project should not adversely affect archaeological sites 20MN324 and 20MN329. However, there may be unknown archaeological resources that could be adversely affected by future operation and maintenance of the project. The HPMP filed with the license application contains provisions for the treatment of previously undiscovered archaeological resources in the APE and ensures that any previously unidentified archaeological resources would not be adversely affected by the project.

Continued operation of the Ludington Project would ensure that the National Register eligible project would continue to be operated as designed, and would therefore be beneficial. However, without protection measures in place, continued operation and maintenance could have an adverse effect on the project. The HPMP contains treatment and mitigation measures for unavoidable and unanticipated adverse effects and a procedure for consulting with the Michigan SHPO. Therefore, any potential adverse effects of project operation and maintenance on the Ludington Project would be addressed by the proposed HPMP.

An executed PA, which would be signed by the Commission and Michigan SHPO would implement the proposed HPMP. We anticipate that any effects on known or unknown archaeological and historic properties would be taken into account through the executed PA and HPMP, ensuring that any adverse effects on archaeological and historic properties within the APE would be resolved.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the project's use of the Lake Michigan for hydropower purposes to see what effects various environmental measures would have on the project's costs and power generation. Under the Commission's approach to evaluating the economics of a hydropower project, as articulated in *Mead Corp*.,[75] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in *Mead Corp.*, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of individual measures considered in the EA for the protection, mitigation, and enhancement of environmental resources affected by the project; (2) the cost of alternative power; (3) the total project cost (*i.e.*, capital costs, operation, maintenance, and environmental measures); and (4) the difference between the cost of alternative power and total project cost for the project. If the difference between the cost of alternative power and total project cost is positive, the project helps to produce power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, then the project produces power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND ECONOMIC BENEFITS OF THE PROJECT

Table 13 summarizes the assumptions and economic information we use in our analysis for the project. This information was provided by Consumers Energy and DTE Companies in its license application and subsequent replies to additional information or estimated by staff. We find that the values provided by Consumers Energy and DTE Companies are reasonable for the purposes of our analysis. Cost items common to all alternatives include: the undepreciated value of the project (net investment), operation

[75] See *Mead Corporation, Publishing Paper Division*, 72 FERC ¶ 61,027 (1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

and maintenance (including direct plant costs, administrative and general expenses, insurance, relicensing cost, and Commission fees), and pumping expenses.

Table 13. Parameters for the economic analysis of the Ludington Project (Source: Consumers Energy and DTE Companies and Staff).

Parameters	**Values (2017 dollars)[a]**	**Source**
Period of analysis	30 years	Staff
Term of financing	20 years	Staff
Escalation rate	0 percent	Staff
Interest rate	8.29 percent[b]	Consumers Energy and DTE Companies
Discount rate	8.29 percent[c]	Staff
Federal tax rate	21 percent[d]	Staff
Local tax rate	3.95 percent[e]	Consumers Energy and DTE Companies, and Staff
Net investment	$441,881,841[f]	Consumers Energy and DTE Companies
Installed capacity	1,785 MW	Consumers Energy and DTE Companies
Dependable capacity	1,785 MW[g]	Consumers Energy and DTE Companies
Energy - Generation	2,658,200[h]	Consumers Energy and DTE Companies
Energy - Pumping	3,649,742[i]	Consumers Energy and DTE Companies
Dependable capacity value	$45.37/ kilowatt-year[j]	Consumers Energy and DTE Companies
Alternative energy value	$65.00/MWh[k]	Consumers Energy and DTE Companies

Pumping energy value	$22.33/MWh[l]	Consumers Energy and DTE Companies
Operation and Maintenance	$41,169,560[m]	Consumers Energy and DTE Companies, and Staff

[a] Costs provided by Consumers Energy and DTE Companies in 2016 dollars were converted to 2017 dollars using the Bureau of Reclamation Construction Cost Indexes. The index for December 31, 2017 (377) was divided by the index for December 31, 2016 (371) to obtain the multiplier 1.0162 which staff used to update the costs.

[b] Composite rate for Consumers Energy and DTE Companies, Exhibit D, page D-4-1.

[c] Staff assumes the discount rate is the same as the interest rate.

[d] The Tax Cuts and Jobs Act of 2017 reduced the corporate tax rate from 35 percent to 21 percent effective January 1, 2018.

[e] Calculated by dividing $17,436,683 Consumers Energy and DTE Companies paid in real estate taxes for 2017, by the net investment.

[f] From the June 4, 2018 "2017 Financial Data Supplement to the Final License Application," table D-2.2-1. Includes relicensing cost of approximately $2,000,000.

[g] Exhibit B, page B-2-1.

[h] Exhibit D, page D-5-1.

[i] From the September 25, 2017 response to staff's additional information request (AIR) Item 10, page B-10.

[j] From the September 25, 2017 response to staff's AIR Item 4, page B-3. Consumers Energy and DTE Companies provided a range of $45.37 to $68.06/kW-yr. Staff assumed $45.37/kW-yr.

[k] From the September 25, 2017 response to staff's deficiency Item 5, page A-8.

[l] From the June 4, 2018 "2017 Financial Data Supplement to the Final License Application," table E-5.1-1.

[m] From February 7, 2018 "Conference Call Summary," Enclosure 2; Exhibit D, table D-4.6-2; and the June 4, 2018 "2017 Financial Data Supplement to the Final License Application," total property taxes table. Consumers Energy and DTE Companies calculate the O&M annual cost by adding the fixed costs (direct plant, fish barrier net, and real estate taxes) and the variable costs (administrative and general, employee pensions, insurance, etc.). Using Consumers Energy and DTE Companies' method and the sources mentioned in this footnote, staff calculates that the 2017 O&M cost is $61,940,000. Because staff's economic model accounts for real estate taxes, we deduct the 2017 real estate taxes ($17,436,683) from the O&M cost of $61,940,000. We also deduct the 2017 cost of the fish barrier net of $3,338,126 and account for it separately as a environmental measure. The resulting staff O&M cost calculation is $41,169,560.

4.2 COMPARISON OF ALTERNATIVES

Table 14 compares the alternative power values, annual costs, and net benefits of the no-action alternative, Consumers Energy and DTE Companies' proposed action, the staff alternative, and the staff alternative with mandatory conditions. In section 5.1, *Comprehensive Development and Recommended Alternative*, we discuss our reasons for recommending the staff alternative with mandatory conditions, and explain why we conclude the environmental benefits are worth the power benefit reductions.

Table 14. Comparison of alternatives for the Ludington Project (Source: Staff).

	No-Action	**Consumers Energy and DTE Companies' Proposal**	**Staff Alternative**	**Staff Alternative with Mandatory Conditions**
Installed capacity (MW)	1,785	1,785	1,785	1,785
Annual generation (MWh)	2,658,200	2,658,200	2,658,200	2,658,200
Annual cost of alternative power ($ and $/MWh)	253,768,450 95.47	253,768,450 95.47	253,768,450 95.47	253,768,450 95.47
Annual project cost ($ and $/MWh)	214,767,891 80.79	215,186,183 80.95	215,068,679 80.91	215,075,715 80.91
Difference between the cost of alternative power and project cost ($ and $/MWh)	39,000,559 14.67	38,582,267 14.51	38,699,771 14.56	38,692,735 14.56

4.2.1 No-Action Alternative

In December 2011, Consumers Energy and DTE Companies submitted a request for a maintenance upgrade amendment proposing to replace the six pump-turbine runners and rewind the corresponding motor/generators thus raising the authorized installed capacity from 1,657.5 MW to 1,785 MW. The Commission issued an amendment authorizing the upgrades on May 7, 2012. The work started in 2013 and is being completed during the relicensing process with the last unit upgrade scheduled for completion in 2019.

The project's net investment of $441,881,841 includes three unit maintenance upgrades completed through December 31, 2017. The anticipated capital costs for the

additional three unit upgrades is $160,000,000. Additional plant capital costs projected for 2018 through 2021 unrelated to unit upgrades (i.e., step-up transformer replacement/refurbishment, HVAC[76] replacement, cooling water strainer replacement, etc.) total $58,000,000.

These expenses are incurred by Consumers Energy and DTE Companies during the current license term and, when all work under the amendment is complete (together with the work unrelated to unit upgrades), the project would constitute "current project" under the no-action alternative. Under this alternative, the only environmental measure implemented by Consumers Energy and DTE Companies is to continue to annually install and maintain the fish barrier net at a cost of $3,338,126.

Under the no-action alternative, the project would have an installed capacity of 1,785 MW, and generate an average of 2,658,200 MWh of electricity annually. The average annual cost of alternative power would be $253,768,450, or about $95.47/MWh. The average annual project cost would be $214,767,891or about $80.79/MWh. Overall, the project would produce power at a cost of about $14.67/MWh, which is $39,000,559 less than the cost of alternative power.

4.2.2 Consumers Energy and DTE Companies' Proposal

The measures that Consumers Energy and DTE Companies propose would increase the annualized cost of the project by $418,292 relative to the no-action alternative. Under this proposal, Consumers Energy and DTE Companies would implement all the environmental measure agreed upon in the Settlement Agreement and other measures Consumers Energy and DTE Companies proposed outside of the Settlement Agreement, as shown in Table 15. Under the Consumers Energy and DTE Companies' proposal the project would have an installed capacity of 1,785 MW, and generate an average of 2,658,200 MWh of electricity annually. The average annual cost of alternative power would be $253,768,450, or about $95.47/MWh. The average annual project cost would be $215,186,183 or about $80.95/MWh. Overall, the project would produce power at a cost of about $14.51/MWh, which is $38,582,267 less than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative is based on the Consumers Energy and DTE Companies' proposal with staff modifications and additional measures. The staff alternative would have an installed capacity of 1,785 MW, and generate an average of 2,658,200 MWh of electricity annually. The average annual cost of alternative power would be

[76] Heating, Ventilation, and Air Conditioning.

$253,768,450, or about $95.47/MWh. The average annual project cost would be $215,068,679 or about $80.91/MWh. Overall, the project would produce power at a cost of about $14.56/MWh, which is $38,699,771 less than the cost of alternative power.

4.2.4 Staff Alternative with Mandatory Conditions

This alternative includes the same measures as the staff alternative and adds three mandatory conditions as shown in Table 15. Under this alternative the project would have an installed capacity of 1,785 MW, and generate an average of 2,658,200 MWh of electricity annually. The average annual cost of alternative power would be $253,768,450, or about $95.47/MWh. The average annual project cost would be $215,075,715 or about $80.91/MWh. Overall, the project would produce power at a cost of about $14.56/MWh, which is $38,692,735 less than the cost of alternative power.

4.3 COST OF ENVIRONMENTAL MEASURES

Table 15. Cost of environmental mitigation and enhancement measures considered in assessing the effects of operating the Ludington Project (Source: Consumers Energy and DTE Companies, and Staff).

Enhancement/Mitigation Measure	Entity	Capital Cost (2017$)[a]	Annual Cost (2017$)[a]	Levelized Annual Cost (2017$)	Notes
General					
1. Continue to operate the project as an open loop system (Michigan DEQ certification condition 1.1).	Consumers and DTE Companies, Michigan DEQ, Staff	$0	$0	$0	
Aquatic Resources					
2. Continue to fund the SAT.	Settling Parties[n]	$0	$30,485	$30,485	b
3. Continue to annually install and maintain the fish barrier net at the project for the longest practicable period each year during the ice-free season (i.e., from April 15 to Oct. 15 at a minimum) to minimize fish entrainment.	Settling Parties, Staff	$0	$3,338,126	$3,338,126	c

4. Procure, maintain, and make available additional fish barrier net replacement equipment and materials necessary to maintain the net on a continuous basis during the ice-free season and to allow for the replacement of all elements of the net system.	Settling Parties, Staff	$0	$0	$0	d
5. Continue to fund studies to monitor the effectiveness of the fish barrier net on an annual basis.	Settling Parties, Staff	$0	$0	$0	e
6. Maintain an annual fish barrier net effectiveness target of 80 percent for all fish equal to or greater than 5 inches in length. If 80 percent effectiveness is not achieved for two consecutive years, initiate discussions with the SAT in accordance with the procedures proposed under the Settlement Agreement's Adaptive Management Process to improve net performance.	Settling Parties, Staff	$0	$0	$0	f
7. Continue to provide annual reports to the Commission and Settling Parties that describe: (a) the actions taken by Consumers and DTE to evaluate and improve both the effectiveness of the fish barrier net, and (b) the measures taken by Consumers and DTE to maintain the	Settling Parties, Staff	$0	$0	$0	r

proper replacement capacity of the fish barrier net during the ice-free season.					
8. As part of the Settlement Agreement's Adaptive Management Process, develop a plan for the installation of additional floatation and anchor pilings, and stronger net materials in targeted areas of the fish barrier net to improve net effectiveness.	Settling Parties, Staff	$1,473,450	$0	$124,185	g
9. As part of the Settlement Agreement's Adaptive Management Process, develop a plan to monitor the effectiveness of any measures implemented to enhance the performance of the fish barrier net.	Settling Parties, Staff	$0	$254,043 Years 1 through 3	$59,442	h
10. As part of the Settlement Agreement's Adaptive Management Process, develop and implement studies to characterize the fish community near the project to ensure barrier net effectiveness remains biologically relevant during the term of any new license issued for the project.	Settling Parties, Staff	$0	$254,043 Years 1 through 3	$59,442	j
11. Develop a plan that guides the proposed fish community studies (measure no. 11) and includes: (a) sampling methodologies; (b) a description of the study area; (c) a description of the anticipated timing and frequency of all	Staff	$10,000	$0	$843	i

fish sampling; (d) an implementation schedule; and (e) reporting requirements.					
12. As part of the Settlement Agreement's Adaptive Management Process, develop and implement additional studies to support the decision making process for any additional optimizations of the fish barrier net or any ancillary fixtures of the entrainment abatement system.	Settling Parties	$0	$254,043 Years 4 and 5	$32,431	k
13. File a report with the Commission that summarizes the efforts undertaken during the first five years of the Adaptive Management Process.	Settling Parties	$0	$0	$0	o
14. Beginning in year six of any new license issued for the project and continuing for the duration of the license, provide additional funding to the SAT to enable the continuation of studies under the Settlement Agreement's Adaptive Management Process.	Settling Parties	$0	$508,086 in years 6 and 16, and $254,043 in year 26.	$44,647	l
15. Continue to review fish entrainment abatement technologies at least once every ten years. This proposal also includes the following measures: (a) develop study plans, in consultation with the SAT, prior to implementing each review, and (b) reporting requirements.	Settling Parties, Staff	$0	$30,485 Years 10 and 20	$1,820	m

16. Develop a plan that guides Consumers and DTE's proposal to conduct fish entrainment abatement technology reviews (measure no. 16) and includes: (a) a description of the consultation process that will be used to determine the frequency of the fish entrainment abatement technology reviews; (b) a provision for the individual study plans to be filed with the Commission, for approval, prior to implementation; and (c) an implementation schedule.	Staff	$10,000	$0	$843	i
17. Monitor water temperatures in Lake Michigan (adjacent to the project) on an hourly basis from June 1 through Oct. 31 of each year (Michigan DEQ certification condition 3.1).	Michigan DEQ	$2,000	$1,000	$1,169	i, q
18. Beginning the first year after license issuance and continuing every five years thereafter, provide fish tissue samples to Michigan DEQ for an analysis of contaminants (i.e., mercury, PCBs, dioxin/furans, and dioxin-like PCBs) (Michigan DEQ certification condition 3.2).	Michigan DEQ	$0	$12,000 starting in year 1, then every 5 years Years 1, 6, 11, 16, 21, and 26.	$2,735	i, p
19. Develop a plan to formalize all water quality and contaminant monitoring	Michigan DEQ	$7,500	$2,500	$3,132	i

required by the certification (measure no. 19) and provide annual reports on the results to Michigan DEQ (Michigan DEQ certification condition 3.3).					
Terrestrial Resources					
20. Develop an invasive species monitoring plan.	Staff	$5,000	$0	$421	i
21. Implement bald eagle protection measures.	Staff	$0	$0	$0	o
22. Restrict routine maintenance activity from April 15th through August 15th to protect migratory birds	FWS	$0	$0	$0	o
Threatened and Endangered Species					
23. Implement Indiana bat and northern long-eared bat protection measures.	Consumers and DTE Companies, Staff, FWS	$0	$0	$0	o
24. Minimize foot traffic and restrict the use of vehicular equipment in the spring and summer to protect piping plover nests and Pitcher's thistle.	Consumers and DTE Companies, FWS	$0	$0	$0	o

Recreation Resources					
25. Implement Recreation Plan to operate and maintain existing facilities for the term of the license	Consumers Energy and DTE Companies	$20,323	$0	$1,713	
26. Continue to operate and maintain existing project recreation facilities at project and North Pigeon Pier.	Consumers Energy and DTE Companies	$0	$40,647	$40,647	
27. Annual consultation with Mason County on Mason County Day Use/Picnic area and Mason County Campground.	Consumers Energy and DTE Companies	$0	$1,016	$1,016	
28. Develop a Recreation Enhancement Plan to provide beach and fishing access at the Twin Rivers site and portage at Buttersville Beach, including parking, restrooms, signage, and boat racks.	PM Township, Michigan DNR, NPS	$800,000	$0	$67,426	i
29. Provide transport service to assist kayakers with portage to and from Buttersville Beach to Lake Michigan.	NPS	$0	$50,000	$50,000	i
Cultural Resources					
30. Implement an HPMP.	Consumers Energy and DTE Companies, Staff	$25,404	$20,323	$22,464	
31. Implement a PA.	Staff	$0	$0	$0	

a Costs provided by Consumers and DTE in the final license application and updated by staff to 2017 dollars using the multiplier 1.0162 as shown in Table 13.

b Cost (in 2016 dollars) provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017, and updated by staff to 2017 dollars. Consumers and DTE state that the annual limit of $30,485 shall thereafter be annually adjusted for inflation as detailed in the Settlement Agreement.

c Cost provided by Consumers and DTE in its additional information response filed on September 25, 2017, and updated by staff to 2017 dollars.

d The costs for procuring, maintaining, and making available additional fish barrier net replacement equipment and materials are included in the $3,338,126 annual cost for installing and maintaining the fish barrier net.

e The costs for monitoring the effectiveness of the barrier net are included in the $3,338,126 annual cost for installing and maintaining the fish barrier net.

f A cost for this measure was not provided by Consumers and DTE. We are unable to estimate a cost for this measure because it would involve an unknown number of future meetings and consultations between Consumers and DTE and the members of the SAT.

g Cost (in 2016 dollars) provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017, and updated by staff to 2017 dollars. The estimated annual cost of $1,473,450 includes the installation of approximately 40 additional pile anchors for the 23 barrier net panels in the areas of highest flow and the purchase of enhanced replacement barrier net panels for the 23 panels.

h Cost (in 2016 dollars) provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017, and updated by staff to 2017 dollars. It includes the annual cost for implementation of the performance monitoring of the barrier net system improvements in years 1, 2, and 3 of any new license issued for the project. Although the staff alternative does not include Consumers and DTE's proposal for the development of a plan to monitor the effectiveness of measures (i.e., additional floatation, additional anchor pilings, and stronger net materials) implemented to improve the performance of the existing fish barrier net, staff assumes that the estimated costs associated with conducting the monitoring itself would be still incurred by Consumers and DTE.

i Cost estimated by staff.

j Cost (in 2016 dollars) provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017, and updated by staff to 2017 dollars. It includes the annual cost for implementation of the fish community characterization studies in years 1, 2, and 3 of any new license issued for the project.

k Cost (in 2016 dollars) provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017, and updated by staff to 2017 dollars. It includes the annual cost for implementation of "other Adaptive Management Process-directed studies, fish community characterization studies, and/or incremental barrier net improvements indicated by Adaptive Management Process studies" in years 4 and 5 of any new license issued for the project.

l Cost (in 2016 dollars) provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017, and updated by staff to 2017 dollars. Based on Consumers and DTE's proposal, it assumes an annual cost of $508,086 in years 6 and 16, and $254,043 in year 26 of any new license issued for the project.

m Cost assumes the fish entrainment abatement technology reviews would be conducted every ten years for the duration of any new license issued for the project

n In addition to Consumers and DTE, signatories (parties) to the settlement include: Attorney General for the State of Michigan; Michigan Department of Natural Resources (Michigan DNR); Interior, on behalf of the United States Fish and Wildlife Service and as Trustee for Indian tribes, bands, or communities with reserved treaty rights in the Michigan waters of Lake Michigan; Grand Traverse Band of Ottawa and Chippewa Indians; Little River Band of Ottawa Indians; Little Traverse Bay Bands of Odawa Indians; Michigan United Conservation Clubs; and National Wildlife Federation.

o Staff estimates that the cost to implement this measure would be negligible.

p Although Michigan DEQ certification condition 3.2 requires that Consumers and DTE provide fish tissue samples to Michigan DEQ for contaminant testing in a state laboratory, staff assumes that Consumers and DTE would be responsible for all costs associated with this testing. Staff's estimated cost assumes contaminant testing would be conducted every 5 years for the duration of any new license issued for the project.

q Staff estimates $2,000 in capital costs for one temperature sensor, one data logger, and a back-up sensor/data logger. Staff also estimates $1,000 in annual costs for maintenance and repair of the equipment. Although Michigan DEQ certification 3.1 contemplates a reduced water temperature monitoring schedule after one year of monitoring, because there is no assurance monitoring would be reduced in the future, staff assumes the annual costs would be incurred by Consumers and DTE for the duration of any new license issued for the project.

r The costs for providing annual reports to the Commission and Settling Parties are included in the $3,338,126 annual cost for installing and maintaining the fish barrier net.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for relicensing the project. We weigh the costs and benefits of our recommended alternative against other proposed measures.

Based on our independent review of agency and public comments filed on the project and our review of the environmental and economic effects of the proposed project and project alternatives, we selected the staff alternative as the preferred alternative. We recommend this alternative because: (1) issuing a new license for the project would allow Consumers Energy and DTE Companies to continue to operate the project as a dependable source of electrical energy; (2) the 1,785 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution; (3) the public benefits of the staff alternative would exceed those of the no-action alternative; and (4) the proposed and recommended measures would protect and enhance fish and wildlife resources and would improve public recreation opportunities at the project.

In the following section, we make recommendations as to which environmental measures proposed by Consumers Energy and DTE Companies or recommended by agencies or other entities should be included in any new license issued for the project. In addition to Consumers Energy and DTE Companies' proposed environmental measures listed below, we recommend additional staff-recommended environmental measures to be included in any license issued for the project.

5.1.1 Measures Proposed by Consumers Energy and DTE Companies

Based on our environmental analysis of Consumers Energy and DTE Companies' proposal in section 3, *Environmental Analysis*, and the costs presented in section 4, *Developmental Analysis*, we conclude that the following environmental measures proposed by Consumers Energy and DTE Companies would protect and enhance environmental resources and would be worth the cost. Therefore, we recommend including these measures in any license issued for the project.

To protect or enhance fisheries resources at the project, Consumers Energy and DTE Companies propose to:

- Continue to annually install and maintain the fish barrier net at the project for the longest practicable period each year during the ice-free season to minimize fish entrainment (section V.A of the Settlement Agreement).[77]
    - Procure, maintain, and make available additional fish barrier net replacement panels, anchors, buoys, lines, and other equipment and materials necessary to maintain the net on a continuous basis during the ice-free season and to allow for the replacement of all elements of the net system in the event of an extraordinary storm or other event that may damage the net system (section V.A.2 of the Settlement Agreement).
    - Continue to fund studies to monitor the effectiveness of the fish barrier net (section V.A.3 of the Settlement Agreement).
    - Maintain an annual fish barrier net effectiveness target of 80 percent for all fish equal to or greater than 5 inches in length and if 80 percent effectiveness is not achieved for two consecutive years, initiate discussions with the SAT in accordance with the procedures proposed under the Adaptive Management Process (as discussed below) to improve net performance (section V.A.1 of the Settlement Agreement).
    - Continue to provide annual reports to the Commission and Settling Parties that describe: (1) the actions taken by Consumers Energy and DTE Companies to evaluate and improve both the effectiveness of the fish barrier net and the methodology employed to measure barrier net effectiveness; and (2) the measures taken by Consumers Energy and DTE Companies to maintain the proper replacement capacity of the fish barrier net during the ice-free season (section V.A.4 of the Settlement Agreement).

- Implement an Adaptive Management Process (included as Appendix B to the Settlement Agreement) that includes the following measures to further minimize fish entrainment mortality at the project (section V.C of the Settlement Agreement):
    - Develop a plan, in consultation with the SAT, for the installation of additional floatation and anchor pilings, and stronger net materials in

[77] Consumers and DTE Companies propose in the Settlement Agreement that, at a minimum, the fish barrier net would be installed from April 15 to October 15 on an annual basis.

targeted areas of the fish barrier net to improve net effectiveness and file the plan for Commission approval (section V.B of the Settlement Agreement).
    - Develop a plan, in consultation with the SAT, to monitor the effectiveness of any measures implemented to enhance the performance of the fish barrier net (Appendix B of the Settlement Agreement).
    - After five years of implementing the Adaptive Management Process, file a report with the Commission that summarizes the efforts undertaken during the first five years of this process (Appendix B of the Settlement Agreement).

- Continue to review fish entrainment abatement technologies at least once every ten years for the purpose of determining if any new technologies are practicable for use at the project either in conjunction with or in lieu of the existing fish barrier net to reduce fish mortality at the project (section V.D of the Settlement Agreement).

- Continue to develop a fish entrainment abatement technology review study plan, in consultation with the SAT, prior to implementing each review, and upon completion of each study, provide a report to the Commission, SAT, and Settling Parties that describes the conclusions and recommendations concerning the feasibility, biological effectiveness, and costs associated with implementing any new fish entrainment abatement technologies at the project (section V.D of the Settlement Agreement).

Threatened and Endangered Species

- Restrict the cutting of trees at the project during periods when northern long-eared bats may be making use of forested habitat.

Recreation Resources

- Implement the proposed Recreation Plan, which includes measures to continue to operate and maintain existing project recreation facilities and monitor recreation use for the term of the license.

- Consult with Mason County on an annual basis on the maintenance and facility management of the Mason County Day Use/Picnic area and Mason County Campground.

Cultural Resources

- Implement the proposed HPMP filed on June 28, 2017.

5.1.2 Additional Measures Recommended by Staff

In addition to Consumers Energy and DTE Companies' proposed measures noted above, we recommend including the following additional measures in any license that may be issued for the Ludington Project:

- Develop a plan that guides the proposed fish community studies and includes provisions for: (1) a description of the sampling methodologies, study area, and the anticipated timing and frequency of all fish sampling; (2) an implementation schedule; and (3) a protocol for providing the study results to the Commission.

- Develop a plan that guides the proposed fish entrainment abatement technology reviews and includes provisions for: (1) a description of the consultation process that will be used to determine the need for and frequency of the reviews, which at a minimum must occur every ten years for the term of the license; (2) detailed study plans to be developed prior to implementing each fish entrainment abatement technology review; (3) an implementation schedule; and (4) a protocol for providing the results of each fish entrainment abatement technology review to the Commission.

Threatened and Endangered Species

- Implement bald eagle protection measures to minimize adverse project maintenance effects on nesting eagles within the project boundary.

- Avoid cutting trees between June 1 and July 31 to protect roosting Indiana and northern long-eared bats.

- Develop an invasive species monitoring plan that includes provisions for monitoring autumn olive and other invasive plants within the project boundary.

Land Use

- Remove from the project boundary approximately 155 acres of forested land that surrounds the embankment around the transmission corridor in the southwest corner.

- Expand the project boundary to include the seasonal fish barrier net when it is installed at the project.

Cultural Resources

- Execute a PA to protect historic properties.

The staff alternative does not include Consumers Energy and DTE Companies' proposals to: (1) fund the SAT; (2) implement as-yet unidentified and uncertain studies during the first five years of the proposed Adaptive Management Process; (3) provide funding to third party entities (i.e., the Great Lakes Fishery Trust and SAT) under the Adaptive Management Process; and (4) develop and implement a plan to monitor the effectiveness of measures (i.e., additional floatation, additional anchor pilings, and stronger net materials) at improving the performance of the existing fish barrier net. The staff alternative also does not include Michigan DEQ certification condition 2.1, which would require that Consumers Energy and DTE Companies operate the project in such a manner as to adhere to state water quality standards for water temperature in Lake Michigan. We also do not recommend Michigan DEQ certification conditions 2.2, 3.1, and 3.3, which would require that Michigan DEQ develop a plan to continuously monitor water temperature in Lake Michigan (from June 1 through October 31) to verify project-related effects on water temperature. Lastly, the staff alternative does not include Michigan DEQ certification condition 3.2, which would require that Consumers Energy and DTE Companies conduct (at five year intervals) contaminant monitoring (i.e., mercury, PCBs, dioxin/furans, and dioxin-like PCBs) of the edible portion of fish collected from within the project vicinity.

Below, we discuss the rationale for the additional staff-recommended modifications and measures, and the measures we are not recommending.

Fish Barrier Net Improvements

Consumers Energy and DTE Companies propose to develop and implement a plan for the installation of additional floatation, additional anchor pilings, and stronger net materials in targeted areas of the existing fish barrier net to improve its effectiveness. Upon completion of the installation of any physical improvements to the fish barrier net, Consumers Energy and DTE Companies also propose to develop and implement a separate plan to monitor the effectiveness of these measures at improving the performance of the net.

As discussed in section 3.3.1, *Aquatic Resources*, Consumers Energy and DTE Companies' proposal would help to reduce net submergence and net lifting events, which would improve the structural integrity of the net and potentially increase its effectiveness at minimizing fish entrainment-related mortality at the project. Consumers Energy and DTE Companies' proposal to utilize an adaptive management approach by implementing specific physical improvements to the net on an incremental basis and assessing the effectiveness of these measures at improving the net's overall structural integrity would help address any uncertainty associated with whether or not improvements made to the net result in actual increases in performance. Assessing the effectiveness of these measures at improving the net's overall structural integrity would also help to inform the

need for additional improvements to the net to further improve the net's structural integrity. However, as discussed below (section 5.1.3, *Measures Not Recommended*), Consumers Energy and DTE Companies' proposal to develop a plan to monitor the effectiveness of these measures at improving the performance of the net would be redundant with its other proposal to monitor barrier net effectiveness on an annual basis and, therefore, is unnecessary. We also note that any future proposals to implement additional physical modifications to the fish barrier net may not be implemented without prior Commission authorization granted after the filing of an application to amend the license.

We estimate that the levelized annual cost of developing and implementing this plan would be $184,500. We conclude this is a reasonable cost to ensure that the barrier net continues to function as an effective fish protection technology for minimizing fish entrainment-related mortality at the project.

Fish Entrainment Abatement Technology Reviews

Consumers Energy and DTE Companies propose to continue to review fish entrainment abatement technologies in consultation with the SAT at least once every ten years or more frequently if recommended by the SAT and there is a reasonable basis for such a recommendation. As part of this proposal, Consumers Energy and DTE Companies would develop fish entrainment abatement technology review study plans in consultation with the SAT, prior to implementing each review. Upon completing the review, the results, including conclusions and recommendations concerning the feasibility, biological effectiveness, and costs of implementing any new fish entrainment abatement technologies at the project, would be reported to the Commission, SAT, and Settling Parties.

As discussed in section 3.3.1, *Aquatic Resources*, conducting reviews of fish entrainment abatement technologies would provide a mechanism to identify and evaluate the feasibility of any new technologies or as-yet unidentified measures that may become available for application at the project to potentially further reduce fish entrainment at the project during the term of any new license issued. However, this proposal does not include any details on the consultation process that would be used by Consumers Energy and DTE Companies to determine the need for and frequency of the reviews. Therefore, we recommend that Consumers Energy and DTE Companies develop, after consultation with Interior and Michigan DNR, a plan to conduct fish entrainment abatement technology reviews. We recommend that the plan contain: (1) specific details regarding the consultation process that will used by Consumers Energy and DTE Companies, and the above agencies to determine the need for and frequency of the reviews, which at a minimum should occur every ten years for the term of the license; (2) a provision for the individual study plans to be developed in consultation with the above agencies, prior to implementation; (3) a provision to consult with the above agencies on the study results,

prior to filing a report on the results with the Commission; (4) a provision to include in the reports, any proposals to implement new fish entrainment abatement technologies at the project (i.e., either in conjunction with or in lieu of the existing barrier net) based on the study results; and (5) an implementation schedule.

We estimate that the levelized annual cost of developing and implementing a fish entrainment abatement technology review plan would be $2,700. We conclude this is a reasonable cost to ensure that all available fish protection technologies are given adequate consideration for application at the project to potentially further minimize fish entrainment-related mortality at the project during the term of any new license issued for the project.

Fish Community Studies

As discussed in section 3.3.1, *Aquatic Resources*, changes in fish composition and abundance in the project vicinity over the past 45 years have been well documented, as have the effects of these changes on the ability of the existing fish barrier net to meet current biological performance standards. Given that the Lake Michigan ecosystem and fish community is likely to continue to change in the future, conducting Consumers Energy and DTE Companies' proposed fish community characterization studies would help to ensure barrier net effectiveness targets remain biologically relevant during the term of any new license issued for the project. However, Consumers Energy and DTE Companies' proposal lacks detail and specificity, and does not provide for Commission oversight.

To allow the Commission to ensure that the biological relevance of the barrier net effectiveness targets are maintained and to facilitate Commission oversight of the license, we recommend that Consumers Energy and DTE Companies develop, after consultation with Interior and Michigan DNR, a fish community study plan. To maximize the effectiveness of the plan, we recommend that the plan contain, at a minimum: (1) a detailed description of the methods to be employed to assess the fish community in the project area, including the metrics that would be used to evaluate the fish community; (2) a description of the study area, which should be in the vicinity of the barrier net, and identification of all sampling locations; (3) a description of the anticipated timing and frequency (e.g., yearly, every five years, etc.) of all fish sampling; (4) a provision to provide a report on the results of the fish community studies along with an analysis based on the results of any changes to the biological relevance of the barrier net effectiveness targets, to the agencies identified above, for their review and comment, prior to filing the reports with the Commission; and (5) an implementation schedule. The plan should also document consultation with the agencies identified above and any comments received on the plan and responses to those comments. We also recommend that the reports on the results of the fish community studies include any proposed changes to the barrier net effectiveness targets or modifications of the barrier net based on the results of the studies.

We estimate that the levelized annual cost of developing and implementing a fish community study plan for the project would be $60,300 and conclude that the benefits of protecting fishery resources in the project area through the continued installation of an effective barrier net on an annual basis outweigh the cost.

Project Boundary

Approximately 155 acres of forested land surrounds the embankment around the transmission corridor in the southwest corner within the existing project boundary. However, there is no public access to this land, nor is it used for project purposes. Therefore, because this land does not provide access to project recreation opportunities nor is it needed for the operation or maintenance of the project, we recommend that this land be removed from the project boundary. There would be no capital or annual levelized cost to removing these lands from the existing boundary.

The seasonal barrier net is not included in the existing project boundary. As discussed in section 3.3.1, *Fishery Resources,* the net is installed seasonally to prevent losses of fish at the project due to project operation. Therefore, because the barrier net serves a project purpose by mitigating the effects of project operation on fish, we recommend the barrier net be included in the project boundary when installed.[78]

Bald Eagle Protection

As discussed in section 3.3.2, *Terrestrial Resources*, an immature bald eagle was observed during the 2015 wildlife survey, and the types of hardwood trees that are known to provide nesting habitat for bald eagles occur within the project boundary. The operation of machinery during maintenance of the project has the potential to disturb bald eagles during nest building, incubation, and fledging phases of their reproductive cycle. Loud and disruptive activities, such as those originating from Consumers Energy and DTE Companies' timber harvests, may result in eagles engaged in nest building, incubating, or other reproductive behaviors to abandon the nest. Therefore, implementing the following measures in accordance with the National Bald Eagle Management Guidelines (FWS, 2007a) would prevent project-related effects to bald eagles, ensure the protection of bald eagle nesting habitat within project-affected lands, and come at no additional cost to Consumers Energy and DTE Companies: (1) restrict clear cutting or removal of overstory trees within 330 feet of a nest at any time; (2) restrict timber harvesting operations, including road construction, chain saw and yarding operations, during the breeding season (January through August) within 660 feet of a

[78] Note the project boundary is static and the new project boundary would remain unchanged when the barrier net is not in operation.

nest; and (3) maintain landscape buffers that screen project activity from the nest. The implementation of bald eagle protection measures would be minimal.

Indiana and Northern Long-Eared Bat Protection

As described in section 3.3.3, *Threatened and Endangered Species*, approximately 190 acres of woodland occurs within project boundary which are subject to periodic timber sales. On average, 68 trees are removed per year, with the most recent timber sale in 2017 removing 460 predominantly mature, hardwood trees. These mature, hardwood trees may provide roosting habitat to the Indiana and northern long-eared bats. As discussed in section 3.3.4, *Recreation and Land Use*, approximately 155 acres of forested lands that serve no project purpose would be removed from the project boundary. However, tree removal in the remaining 35 acres resulting from Consumers Energy and DTE Companies' intermittent tree harvests has the potential to disturb roosting bats and their newly born pups during a sensitive period of their life cycle. Therefore, implementing a seasonal clearing restriction from June 1 to July 31 would ensure that any negative effects resulting from tree removal to the Indiana or northern long-eared bat residing would be minimized, and would come at no additional cost to Consumers Energy and DTE Companies.

Invasive Species Monitoring

As discussed in section 3.3.2, *Terrestrial Resources*, 16 plant species considered to be invasive by the state of Michigan occur at the project. Of those 16 plant species, autumn olive is the most abundant, and was identified covering an estimated 12 acres in lands adjacent the reservoir. Invasive plants are able to out-compete and displace native species, thereby reducing biodiversity and altering compositions of existing native plant and animal communities. Consumers Energy and DTE Companies conduct scheduled maintenance activities (e.g., mowing) along roadways and recreational areas, as well as limited brush removal and herbicide treatments on the upper reservoir embankment, for dam safety and security purposes. However, it is unclear how pervasive invasive plants are at the project, and how these plant populations have responded to routine maintenance, which incidentally suppresses the growth of invasive plants.

An invasive species monitoring plan would ensure the protection of native vegetation, wildlife habitat and recreational resources by minimizing adverse effects associated with the proliferation of autumn olive and other invasive plants within the project boundary. An effective invasive species monitoring plan implemented to monitor the expansion of autumn olive and other invasive plants within project lands would contain: (1) a description of the proposed monitoring methods; (2) the proposed frequency of monitoring; (3) the proposed criteria to be used to determine when control measures will be implemented; and (4) a schedule for filing monitoring reports. Implementing a plan with criteria to enact control measures to manage autumn olive within project-affected lands would reduce the likelihood of adverse effects to local plant

communities by limiting invasive species expansion and reducing the likelihood of their transmission to other adjacent property. The development and implementation of a plan with these measures would be worth the levelized annual cost of $421.

Cultural Resources

To address any potential effects on both identified and unidentified historic resources, Consumers Energy and DTE Companies propose to implement an HPMP that includes measures for: (1) treatment and mitigation measures for unavoidable adverse effects; (2) treatment and mitigation measures for unexpected adverse effects, including erosion, vandalism, unanticipated discoveries and human remains, treatment of historic properties during emergencies, and counter-terrorism measures; and (3) implementation procedures, including periodic reporting and periodic review and revision of the HPMP, and actions requiring consultation with the Michigan SHPO and Saginaw Tribe. An executed PA would enforce the proposed HPMP and ensure that Consumers Energy and DTE Companies adopt measures to avoid, lessen, or mitigate for any adverse effects to the Ludington Project and any undiscovered archaeological sites, if future project maintenance and operation requires modifications or ground disturbance, or if emergency situations arise. The Commission is the party responsible for carrying out section 106 of the NHPA. We anticipate that any effects on unknown historic properties would be taken into account through the executed PA and HPMP.

5.1.3 Measures Not Recommended by Staff

Barrier Net Effectiveness Monitoring Plan

Upon completion of the installation of additional floatation, additional anchor pilings, and stronger net materials to the fish barrier net (*see* discussion above), Consumers Energy and DTE Companies propose to develop and implement a plan to monitor the effectiveness of these measures at improving the performance of the net. Information gathered as a result of implementing such a plan would be redundant with the information that would be provided through Consumers Energy and DTE Companies' proposal to monitor the overall biological effectiveness of the barrier net on an annual basis. Therefore, a license condition requiring such a plan would be unnecessary.

Scientific Advisory Team

Consumers Energy and DTE Companies propose to continue funding the SAT. The purpose of the SAT would be to continue serving in an advisory role to Consumers Energy and DTE Companies. Consumers Energy and DTE Companies propose that the SAT would evaluate data and information relevant to the Settlement Agreement and the scientific activities established or authorized in the Settlement Agreement, including, but not limited to, technical oversight of all information related to fish protection at the project. As discussed in section 3.3.1, *Aquatic Resources*, while we have no objection to

Consumers Energy and DTE Companies establishing and consulting with any or all members of the proposed SAT, we do not recommend that it be a requirement of any new license issued for the project. The Commission only has authority over its licensees and cannot impose or enforce such provisions on or against third parties. Therefore, a license condition requiring the establishment of the SAT would serve no useful purpose.

Adaptive Management Process Studies

Consumers Energy and DTE Companies propose to implement an Adaptive Management Process at the project to minimize fish entrainment mortality during the term of any new license issued for the project. As part of this process, Consumers and DTE Energy and DTE Companies, in consultation with the SAT, would develop, fund, and implement additional studies to support the decision making process for any additional optimizations of the fish barrier net or ancillary fixtures of the entrainment abatement system. For the reasons discussed in section 3.3.1, *Aquatic Resources,* where specific measures or studies have been proposed as part of the Adaptive Management Process to further minimize fish entrainment-related mortality at the project and are in the public interest, we recommend that these measures and studies (e.g., fish barrier net improvement plan and fish entrainment abatement technology reviews) be included in any new license issued for the project. However, we are not recommending those provisions of the Adaptive Management Process that contemplate as-yet unidentified and uncertain studies because we are unable to assess the needs and benefits of the studies or whether the studies would have a connection to a specific project effect and/or fulfill a project-related purpose. Absent such information, we are unable to make a public interest finding with respect to these studies. Consumers Energy and DTE Companies would be free to pursue any studies it and the SAT deem necessary outside of any new license that may be issued for the project.

Adaptive Management Process Funding

Consumers Energy and DTE Companies propose to fund the Adaptive Management Process at a minimum of $3,450,000 over the first five years with $1,450,000 dedicated to the installation of increased net floatation and additional permanent pile net anchors in high flow areas and $2,000,000 dedicated to studies and/or incremental net improvements.[79] Consumers Energy and DTE Companies also propose that if it determines, in consultation with the SAT, that no additional optimizations would provide beneficial outcomes for management objectives to minimize fish mortality, any funds remaining from the $1,450,000 could, at the SAT's discretion, be deposited into the Great Lakes Fishery Trust's corpus.

[79] These costs (in 2016 dollars) were provided by Consumers and DTE in the Fish Entrainment Settlement Agreement filed on November 13, 2017.

To support the continued implementation of studies under the Adaptive Management Process, Consumers Energy and DTE Companies also propose to create a "Study Fund" by providing $500,000 to the SAT in year six of any new license issued for the project. Every ten years thereafter, Consumers Energy and DTE Companies propose to provide sufficient funds to increase the Study Fund to $500,000, as adjusted for inflation, except for the last payment, which would increase the Study Fund balance to $250,000. Consumers Energy and DTE Companies also propose: (1) that any funds remaining from the $2,000,000 dedicated to studies and/or incremental net improvements could be used to reduce Consumers Energy and DTE Companies' obligation to the Study Fund in year six of any new license issued; and (2) if more than $2,000,000 is spent by Consumers Energy and DTE Companies to conduct studies and/or make incremental net improvements during the initial five years of any new license issued, expenditures above $2,000,000 could be used to reduce its obligation to the Study Fund.

As discussed in section 3.3.1, *Aquatic Resources*, the Commission has no authority over any party (e.g., Great Lakes Fishery Trust or SAT) to a hydroelectric licensing proceeding other than the licensee and a licensee cannot satisfy the obligation to perform certain tasks by making a simple payment to another party. Consumers Energy and DTE Companies' proposals in regard to the funding commitments described above also do not include specific measures or studies. Without specifics, we cannot determine what benefits would accrue under the funds, the location of the measures or studies in relation to the project, or the nexus between the measures or studies and project effects or purposes. Further, Energy and DTE Companies' proposal in regard to creating and maintaining a "Study Fund" for the SAT appears to contemplate cost caps when certain funding limits or financial obligations have been met; however, a licensee is ultimately responsible for ensuring that measures required by a license are implemented, even if the costs for such measures exceed an agreed-upon cap. Overall, because a license's environmental measures must be directed toward a specific project effect and/or fulfill a project-related purpose, where such non-specific measures have been proposed, the Commission might not require them in a license. For these reasons, we do not recommend Consumers and DTE Energy and DTE Companies' proposals to contribute funds to the Great Lakes Trust or the SAT. However, this would not prevent Consumers and DTE Energy Companies from pursuing such funding measures separate from any new license that may be issued.

Water Quality Monitoring

Michigan DEQ certification condition 2.1 would require that Consumers Energy and DTE Companies operate the project in such a manner as to adhere to state water quality standards for water temperature in Lake Michigan. To verify project-related effects on water temperature, Michigan DEQ certification conditions 2.2 and 3.1 would require that Consumers Energy and DTE Companies continuously monitor water temperature at a location within Lake Michigan from June 1 through October 31,

beginning the first year after license issuance. Michigan DEQ certification condition 3.3 would require that the water quality monitoring required by the certification be formalized in a water quality plan that would be submitted to Michigan DEQ for approval.

As discussed in section 3.3.1.2, *Aquatic Resources, Environmental Effects*, water temperature and dissolved oxygen data collected by Consumers Energy and DTE Companies in the upper reservoir and Lake Michigan indicate that these parameters are consistent with values specified by Michigan state water quality standards. These data also indicate that the upper reservoir rarely experiences thermal stratification, which is likely the result of mixing related to pumping operations and the relatively high turnover rate of the upper reservoir. Further, water temperature and dissolved oxygen concentrations within the project reservoir were shown to generally mimic water quality conditions within Lake Michigan. Overall, these findings support the conclusion that there are no project-related water temperature issues under existing project operations. Because Consumers Energy and DTE Companies do not propose any changes to exiting project operations, we do not expect any changes to water quality in the future under the proposed action. Consequently, there is no justification for recommending a license requirement for Consumers Energy and DTE Companies to develop a plan to conduct post-license water temperature monitoring in Lake Michigan. Nevertheless, because certification conditions 2.1, 2.2, 3.1, and 3.3 are mandatory, they would be requirements of any license issued.

Fish Tissue Sampling

Michigan DEQ certification condition 3.2 would require that Consumers Energy and DTE Companies conduct (at five year intervals) contaminant monitoring (i.e., mercury, PCBs, dioxin/furans, and dioxin-like PCBs) of the edible portion of fish samples collected in the project vicinity. Elevated levels of bioaccumulative contaminants in fish tissue have been reported throughout the Lake Michigan basin and currently Lake Michigan is under fish consumption advisories for mercury, PCBs, dioxins, chlordane, and DDT. As discussed in section 3.3.1, *Aquatic Resources*, Consumers Energy and DTE Companies do not propose any changes to existing project operation or any new construction that would disturb potentially contaminated sediment in the project area. Therefore, we do not expect any changes in the levels of bioaccumulative contaminants in sportfish as a result of continued project operation. Although the data generated from this monitoring would assist state agencies in monitoring bioaccumulative contaminant levels in sportfish and support the development of new or modified fish consumption advisories in the project area, the bioaccumulation of mercury, PCBs, dioxin/furans, and dioxin-like PCBs in fish within the project area are not project-related. Consequently, there is no justification for recommending a license requirement for Consumers Energy and DTE Companies to periodically monitor fish for

the contaminants noted above. Nevertheless, because certification condition 3.2 is mandatory, it would be a requirement of any license issued.

Migratory Bird Protection

A variety of migratory birds make use of shoreline and woodland habitat within the project boundary on a seasonal basis. FWS recommends that scheduled maintenance activities, such as mowing and the removal of other nesting structures, such as shrubs or trees, be restricted from April 15 to August 15 to minimize potential effects to migratory birds.

Consumers Energy and DTE Companies mow grassland communities as part of regularly scheduled maintenance. As discussed in section 3.3.2, *Terrestrial Resources,* mowing project lands is conducted for security purposes and maintains the aesthetic features of the landscape, as well as incidentally suppressing the growth of invasive plant species within the project boundary; as such, the suggestion to restrict mowing during the summer months when vegetative growth is the greatest is impractical. Additionally, FWS has not demonstrated which migratory bird species would favor meadow or prairie grasslands over other habitats within the project boundary. For these reasons, we do not recommend FWS's proposal to restrict mowing and other maintenance activities from April 15 to August 15.

Migratory birds may use woodlands within the project boundary during the summer months as nesting habitat, however. Staff's recommendation to suspend tree clearing for the northern long-eared bat and Indiana bat during June and July would similarly benefit migratory birds that make use of trees for nesting habitat.

Pitcher's Thistle and Piping Plover Protection

Extensive shorelines along Lake Michigan and within the project boundary provide potential habitat for the Pitcher's thistle and piping plover. FWS recommends that Consumers Energy and DTE Companies provide access to the project area to periodically survey for piping plover nests, and that Consumers Energy and DTE Companies close an area within a 100-foot perimeter around any future nest site, and prohibit the use of vehicular equipment to minimize human disturbance to nesting plovers. With respect to the Pitcher's thistle, FWS recommends that if the Pitcher's thistle colonizes shoreline habitat within the project boundary in the future, vehicular use should be restricted and foot traffic minimized. Consumers Energy and DTE Companies propose to minimize foot traffic and prohibit the use of vehicular equipment during the piping plover active nesting period to ensure nests are not destroyed

As discussed in section 3.3.3, *Threatened and Endangered Species*, there is no evidence the Pitcher's thistle and piping plover currently make use of project lands.

Wildlife and botanical surveys conducted in 2015 indicate the probable absence of these species at the project. Therefore, with no clear nexus of the project's effects to the Pitcher's thistle and piping plover, there is no need to require specific protection or mitigation measures for these species at the project. If unforeseen or unanticipated adverse project effects to these species are observed, however, FWS could petition the Commission to reopen the license to consider protective measures pursuant to Standard Article 15 of Form L-10. The Commission's standard license reopener polices would provide a mechanism to review potential project effects and protective measures at that time. If the applicant elects to provide access to the project for the purposes of surveying threatened or endangered species, or develop additional measures for the protection of these species, they may do so under an off-license agreement with the FWS.

Recreation Enhancement Plan

Both the Park Service and Pere Marquette recommend a Recreation Enhancement Plan to provide beach and fishing access at the Twin Rivers site and a portage facility at the Buttersville Beach site, including parking, restrooms, signage, boat racks, and boater transport to and from Lake Michigan. However, both the Twin Bridges and Buttersville Beach sites are located outside of the project boundary, are not affected by project operation or maintenance, and do not provide access to project land or water. Further, neither Pere Marquette nor Park Service has demonstrated a need for additional recreation access at the Ludington Project. Fishing access to Lake Michigan is currently provided at Pigeon Lake North Pier, a project facility, and both beach and fishing recreational opportunities currently exist at several public recreation sites within two to three miles from the project. Although development of an angler access facility at the Twin Bridges site would provide additional fishing opportunities, we find this recommendation unjustified based on the amount and availability of existing public fishing access sites in the project area.

As a part of the recommended Recreation and Enhancement Plan, both the Park Service and Pere Marquette recommend Consumers Energy and DTE Companies provide a portage facility at Buttersville Beach site and Park Service additionally recommends boater transport service to provide portage around the project to the Michigan Lake Water Trail. Both agencies state the project is a physical obstacle that creates significant safety issues for paddlers and it impedes the development of the Lake Michigan Water Trail. Although the Ludington Project interrupts the proposed Lake Michigan Water Trail, the Lake Michigan Water Trail Plan wasn't proposed until 2013,[80] well after the project was already in existence. Further, it is not clear when or if the Lake Michigan

[80] West Michigan Shoreline Regional Development Commission (http://wmsrdc.org/project/lake-michigan-water-trail-plan/).

Water Trail will ever be completed in this section of the trail. Phase I of the Lake Michigan Water Trail Plan, which included an inventory and assessment of existing access sites and paddling-related amenities, was completed in 2014,[81] but there appears to be no further development of the trail since completion of the inventory and assessment. While the addition of amenities such as canoe and kayak racks and boater transport service would enhance the existing site, Buttersville Beach site is not affected by project operation or maintenance nor does it provide access to project land or water. Moreover, Pere Marquette already provides parking, restrooms, and beach access at this site.

As discussed in section 3.3.4, *Recreation and Land Use*, there is no reason to believe that the nearby townships that manage these public recreation sites would not continue to operate and maintain these facilities over the term of a new license. For these reasons, we do not recommend a Recreation Enhancement Plan to provide beach and fishing access at the Twin Rivers site and a portage facility with kayaker transport service at the Buttersville Beach site.

5.2 UNAVOIDABLE ADVERSE EFFECTS

Continued operation of the project would result in some unavoidable fish entrainment-related mortality as fish would continue to pass through the turbine/generator units during pumping and generation. However, Consumers Energy and DTE Companies' proposal to continue with the seasonal installation and maintenance of the fish barrier net around the project jetties and breakwater would continue to minimize fish entrainment losses at the project, particularly for fish greater than 5 inches long. Consumers Energy and DTE Companies' proposal to continue monitoring the effectiveness of the barrier net on an annual basis would help inform the need for structural modifications to the barrier net or changes to other project facilities or operation to further reduce project-related entrainment. Consumers Energy and DTE Companies' proposal to implement specific measures to improve the performance of the fish barrier net and monitor the effectiveness of such measures, as part of an Adaptive Management Process, would similarly serve as an effective method to potentially increase the effectiveness of the existing barrier net during the term of any new license issued for the project. Lastly, Consumers Energy and DTE Companies' proposal to review (at least once every ten years) existing fish entrainment abatement technologies would provide an effective approach to identifying and evaluating the feasibility of any new technologies or as-yet unidentified measures that may become available in the future to potentially further reduce fish entrainment at the project during the term of any new license issued for the project. Overall, however, project-related fish losses, which

[81] Lake Michigan Water Trail Plan, Phase I (http://wmsrdc.org/wp-content/uploads/2015/08/Lake-Michigan-Water-Trail-Phase-I-Plan_Inventory_Assessment_wmsrdc.pdf).

primarily would consist of fish less than 5 inches in length, would not significantly affect fish populations and recreational fishing opportunities in Lake Michigan. Although numerous factors have been identified as being responsible for the observed changes to the Lake Michigan fish community over the past 45 years, based on information contained in the project record, none of these changes to the fish community have been shown to be directly affected by project operation or are expected to be affected in the future by continued operation of the project.

5.3 FISH AND WILDLIFE AGENCY RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project.

Section 10(j) of the FPA states that whenever the Commission believes that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency will attempt to resolve any such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

In response to the Commission's Ready for Environmental Analysis notice, no fish and wildlife agencies submitted recommendations for the project.

5.4 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2) of the FPA, 16 U.S.C., § 803(a)(2)(A), requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. We reviewed 9 qualifying comprehensive plans that are applicable to the Ludington Project, located in Michigan.[82] No inconsistencies were found.

[82] (1) Great Lake and Northern Great Plains Piping Plover Recovery Plan. Department of the Interior, Twin Cities, Minnesota. May 12, 1988; (2) Michigan Department of Environmental Quality. 1996. Non-indigenous aquatic nuisance species, State management plan: A strategy to confront their spread in Michigan. Lansing, Michigan; (3) Michigan Department of Natural Resources. 1977. Muskegon state game area master plan. Grand Rapids, Michigan; (4) Michigan Department of Natural Resources. Statewide Comprehensive Outdoor Recreation Plan (SCORP): 2008-2012. Lansing, Michigan; (5) Michigan Department of Natural Resources. 1997. Lake Sturgeon rehabilitation strategy. Special Report 18. Lansing, Michigan. August 1997; (6) National Park Service. The Nationwide Rivers Inventory. Department of the Interior, Washington, D.C. 1993. U.S. Fish and Wildlife Service. 1988; (7) U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American waterfowl management plan. Department of the Interior. Environment Canada. May 1986; (8) U.S. Fish and Wildlife Service. 1988. The Lower Great Lakes/St. Lawrence Basin: A component of the North American waterfowl management plan. December 29, 1988; (9) U.S. Fish and Wildlife Service. 1993. Upper Mississippi River & Great Lakes Region joint venture implementation plan: A component of the North American waterfowl management plan. March 1993.

6.0 FINDING OF NO SIGNIFICANT IMPACT

If the Ludington Project is issued a new license as proposed with the additional staff-recommended measures, the project would continue to operate while providing protective measures for aquatic, terrestrial, recreation, and cultural and historic resources in the project area.

Based on our independent analysis, we find that the issuance of a license for the Ludington Project, with additional staff-recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.

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8.0 LIST OF PREPARERS

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APPENDIX A: LICENSE CONDITIONS RECOMMENDED BY STAFF

In this section, we present draft license articles for staff-recommended measures:

Draft Article 2xx. *Administrative Annual Charges*. The licensee must pay the United States annual charges, effective the first day of the month in which this license is issued, and as determined in accordance with the provisions of the Commission's regulations in effect from time to time, to reimburse the United States for the cost of administration of Part 1 of the Federal Power Act. The authorized installed capacity for that purpose is 1,785 megawatts.

Draft Article 2xx. *Exhibit Drawings.* Within 45 days of the date of issuance of this license, as directed below, the licensee must file two sets of the approved exhibit drawings in electronic file format on compact disks with the secretary of the Commission, ATTN: OEP/DHAC.

Digital images of the approved exhibit drawings must be prepared in electronic format. Prior to preparing each digital image, the FERC Project-Drawing Number (i.e., P-2680-1001 through P-2680-1007) must be shown in the margin below the title block of the approved drawing. The licensee must file two separate sets of exhibit drawings in electronic format on compact disks with the Secretary of the Commission, ATTN: OEP/DHAC. Exhibit F drawings must be segregated from other project exhibits, and identified as **Critical Energy Infrastructure Information (CEII) material under 18 C.F.R. §388.113(c).** Each drawing must be a separate electronic file, and the file name must include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this License, and file extension in the following format [P-2680-1001, F-1, Description, MM-DD-YYYY.TIF]. All digital images of the exhibit drawings must meet the following format specification:

IMAGERY – black & white raster file
FILE TYPE – Tagged Image File Format (TIFF) CCITT Group 4 (also known as T.6 coding scheme)
RESOLUTION – 300 dots per inch (dpi) desired, (200 dpi minimum)
DRAWING SIZE FORMAT – 22” x 34” (minimum), 24” x 36” (maximum)
FILE SIZE – less than 1 megabyte desired

Draft Article 2xx. *Exhibit G Drawings*. Within 90 days of the effective date of the license, the licensee must file, for Commission approval, revised Exhibit G drawings enclosing within the project boundary all principal project works necessary for operation and maintenance of the project, including the seasonal barrier net when installed at the project. The Exhibit G drawings must comply with sections 4.39 and 4.41 of the Commission’s regulations.

Draft Article 2xx. *Amortization Reserve*. Pursuant to section 10(d) of the Federal Power Act, a specified reasonable rate of return upon the net investment in the project must be used for determining surplus earnings of the project for the establishment and maintenance of amortization reserves. The licensee must set aside in a project amortization reserve account at the end of each fiscal year one half of the project surplus earnings, if any, in excess of the specified rate of return per annum on the net investment. To the extent that there is a deficiency of project earnings below the specified rate of return per annum for any fiscal year, the licensee must deduct the amount of that deficiency from the amount of any surplus earnings subsequently accumulated, until absorbed. The licensee must set aside one-half of the remaining surplus earnings, if any, cumulatively computed, in the project amortization reserve account. The licensee must maintain the amounts established in the project amortization reserve account until further order of the Commission.

The specified reasonable rate of return used in computing amortization reserves must be calculated annually based on current capital ratios developed from an average of 13 monthly balances of amounts properly included in the licensee's long-term debt and proprietary capital accounts as listed in the Commission's Uniform System of Accounts. The cost rate for such ratios must be the weighted average cost of long-term debt and preferred stock for the year, and the cost of common equity must be the interest rate on 10-year government bonds (reported as the Treasury Department's 10-year constant maturity series) computed on the monthly average for the year in question plus four percentage points (400 basis points).

Draft Article 2xx. *As-built Exhibits*. Within 90 days of completion of construction of the facilities authorized by this license, including any modifications to the existing fish barrier net, the licensee must file for Commission approval, revised Exhibits A, F, and G, as applicable, to describe and show those project facilities as built. A courtesy copy must be filed with the Commission's Division of Dam Safety and Inspections (D2SI) – Chicago Regional Engineer, the Director, D2SI, and the Director, Division of Hydropower Administration and Compliance.

Draft Article 3xx. *Project Modification Resulting from Environmental Requirements*. If environmental requirements under this license require modification that may affect the project works or operations, the Licensee must consult with the Commission's Division of Dam Safety and Inspections (D2SI)–Chicago Regional Engineer. Consultation must allow sufficient review time for the Commission to ensure that the proposed work does not adversely affect the project works, dam safety, or project operation.

Draft Article 4xx. *Notification and Filing of Amendments*

(a) Requirement to Notify the Commission of Planned and Unplanned Deviations from License Requirements

Michigan DEQ certification condition no. 1.2 in Appendix C would allow the licensee to temporarily modify project operations under certain conditions. The Commission must be notified prior to implementing such modifications, if possible, or in the event of an emergency, as soon as possible, but no later than 10 days after each such incident.

Michigan DEQ Certification Condition No.	License Requirement
1.2	Project operation during adverse conditions

(b) Requirement to File Amendment Applications

Certain conditions of the Michigan DEQ's certification in Appendix C contemplate unspecified long-term changes to project operation or facilities for the purposes of complying with the certification or mitigating environmental impacts. For example, certification condition 2.3 contemplates long-term changes to project facilities or operations for the purposes of complying with state water quality standards and minimizing impacts on adjacent waters. In addition, condition 3.1 requires that Consumers Energy and DTE Companies seek approval (if so desired) from Michigan DEQ for a reduced monitoring schedule, if after one year of continuous monitoring, water temperature values are shown to be consistent with state standards. Such changes may not be implemented without prior Commission authorization granted after the filing of an application to amend the license.

Draft Article 4xx. *Fish Barrier Net*. The licensees must annually install and maintain the existing fish barrier net around the project's intake on Lake Michigan to reduce fish entrainment and mortality when the project is in pumping mode. The barrier net must be installed for the longest practicable period each year during the ice-free season, and, at a minimum, from April 15 to October 15. The licensees must also procure, maintain, and make available additional fish barrier net replacement panels, anchors, buoys, lines, and other equipment and materials necessary to maintain the net on a continuous basis during the ice-free season and to allow for the replacement of all components of the net system in the event of an extraordinary storm or other event that may damage the net system in its entirety. To document compliance with these requirements, the licensees must file reports with the Commission that verify both the completed installation and removal dates of the barrier net and describe the measures the licensees have taken to meet the provisions detailed above for net replacement. These reports must also provide a detailed description of the reasons for any failure by the licensees to meet the requirements of this article.

Draft Article 4xx. *Fish Barrier Net Effectiveness Monitoring*. The licensees must monitor the biological effectiveness of the fish barrier net on an annual basis. Biological effectiveness must be expressed as a percentage, calculated by comparing the relative fish abundance from sample collections made inside the barrier net to those made outside the barrier net. The purpose of this monitoring is to ensure that the barrier net provides an 80 percent reduction (measured as a three year rolling average of the annual barrier net effectiveness percentages) in the entrainment of all fish equal to or greater than five inches in length. During the initial three years of this new license, conformance with this net performance standard should be calculated using a rolling average of the barrier net effectiveness percentages from the relevant years predating issuance of the new license. To document compliance with this requirement, the licensees must file with the Commission by December 31 of each year, an annual fish barrier net effectiveness monitoring report that includes, at a minimum:

(1) a description of the actions that have been taken by the licensees during the previous year to evaluate and improve the effectiveness of the barrier net, including the methodologies used to calculate net effectiveness;

(2) representative data and analysis related to the installation, maintenance, performance, improvement, and removal of the barrier net during the previous year;

(3) documentation of consultation with the U.S. Department of the Interior and Michigan Department of Natural Resources during the previous year in regard to barrier net effectiveness monitoring, including a provision to consult with these agencies no later than one year after the filing of this report (if such consultation has yet to occur), to discuss potential options to improve the effectiveness of the barrier net or otherwise reduce fish entrainment at the project if the three year rolling average of the annual barrier net effectiveness percentage falls below 80 percent for two consecutive years (beginning the first two full calendar years after license issuance);

(4) for Commission approval, any proposals to implement physical modifications to the fish barrier net to improve its effectiveness based upon the monitoring results, as necessary; and

(5) documentation of consultation with the above agencies, including copies of comments and recommendations on the report after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the report. The licensees must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the report with the Commission. If the licensees do not adopt a recommendation, the filing must include the licensee’s reasons based on project-specific information.

Any proposals to implement physical modifications to the fish barrier net to improve its effectiveness based upon the monitoring required by this article may not be implemented without prior Commission approval.

Draft Article 4xx. *Fish Barrier Net Improvement Plan.* Within six months of license issuance, the licensees must file, for Commission approval, a plan for the installation of additional floatation, additional anchor pilings, and stronger net materials in targeted areas of the existing fish barrier net. The purpose of this plan is to reduce net submergence and net lifting events in high flow areas during project generation, which would improve the structural integrity of the net and increase its effectiveness at minimizing fish entrainment and mortality at the project.

The plan must include, but not necessarily be limited to, a detailed description of the physical improvements that would be installed at the existing barrier net, including the specific locations of the existing barrier net that would be targeted for improvement, and an implementation schedule. Within 90 days of completing the above physical improvements to the existing barrier net, the licensee must file, for Commission approval, as-built drawings pursuant to Draft Article 2xx of this order that clearly describe and show the barrier net as built.

The licensees must prepare the plan after consultation with the U.S. Department of the Interior and Michigan Department of Natural Resources. The licensees must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies and specific descriptions of how the agencies' comments are accommodated by the plan. The licensees must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensees do not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. The licensees must not begin implementing the plan until the Commission notifies the licensees that the plan is approved. Upon Commission approval, the licensees must implement the plan, including any changes required by the Commission.

Draft Article 4xx. *Fish Entrainment Abatement Technology Reviews*. Within six months of license issuance, the licensees must file, for Commission approval, a plan to conduct fish entrainment abatement technology reviews every 10 years throughout the license term, commencing 10 years from the effective date of the license and concluding 10 years prior the expiration date of the license. The purpose of these reviews are to determine if any new fish entrainment abatement technologies become available during the term of the license and are practicable for use at the project to reduce fish entrainment relative to the existing fish barrier net. The plan must include, but not necessarily be limited to, the following:

(1) a description of the consultation process among the licensees, U.S. Department of the Interior, and Michigan Department of Natural Resources that will be used to determine the need for and frequency of the fish entrainment abatement technology reviews, which at a minimum must occur every ten years for the term of the license;

(2) a provision for a detailed study plan to be developed in consultation with the above agencies, prior to implementing each fish entrainment abatement technology review;

(3) an implementation schedule; and

(4) procedures for preparing and filing a report with the Commission that summarizes the results of each fish entrainment abatement technology review by no later than December 31 of the year in which the review is required. The report must include a detailed description of the fish entrainment abatement technologies evaluated and conclusions reached regarding the feasibility, biological effectiveness, and estimated costs associated with implementing these technologies at the project. The report must also include, for Commission approval, any proposals to implement new fish entrainment abatement technologies (i.e., either in conjunction with or in lieu of the existing barrier net) to protect fishery resources at the project based on the study results, as necessary; documentation of consultation with the agencies above prior to implementing each review; documentation of consultation with the agencies above after completion of each report, including copies of comments and recommendations on each report after it has been prepared and provided to the agencies above, and specific descriptions of how the agencies' comments are accommodated by the report. The licensees must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the report with the Commission. If the licensees do not adopt a recommendation, the filing must include the licensee's reasons based on project-specific information.

The licensees must prepare the plan after consultation with the above agencies. The licensees must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies and specific descriptions of how the agencies' comments are accommodated by the plan. The licensees must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensees do not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. The licensees must not begin implementing the plan until the Commission notifies the licensees that the plan is approved. Upon Commission approval, the licensees must implement the plan, including any changes required by the Commission.

Draft Article 4xx. *Fish Community Study Plan*. Within six months of license issuance, the license must file, for Commission approval, a fish community study plan. The purpose of this study is to ensure that the biological relevance of the barrier net effectiveness targets required by Article 4xx of this license are maintained during the term of the license. The plan must include, but not necessarily be limited to, the following:

(1) a detailed description of the methodologies that will be used to assess the fish community in the project area, including the metrics that would be used to evaluate the fish community;

(2) a description of the study area, which should be in the vicinity of the barrier net, and identification of all sampling locations;

(3) a description of the anticipated timing and frequency (e.g., yearly, every five years, etc.) of all fish sampling;

(4) a provision to prepare and file a report on the results of the fish community studies along with an analysis based on the results of any changes to the biological relevance of the barrier net effectiveness targets, no later than December 31 of each year in which monitoring occurs. The report must also include for Commission approval, any proposed changes to the barrier net effectiveness targets or modifications of the barrier net based on the results of the studies, as necessary; documentation of consultation with U.S. Department of the Interior and Michigan Department of Natural Resources, including copies of comments and recommendations on the report after it has been prepared and provided to the agencies above, and specific descriptions of how the agencies' comments are accommodated by the report. The licensees must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the report with the Commission. If the licensees does not adopt a recommendation, the filing must include the licensee's reasons based on project-specific information; and

(5) an implementation schedule.

The licensees must prepare the plan after consultation with the above agencies. The licensees must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies and specific descriptions of how the agencies' comments are accommodated by the plan. The licensees must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensees do not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. The licensees must not begin implementing the plan until the Commission notifies the licensees that the plan is approved. Upon Commission approval, the licensees must implement the plan, including any changes required by the Commission.

Draft Article 4xx. *Invasive Species Monitoring Plan.* Within one year of the date of issuance of this license, the licensee must file with the Commission, for approval, an invasive species management plan. Invasive species of interest include, but are not necessarily limited to, autumn olive, reed canary grass, and Japanese barberry. The plan must include, but not necessarily be limited to, the following:

(1) a description of the proposed monitoring methods for invasive plant species;

(2) the proposed frequency of monitoring;

(3) the proposed criteria to be used to determine when control measures would be implemented; and

(4) a schedule for filing monitoring reports with Michigan Department of Natural Resources (Michigan DNR) and the Commission.

The licensee must prepare the plan after consultation with the Michigan DNR. The licensee must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the Michigan DNR, and specific descriptions of how the Michigan DNR is accommodated by the plan. The licensee must allow a minimum of 30 days for Michigan DNR to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval the licensee must implement the plan, including any changes required by the Commission.

Draft Article 4xx. *Bald Eagle Protection Measures*. To protect bald eagles that may nest within the project boundary, the licensee must:

(1) restrict clear cutting or removal of overstory trees within 330 feet of a nest at any time, unless they pose an immediate threat to human life or property;

(2) restrict timber harvesting operations, including road construction, chain saw and yarding operations, during the breeding season (January through August) within 660 feet of a nest; and

(3) maintain landscape buffers that screen project maintenance from the nest.

Draft Article 4xx. *Indiana and Northern Long-Eared Bat Protection Measures*. The licensee must implement the following measures to protect Indiana and northern long-eared bat habitat:

(1) restrict cutting trees within the project boundary from June 1 through July 31, unless they pose an immediate threat to human life or property; and

(2) where trees need to be removed, only remove trees between August 1 and May 31.

Draft Article 4xx. *Recreation Plan*. The Recreation Plan filed on June 28, 2017, in Appendix E-2 of the final license application is approved, made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee must implement the

Recreation Plan to continue to operate and maintain six recreational facilities at the project: Mason County Campground, Hull Field, Mason County Day Use and Picnic Area, Reservoir Overlook, Lake Michigan Overlook, and a satellite recreation site (Pigeon Lake North Pier).

Draft Article 4xx. *Programmatic Agreement and Historic Properties Management Plan.* The licensee must implement the "Programmatic Agreement Between the Federal Energy Regulatory Commission and the Michigan Historic Preservation Officer for Managing Historic Properties that May be Affected by Issuance of a License to Consumers Energy and DTE Companies for the Continued Operation of the Ludington Pumped Storage Hydroelectric Project in Mason and Ottawa Counties, Michigan (FERC No. 2680)," executed on XXXX, and the Historic Properties Management Plan (HPMP), filed on June 28, 2017, for the project. In the event that the Programmatic Agreement is terminated, the licensee must continue to implement the provisions of its approved HPMP. The Commission reserves the authority to require changes to the HPMP at any time during the term of the license.

Draft Article 4xx. *Use and Occupancy.* (a) In accordance with the provisions of this article, the licensee must have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee must also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee must take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to

protect and enhance the project's scenic, recreational, and other environmental values, the licensee must require multiple use and occupancy of facilities for access to project lands or waters. The licensee must also ensure that, to the satisfaction of the Commission's authorized representative, the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee must: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kilovolts or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee must file a copy of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on

recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must file a letter with the Commission, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Commission's authorized representative, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee must consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee must determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed must not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee must take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee must not unduly restrict public access to project lands and waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not

necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project must be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article must not apply to any part of the public lands and reservations of the United States included within the project boundary.

APPENDIX B: SETTLEMENT AGREEMENT MEASURES

V. PROPOSED FERC LICENSE CONDITIONS TO MINIMIZE FISH MORTALITY

A. Seasonal Barrier Net

The Licensees shall install and continuously maintain the seasonal barrier net for the longest practicable period each year during the ice-free season, and, at a minimum, from April 15 to October 15. This obligation shall continue, subject to Force Majeure as defined in Section VII of this Settlement Agreement, until the license expires, is revoked, or the Project is permanently shut down, whichever occurs first. Licensees may also, after consultation with the Scientific Advisory Team (SAT), temporarily suspend the barrier net program described in this Section V.A of this Settlement Agreement if the Project is shutdown on a temporary, but long-term basis, for reasons other than Force Majeure.

1. Net Performance Standards

Over an entire seasonal period and subject to the following evaluation process, the barrier net shall provide an 80 percent reduction in the entrainment of all fish equal to or over five inches in length. Conformance with the standard will be determined using a three year rolling average of the annual barrier net effectiveness percentage. During the initial three years of the new Federal Energy Regulatory Commission (FERC) license, such rolling average shall be calculated using barrier net effectiveness percentages from the relevant years predating the issuance of the new FERC license.

If this rolling average falls below 80% percent for two consecutive years, the SAT and Licensees shall promptly initiate discussions under the Adaptive Management Process (AMP) to strive to improve barrier net performance, preferably during the first official SAT meeting after the filing of the annual barrier report required under Section V.A.4 and no later than one year after such filing. The initial two consecutive year period to be considered under this paragraph are the first two full calendar years after issuance of the new FERC license.

2. Maintenance of Replacement Capacity

The Licensees shall provide that additional net replacement panels, anchors, buoys, lines, and other equipment and materials necessary to maintain the net on a continuous basis are procured, maintained, and made available to the Project. The equipment and material redundancies shall be sufficient to allow for replacement

of all elements of the net system in the event of an extraordinary storm or any other impact that may damage the net system.

3. Monitoring Barrier Net Performance

The Licensees shall provide funding for studies to monitor the effectiveness of the barrier net.

4. Reporting Requirements

The Licensees shall submit a written annual report to FERC on an informational basis and the other Parties by December 31 of each year. The annual report shall describe the actions which have been taken to evaluate and improve both the effectiveness of the barrier net and the methodology employed to measure net effectiveness. The report shall also include representative data and reports received by the Licensees or their representatives during the previous year relating to the installation, maintenance, performance, improvement, and removal of the barrier net. The SAT shall have access to all data and reports relative to the installation, maintenance, performance, improvement, and removal of the barrier net. The annual report shall also describe the measures the Licensees have taken to maintain the proper replacement capacity for the seasonal barrier net.

B. Implementation of Barrier Net Improvements

As described in the AMP, the Licensees will develop a plan for the installation of additional flotation, additional anchor pilings, and stronger net materials in targeted areas of the barrier net. The Licensees shall submit the plan to FERC for approval, and upon such approval, implement the plan.

C. Adaptive Management Process

Licensees shall implement the AMP with the goal of minimizing fish entrainment mortality on a basis that is reasonable, financially prudent, and maintains effective and acceptable generation operations at the Project.

D. Periodic Studies of Technologies to Reduce Fish Mortality

At least once every ten years after the execution of this Settlement Agreement, or more frequently if recommended by the SAT and there is a reasonable basis for such recommendation, the Licensees shall conduct a study of other evolving technologies that may be available to reduce fish mortality at the Project. Before conducting each such study, the Licensees shall provide a study plan to SAT for review and comment. After completion of each study, the Licensees shall submit a written report to FERC, the other Parties, and the SAT containing an evaluation of such technologies and conclusions and

recommendations concerning the feasibility, biological effectiveness, and costs of utilizing any new technologies at the Project.

E. Scientific Advisory Team

The SAT established under the 1995 Settlement Agreements shall continue to exist under the terms of this Settlement Agreement for the purpose of evaluating the data and information relevant to this Settlement Agreement and the scientific activities established or authorized by this Settlement Agreement.

1. Purposes of the SAT

The duties and responsibilities of the SAT shall include, but are not necessarily limited to, the following related to technical oversight of fish mortality abatement measures and implementation of its responsibilities under this Settlement Agreement:

a. Technical oversight of the seasonal barrier net monitoring program, including establishment of protocols, and procedures subject to FERC approval as necessary;

b. Technical oversight of improvements and modifications to the seasonal barrier net provided for in a new FERC license;

c. Technical oversight of and participation in the AMP provided for in a new FERC license;

d. Review of the Licensee's periodic (every ten years) studies of evolving methods and technologies to reduce fish mortality and recommendations for more frequent studies if warranted under Section V.D of this Settlement Agreement;

e. Technical oversight of the annual determination of compensation for fish mortality, using the method specified in Appendix A, including any subsequent adjustments to that method agreed to by the Parties; and

f. Review of and recommendations to the Great Lakes Fishery Trust (Trust) regarding funding proposals submitted to the Trust for fishery research, habitat improvement, or other projects to enhance Great Lakes fishery resources and public access to them.

2. Composition of the SAT

The SAT shall be co-chaired by the Michigan Department of Natural Resources and a representative of the Licensees. Membership of the SAT shall be comprised of one designee of each of the following organizations except for the Michigan Department of Natural Resources, which may designate two members of the SAT:

a. Designee of the Secretary of the Interior;

b. Michigan Department of Natural Resources;

c. Michigan United Conservation Clubs;

d. National Wildlife Federation;

e. Consumers Energy Company (2 votes - FERC license issues only as discussed below);

f. DTE Electric Company (2 votes - FERC license issues only as discussed below);

g. Chippewa-Ottawa Resource Authority or its successors or assigns;

h. Grand Traverse Band of Ottawa and Chippewa Indians;

i. Little River Band of Ottawa Indians;

j. Little Traverse Bay Bands of Odawa Indians; and

k. One member chosen by mutual agreement of Michigan Department of Natural Resources, Michigan United Conservation Clubs, and National Wildlife Federation.

All decisions of the SAT shall be by simple majority of those present and voting. No vote of the SAT shall proceed unless written or electronic notice of the meeting at which the vote occurs has been provided to every SAT member at least ten business days before the meeting. With regard to the SAT activities identified in subsections V.E.1.a through V.E.1.d, and any other matter covered in the new FERC license upon which the SAT votes, Consumers Energy Company and DTE Electric Company shall each have two votes. With regard to all other matters, Consumers Energy Company and DTE Electric Company shall each have one vote. Each non-Licensee member of the SAT shall have one vote for all matters, regardless of whether such matters relate to Licensees' new FERC license. The SAT shall keep minutes of each meeting, including but not limited to a voting record. The SAT may prescribe other bylaws and procedures at its discretion. All

minutes, voting records, bylaws, and procedures of the SAT shall be made available to any SAT member or Party upon request.

3. Funding of the SAT

The Licensees shall fund the reasonable and prudent administrative costs of operating the SAT, based upon an annual billing from the Trust or its designee, subject to an initial annual limit of $30,000. The annual limit shall thereafter be annually adjusted for inflation, using the Detroit Consumer Price Index made available by the United States Department of Labor, Bureau of Labor Statistics, or it successor.

4. FERC Review and Approval

For any SAT recommendations or decisions which involve structural or operational modifications to the Project, including substantial modifications to the barrier net and the associated monitoring programs, the Parties recognize that FERC review and approval is necessary. Licensees shall be under no obligation to comply with such SAT recommendations or decisions until all necessary FERC approvals are obtained. In the case of any SAT recommendations or decisions presented to FERC for review and approval, all Parties represented on the SAT shall not oppose the same.

F. Dispute Resolution

Any dispute that arises under Section V of this Settlement Agreement, including disputes regarding recommendations and decisions of the SAT, shall be the subject of informal negotiations among the Parties prior to the commencement of litigation in any forum. The Parties shall engage in a period of informal negotiations not to exceed twenty-one days from the date of written notice by any Party or Parties that a dispute has arisen unless extended by agreement. Such written notice shall be served upon all Parties. If the Parties are unable to resolve the dispute within twenty-one days of the close of negotiations, a majority of the Parties shall provide to the disputing Party or Parties a written statement setting forth their proposed resolution of the dispute. Within fourteen days of receiving the proposed resolution of a majority of the Parties, the disputing Party or Parties shall indicate to the majority Parties, in writing, whether the disputing Party or Parties reject the proposed resolution. During this informal dispute resolution period, any Party may request the FERC Director of the Division of Hydropower Administration and Compliance or the Director's designee to participate in the negotiations to assist in resolving the dispute.

If a disputing Party or Parties reject the proposed resolution of the majority parties, the disputing Party or Parties shall have twenty-eight days after receipt of proposed resolution to refer the dispute to FERC for expedited dispute resolution, if the dispute

involves any matter contained in the new FERC license for the Project. All disputes taken to FERC under this Section shall be governed by FERC's Rules of Practice and Procedure, 18 CFR Part 385. The proposed resolution of the majority Parties and produced in the dispute resolution process may be presented to FERC. If a disputing Party or Parties do not refer a dispute to the FERC within the twenty-eight day period, the majority proposed resolution will become binding on all Parties and effective upon receipt of all necessary governmental permits and authorizations.

G. Support by the Parties for a Fifty Year License Term

The Parties shall support the issuance of the new license by FERC consistent with the terms of this Settlement Agreement for a fifty year term, including providing upon request by the Licensees, written comments in support of a fifty year term.

H. Matters for Which the Parties Seek Approval by FERC

The Parties request that FERC approve and incorporate into the new license: (a) all terms of Section V of this Settlement Agreement; and (b) all relevant and appropriate terms of Section VII (General Provisions) of this Settlement Agreement, except subsections VII.E and VII.G.

APPENDIX C: WATER QUALITY CONDITIONS ISSUED BY MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY ON JUNE 6, 2018 FOR THE LUDINGTON PUMPED STORAGE PROJECT NO. 2680

1.0 Operational Requirements:

1.1 Upon FERC license issuance, the Ludington Pumped Storage Project will operate as an open loop system.

1.2 During adverse conditions such as a heavy rain or storm when the requirements in this certificate cannot be met, the Licensees shall, within one business day, contact the Michigan Department of Environmental Quality, Cadillac District Supervisor, regarding emergency actions taken or planned to meet the requirements. Consultation during the adverse conditions shall continue following a mutually agreed upon schedule. Upon cessation of the adverse conditions, the Ludington Pumped Storage Project shall resume the normal operations.

2.0 Water Quality Limitations:

2.1 The Ludington Pumped Storage Project shall not warm Lake Michigan, by operation of the project, to temperatures in degrees Fahrenheit higher than the following monthly maximum temperatures:

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
40	40	40	50	55	70	75	75	75	65	60	45

This Section (2.1) shall not apply when the natural temperatures of Lake Michigan exceed the above monthly maximum temperature values. In such cases water released from the man-made impoundment should not raise the Lake Michigan water temperature by more than 3 degrees Fahrenheit.

2.2 The compliance point for the temperature shall be at a representative location in Lake Michigan, which will be identified in the Water Quality Monitoring Plan referenced in Section 3.3, and must be approved by the Michigan Department of Environmental Quality.

2.3 In the event that any of the water quality limitations listed in this certification are not met, or if conditions change to indicate that they may not be met, the Ludington Pumped Storage Project shall immediately notify the Michigan Department of Environmental Quality, Cadillac District

Supervisor, and take all practical steps, including appropriate monitoring, to achieve compliance and minimize impacts on adjacent waters.

3.0 Water Quality Monitoring and Reporting:

3.1 The Ludington Pumped Storage Project shall monitor the temperature adjacent to the pumped storage facility at the compliance point hourly from June 1 through October 31 after the FERC license is issued. If the daily average value consistently meets the limits in Sections 2.1 of this certification after one year of continuous monitoring, Licensees may request Michigan Department of Environmental Quality approval for a reduced monitoring schedule.

3.2 After the issuance of the FERC license and every five years thereafter, the Ludington Pumped Storage Project shall provide fish samples for Michigan Department of Environmental Quality monitoring of the edible portion of fish from the project area for mercury, polychlorinated biphenyls (PCB), dioxin/furans, and dioxin-like PCBs. The sample shall consist of ten legal-size (greater than 15 inches total length) Lake Trout (*Salvelinus namaycush*) in a range of sizes if possible. These fish can be collected in Lake Michigan, in the project area, during the routine gill net surveys inside and outside of the barrier net. Fish shall be frozen and provided to the Michigan Department of Environmental Quality for individual analysis at the state laboratory. Other fish tissue data of adequate quality less than five-years old from the project area may be substituted upon approval of the Michigan Department of Environmental Quality.

3.3 The Ludington Pumped Storage Project shall submit for the Michigan Department of Environmental Quality approval a plan for the monitoring specified in Sections 3.1 and 3.2 within six months of FERC license issuance. An annual report of the data generated to comply with Sections 3.1 and 3.2 shall be submitted to the Michigan Department of Environmental Quality within 3 months of completing the sampling. The report shall include a summary of quality assurance data.

4.0 Emergency Response Plan Requirement:

4.1 The Licensees shall notify the Michigan Department of Environmental Quality with an emergency response per the current emergency plan for access to the facility in the event of shoreline erosion damaging the main entrance road leading to the facility.

5.0 Schedule Modification:

5.1 The Michigan Department of Environmental Quality may modify the specified implementation schedules within this certification upon written request from the Licensees, in the event the Licensees, despite their good faith effort, are unable to meet the schedules specified within this certification because of events beyond their control. Schedules identified in this certification may be modified by the Michigan Department of Environmental Quality, in consultation with the Licensees, should the data being collected no longer be needed or the frequency of collection changes.

6.0 Natural Resources Damages and Penalties:

6.1 The state reserves the right to seek civil and/or criminal penalties and liabilities under applicable law for natural resource damages that may occur.

7.0 Permits and Approvals:

7.1 The issuance of this certification does not authorize violation of any federal, state, or local laws or regulations, nor does it obviate the necessity of obtaining such permits, including any other Michigan Department of Environmental Quality permits, or approvals from other units of government as may be required by law.

8.0 Right of Entry:

8.1 The Licensees shall allow the Michigan Department of Environmental Quality, or any agent appointed by the Michigan Department of Environmental Quality, upon the presentation of credentials, to enter upon the Ludington Pumped Storage Project premises at reasonable times to have access to, and copy any records required to be kept under the conditions of this certification, and to inspect the facilities or to conduct any environmental sampling for compliance with this certificate. Michigan Department of Environmental Quality agents shall comply with Consumers Energy personnel safety requirements while on Consumers Energy property unless more stringent safety procedures are required by the State of Michigan.

9.0 Project - Changes:

9.1 The Licensees shall provide written notification to the Michigan Department of Environmental Quality, and a copy to the Michigan Department of Natural Resources, within five days of any change that has

occurred or may occur in the structures or operation of the Ludington Pumped Storage Project, which may affect compliance with this certification or the water quality standards.

10.0 Revocation:

10.1 If the Michigan Department of Environmental Quality determines that the Licensees can no longer comply with Section 401(a) of the federal Clean Water Act or the water quality standards, then this certification may be revoked or modified after appropriate public notice.