DOCUMENT ORGANIZATION

This License Application was assembled based on the requirements set forth in 18 CFR §4.61 and is organized as follows:

- Initial Statement (18 C.F.R. § 4.61(b))
- General Content Requirements (18 C.F.R. § 4.32(a))
- Exhibit A — Description of the Project and Proposed Operation (18 CFR § 4.61(c))
- Exhibit E — Environmental Report (18 C.F.R §§ 4.38 and 4.61)
- References
- Exhibit F — Project Structures and Equipment - CEII (18 C.F.R. § 4.41(g))
Detailed single-line electrical diagram (Exhibit A, item (8))
- Exhibit G — Map of the Project and Project Boundary (18 C.F.R. § 4.41(h))
- Attachments — Consultation Information (18 C.F.R. § 4.38)
Additional Supporting Information

The GIS layers that were used to create the figures within this License Application were downloaded from the Michigan Geographic Data Library and/or provided by the County.

INITIAL STATEMENT

(1) Antrim County (the County) applies to the Federal Energy Regulatory Commission (FERC) for a license for the Elk Rapids Hydroelectric water power project (the Project), as described hereinafter.

FERC project number designation: 3030

(2) The location of the project is:

State or territory:	Michigan
County:	Antrim
Township or nearby town:	Elk Rapids
Stream or other body of water:	Elk River, Elk Lake and Lake Skegemog

(3) The exact name, address, and telephone number of the applicant are:

Applicant's Name:	Antrim County
Address:	Mark Stone, Antrim County Drain Commissioner Antrim County Building P.O. Box 217, 203 E. Cayuga St. Bellaire, MI 49615
Telephone number:	231.264.6800

(4) The exact name, address, and telephone number of each person authorized to act as agent for the applicant in this application, if applicable, are:

Name of Agent:	William Stockhausen
Address:	Elk Rapids Hydroelectric Power, LLC 218 W. Dunlap St. Northville, MI 48167
Telephone number:	248.349.2833

(5) Antrim County is a municipality and is not claiming preliminary permit preference under section 7(a) of the Federal Power Act.

(6) Statutory and Regulatory Requirements

(i) The statutory or regulatory requirements of the state(s) in which the project would be located that affect the project as proposed with respect to bed and banks and the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purposes of the license under the Federal Power Act, are:

Part 307 (Inland Lake Levels) of the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451: Requires the County to maintain the legally established lake level for Elk River, Elk Lake, and Lake Skegemog (the Impoundment).

Section 401 of the Federal Clean Water Act: The Project must obtain a Section 401 water quality certification from the State of Michigan.

(ii) The steps which the applicant has taken or plans to take to comply with each of the laws cited above are:

Part 307 (Inland Lake Levels) of the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451 : The lake level for the Impoundment was established in a Court Order issued in 1973 by the Circuit Court in Antrim County (See Appendix A). The lake level is measured at the Elk Rapids Dam Gauge, located on the south wall of the headrace/forebay area just in front of the Project powerhouse. The lake level for the summer period (April 15 to November 1) is 590.8 feet Elk Rapids Dam Gauge (588.26 feet International Great Lakes Datum (IGLD55)). The lake level for the winter period (November 1 to April 15) is 590.2 feet Elk Rapids Dam Gauge (587.66 IGLD55). The Project maintains the legally established lake levels through its normal operation. The lake level is adjusted gradually over a two week period at each seasonal changeover.

(7) Brief project description:

The Project is an existing 700kW water power project. The Project consists of a dam, appurtenant facilities and water rights and is located on the Elk River in the Village of Elk Rapids, Antrim County, Michigan. The Project's Impoundment consists of the Elk River, Elk Lake and Skegemog Lake up to the summer legally established lake level for Elk and Skegemog Lakes. The Project is operated on the County's behalf by Elk Rapids Hydroelectric Power, LLC (ERHP).

(i) Proposed installed generating capacity - 700 kilowatts (kW)

(ii) Existing dam

(iii) No lands of the United States are affected

(vi) Surveyed land

(9) The Project is currently in operation. No additional construction or changes to the Project's current operation are planned.

GENERAL CONTENT REQUIREMENTS (18 CFR § 4.32(a))

1. PROJECT BOUNDARY

According to a recent FERC Policy Statement,

> project boundaries are used to designate the geographic extent of the lands, waters, works and facilities that the license identifies as comprising the licensed project and for which the licensee must hold the rights necessary to carry out project purposes (FERC 2006).

The Federal Power Act defines a "project" as a "complete unit of improvement or development" consisting of the following:

> [A] power house, all water conduits, all dams and appurtenant works and structures (including navigation structures) which are a part of said unit, and all storage, diverting, or forebay reservoirs directly connected therewith, the primary line or lines transmitting power therefrom to the point of junction with the distribution system or with the interconnected primary transmission system, all miscellaneous structures used and useful in connection with said unit or any part thereof, and all water-rights, rights-of-way, ditches, dams, reservoirs, lands, or interest in lands, the use and occupancy of which are necessary or appropriate in the maintenance and operation of such unit (Federal Power Act 2005).

The licensee must "acquire and retain all interests in non-federal lands and other property necessary or appropriate to carry out the project purposes" but these interests are not required to be 100% fee simple title and can vary from "fee simple to perpetual or renewable leases, easements, and rights-of-way," and "can be owned by someone other than the licensee, so long as the licensee holds the necessary property interests and permits…to carry out licensed project purposes." (FERC 2008). See Appendix B Opinion of Counsel on Water Rights, Flowage Rights and Project Boundary.

The Project Boundary comprises the land on which the Project's physical structures are located and the Impoundment up to the summer legally established lake level, plus all water rights, flowage rights, and property interests required to operate the Project (Figures 1 and 2). The County holds all necessary rights, property interests and permits to carry out the licensed Project purposes (See Appendix B).

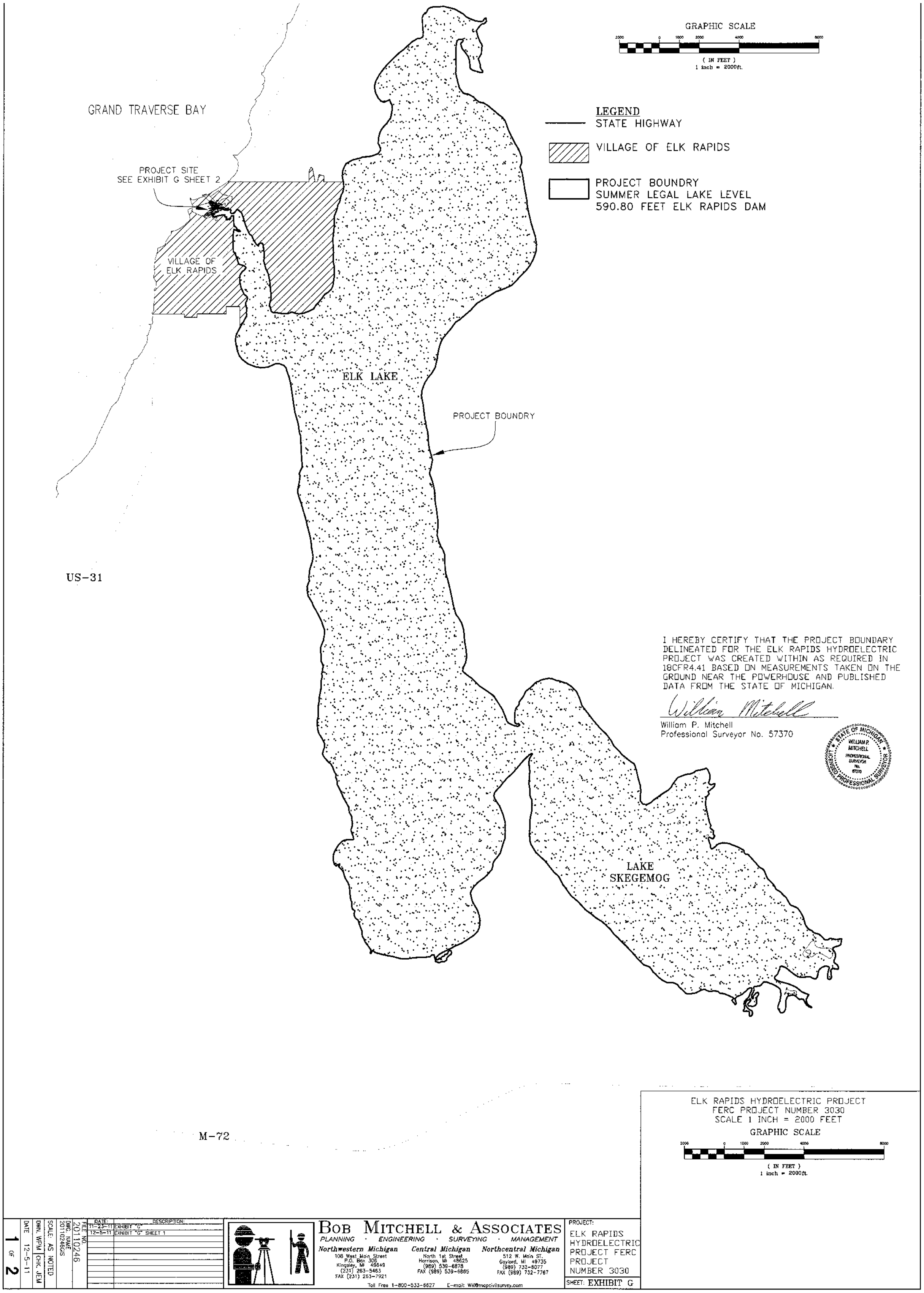

Figure 1 Project Boundary (Antrim County 2011)

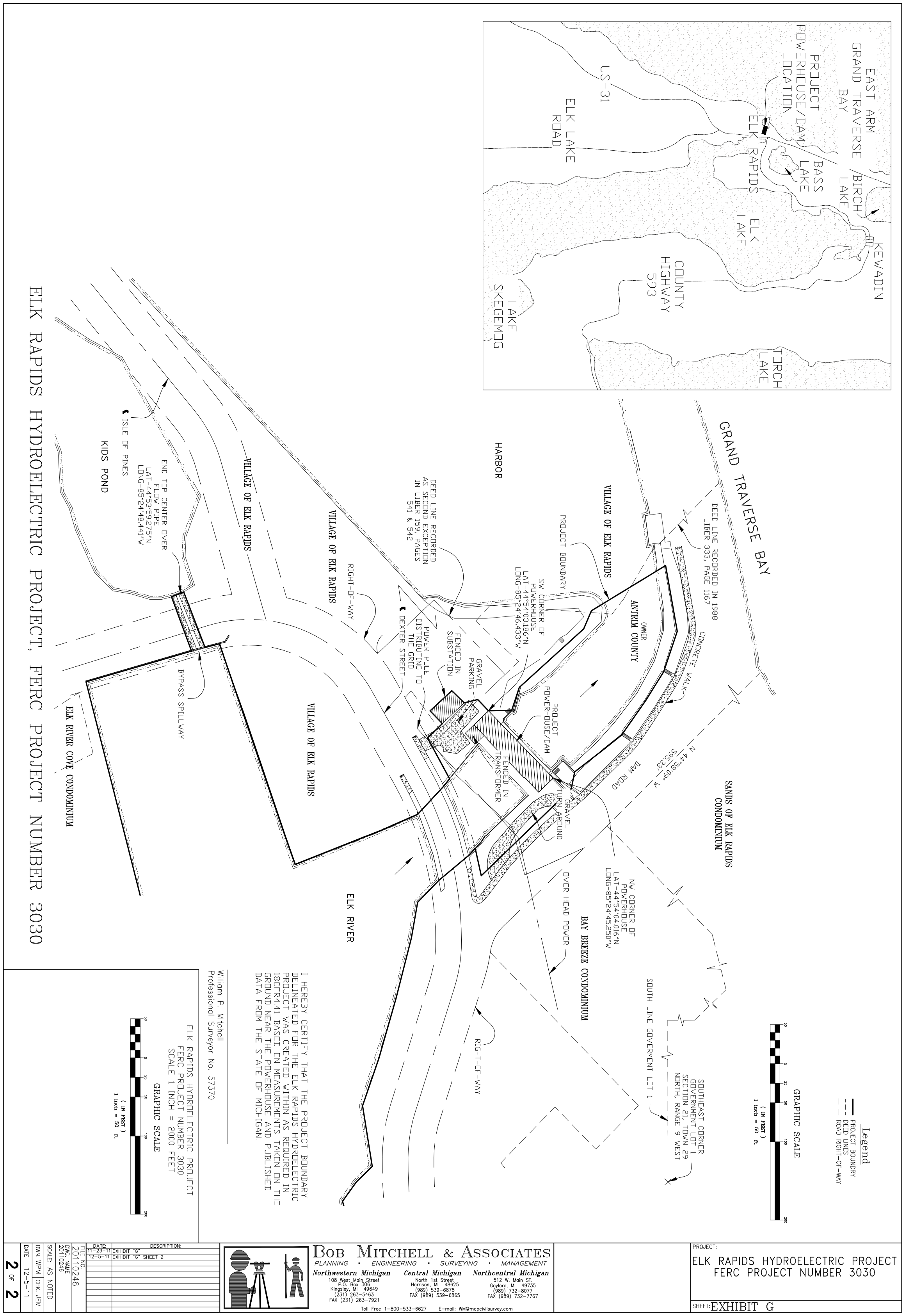

Figure 2 **Project Boundary, cont'd (Antrim County 2011)**

2. NAMES AND MAILING ADDRESSES OF POTENTIALLY AFFECTED ENTITIES

(i) Counties in which any part of the project is located, and in which any Federal facility that is used by the project is located:

Antrim County, Michigan	Kalkaska County	Grand Traverse County
PO Box 187	890 Island Lake Road	400 Boardman Ave.
Bellaire, MI 49615	Kalkaska, MI 49646	Traverse City, MI 49684

(ii) Every city, town, or similar local political subdivision a) in which any part of the project is located and any Federal facility that is used by the project is located, or b) that has a population of 5,000 or more people and is located within 15 miles of the project dam:

Village of Elk Rapids	Township of Elk Rapids
PO Box 398	PO Box 365
Elk Rapids, MI 49629	Elk Rapids, MI 49629

(iii) Every irrigation district, drainage district, or similar special purpose political subdivision a) in which any part of the project and any Federal facility that is used by the project is located, or b) that owns, operates, maintains, or uses any project facility or any Federal facility that is used by the project:

There is no such irrigation district, drainage district, or similar special purpose political subdivision. The Project uses no Federal facilities and occupies no Federal lands.

(iv) Every other political subdivision in the general area of the project that there is reason to believe would be likely to be interested in, or affected by, the notification:

Milton Township	Clearwater Township	Whitewater Township
P.O. Box 309	P.O. Box 1	9606 Elk Lake Road
Kewadin, MI 49648	Rapid City, MI 49676	Williamsburg, MI 49690

(v) Indian tribes that may be affected by the Project:

Grand Traverse Band of Ottawa and Chippewa Indians
2605 N West Bay Shore Dr.
Peshawbestown, MI 49682-9275

EXHIBIT A

DESCRIPTION OF THE PROJECT AND PROPOSED MODE OF OPERATON (18 CFR § 4.61(C)(1))

(i) Number of generating units, including auxiliary units:	2
Capacity of each unit	350 kW
(ii) Type of each hydraulic turbine(s)	Francis-type runners, James Leffel & Co., 51-inch, Type “S” Turbine
(iii) Description of how the plant is to be operated, manual or automatic	Manual
Whether the plant is to be used for peaking	Plant is operated run-of-the-river
(iv) Estimated average annual generation in kilowatt-hours	2,422,000 kWhr
(v) Estimated average head on the plant	10.5 feet
(vi) The reservoir surface area in acres and, if known, the net and gross storage capacity	10,290 acres; 611,400 acre-feet storage capacity
(vii) Estimated minimum/maximum hydraulic capacity of the plant (flow through the plant) in cubic feet per second (cfs)	Mininum - 20 cfs with units shut down and spill control closed; Maximum - 1,620 cfs
Estimated average flow of the stream or water body at the plant/point of diversion	Mean Annual Flow = 603 cfs
(viii) Sizes, capacities, and construction materials of:	See Figure A.1 for location of described structures
Headrace and Forebay	200 foot long open flume with gravel bottom and concrete side walls. Average width - 80 feet; Average depth - 8 feet
Tailrace	200 foot long open flume with riprap sides and gravel bottom. Average width - 90 feet; Average depth - 10 feet

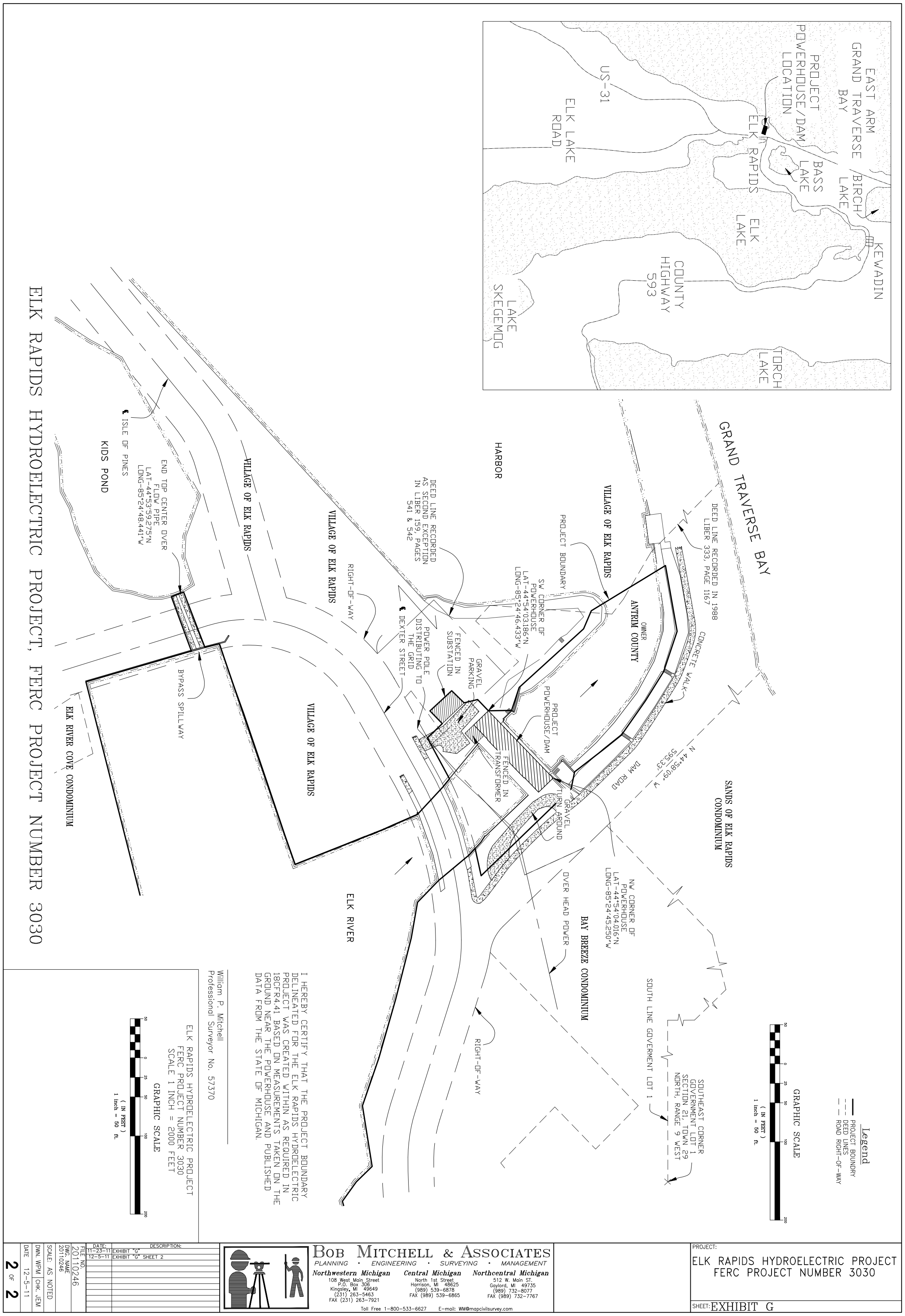

Figure A.1 Project Boundary, cont'd (Antrim County 2011)

Intake Facilities	There are 4 bays, each 22 feet wide, with sliding head gates at the Powerhouse wall. The head gates are lifted by overhead hoist on an I-beam and trolley. Only two of the bays have turbines in them. Trashrack bars are ¼-inch thick with a two-inch center spacing leaving an open space width of 1¾ inches.
Integral Powerhouse/Dam	The Project Powerhouse/dam structure spans the north channel. It is a one story solid brick masonry superstructure with a concrete substructure and foundation. It is 121 feet long, 26 feet wide and 52 feet in overall height. The powerhouse/dam structure is classified as a low hazard potential by MDEQ.
Bypass Spillway	The Bypass Spillway is located 400 feet south of the Powerhouse. It is a 14 foot wide channel that flows into 2 - 5 foot diameter culverts under Dexter St. and outfalls into Kids' Pond.
Transmission Lines	The interconnection with the utility is via a fenced-in 20 foot by 30 foot transformer and metering enclosure. It is located 30 feet south of the Powerhouse, at the 12.5 kV distribution line.
(ix) Estimated cost of the Project	The current net investment in the Project is difficult to calculate in a straightforward manner. The Project was originally acquired by the County in 1967 for one dollar from Consumers Power Co. who had decommissioned the plant. The transaction was based on the public trust value of the County maintaining the impoundment lake levels rather than actual value. The cost to recommission the Project in 1983 was $844,000. A DOE Small Hydro Demonstration Project grant covered $164,000 and a loan was taken for the remaining $680,000. The County changed plant operators in 2007 and the new operators have since made equipment improvements and upgrades totaling about $80,000.

(x) Estimated capital costs and estimated annual operation and maintenance expense of each proposed environmental measure	A. *Obligations under Settlement Agreement.* The County has entered into an agreement with MDNR under which (1) the County shall make an annual deposit of 0.5 mils per kWh of net generated energy from the Project for the first twenty-five (25) years of the license into an escrow account. The County's estimated annual deposit into this fund is $1,200. The funds will be used for funding fishery enhancements within the ERCOL. No other environmental measures have been requested or proposed for the Project; and (2) the County shall monitor stream flow. The estimated capital costs associated with such monitoring is $2,600. The annual operation and maintenance costs are estimated to be $500 per year. B. *Water Quality Monitoring.* The County's 401 certification requires the County to monitor dissolved oxygen levels and temperature downstream from the Project in the first year after the license is issued. The estimated capital costs of such monitoring is $5,000 and the estimated annual monitoring costs are $2,000 per year.

1. PROJECT DESCRIPTION

1.1. Location and Lands

The Project is located in Section 21, Township T29N, Range R9W on the Elk River within the Village of Elk Rapids, Antrim County, Michigan. The Project is located about 1,000 feet upstream from the river's outlet into Grand Traverse Bay, Lake Michigan (Figure A.2).

The Project Boundary comprises the land on which the Project's physical structures are located and the Impoundment, up to the summer legally established lake level, plus all water rights, flowage rights, and property interests required to operate the Project (Figure A.3). The County holds all necessary rights, property interests and permits to carry out the licensed Project purposes (See Appendix B Opinion of counsel on water rights, flowage rights and project boundary).

The Project's physical structures are located on a 3.7 acre parcel owned by the County. The parcel extends from the west edge of Dexter Road to Grand Traverse Bay and includes a narrow band of land on both sides of the Elk River. It is bordered on the north side by Dam Road. The Project occupies about .46 acres of the parcel. The remaining portion of the parcel is leased to the Village under a 99 year lease for public open space and recreational use (Antrim County and Village of Elk Rapids 1985).

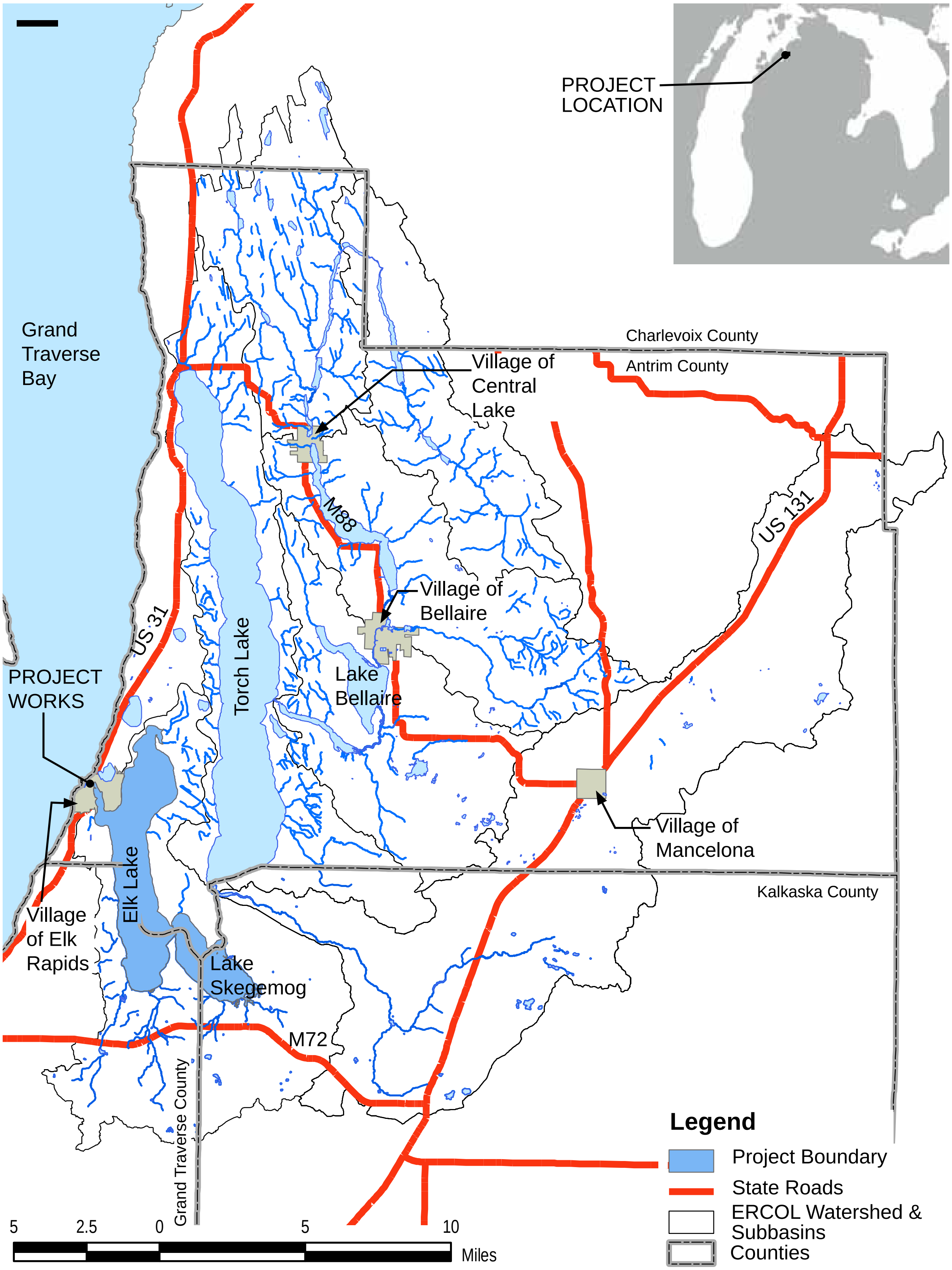

Figure A.2 Project Location (Data Source: MGDL 2012)

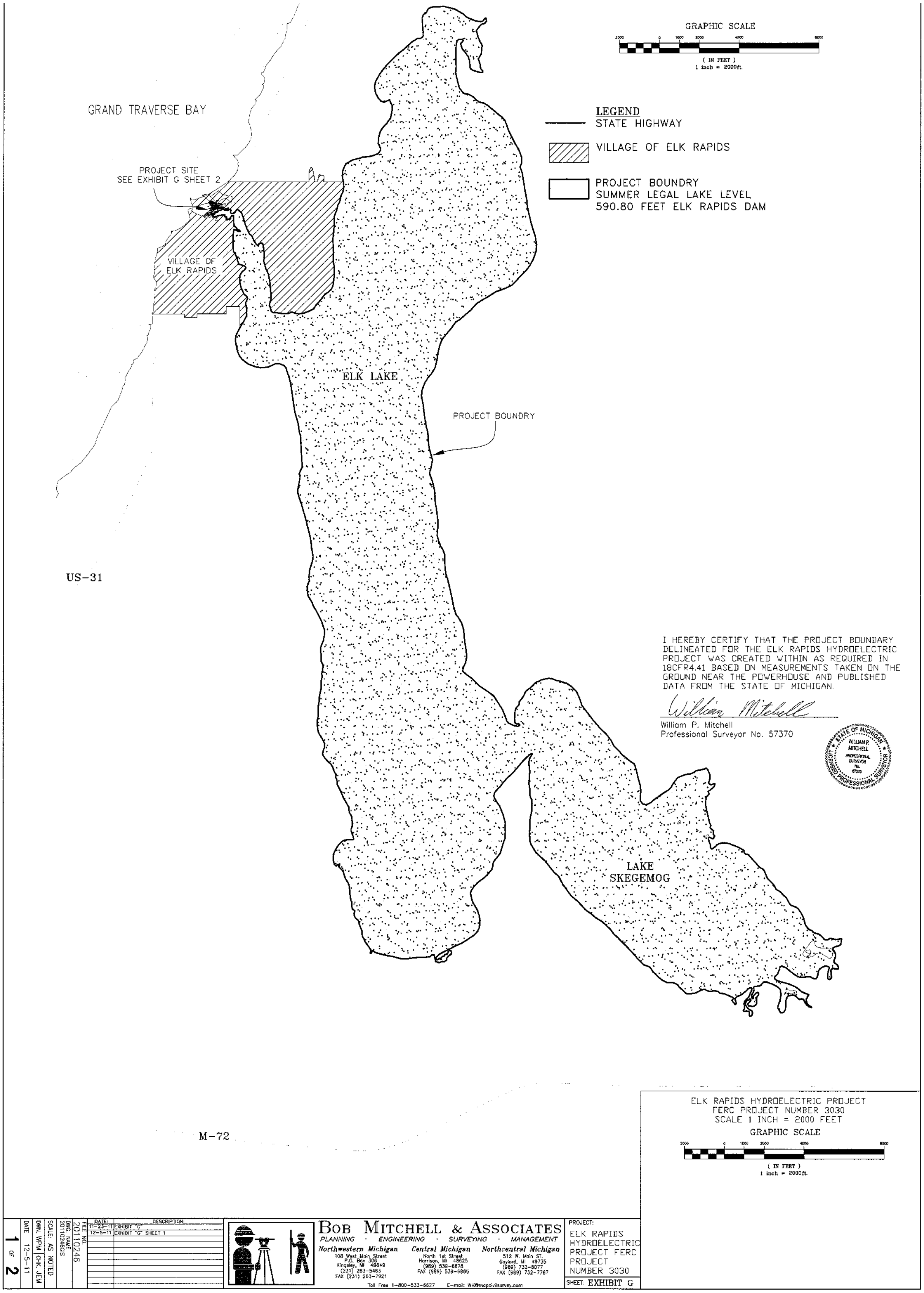

Figure A.3 Project Boundary (Antrim County 2011)

1.2. Project Facilities

1.2.1 Physical Composition of Structures Included in Project

One of the last remaining islands from an ancient archipelago is located at the mouth of the Elk River. It separates the river into two channels. The Project Powerhouse spans the north channel. This channel takes the vast majority of the river's flows and passes through the Project's integral Powerhouse before emptying into the East Arm of Grand Traverse Bay, Lake Michigan. The Powerhouse is classified as a low hazard potential by the Michigan Department of Environmental Quality (MDEQ).

The Powerhouse is oriented longitudinally northeast to southwest and overall is 121 feet long by 26 feet wide and about 52 feet in height. The superstructure is a one-story building, 24 feet in height, of solid brick masonry construction with a steel I-beam supported concrete panel roof. The substructure includes the intakes and turbine pits which are about 13 feet in height, and a foundation below that, which incorporates the discharge draft tubes and is of solid concrete construction, 13 feet in height. The Powerhouse completely spans the main Elk River channel (Figure A.1, Photos A.1-A.5).

The Powerhouse has four bays, each 22 feet wide, with sliding head gates at the Powerhouse wall. The head gates are lifted by overhead hoist on an I-beam and trolley. The two northernmost bays contain the operating turbines and generator units, while the two south bays contain the turbine gate cases that were left after the plant was decommissioned in 1965. The two south bays are used to spill excess water and provide run-of-the-river flow when one or both of the generating units are down for maintenance. The intake rash rack bars are ¼-inch thick with a two-inch center spacing leaving an open space space of 1¾ inches.

About 400 feet south of the Powerhouse, the Elk River's south channel diverts into a 14-foot wide overflow spillway that is stoplog controlled with two 5 foot diameter culverts under Dexter St. This bypass spillway provides a minimum flow of 35 cubic feet per second (cfs) through the "Kids' Pond". The flows then enter a small stream and discharge into Grand Traverse Bay (Photos A.6-A.8).

The 400 foot long irregularly shaped land mass between the Powerhouse and the small Bypass Spillway forms a barrier of about 250 feet wide at its narrowest point between Elk River and Edward C. Grace Memorial Harbor on Grand Traverse Bay and about 70 feet between Elk River and the "Kids Pond." It is primarily a natural formation of clay, silty clay, and sand with added earthen fill that has been paved over to form the Dexter Street right-of-way and that holds the commercial property fronting the Elk River and the Powerhouse headrace.

The shoreline facing Elk Lake has been stabilized with a concrete wall and sheet steel piling along its entire length from the Powerhouse to about 130 feet beyond the Bypass Spillway - a total length of about 700 feet (see Section 12). This land mass forms a stable barrier for retaining the Elk River. The surface of Dexter St. itself provides about 2.5 feet of freeboard at the legally established summer lake level for Elk Lake (see Section 1.2.3).

Photo A.1 **Front of Powerhouse and Headrace (Photo: ERHP 2009)**
The two bays in the right of the photo contain the turbines.

Photo A.2 **Back of Powerhouse and Tailrace (Photo: ERHP 2009)**

Photo A.3 Looking Upstream from the Headrace (Photo: ERHP 2009)
U.S. 31 can be seen in the distance.

Photo A.4 Looking Downstream to Edward C. Grace Memorial Harbor (Photo: ERHP 2009)
In the foreground is the park leased to and maintained by the Village. The Harbor is behind the park. The Dam Fishing Park is on the opposite shore. Grand Traverse Bay can be seen in the far background.

Photo A.5 Looking Back at the Tailrace (Photo: ERHP 2009)
The Dam Fishing Park is in the foreground.

Photo A.6 Looking Down the South Channel to the Bypass Spillway Inlet (Photo: ERHP 2009)

Photo A.7 Looking Upstream to the Spillway (Photo: ERHP 2009)
The Kids' Pond is in the foreground.

Photo A.8 Looking Downstream from the Kids' Pond (Photo: ERHP 2009)
The stream discharges into Edward C. Grace Memorial Harbor just around the corner.

The Project's normal operating head is about 10.5 feet. On the intake side, the Impoundment level is dictated by the legally established lake level for Elk and Skegemog Lakes. The tailrace is directly connected to Grand Traverse Bay. As a result, the tailrace level is the same as Lake Michigan, whose level varies naturally on a seasonal and annual basis. Consequently, the Project's net head varies as Lake Michigan rises and falls. Records of Lake Michigan levels have been kept since 1860 and are now recorded by the National Oceanic and Atmospheric Administration (NOAA). Since 1916, when the current Powerhouse was constructed, Lake Michigan has seen a maximum high and minimum low of about three feet above and below a mean level of 578.8 feet (176.45 meters International Great Lakes Datum – 1985) (Figure A.4).

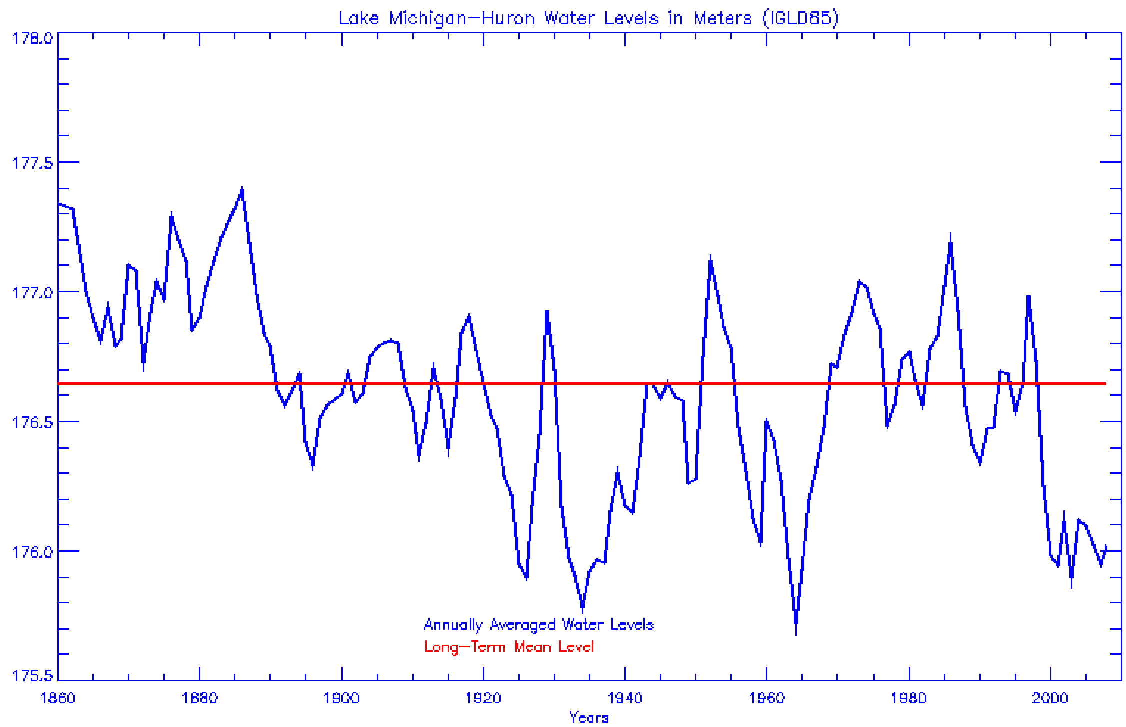

Figure A.4 Lake Michigan-Huron Water Levels 1860-2009 (Source: NOAA) Elevation (Meters IGLD 1985), 1 meter = 3.28 feet

1.2.2 Impoundment

The Elk River, Elk Lake and Skegemog Lake up to the summer legally established lake level comprise the Project's Impoundment. Skegemog Lake is connected to Elk Lake via a one-quarter mile-wide, five-foot deep narrows (the Narrows). The Narrows does not restrict flow between the lakes and therefore does not cause a surface level difference between the lakes (See Appendix C for hydraulic calculations).

Elk Lake has a surface area of twelve square miles (7,730 acres) and a volume of about 550,000 acre-feet. Skegemog Lake has a surface area of four square miles (2,560 acres) and volume of 30,700 acre-feet. The lakes' combined surface area and volume are sixteen square miles (10,290 acres) and 580,700 acre-feet respectively. Elk and Skegemog Lakes have the same seasonal legally established lake level pursuant to a Court Order issued in 1973 by the Circuit Court in

Antrim County (See Appendix D). The lake level is measured at the Elk Rapids Dam Gauge, located on the south wall of the headrace/forebay area just in front of the powerhouse. Lake level for the summer period (April 15 to November 1) is 590.8 feet Elk Rapids Dam Gauge (588.26 feet International Great Lakes Datum (IGLD55)). Lake level for the winter period (November 1 to April 15) is 590.2 feet Elk Rapids Dam Gauge (587.66 IGLD55). The Project is responsible for maintaining the legally established lake levels through its normal operation. The lake level is adjusted gradually over a two week period at each seasonal changeover.

Based on a review of the historic record, the Impoundment's surface elevation today appears to be relatively unchanged from its elevation in 1856 when the first dam was put in place on the Elk River. The river's first saw mill was set up a few years earlier, around 1850. The saw mill used only the hydraulic head that resulted from the Elk River's original rapids and did not include a dam (Neumann 2008). There would have had to have been a minimum head of at least 4-5 feet between the upper end of the rapids and Grand Traverse Bay in order to develop sufficient power to operate the saw mill. When the first dam went in around 1856, the head formed by the dam was reported to be 7-7.5 feet (Scott 1921). In 1860, the surface level of Lake Michigan was about 4 feet higher than it is today (Figure A7), meaning that the original dam would have raised the lake level of Elk and Skegemog Lakes no more than 2-3 feet:

Original dam head (7-7.5 ft.) minus pre-dam head (4-5 ft.) = 2-3 ft.

Since the head today is about 11 feet, the height of the current dam must be very close to the height of the original 1856 dam:

Original dam head (7-7.5 ft.) + decrease in Lake Michigan level (4 ft.) = 11 ft.

Thus, the surface level of the Impoundment has remained essentially unchanged for over 150 years, since 1856 when the original dam went in.

While the water bodies between the Bellaire Dam and Skegemog Lake (Torch River, Rapid River, Torch Lake, Clam Lake, and Lake Bellaire) are connected to the Impoundment, they are not part of the Impoundment because they do not form the Project's hydraulic head and do not affect the surface level of Elk and Skegemog Lakes.

Torch River connects Torch Lake with Skegemog Lake. It is a smoothly flowing channel about 1.9 miles long on which small boats can easily travel between the two lakes. The Rapid River feeds into Torch River about 2,600 feet south of Torch Lake's outlet. The width of Torch River varies between 45 and 170 feet, having a weighted average width of about 120 feet. The river's average depth is about 4.5 feet. Despite its seemingly gentle flow, the Torch River's channel has a significant flow restriction which creates a surface level difference between Torch and Skegemog Lakes that keeps the two water bodies separate.

The above conclusion was arrived at by modeling flow conditions between Torch Lake and Skegemog Lake. The Torch River channel was broken up into five sections and Manning's formula for flow in open channels applied to each section. The results show that at conditions of an annual median flow of 569 cfs, which is equivalent to the annual median outflow through the Project dam, Torch Lake is almost one foot (11.4 inches) higher than the Impoundment (See Appendix C).

Furthermore, because the Project is operated run-of-the-river, the surface level of Torch Lake and the water bodies above it cannot influence the surface level of Elk and Skegemog Lakes. If an inch of rain were to fall only on Torch Lake and the water bodies above, thereby raising their lake levels, the higher level in these lakes would simply increase the flow going into the Torch River and thence into the Impoundment. It would not raise the level of Elk or Skegemog Lakes because the Project turbines would simply be opened up further in order to keep the lake level constant as required by law.

1.2.3 Hydraulic and Installed Capacity

The Project is a run-of-the-river plant with a total installed nameplate capacity of 700 kW and a hydraulic flow capacity of 1,675 cfs. The Project's hazard potential classification is "low". As described above, the Project powerhouse has four bays. The two northern bays contain identical turbines, speed increaser gearboxes, and induction generators. They were installed when the Project was rehabilitated and brought back online in 1984. The two south bays have the originally installed turbine gate cases without runners. They are used to spill excess water and provide run-of-the-river flow operation when one or both of the generating units are down for maintenance.

At the request of the Michigan Department of Natural Resources (MDNR) in a letter dated May 4, 2009 (see Appendix D), a calibrated set of flow tables were developed for each of the units at the project as well as a total flow measurement. To that effect, discharge flow measurement tests were conducted by United States Geological Survey (USGS) personnel on August 8 and 9, 2011, at the Powerhouse (Stockhausen 2011).

Specifications for each of the generating Units #3 and #4 are as follows:

<u>Turbine</u>
51-inch Type "S" Turbine, manufactured by the James Leffel & Co.
Rated at 525 horsepower at 11 feet head, 500 cfs flow, 100 rpm
USGS maximum flow measured for each unit was 504 cfs.

<u>Gearbox Speed Increaser</u>
XTEK-1905
470 service horsepower
1.5 service factor
100 rpm input
9.417 ratio

<u>Generator</u>
Allis-Chalmers
Induction Motor
500 horsepower (350 kW), 900 rpm

Specifications for the spill control gate cases are as follows:

> Bay #1 (the southernmost gate case) is an older unit manufactured by the James Leffel & Co. USGS maximum flow measured for this unit is 239 cfs.
>
> Bay #2 (second position from southernmost) is the gate case for a 51-inch Type "S" turbine manufactured by the James Leffel & Co. This hardware is identical to Units #3 and #4 but with 3 out of every 4 of the runner vanes cut out and the runner shaft cut off and welded to the gate case. USGS maximum flow measured for this unit is 442 cfs.
>
> Capacity of all four units in the Powerhouse flowing at the same time is 1,620 cfs (this amount is less than the sum of the individual units due to some amount of flow interference between individual units).
>
> Maximum capacity of the total Project (Powerhouse plus the Bypass Spillway) is 1,620 cfs + 55 cfs = 1,675 cfs. (Stockhausen 2011).

The Elk River serves as the outfall for the Elk River Chain of Lakes Watershed (the ERCOL). The flood design discharge for the ERCOL has been estimated by MDEQ as the 1% chance (100-year) flood of 2,933 cfs, which would increase the summer pool elevation by no more than 18.2 inches and would leave a freeboard of 12 inches or more. This is due to the substantial storage capacity of Elk and Skegemog Lakes. When the Impoundment is combined with Torch Lake, the next lake in the ERCOL upstream from Skegemog Lake, the three lakes have a combined surface area of about 45 square miles and combined storage volume of 3,191,623 acre-feet (Stockhausen 2011). It was additionally determined that the Project has ample storage to attenuate floods up to 1.6 times greater than the MDNR estimated 100-year flood of 1,800 cfs. (Harding 2011).

FEMA has developed flood maps for portions of the Impoundment, but not all of it (Figures A.5-A.7). Except for the Village of Elk Rapids (the Village), the northwest portion of Elk Lake and the lower portion of Skegemog Lake are unmapped.

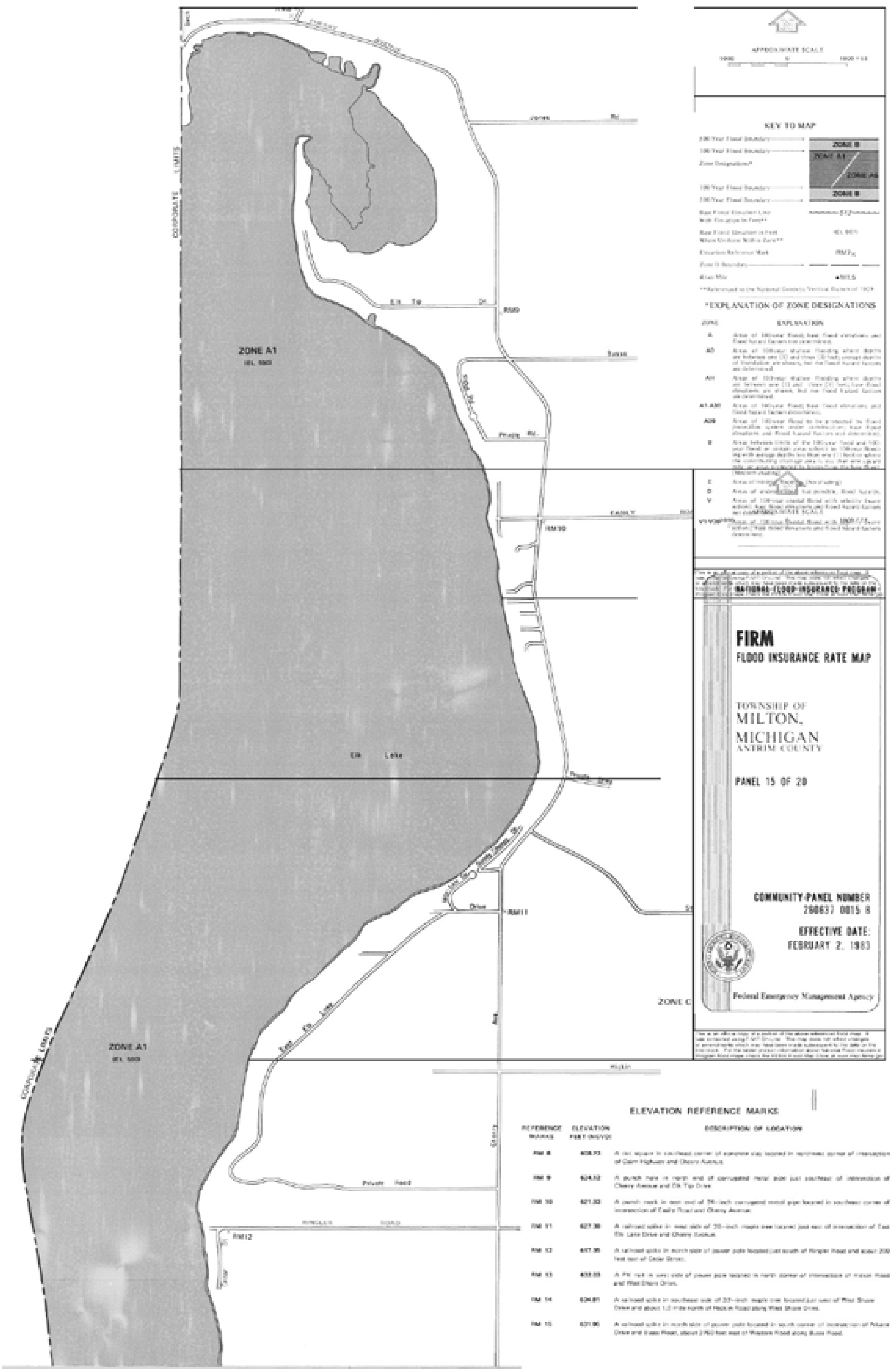

Figure A.5 **Flood Insurance Rate Map #2606370015B (Source: FEMA 1983)**

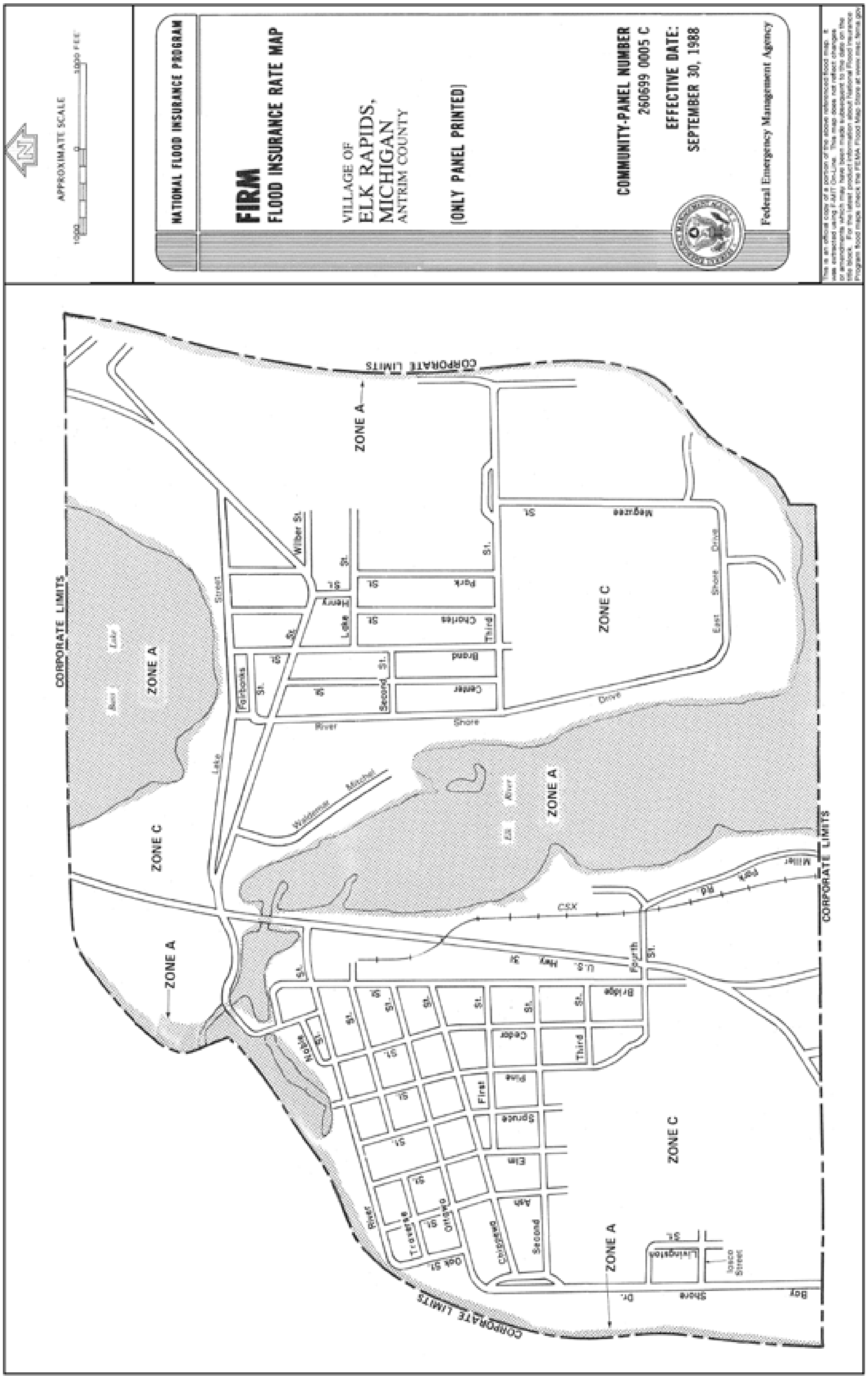

Figure A.6 **Flood Insurance Rate Map #2606990005C (Source: FEMA 1988)**

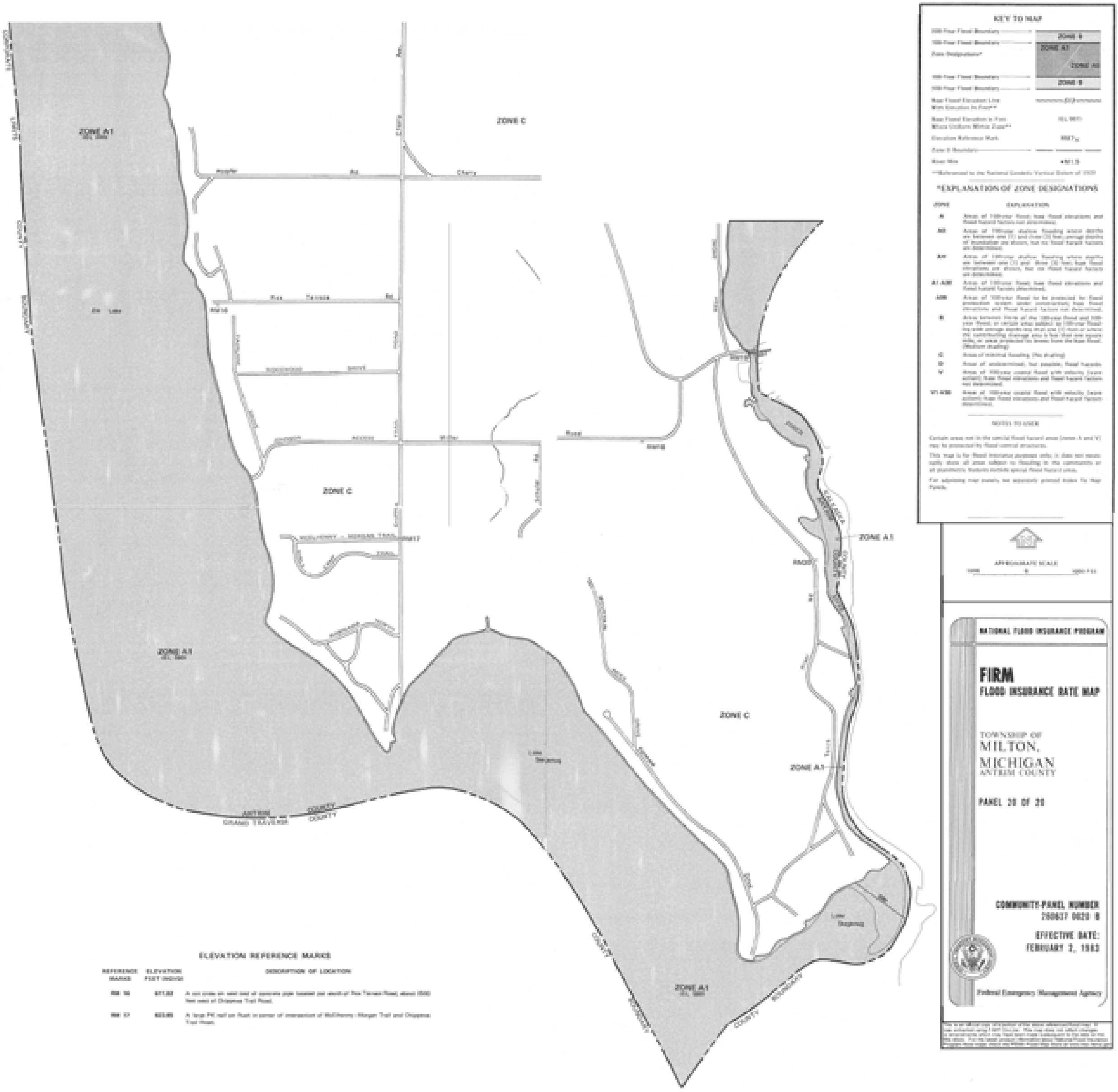

Figure A.7 Flood Insurance Rate Map #2606370020B (Source: FEMA 1983a)

1.2.4 Transmission Line Connections

The Project is interconnected with the local utility, Consumer's Energy, by means of an underground 4,160kV line that runs about 30 feet from the powerhouse to a fenced-in transformer and metering enclosure of about 20 feet by 30 feet at the property's south end and is then interconnected with the local 12.5 kV distribution line. (Photo A.9).

Photo A.9 Transformer Enclosure (Photo: ERHP 2009)

2. PROPOSED MODE OF OPERATION

The Project is currently operated run-of-the-river. The Project is manually operated by ERHP personnel using conventional electrically and mechanically controlled protective devices and relaying. The plant is checked for operation two to three times each day, seven days a week. Impoundment levels are maintained at the legally mandated lake levels through normal run-of-the-river operations. During the semi-annual lake level change (every April and November), generation and water flow is adjusted gradually over a period of two weeks to achieve the required level. The two non-generator south bays are used when the generators are down for maintenance or as otherwise needed to maintain run-of-the-river operation.

At this time, there are no proposed changes to the Project's operation and no proposed additional construction. The Project will continue to be operated as it has been operated under the current license.

3. PURPOSE OF PROJECT

The Project is operated for the purpose of power generation.

4. ESTIMATED COST TO DEVELOP THE LICENSE APPLICATION

The estimated cost to develop the License Application is about $175,000 to date. This cost includes costs for the following items:

- Survey of the Project's physical structures
- Engagement of the USGS to measure flow discharge in order to verify base flow
- Preparation of the environmental report
- Preparation of the PAD and License Application
- Filings and communication with State and Federal agencies
- Preparation of the legal opinon on the Project Boundary and Project rights status
- Publication of public notices
- Printing, copying, mailing, and other communications with stakeholders
- Public meetings and outreach
- Administrative costs

5. ON-PEAK AND OFF-PEAK VALUES OF PROJECT POWER

Not applicable. The Project is operated run-of-the-river.

6. ANNUAL OPERATION AND MAINTENANCE EXPENSES (INCLUDING INSURANCE, ADMINISTRATIVE AND GENERAL COSTS)

The Project is operated on the County's behalf by ERHP. ERHP's annual operation and maintenance expenses for the Project are about $108,000 per year. This amount includes expenses for the following items:

- Wages
- Insurance
- Repair and maintenance costs
- Administrative costs, including utilities
- General expenses, costs and fees
- Revenue share payable to the County

7. ESTIMATED ANNUAL INCREASE OR DECREASE IN PROJECT GENERATION AND ESTIMATED ANNUAL INCREASE OR DECREASE OF THE VALUE OF THE PROJECT POWER DUE TO CHANGES IN PROJECT OPERATIONS FOR AN APPLICATION FOR A NEW LICENSE.

Not applicable. The Project will be run as it has been run to date.

8. REMAINING UNDEPRECIATED NET INVESTMENT OR BOOK VALUE OF PROJECT.

The remaining undepreciated net investment or book value of the Project is estimated to be $500,000.

9. DETAILED SINGLE LINE ELECTRICAL DIAGRAM

The detailed single line electrical diagram has been provided as Critical Energy Information Infrastructure (CEII) and is not publicly available (Figure CEII 1).

10. MEASURES TAKEN OR PLANNED TO ENSURE SAFE MANAGEMENT, OPERATION, AND MAINTENANCE OF THE PROJECT

The Project is visited a minimum of twice daily by a trained operator. The operator adjusts the generator output to maintain the legally established lake level and to maintain run-of-the-river operation, performs scheduled equipment checks and maintenance, and monitors the Project for potential issues. All adjustments or changes in equipment settings are recorded on daily log sheets.

Preventative maintenance is performed on all equipment at scheduled intervals using a line-item checklist to ensure nothing is overlooked. Equipment operation, maintenance and repair guides are kept in the Powerhouse office for easy reference. An adequate supply of tools, maintenance materials, and replacement parts are stored on-site for immediate use when needed. Emergency reponse procedures and contact personnel are posted in full view in case of need.

Further monitoring is done remotely by computer link. An automatic phone dialer system calls the local ERHP operator and three other ERHP personnel in sequence if there is an equipment malfuntion; operator response time is typically within 15 minutes of the call.

EXHIBIT E
ENVIRONMENTAL REPORT (18 CFR §4.38 AND 4.61)

1. DESCRIPTION OF ENVIRONMENTAL SETTING IN THE VICINITY OF THE FACILITY (18 CFR § 4.61(d)(2))

1.1. General Description of the Project Vicinity

The Project is located within the Elk-Skegemog Subwatershed (the Project Vicinity) of the ERCOL (Figure E.1.1). The ERCOL covers approximately 512 square miles across five counties: Antrim, Grand Traverse, Kalkaska, Charlevoix and Otsego counties. This unique watershed has over 200 miles of shoreline and roughly 53 square miles of surface water. Approximately 11% of the ERCOL's drainage area is covered by water in the form of very high quality lakes and streams. According to MDNR - Fisheries Division, there are approximately 138 miles of recognized trout streams within the ERCOL, including 55 miles of designated Class I trout streams.

The Project Vicinity comprises a subwatershed of roughly 214 square miles, or 42% of the ERCOL (Bretz 2006). As in the ERCOL as a whole, the Project Vicinity's water bodies have some of the highest water quality and ecosystem health within the state.

Due to Lake Michigan's moderating influence, the Project Vicinity's climate resembles that of Traverse City, located about 35 miles further south. The lake effect increases cloudiness and snowfall during fall and winter and keeps temperatures warmer in late fall/early winter and cooler in late spring/early summer. Average annual rainfall is around 30-33", over half of which falls April through September. Average annual snowfall is about 87". Summer precipitation occurs mainly as afternoon showers and thundershowers. Approximately 16" of this rain recharges the groundwater table, while 20" are evapotranspirated and 6" become overland flow (Watershed Center 2005). First frost usually occurs in mid/late October. Temperatures in the winter range from the high teens to mid-20s, while average summer temperatures are in the high 60s (Village of Elk Rapids 2007).

The Project Vicinity crosses the following political jurisdictions (Table E.1.1):

Lake	County	Townships	Municipalities
Skegemog Lake	Antrim Kalkaska Grand Traverse	Clearwater Milton	None
Elk Lake	Antrim Grand Traverse	Milton Elk Rapids Whitewater	Village of Elk Rapids Village of Kewadin

Table E.1.1 Project Vicinity Political Jurisdictions

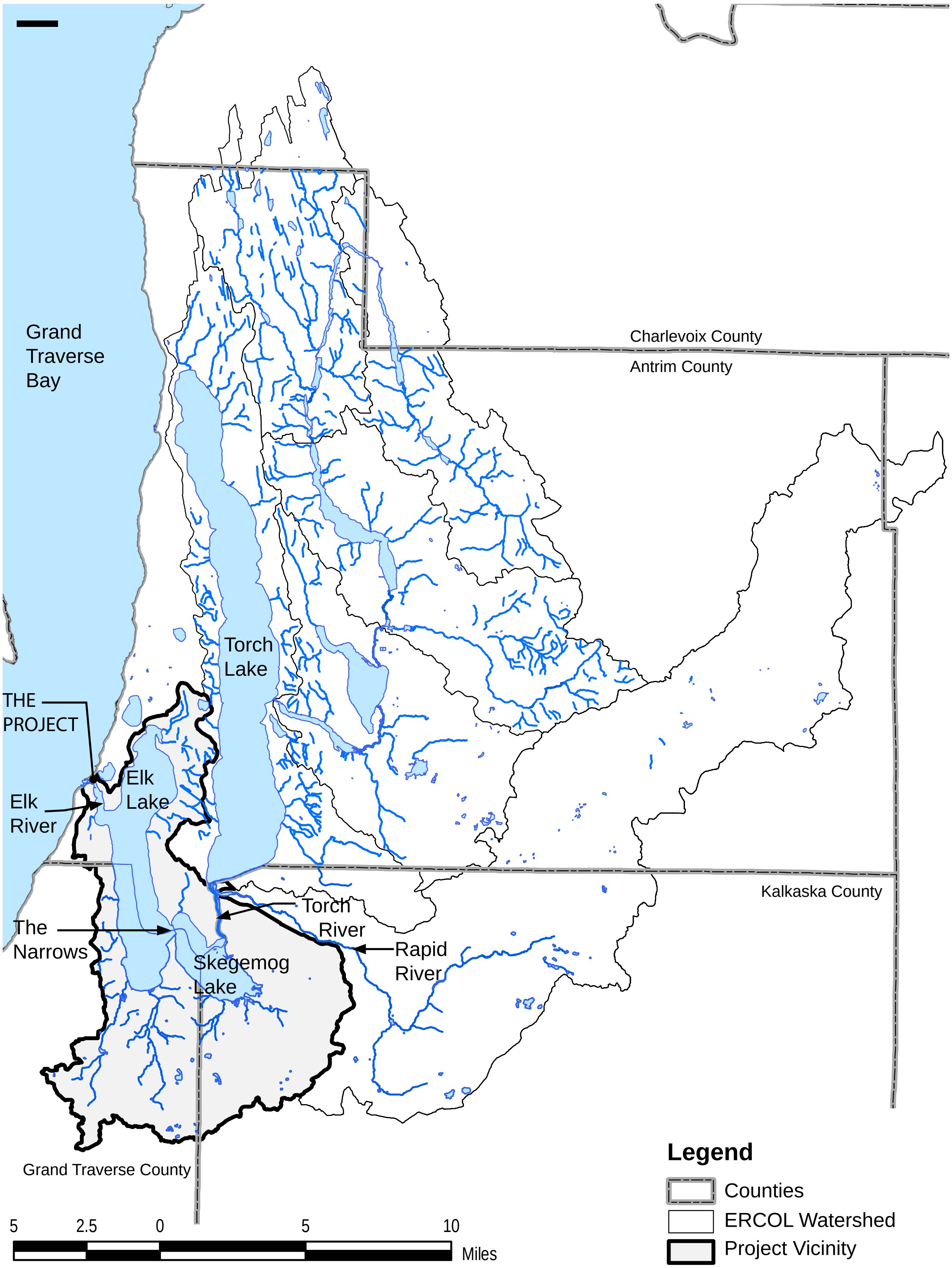

Figure E.1.1 Project Vicinity (Data Source: MGDL 2012)

1.2. Area of the Project Vicinity and Length of Stream Reaches

The Project Vicinity comprises a land area of roughly 84 square miles. Its immediate drainage area (the area that drains into the Impoundment without first passing through another lake) is about 214 square miles; the Impoundment's total drainage area is the entire ERCOL (about 512 square miles) (Bretz 2006). Water flows from the Torch River south into Skegemog Lake, then northwest into Elk Lake. Flows continue north to enter the Elk River and then travel northwest to discharge into Grand Traverse Bay (Figure E.1.2).

The Project Vicinity includes 23 tributaries - 6 tributaries discharge into Skegemog Lake and 17 discharge into Elk Lake. The Project Vicinity's major tributaries are delineated in Figure E.1.3. The major tributaries have a combined total length of approximately 21.7 miles (Table E.1.2). The remaining, minor tributaries comprise about 7.39 miles and are unnamed. Most of these have limited seasonal flow or no flow.

Tributaries (by Lake)	Length (miles)
Skegemog Lake	
Torch River	1.9
Vargason Creek	1.0
Desmond Creek	2.0
Barker Creek	2.5
Copeland Creek	1.0
Elk Lake	
Battle Creek	4.0
Maplehurst Creek	2.8
Williamsburg Creek	5.5
Elk River	<1.0

Table E.1.2 Length of Major Tributaries in the Project Vicinity (Source: Fuller 2001, MDNR 2009)

1.3. Major Land and Water Uses in the Project Area

Land use within the Project Vicinity is predominantly forest (34%), followed by water (28%) and agriculture (16%) (Table E.1.3, Figure E.1.4). Agricultural land is about evenly divided between orchards and cropland. About 7% of land in the Project Vicinity is residential or commercial/ industrial. Residential use is concentrated within the Village and around the lakes. About 5% of the land is wetlands. Land within the larger ERCOL is slightly more forested (47%) and agricultural (18%) with water comprising a smaller, but still large percentage of land cover (11%) (The Watershed Center 2005).

The waterfront property along Elk and Skegemog Lakes is roughly 80% developed with residences (both seasonal and year-round) and businesses. Fishing, boating, hunting, hiking, wildlife viewing and other tourism related activities are major land and water uses in the Project Vicinity and are the area's major economic drivers (See Section 4.7 Recreation and Land Use and Section 4.10 Socio-Economic Resources).

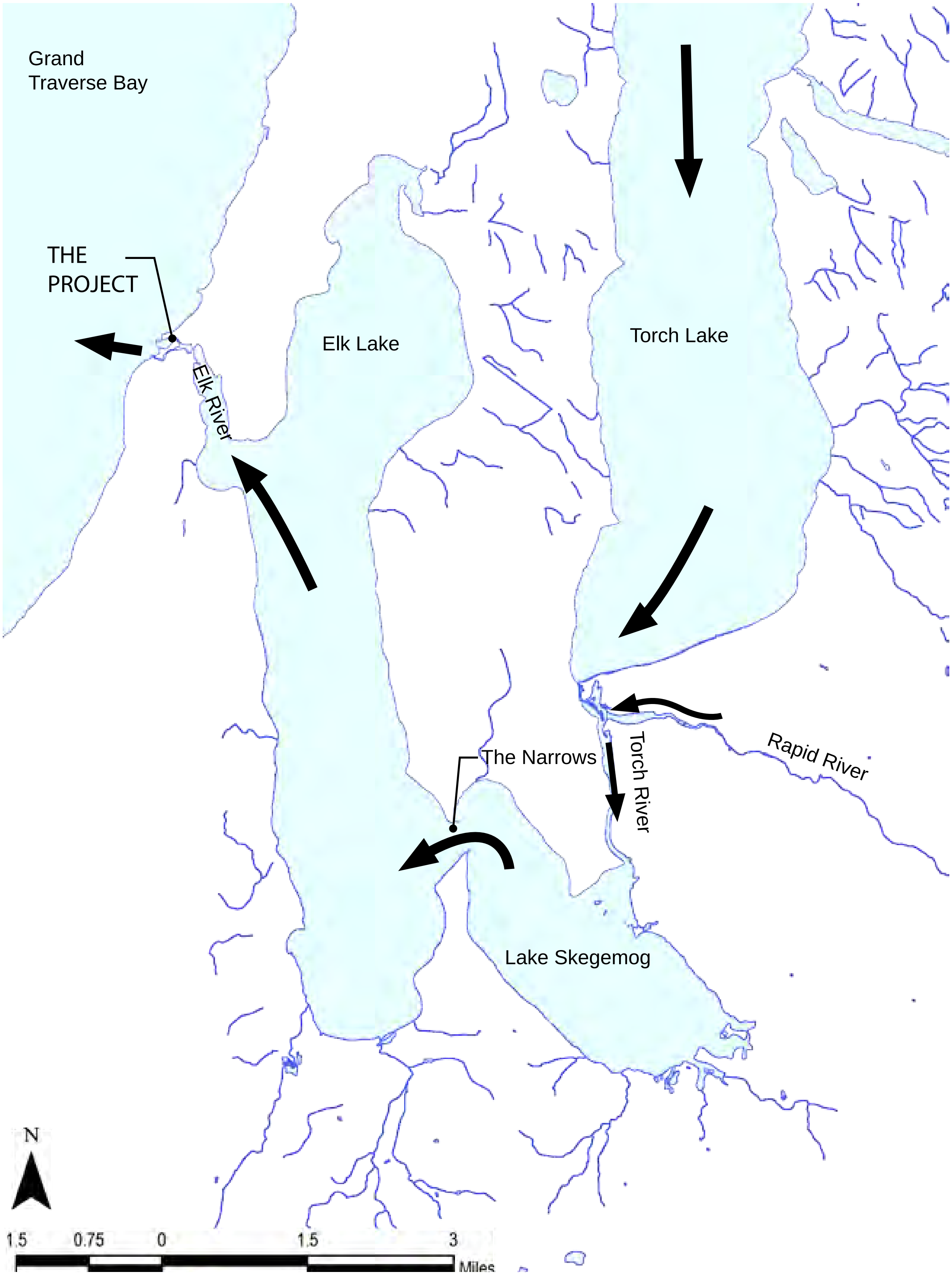

Figure E.1.2 Project Vicinity Direction of Flows (Data Source: Antrim County 2009)

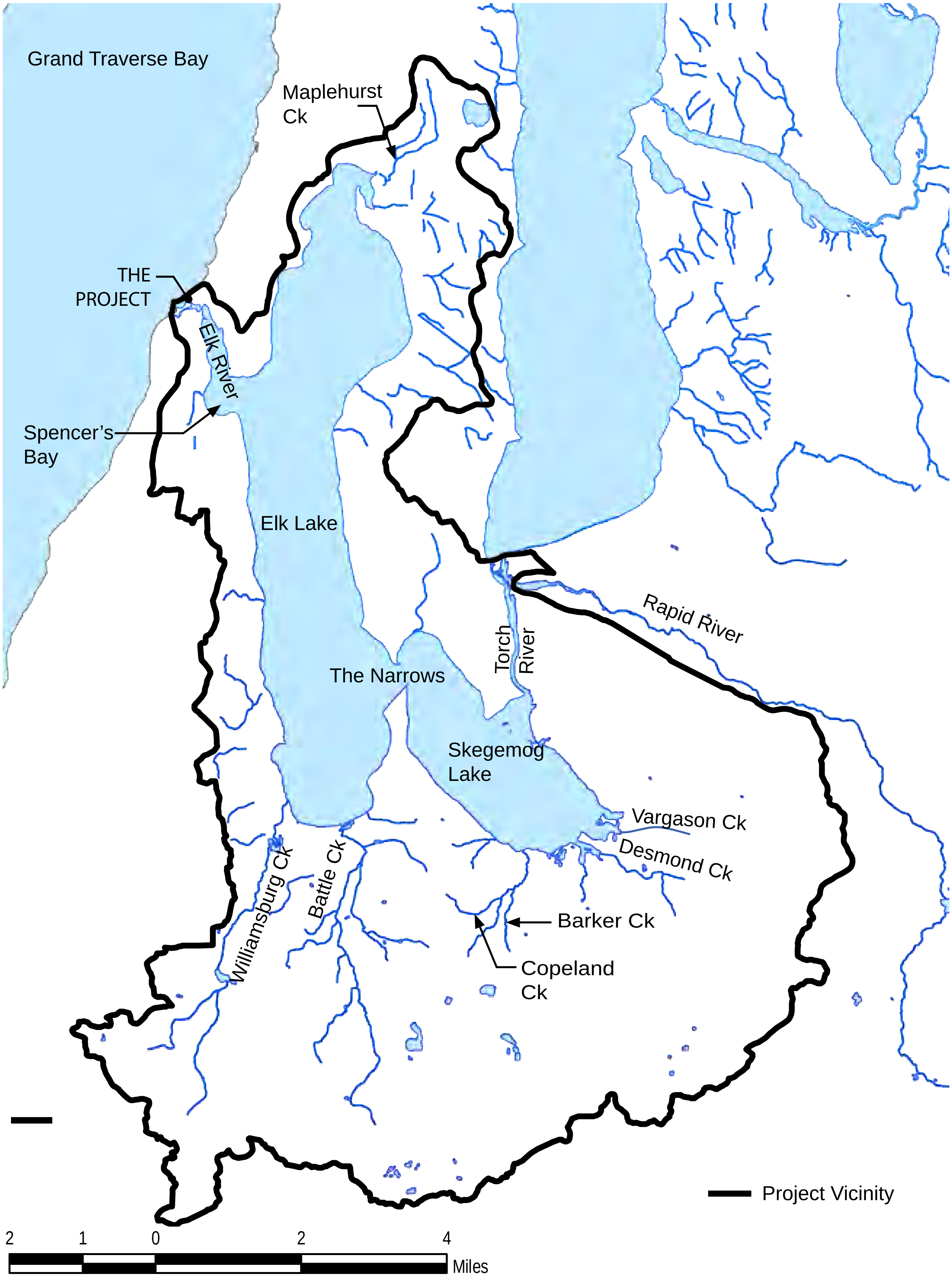

Figure E.1.3 Project Vicinity Major Tributaries (Data Source: Antrim County 2009)

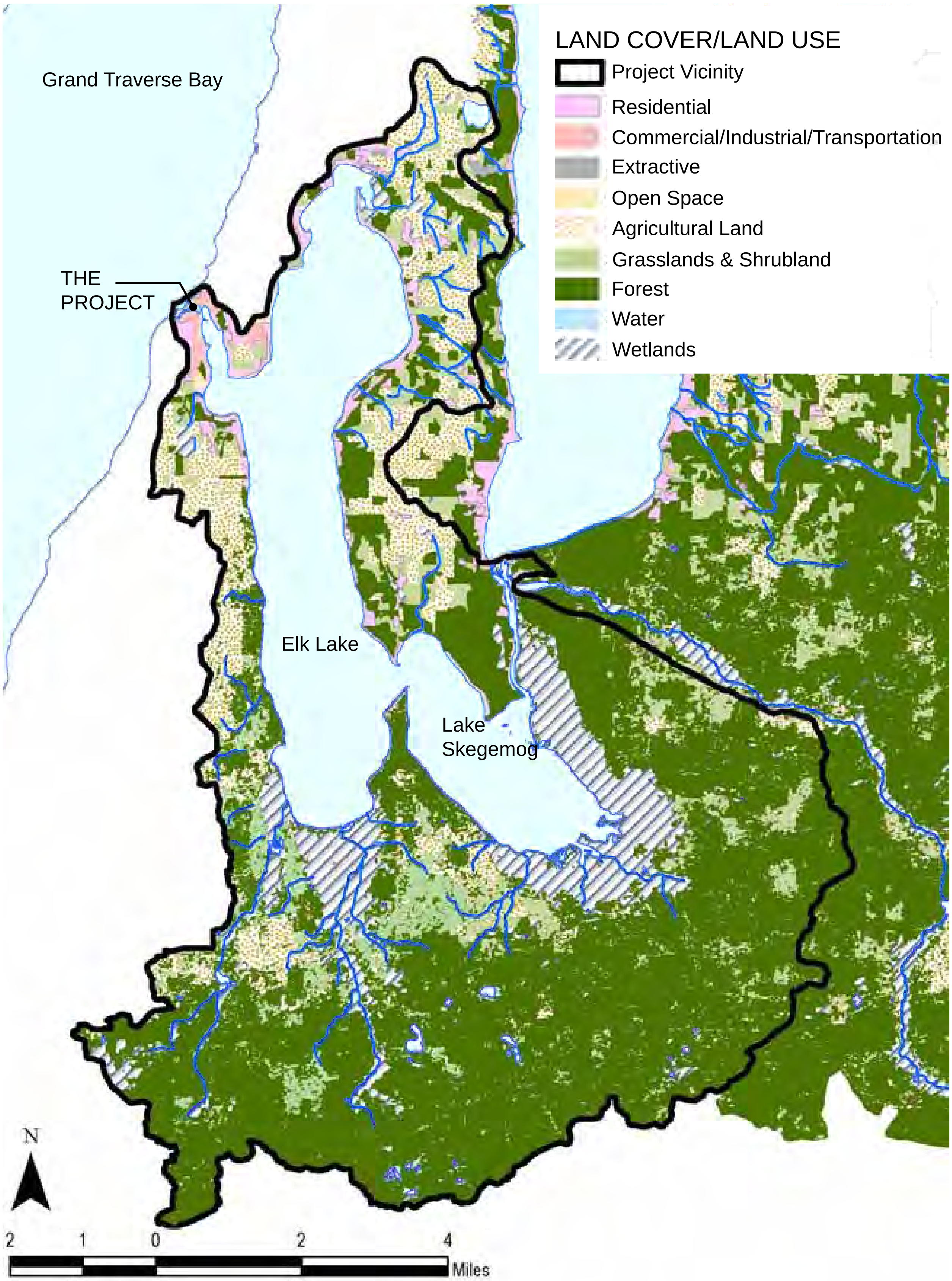

Figure E.1.4 Project Vicinity Land Cover/Land Use (Data Source: Antrim County 2009)

Land Cover/Land Use	Area (acres)	Percent
Forest	7956	34%
Mesic Northern Forest	5296	23%
Dry Northern Forest	2081	9%
Dry Mesic Forest	580	2%
Water	6612	28%
Agricultural	3757	16%
Orchards	1830	8%
Cropland	1719	7%
Pasture	157	1%
Grasslands/Shrubs	2325	10%
Residential	1289	6%
Wetlands	1101	5%
Forested Wetlands	910	4%
Non Forested Wetlands	192	1%
Commercial/Industrial	223	1%
Open Space	115	0.5%
Other	13	0.05%
TOTAL AREA	**23,390**	**100%**

Table E.1.3 Project Vicinity Land Cover/Land Use (Data Source: Antrim County 2009)

Land Cover/Land Use	Area (acres)	Percent
Residential	527.4	41%
Lakes	233.1	18%
Commercial, services, institutional	119.8	9%
Open land, other	90.3	7%
Industrial	77.6	6%
Grasses and forbs	82.1	6%
Shrubs	45.7	4%
Broadleaved forest	51.7	4%
Cropland	27.3	2%
Coniferous forest	10.2	1%
Beaches and Riverbanks	9.8	1%
Other	3.6	1%
TOTAL	**1278.6**	**100%**

Table E.1.4 Village of Elk Rapids Land Cover/Land Use (Source: Source: Antrim County 2004)

The Village of Elk Rapids is the largest urban center within the Project Vicinity and the ERCOL. Within the Village, 56% of the land use is residential, commercial or industrial. The rest is open space, forest, recreational use or cemetery. As in the Project Vicinity, the second largest land cover in the Village is water (223.1 acres or 18%) (Table E.1.4, Figure E.1.5).

1.4. Dams and Diversion Structures Within the Project Vicinity

There are no other operating hydropower facilities, dams or diversion structures within the

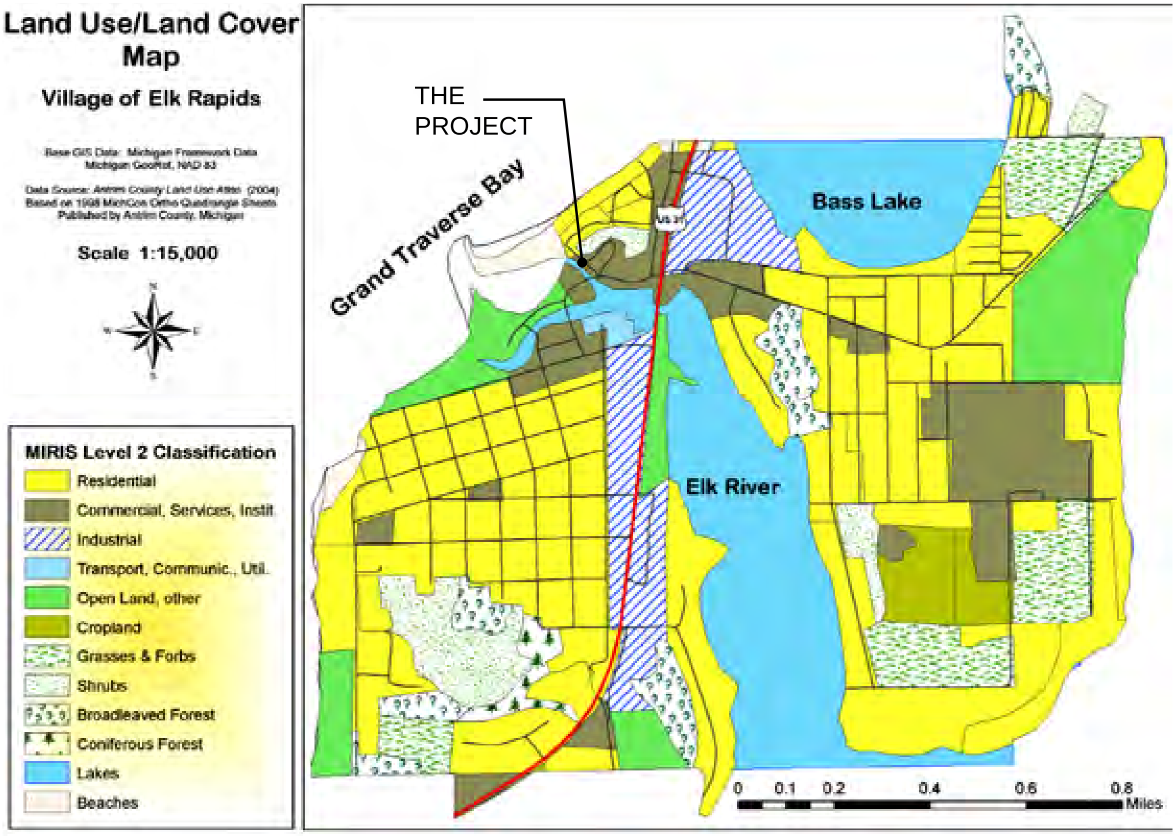

Figure E.1.5 Village of Elk Rapids Land Cover/Land Use (Source: Elk Rapids 2007)

Project Vicinity. The Bellaire Dam is located upstream of the Project Vicinity on the Intermediate River above Lake Bellaire in the Village of Bellaire. This dam manages flows from ERCOL's subwatersheds further upstream. Except for the Bellaire Dam and the Project dam, the watershed's chain of lakes is navigable by small craft.

1.5. Potentially Affected Tributary Rivers and Streams

As noted above, the Project is operated run-of-the-river and a dam and hydropower plant have been in place at the Project site for over 150 years. Consequently, the Project Vicinity's tributary rivers and streams adjusted long ago to the presence of a dam and hydropower plant in this location. The Project Vicinity's tributary rivers and streams are listed in Table E.1.2.

2. WATER QUALITY AND QUANTITY

2.1. Drainage Area

The Project's drainage area comprises the ERCOL, a drainage area of about 512 square miles. The Project's immediate drainage area (the area that drains into Elk or Skegemog Lake without first passing through another lake) is 213 square miles (Bretz 2006).

2.1.1 Skegemog Lake

Skegemog Lake (formerly known as Round Lake) is situated between Torch Lake and Elk Lake. Originally a bay of Elk Lake, Skegemog Lake is connected to Elk Lake via the Narrows (Figure E.2.1). Hydraulic Unit Code #: 040601050404, 040601050404-01

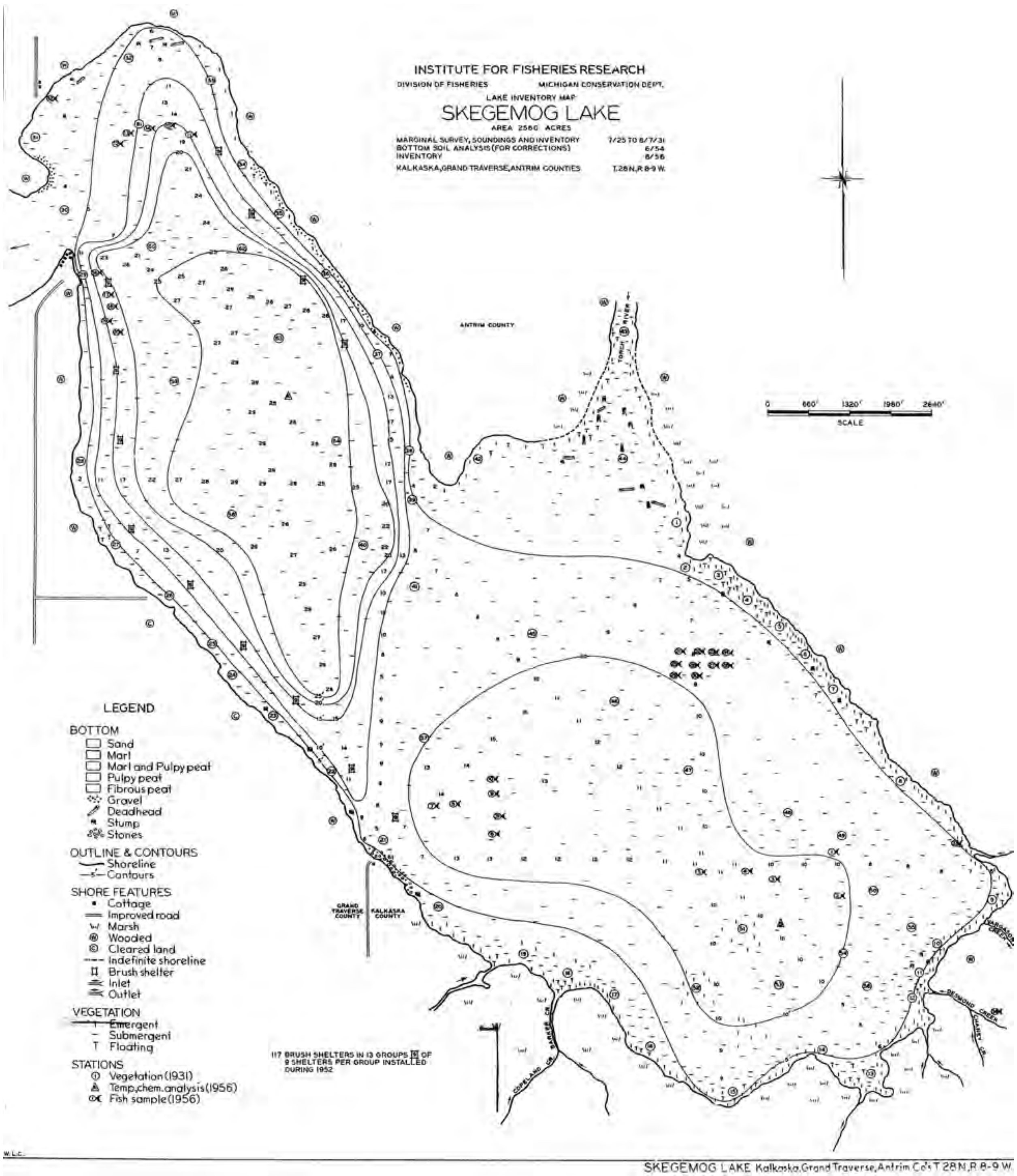

Figure E.2.1 Skegemog Lake (Source: MDNR 1957)

Immediate Drainage Area: 188 square miles

The reason for the lake's very large immediate drainage area vs. the Project Vicinity's total land area of 84 square miles is that the Rapid River outfalls into Torch River immediately above Skegemog Lake. The Rapid River subwatershed comprises about 143 square miles (MGLD 2009).

Surface Area: 4 square miles (2,560 acres)

Volume: 30,720 acre-feet

Maximum Depth: 29 feet

Mean Depth: 12 feet

Flushing Rate: 24 days

Shoreline Length: 11 miles

Substrate Composition:
- 70% - Sand
- 29% - Mix of rocks, gravel and sand
- 11% - Soft muck/marl (mostly in the eastern end)

Trophic Status: Mesotrophic (medium productivity)

Major Tributaries: Torch River, Rapid River, Vargason Creek, Desmond Creek, Barker Creek, Copeland Creek

2.1.2 Elk Lake

Elk Lake is the last lake in the ERCOL's chain of lakes. Elk Lake is the 14th largest lake in Michigan by volume and the second deepest. Torch Lake further upstream in the ERCOL is the deepest lake in Michigan (Figure E.2.2).

Hydraulic Unit Code #: 040601050404-02

Immediate Drainage Area: 26 square miles

Surface Area: 12 square miles (7,730 acres)

Volume: 548,830 acre-feet

Maximum Depth: 192 feet

Mean Depth: 71 feet

Flushing Rate: 1 year

Shoreline Length: 26 miles

Substrate Composition:
- 44% - Sand (mostly north and south ends)
- 54% - Mix of rocks, gravel and sand
- 2% - Soft muck/marl (mostly sheltered areas along the Kewadin wetlands and portions of Spencer's Bay near the outlet)

Trophic Status: Oligotrophic (low productivity)

Major Tributaries: Battle Creek, Maplehurst Creek, Williamsburg Creek, Elk River

2.1.3 Tributaries

Skegemog Lake has 6 tributaries and Elk Lake has 17 tributaries, comprising a total length of roughly 29 miles (See Section 1.2). All of these tributaries are classified as coldwater streams, except for Torch River and Elk River, which are classified as a warmwater streams (Fuller 2001).

2.2. Flows at the Intake

The only currently operating USGS gauging station within the ERCOL is located in Intermediate Lake, upstream from the Project Vicinity. It is just a surface level staging gauge, so no continuous record flow data is available.

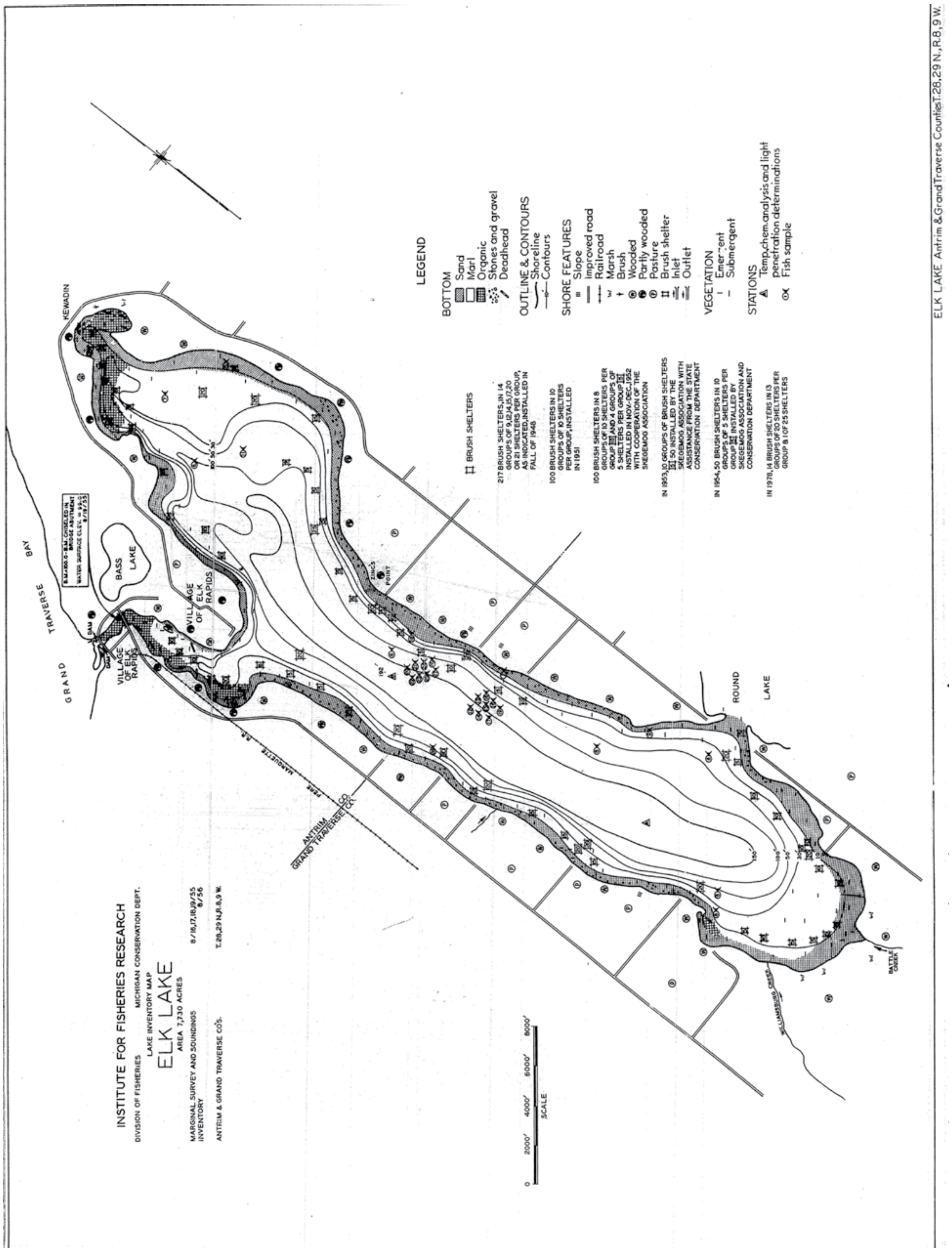

Figure E.2.2 Elk Lake (Source: MDNR 1957)

Because a complete set of calibrated turbine flow data has been obtained with USGS testing (Stockhausen 2011), MDNR has decided to use historical generation data to obtain a continuous record of accurate out-flow for the Elk River drainage basin. To that end, generation data from the Project for the past 11 years has been gathered from Consumers Energy. Consumers Energy is the utility that has metered the generated energy since the Project was rehabilitated in the 1980s. The data was transformed using the USGS calibrated turbine rating curves into a matrix of daily flow values. Historic operation logs from plant operator, Traverse City Light and Power, were used to modify the resulting data for bypassed flows that were encountered during repairs or down time of the generating units. Further adjustments were made to the data twice annually to offset the effects of raising and lowering the Elk Lake level during the legally mandated spring and fall seasons. A final adjustment was made by adding the flow through the Kid's Pond auxiliary spillway.
The annual mean flow is calculated to be 603 cfs. The resulting monthly flow data based on the 2001-2011 period is summarized in Table E.2.1 and plotted in Figure E.2.3.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	933	805	857	1044	1016	1049	792	753	904	871	951	823
Mean	663	656	644	714	720	661	497	454	412	537	651	636
Min	369	391	375	370	396	386	349	308	247	301	363	355

Table E.2.1 Monthly Flows at the Project Intake (Source: MDNR, Stockhausen 2011)

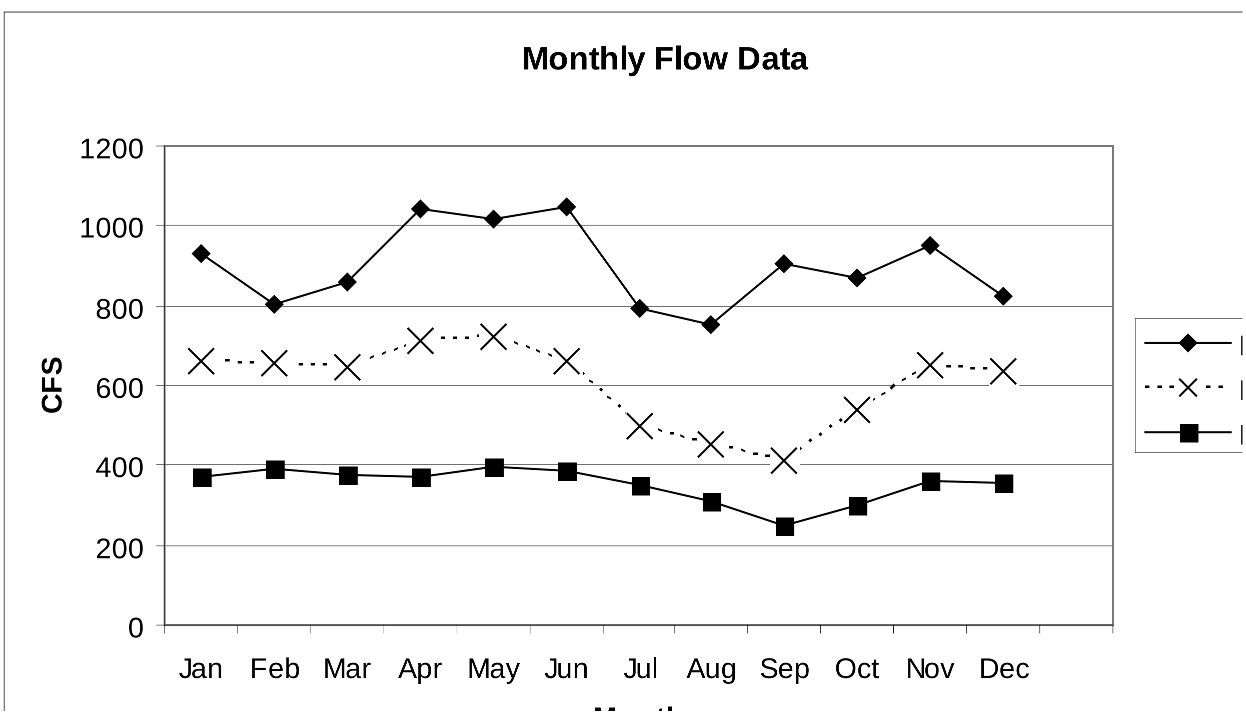

Figure E.2.3 Monthly Flows at the Project Intake (Source: MDNR, Stockhausen 2011)

2.2.1 Monthly Flow Duration Curve

The monthly flow duration curves have been calculated based on the data described in this Section 2.2 (Figure E.2.4).

2.3. Summary of Project Generation and Outflow Records

The Project's installed nameplate capacity is 700 kW. The Project's average annual power generation for the past ten years is listed below (Table E.2.2).

Year	kWhr	Year	kWhr	Year	kWhr
2001	2,479,625	2005	2,272,224	2009	2,573,928
2002	2,472,888	2006	2,314,271	2010	2,224,491
2003	2,423,707	2007	2,162,418	2011	2,577,674
2004	2,538,090	2008	2,710,712		

Table E.2.2 Project Annual Power Generation (Source: ERHP 2012)

2.4. Existing and Proposed Uses of Project Waters

2.4.1 Existing Uses

The Project Vicinity and, indeed, the entire ERCOL's water resources, are recognized nationally for their recreation and tourism values (MDNR and EPA 1993). Other than the Project's use to generate hydropower, the primary uses of Project waters are for habitat, fish and wildlife conservation, recreational boating, fishing and wildlife viewing. No other uses are being proposed at this time.

There are several boat-related facilities on the Elk River above the Powerhouse, including a large marina, public moorage spots, a public boat ramp, and a boat gas station. Additional water-related recreation and boat facilities are located on Elk and Skegemog Lakes (see Section 7). The Project maintains navigational buoys and a log boom upstream of the dam's headrace to warn boaters to stay clear and to prevent large debris from entering the headrace. The only facility below the Project is Edward C. Grace Memorial Harbor, which is situated below the tailrace on Grand Traverse Bay. The harbor's water level is determined by the level of Lake Michigan.

The Project is required to operate in run-of-the-river mode in order to mimic what has been determined to be the river's natural flow. The Project's operation is crucial to the above uses of Project waters. The Project's maintenance of the legally established lake level for Elk and Skegemog Lakes ensures that the lakes remain deep enough for mooring and navigation. The lakes' extensive wetland communities, as well as the aquatic communities within the area's lakes and streams, have become established over the last 150 years and are dependent on the Project's maintenance of the legal lake level.

2.5. Existing Instream Flow Uses and Water Rights

There are no known existing instream flow uses, other than the Project's use of the Elk River's flow for hydropower generation. There are no known water rights or water rights applications potentially affecting or affected by the Project. Water rights in Michigan are standard riparian rights and not a form of deed ownership. The use of water for domestic purposes is one of the

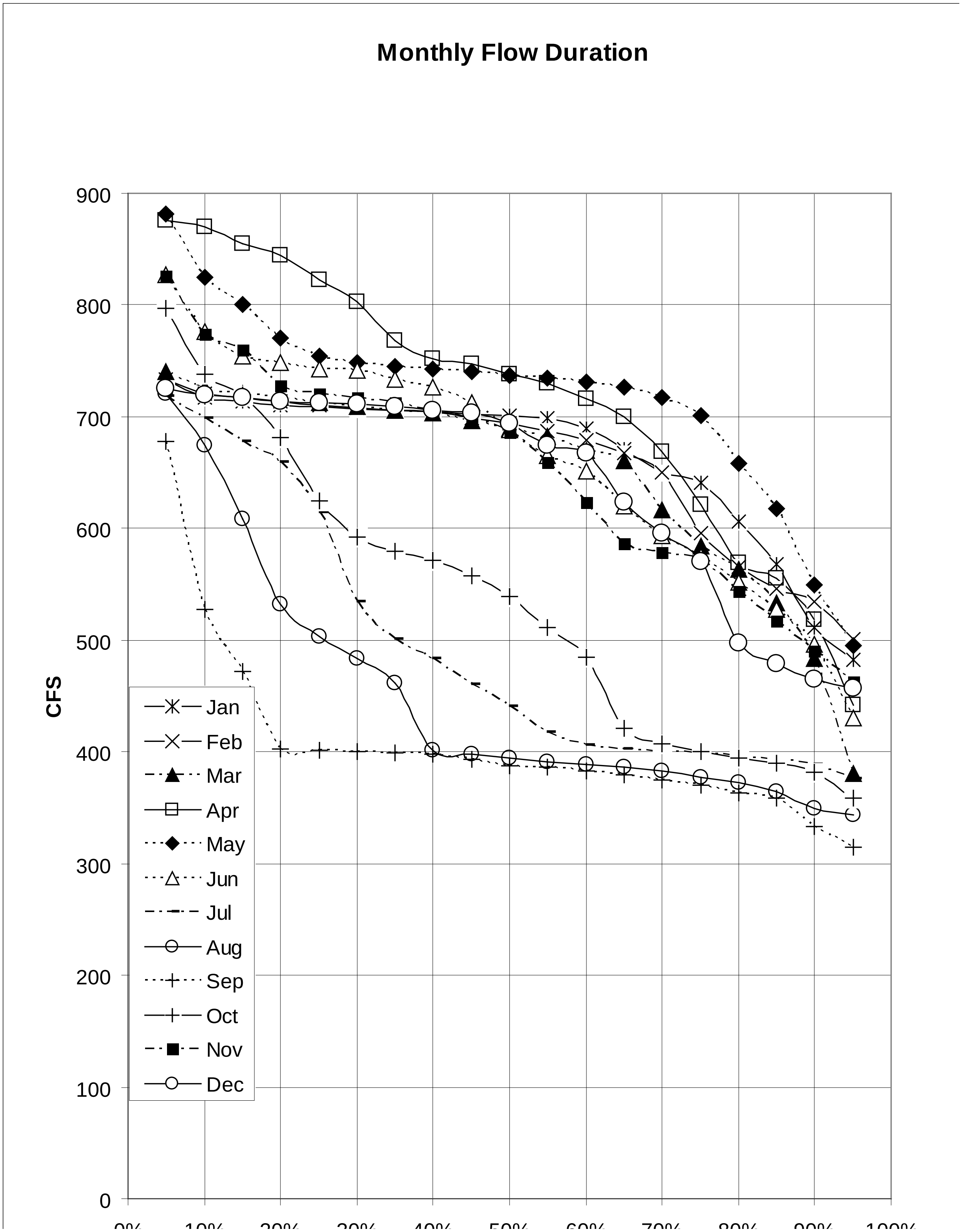

Figure E.2.4 Monthly Flow Duration Curves (Source: MDNR, Stockhausen 2011)

rights granted to property owners, subject to a navigational servitude in favor of the federal government and citizens of the states, the common law public trust doctrine or the correlative use by members of the public, and the state's valid exercise of its police powers (Olson 1981). The County possesses all flowage and water rights required to operate the Project.

2.5.1 Existing Municipal Uses

The Village withdraws surface water for fire protection and limited irrigation of parks and public properties at four locations. Along the Elk River's south channel, water is withdrawn at Memorial Park and on Dexter Street near Kids' Pond. Above the Project, water is withdrawn from the river's north channel off the west side of U.S. 31 south of Dexter Street and at a location east of U.S. 31 near the River Walk Restaurant. No municipality withdraws surface water from the Project Vicinity for drinking water.

2.5.2 Existing Residential Uses

Riparian landowners and golf courses are permitted to withdraw surface water for irrigation. Some riparian landowners also have seasonal pumps that they use for irrigating their lawns and gardens.

2.5.3 Existing Agricultural, Industrial and Commercial Uses

No farms or industries withdraw surface water from the water bodies within the Project Vicinity. Businesses located within the Village are on the municipal water supply and receive water through the Village water system. Riparian businesses outside the Village have the same rights as other riparian landowners.

2.6. Water Quality Standards

The U.S. Environmental Protection Agency (EPA) sets surface water quality standards based on designated uses. The surface waters in the Project Vicinity, as in the rest of the ERCOL, have been designated for the following uses:

- Agriculture
- Industrial
- Public water supply at point of intake
- Navigation
- Coldwater fishery
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Total body contact recreation May 1 - October 1.

MDEQ administers federal and state surface water quality standards for wastewater, non-point source pollution, septage and NPDES permits. These water quality standards are described in detail in *Part 4 Rules of Part 31 of the Water Resources Protection Act 451 of 1994*, as amended (State of Michigan 1994). The water quality standards that apply to the waters within the Project Vicinity are summarized in Table E.2.3.

Parameter	Application	Standard
E. Coli	Total Body Contact Recreation	130 E.coli per 100ml water as 30-day average; 300 E. coli per 100ml water at any time
	Partial Body Contact	1000 E. coli per 100ml water
Fecal coliform	Sewage, NPDES Permits	200 fecal coliform bacteria per 100ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average
Other Infectious Organisms		Limits set case-by-case basis
Chlorine	Bacterial Disinfection	Treated wastewater must be dechlorinated prior to discharge
Dissolved Oxygen	All surface waters of the State	Min. 7 mg/L in designated coldwater fisheries; Min. 5 mg/L in designated warmwater fisheries
	NPDES Permit	Commonly placed in permits for wastewater treatment plants, food processing and manufacturing operations, landfills and other discharges which have the potential to exert an oxygen demand. Limits are typically developed in conjunction with limits in the permit for biochemical oxygen demand and ammonia nitrogen.
pH	All surface waters of the State	6.5-9.0
	NPDES Permit	6.5 daily minimum; 9.0 daily maximum
Temperature	Great Lakes and connecting waters	No receipt of a heat load is permitted that will increase the receiving water's temperature more than 3° F above the existing natural water temperature.
	Rivers, streams and impoundments	No receipt of a heat load is permitted that will increase the receiving water's temperature more than 2° F above the existing natural water temperature for coldwater fisheries, and 5° F for warmwater fisheries or which will increase the temperature of the receiving water above the monthly maximum temperature designated for that water body.
	Inland Lakes	No receipt of a heat load is permitted that will increase the receiviing water's temperature more than 3° F above the existing natural water temperature. No receipt of a head load is permitted that will increase the temperature of the hypolimnion (the dense, cooler layer of water at the bottom of a lake) or decrease its volume.
	Warmwater rivers and inland lakes that serve as principal migratory routes for salmon	No receipt of a heat load is permitted which may adversely affect salmonid migration.
	NPDES Permit	Follows the above standards.
Phosphorus	Point source discharge	1 mg/L total phosphorus as a monthly average; other limits may be placed in permits when deemed necessary.
Other Nutrients	Point source discharge	Must be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria which could impair designated uses of the surface water.

Table E.2.3 Summary of State Water Quality Standards (Source: State of Michigan 1994)

Parameter	Application	Standard
	NPDES Permit	1 mg/L in permits for discharges to surface waters which do not have substantial problems with high levels of nutrients. In the case of nutrient sensitive waters, MDEQ determines the total amount of phosphorus (in lbs per day) which can be assimilated into the particular surface water and allocates phosphorus limits among all permittees.
TSS (Total Suspended Solids)	All surface waters of the State	Michigan has a narrative standard rather than numeric standards. None of the following unnatural physical properties are permitted in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits.
	NPDES Permit	The EPA has promulgated standards for municipal wastewater treatment plans and certain other industrial uses. TSS limits for municipal wastewater treatment are: 30 mg/L as a monthly average and 45 mg/L as a 7-day average. If ther is no applicable Federal numeric standards, permit writers follow the state's narrative standard and use their best professional judgement.

Table E.2.3 Summary of State Water Quality Standards, cont'd (Source: State of Michigan 1994)

2.7. NPDES Permits within The Project Vicinity

There are five National Pollution Discharge Elimination System (NPDES) Permits for discharges within the Project Vicinity, all of which are monitored by MDEQ (Table E.2.4).

Location	Permit Holder	NPDES Permit	Address
Elk Lake	Village of Elk Rapids Wastewater Treatment Plant	MIG570208	8228 Herman Road, Elk Rapids 49629
	Burnette Foods, Inc.	MI0000485	701 US Highway 31 South ER 49629

Table E.2.4 NPDES Permits within the Project Vicinity (Source: EPA 2012a)

2.8. Water Quality Monitoring Programs

2.8.1 Federal Programs

The EPA developed the Lake Michigan-Lake Area Management Plan (LaMP) in 2006. Since the ERCOL discharges directly into Lake Michigan, it is included in the LaMP as part of the Boardman-Charlevoix Watershed (Hydraulic Unit Code #04060105). However, the EPA does not monitor any surface water sites within the Project Vicinity.

Torch Lake, which is located upstream from the Impoundment, and Elk Lake are included on the EPA's List of Impaired Waters for reporting year 2008, the most recent reporting year (EPA 2012). No Total Minimum Daily Loads (TMDLs) are currently set for any surface waters within the ERCOL. For Elk Lake, status was listed as good for Agriculture, Industrial Water Supply and Navigation, but impaired for Aquatic Life Harvesting due to Mercury and PCBs in fish tissue. While the EPA notes that TMDLs are needed, it lists the probable sources contributing to impairment as atmospheric deposition only. Torch Lake is noted as requiring TMDLs for:

- PCBs
- Chlordane (pesticides)
- Mercury
- Dioxin

No dates are listed for the implementation of TMDLs for either lake.

The USGS has limited data available with respect to Elk and Skegemog Lakes. The agency has two monitoring sites on the Elk River: one at U.S. Highway 31 (Station #04127695) and the other 500 feet upstream from the river mouth (Station #04127700). According to Stephen Blumer, chief of USGS Network Operations at the Michigan Water Science Center, as of 2009, neither site shows a history of water quality sampling (Blumer 2009).

2.8.2 State Programs

Both MDEQ and MDNR currently monitor water quality in Michigan's lakes and streams. Since 1973, MDNR has been systematically inventorying and sampling lakes to document trophic conditions, as well as to obtain general baseline water quality information. In 1979, EPA awarded funds to Michigan to expand its lakes monitoring effort. An ambient water quality monitoring program was initiated to sample and classify 730 public access lakes across the state.

In 1998, using Clean Michigan Initiative funds, MDEQ established the Lake Water Quality Assessment monitoring program as part of LaMP in cooperation with USGS - Michigan District. MDEQ monitors water quality (nutrients and chemistry) from three stations in Elk Lake (north basin, central basin and south basin); however, the last monitoring data was obtained in 1985 (MDEQ 2009). The state's monitoring efforts are integrated with the citizen volunteer Cooperative Lakes Monitoring Program sponsored by the Michigan Lakes and Streams Association to order to increase monitoring effectiveness. This program has been regularly monitoring water quality in the ERCOL (see Section 2.8.3).

MDEQ monitors for mercury in fish by collecting fish samples from the same three stations in Elk Lake. According to Joseph Bohr, aquatic biologist with MDEQ, "The data is representative of the entire lake and presumably Elk River as well." (Bohr 2009).

2.8.3 Local Programs

Over the years, there have been numerous local water quality monitoring programs to supplement the state programs. ESLA has conducted water quality testing since the 1950s. Other monitoring efforts include:

1976 - 1986: Michigan Lakes and Streams Association - Cooperative Lakes Monitoring Program

1987 - Present: Tip of the Mitt Watershed Council (TOTM) - Comprehensive Water Quality Program

1988: TOTM - *Cladophora* Surveys of Elk Lake and Skegemog Lake

1990: TOTM, MDNR - Self-Help Lake Monitoring Program

2006: Elk Skegemog Lakes Association (ESLA) - Preliminary Study of Water Quality Parameters in Elk and Skegemog Lakes

2007: ESLA - Glacial Relicts of the Elk River Chain of Lakes Watershed in Antrim, Kalkaska and Grand Traverse Counties, Michigan

2007: Three Lakes Association (TLA) - *Diporeia* Survey of Elk Lake

2008: ESLA - Examination of Water Quality Data for Elk Lake

Local lake associations have also received significant local, state and federal funding for a variety of special water quality studies and programs on individual lakes within the ERCOL, including within the Project Vicinity.

Local water quality monitoring data for the Project Vicinity can be found in the databases maintained by The Watershed Center - Grand Traverse Bay (TWC) and TOTM. TLA's website contains complete reports from their monitoring studies. Since water quality is relatively consistent across the ERCOL, a list of additional water quality monitoring programs and studies for the lakes below the Bellaire Dam is attached as Appendix E.

2.9. WATER QUALITY

2.9.1 Summary

In general, the lakes within the ERCOL have exceptionally high water quality that has changed little over time:

> When compared with historical water quality data, results … indicate that the open water quality of these lakes has not changed drastically over the last sixty years, even though recreational use and development pressures within the system have increased substantially. Results … suggest that modern phosphorus levels for all three lakes (Intermediate Lake, Lake Bellaire and Elk Lake) [studied] are similar to those at the time of settlement. Phosphorus reconstruction indicates that phosphorus levels increased coincident with logging and settlement within the watershed, but gradually declined soon after the logging era to the present time. Historical trophic changes in these lakes appear to be confined within a fairly narrow range (MDNR and EPA 1993).

Recent water quality monitoring by lake associations, regional conservation organizations and state and federal agencies suggest that the state of water quality within the Project Vicinity has not changed significantly in the 17 years that have passed since the foregoing statement was made (Table E.2.5). Seven of the Project Vicinity's ten major tributaries are Designated Trout Streams, a state designation only given to streams whose water and habitat is of high enough quality to support healthy trout populations. The lakes and tributaries upstream of the Project Vicinity are of similar quality (TOTM 2008).

The ERCOL's exceptionally high water quality is due to many factors, including:

Waterbody	Water Quality	Nutrient Levels	Oxygen Levels
Torch River	High	Low	Saturation
Skegemog Lake	High	Low	Saturation
Elk Lake	High	Low	Saturation
Elk River	High	Low	Saturation
East Grand Traverse Bay	High	Low	Saturation

Table E.2.5 Overview of Water Quality within the Project Vicinity (Source: TOTM 2008)

Geology: The area contains deep lakes with long flushing rates, and shale and limestone bedrock.

Ecology: Extensive wetlands and natural buffers have been protected and preserved along lakes and streams. The extensive protected wetlands located around the five lakes below the Bellaire Dam have contributed significantly to maintaining the area's high water quality. Extensive publicly owned wetlands have been protected by MDNR, Michigan Natural Resources Trust Fund, and the County, as well as by township and village governments. The Grand Traverse Regional Land Conservancy has worked with hundreds of property owners to protect privately owned wetlands within the watershed. Many of these large wetland complexes were created as a result of the installation of the first dam at the Project site in the 1850s. The consistent and well-regulated lake levels that have resulted from the Project's operation have maintained these critical wetlands and the diverse ecosystems they have supported for the past 150 years.

Development: Shoreline development is primarily single family residential. Major transportation corridors are located on the east and west edges of the watershed. Villages are small, population density is low, and there are no large industries.

Management: Watershed protection organizations, lake associations and land conservancies have been in place for over 50 years, educating communities and actively monitoring and managing the watershed. Farmers follow agricultural practices which protect water quality. Community pride in protecting the area's natural resources extends throughout the ERCOL.

2.9.2 Seasonal Variations in the Lakes

All of the lakes below the Bellaire dam, including Elk and Skegemog Lakes, experience "turn over", a seasonal exchange of surface and bottom water layers. During both summer and winter, the lakes are stratified. Twice a year, in the spring and autumn as temperatures rise and fall, the more dense, colder water sinks, forcing the less dense, warmer water to the surface. While studies of seasonal turnover have not been done for Elk or Skegemog Lake, a study was conducted on Lake Bellaire and Clam Lake in 2006. The results from that study are broadly applicable to Elk and Skegemog Lakes.

Lake Bellaire and Clam Lake were sampled from April through October in order to capture the expected seasonal variation in water quality parameters related to thermal stratification, nutrient loading, plankton productivity and oxygen-demanding processes. Results indicate that water clarity is highest in the spring and steadily decreases through the summer and fall in response to chlorophyll peaks in July and August. Water clarity is lowest in winter. Temperatures in the lakes are near freezing during winter (around 2˚C). They increase through spring and summer to around 25˚C and decrease through the fall. Dissolved oxygen is highest in early spring (15 mg/L) and decreases through the summer, reaching its lowest levels in winter (0.1mg/L). pH peaks in January at 8.75 and reaches a low of 7.25 in October (TLA 2007).

2.9.3 Recent Water Quality Data

MDEQ conducted their most recent water quality sampling on Elk Lake in 1985 (Table E.2.6) and on Skegemog Lake in 2003 (Table E.2.7). TOTM has conducted water quality sampling annually for more than ten years. Their most recent data, summarized with that of ESLA and the Michigan Lakes and Stream Association, is set forth in Table E.2.8.

Water clarity observations by riparian property owners suggest that transparency may be increasing in the watershed as a result of the invasive Zebra mussel (*Dreissena polymorpha*), which first appeared in the ERCOL in the 1980s. However, secchi disk/transparency data for Elk and Skegemog Lakes have remained fairly constant.

There is limited water quality data available for the Project Vicinity's tributaries. EPA conducted a study of selected tributaries to Elk Lake and Skegemog Lake in 2006 to measure Phosphorus. Phosphorus is normally found in concentrations of less than 10 parts per billion (ppb) in high quality surface waters. All of the tributaries and lakes within the Project Vicinity that were sampled met this standard, as do Elk and Skegemog Lakes (Tables E.2.6 - E.2.9).

2.9.4 Fish Consumption Advisories

The Michigan Department of Community Health - Division of Environmental Health reports fish consumption advisories annually based on the fish monitoring done by MDEQ. Advisories are based on Rule 57 of MDEQ's Surface Water Quality Standards and are delineated by species, pollutant, and location. The fish consumption advisories for the Project Vicinity are set forth in Table E.2.10.

2.10. Gradient for Downstream Reaches Directly Affected by the Project

The water in Elk River above the Project dam averages 10.5 feet above the level of Grand Traverse Bay. The legally established summer and winter lake levels are 590.8 feet and 590.2 feet respectively, measured at the Elk Rapids Dam Gauge. The Project maintains the legal lake level through its normal run-of-river operation. Lake Michigan's average elevation is about 579 feet above sea level.

3. FISH AND AQUATIC RESOURCES

3.1. Overview

Since adjusting to the initial impacts of the first dam and hydropower plant in the mid-1850s, the aquatic systems within the Project Vicinity have suffered no substantial impairment or significant change. Aquatic habitat within the Project Vicinity and throughout the lakes and tributaries below the Bellaire Dam is good to excellent. The rivers have stable banks and abundant gravel to support coolwater and coldwater fisheries, while the lack of development, extensive wetlands and numerous groundwater springs provide clean, clear water to the aquatic systems.

Although the Project dam prevents native fish migration between the ERCOL and Lake

Sampling Location	Total Water Temperature	Total Transparency Secchi Disc	Total pH	Total Dissolved O_2	Total Dissolved O_2	Total *Chlorophyll A*	Total Hardness Ca mg	Total Nitrite Nitrogen	Total Nitrite plus Nitrate
	(˚C)	(meters)		(mg/L)	(% Saturation)	(ug/L fluorometric, corrected)	(mg/L as CaCO3)	(mg/L as N)	(mg/L as N)
Elk Lake North Basin (Lat. 44.89639/ Long. -85.3739)									
8/28/1985		4.3							
Near Surface	21		8.5	9.4	104.44%				0.183
Midcolumn	14.37 (avg.)		8.17 (avg.)	9.929 (avg.)	94.996% (avg.)	0.8			0.24
Bottom			8.15	9.6					0.34
4/24/1985		7.0							
Near Surface	6		8.2	12.4	99.21%			0.011	0.28
Midcolumn	5		8.25	12.8	100.01%	0.7	141.757	0.011	0.28
Bottom	4.5		8.35	12.8	97.72%			0.012	0.28
Elk Lake South Basin (Lat. 44.82778/ Long. -85.3733)									
8/28/1985									
Near Surface	21.5			9.6	106.67%				0.164
Midcolumn	14.27 (avg.)			9.957 (avg.)	93.735 % (avg.)				0.25
Bottom				10.2					0.34
4/24/1985		7.6							
Near Surface	5		8.2	12.6	98.44%			0.012	0.28
Midcolumn	4.5		8.2	12.9	98.48%	37	136.452	0.011	0.28
Bottom	4.5		8.2	12.8	97.72%			0.011	0.28

Table E.2.6 Recent State Water Quality Data – Elk Lake (MDEQ 2009)

Sampling Location	Total Ammonia Nitrogen	Total Kjeldahl Nitrogen	Total Organic Nitrogen	Total Phosphorus	Total Phosphorus in Total Orthophosphate	Total Specific Conductance, Field
	(mg/L as N)	(mg/L as N)	(mg/L as N)	(mg/L as P)	(mg/L as P)	(umhos/Cm @ 25˚C)
Elk Lake North Basin (Lat. 44.89639/ Long. -85.3739)						
8/28/1985						
Near Surface	0.009	0.19	0.181	0.007		
Midcolumn	0.026	0.2	0.174	0.007		
Bottom	0.002	0.13	0.128	0.006		
4/24/1985						
Near Surface	0.012	0.08	0.07	0.006	0.001	307
Midcolumn	0.008	0.1	0.09	0.004	0.001	264
Bottom	0.008	0.08	0.07	0.001	0.001	286
Elk Lake South Basin (Lat. 44.82778/ Long. -85.3733)						
8/28/1985						
Near Surface	0.014	0.17	0.156	0.003		
Midcolumn	0.034	0.14	0.106	0.005		
Bottom	0.003	0.14	0.137	0.012		
4/24/1985						
Near Surface	0.014	0.14	0.13	0.002	0.001	317
Midcolumn	0.08	0.14	0.13	0.001	0.001	299
Bottom	0.09	0.08	0.07	0.001	0.001	302

Table E.2.6 Recent State Water Quality Data – Elk Lake, cont’d (MDEQ 2009)

Sampling Location	Total Water Temperature	Total Transparency Secchi Disc	Total pH	Total Dissolved O_2	Total Hardness Ca mg	Total Nitrite plus Nitrate
	(˚C)	(meters)		(mg/L)	(mg/L as CaCO3)	(mg/L as N)
Skegemog Lake Northwest Basin (Lat. 44.8194/ Long. -85.3406)						
Site 1- 8/12/2003						
Near surface	24					
Midcolumn			8			
Bottom	23.5		8	6		0.103
Site 2- 8/12/2003						
Near surface	24			7.6		
Midcolumn	24		8	7.6		
Bottom	24		8	7.6		
Site 3- 8/12/2003						
Near surface	23.5	2.7	8			0.101
Midcolumn			8.1	7.7		0.103
Bottom			7.9	7.3		
Site 4- 8/12/2003						
Near surface	24.5			7.6		
Midcolumn			8	7.3		
Bottom	23.5		7.7	4.8		
Site 1- 4/15/2003						
Near surface						0.27
Midcolumn	5.7 (avg.)					
Bottom			8			0.27
Site 2- 4/15/2003						
Near surface	6	4.9				
Midcolumn			8	11.4	19.6	
Bottom				11.4		

Table E.2.7 Recent State Water Quality Data – Skegemog Lake (MDEQ 2009)

Sampling Location	Total Water Temperature (˚C)	Total Transparency Secchi Disc (meters)	Total pH	Total Dissolved O_2 (mg/L)	Total Hardness Ca mg (mg/L as CaCO3)	Total Nitrite plus Nitrate (mg/L as N)
Skegemog Lake Northwest Basin (Lat. 44.8194/ Long. -85.3406)						
Site 3- 4/15/2003						
Near surface						
Midcolumn	6		8			
Bottom	5.5			11.4		
Site 4- 4/15/2003						
Near surface			8	11.6		
Midcolumn			8	11.45 (avg.)	142	0.267
Bottom	5.5					

Sampling Location	Total Ammonia Nitrogen (mg/L as N)	Total Organic Nitrogen (mg/L as N)	Total Phosphorus (mg/L as P)	Total Specific Conductance, Field (umhos/Cm @ 25˚C)
Skegemog Lake Northwest Basin (Lat. 44.8194/ Long. -85.3406)				
Site 1- 8/12/2003				
Near surface				
Midcolumn				310
Bottom				313
Site 2- 8/12/2003				
Near surface				311
Midcolumn				
Bottom			0.006	
Site 3- 8/12/2003				
Near surface				311
Midcolumn		0.77		311
Bottom				313
Site 4- 8/12/2003				
Near surface		1.27	0.004	310
Midcolumn			0.005	311
Bottom		1.16		311

Table E.2.7 Recent State Water Quality Data – Skegemog Lake, cont'd (MDEQ 2009)

Sampling Location	Total Ammonia Nitrogen	Total Organic Nitrogen	Total Phosphorus	Total Specific Conductance, Field
	(mg/L as N)	(mg/L as N)	(mg/L as P)	(umhos/Cm @ 25˚C)
Skegemog Lake Northwest Basin (Lat. 44.8194/ Long. -85.3406)				
Site 1- 4/15/2003				
Near surface	1.31			
Midcolumn	0.823		0.01	255
Bottom	1.21			255
Site 2- 4/15/2003				
Near surface				
Midcolumn			0.6	
Bottom				
Site 3- 4/15/2003				
Near surface		0.28		
Midcolumn		0.16		255
Bottom		0.37		
Site 4- 4/15/2003				255
Near surface			0.015	255
Midcolumn			0.009	
Bottom				

Table E.2.7 Recent State Water Quality Data – Skegemog Lake, cont’d (MDEQ 2009)

	Dissolved Oxygen	pH	Secchi Disk	*Chlorophyll A*	Total Phosphorus	Specific conductivity	Chloride	Nitrate-nitrogen	Total Nitrogen
	(mg/L)		Ave. Depth (feet)	Mean (ug/L)	(parts/billion)	(parts/billion)	(mg/L)	(parts/billion)	(parts/billion)
MDEQ Standard	7	6.5-9.0	None	None	None. Under 10 is generally considered high water	None	None	None	None
Skegemog Lake	12.75	8.36	14	1.5	1.8	257.7	8.3	300	311
Elk River	11.64	8.47	N/A	N/A	1	267.1	8	245	305
Elk Lake	13.24	8.31	16	0.3	2.9	249.4	9.3	262.3	338
Grand Traverse Bay	13.34	8.29	24	1.04	2	232.6	6.3	257.3	331

Table E.2.8 Recent Local Water Quality Data – Elk and Skegemog Lakes (Source: (Sources: TOTM 2008, Michigan Lakes and Stream Association 2008, ESLA 2008)

Tributary	Phosphorus (ppb)
Torch River	Not available
Rapid River	4
Elk River	3.2
Vargason Creek	7.2
Desmond Creek	3.8
Barker Creek	5.3
Copeland Creek	4.3
Battle Creek	5.5
Maplehurst Creek	Not available
Williamsburg Creek	5.2

Table E.2.9 Phosphorus in Tributaries to Elk and Skegemog Lakes (Source: ESLA 2006)

Location	Common Name	Scientific Name	Pollutants
All inland lakes	Brown trout	*Salmo trutta*	Mercury* - All fish listed
	Crappie	*Pomoxis ssp.*	
	Great Lakes muskellunge	*Esox masquinongy*	
	Largemouth bass	*Miocropterus salmoides*	
	Northern pike	*Esox lucius*	
	Rock bass	*Ambloplites rupestris*	
	Smallmouth bass	*Miocropterus dolomieu*	
	Walleye	*Stizostedion vitreum*	
	Yellow perch	*Perca flavescens*	
Elk Lake	Brown trout	*Salmo trutta*	PCBs, Mercury*
	Lake trout	*Salvelinus namaycush*	PCBs, Mercury*

*Most of the mercury in fish within the region is the result of atmospheric deposition

Table E.2.10 Fish Consumption Advisories within the Project Vicinity (Source: Michigan Department of Community Health 2009)

Michigan, the Project has protected the ERCOL's aquatic systems from the invasions of Sea lamprey, Alewives, Round gobies and other non-native species that have devastated the Great Lakes. In fact, fisheries composition within the Project Vicinity and above has not substantially changed over the period that the Project has been in place. The region remains a premier destination for all kinds of fishermen, from shore anglers to waders to boaters, all attracted by the diverse fish communities that thrive within the ERCOL's lakes, rivers and streams.

The ERCOL is unique in that the many interconnected lakes and rivers enable fish to travel from one water body to another. As a result, this discussion of the Project Vicinity's fish and aquatic resources will, at times, incorporate information regarding the lakes and tributaries found upstream of the Project Vicinity, between Skegemog Lake and the Bellaire Dam, as such information will enhance understanding of the aquatic communities within the Project Vicinity.

3.2. Fish Community Types within the Project Vicinity

The ERCOL's chain of lakes support three distinct fisheries, all of which are found within the Project Vicinity: coldwater, coolwater, and warmwater. While MDNR has not conducted formal studies to assess these fish communities, the agency has used predominant fish species data collected in creel census surveys to designate the lakes and streams within the ERCOL as supporting predominantly coldwater or warmwater fisheries.

Due to the connectivity between the lakes, species from one type of fishery can often be found mingling in other fisheries. For example, Skegemog Lake has a warmwater fishery at its east end where Torch River enters the lake; however, coolwater species can be found at the lake's west end and within the 5 foot deep, 1/4 mile wide narrows that connects Skegemog Lake to Elk Lake, a coldwater fishery (the Narrows). The Elk River into which Elk Lake flows is classified as a warmwater fishery.

3.2.1 Warmwater Fisheries

Warmwater fish are found in the warmer, shallower portions of lakes and streams and the nearshore waters of coldwater lakes, in depths of 1-20 feet. Warmwater fisheries within the

ERCOL are characterized by the species listed in Table E.3.1. See Section E.3.4 for species specific to the Project Vicinity.

3.2.2 Coolwater Fisheries

Coolwater fish occupy the moderate depths of cold, deep lakes, the shallower areas of colder rivers and the mouths of coldwater streams where they enter warmer lakes and rivers. Many warmwater species, such as Yellow perch and Smallmouth bass also live in coolwater areas. Coolwater species are generally found in lakes at depths of 21-50 feet. Coolwater fisheries within the ERCOL are characterized by the species listed in Table E.3.2. See Section E.3.4 for species specific to the Project Vicinity.

3.2.3 Coldwater Fisheries

Coldwater fisheries are found in cold, deep, lakes with low productivity and in cold, fast streams. Coldwater fisheries within the ERCOL are characterized by the species listed in Table E.3.3. See Section E.3.4 for species specific to the Project Vicinity.

3.3. Fish Species within the Project Vicinity

While no comprehensive inventory of fish species has been conducted in the Project Vicinity, MDNR has used various survey methods over the years to describe fish populations, including angler surveys, trap-net lifts, fyke-net lifts, gill net lifts and electrofishing runs. On-site methods, including interviews of anglers at public access sites (also known as “creel censuses”) have been used since 1940. The Statewide Angler Survey Program has been used extensively to estimate angler effort, harvest and catch. These activities have yielded data regarding fish species presence and spatial distribution, but the data is incomplete.

Yet, while the data may be incomplete, it is important to note that fish community composition within the Project Vicinity and between Skegemog Lake and the Bellaire Dam has not changed in the past sixty years, indicating that these systems are healthy and stable. A list of fish species reported in the Project Vicinity or between Skegemog Lake and the Bellaire Dam is set forth in Table E.3.4. Water bodies above the Project Vicinity but below the Bellaire Dam have been included due to the lakes’ connectivity.

3.3.1 Native Fish Species

Forty-three fish species have been reported below the Bellaire Dam; 30 of those species have been reported in the Project Vicinity. There are no catadromous fish found within the ERCOL. The non-native Salmon species introduced by MDNR for sport fishing are the only anadromous fish found. The following native migratory species have been reported below the Bellaire Dam: Great Lakes muskellunge (*Esox masquinongy*) and Lake trout (*Salvelinus namaycush*). Lake sturgeon (*Acipenser fulvescens*) have been reported present in the past but are likely very rare or absent today (see Section 3.7 Rare, Threatened and Endangered Species). While the Project’s presence does prevent these species from migrating to and from Lake Michigan, the Project has also prevented numerous invasive species from entering the ERCOL (see Section 3.3.4).

3.3.2 Introduced Species

Five non-native fish species have been planted in the lakes below the Bellaire Dam in order to increase the sport fishery. These sport fishing species include Brown trout (*Salmo trutta*), Rainbow

Scientific Name	Common Name
Amieurus melas	Black bullhead
Amieurus natalis	Yellow bullhead
Etheostoma nirgum	Johnny darter
Lepisosteus osseus	Longnose gar
Lepomis gibbosus	Pumpkinseed sunfish
Lepomis macrochirus	Bluegill
Miocropterus salmoides	Largemouth bass
Notropis heterdon	Blackchin shiner
Notropis heterolepis	Blacknose shiner
Notropis stamineus	Sand shiner
Perca flavescens	Yellow perch
Pimephales notatus	Bluntnose minnow
Pomoxis nigromaculatus	Black crappie

Table E.3.1 ERCOL Warmwater Fishery Species (Source: MDNR 2009b, 2009c)

Scientific name	Common Name
Ambloplites rupestris	Rock bass
Catostomus commersoni	White sucker
Esox lucius	Northern pike
Esox masquinongy	Great Lakes muskellunge
Etheostoma exiles	Iowa darter
Miocropterus dolomieu	Smallmouth bass
Notropis atherinoides	Emerald shiner
Perca flavescens	Yellow perch
Stizostedion vitreum	Walleye

Table E.3.2 ERCOL Coolwater Fishery Species (Source: MDNR 2009b, 2009c)

Scientific name	Common Name
Coregonus artedi	Lake herring
Coregonus clupeaformis	Lake whitefish
Cottus bairdi	Mottled sculpin
Cottus cognatus	Slimy sculpin
Lota lota	Burbot
Myoxocephalus thompsoni	Deepwater sculpin
Onchorynchus mykiss	Rainbow trout/Steelhead
Percopsis omiscomaycus	Troutperch
Salmo trutta	Brown trout
Salvelinus fontinalis	Brook trout
Salvelinus namaycush	Lake trout

Table E.3.3 ERCOL Coldwater Fishery Species (Source: MDNR 2009b, 2009c)

Scientific name	Common Name	Elk River Below Dam	Elk River Above Dam	Elk Lake	Skegemog Lake	Torch River	Rapid River	Torch Lake	Clam Lake	Grass River	Lake Bellaire
NATIVE FISH											
Acipenser fulvescens	Lake sturgeon	formerly found. Now very rare or absent (See Section 4.7 Rare, threatened and endangered species)									
Ambloplites rupestris	Rock bass	x		x	x	x		x	x	x	x
Amia calva	Bowfin			x							
Amieurus melas	Black bullhead			x	x			x	x	x	
Amieurus natalis	Yellow bullhead			x	x			x			
Amieurus nebulosus	Brown bullhead	x	x	x	x			x	x		x
Catostomus commersoni	White sucker		x	x	x	x		x	x		x
Coregonus artedi	Lake herring		x	x	x	x		x			x
Coregonus clupeaformis	Lake whitefish		x	x				x			
Cottus bairdi	Mottled sculpin	x		x			x	x	x		
Cottus cognatus	Slimy sculpin			x				x	x	x	
Esox lucius	Northern pike		x	x				x	x	x	x
Esox masquinongy	Great Lakes muskellunge		x	x	x	x		x			x
Etheostoma exiles	Iowa darter	x		x							x
Etheostoma nirgum	Johnny darter	x		x				x		x	x
Fundulus diaphanus	Banded killifish	x									x
Hybognathus hankinsoni	Brassy minnow								x		
Ictalurus punctatus	Channel catfish			x	x						
Lepisosteus osseus	Longnose gar			x	x			x	x		x
Lepomis cyanellus	Green sunfish									x	x
Lepomis gibbosus	Pumpkinseed sunfish	x	x	x	x	x		x	x	x	
Lepomis macrochirus	Bluegill	x	x	x	x				x		x
Lepomis megalotis	Longear sunfish	x		x						x	

Table E.3.4 Fish Species Found Below the Bellaire Dam (Source: MDNR 2009b, 2009c, Fuller 2001)

Scientific name	Common Name	Elk River Below Dam	Elk River Above Dam	Elk Lake	Skegemog Lake	Torch River	Rapid River	Torch Lake	Clam Lake	Grass River	Lake Bellaire
NATIVE FISH											
Lota lota	Burbot		x	x				x			
Luxilus cornutus	Common shiner	x		x				x	x		x
Miocropterus dolomieu	Smallmouth bass	x	x	x	x	x		x	x	x	x
Miocropterus salmoides	Largemouth bass	x	x	x	x			x	x	x	x
Myoxocephalus thompsoni	Deepwater sculpin			x				x	x		
Notemigonus crysoleucas	Golden shiner				x				x		x
Notropis atherinoides	Emerald shiner	x							x		
Notropis heterdon	Blackchin shiner	x							x	x	x
Notropis heterolepis	Blacknose shiner	x		x					x	x	x
Notropis hudsonius	Spottail shiner								x		x
Notropis rubellus	Rosyface shiner			x	x				x		
Notropis stamineus	Sand shiner	x		x					x		x
Notropis volucellus	Mimic shiner								x		x
Perca flavescens	Yellow perch		x	x	x	x		x	x	x	x
Percina caprodes	Logperch			x				x			x
Percina maculata	Blackside darter							x			
Percopsis omiscomaycus	Troutperch							x			x
Phoxinus eos	Northern redbelly dace			x							
Pimephales notatus	Bluntnose minnow	x		x				x	x	x	x
Pimephales promelas	Fathead minnow								x		
Pomoxis nigromaculatus	Black crappie			x				x	x		x
Pungitius pungitius	Ninespine stickleback	x	x								
Rhinichthys atratulus	Blacknose dace			x							
Rhinichthys cataractae	Longnose dace			x							

Table E.3.4 Fish Species Found Below the Bellaire Dam, cont'd (Source: MDNR 2009b, 2009c, Fuller 2001)

Scientific name	Common Name	Elk River Below Dam	Elk River Above Dam	Elk Lake	Skegemog Lake	Torch River	Rapid River	Torch Lake	Clam Lake	Grass River	Lake Bellaire
NATIVE FISH											
Salvelinus fontinalis	Brook trout		x	x			x	x	x		x
Salvelinus fontinalis X Salvelinus namaycush	Splake			x	x						
Salvelinus namaycush	Lake trout			x				x			x
Semotilus atromaculatus	Creek chub			x							
Stizostedion vitreum	Walleye		x	x	x			x	x		x
Umbra limi	Central mudminnow	x		x					x		
NONNATIVE FISH	(I) = invasive										
Alosa pseudoharengus	Alewife (I)	x									
Cyprinus carpio	Common carp (I)	x									
Gymnocephalus cernuus	Eurasian Ruffe (I)	x									
Monrone americana	White perch (I)	x									x
Neogobius melanostomus	Round goby (I)	x									
Onchorynchus mykiss	Rainbow trout/ Steelhead	x	x	x	x	x	x	x	x		
Onchorynchus nerka	Kokanee salmon							x			
Oncorhynchus carpio	Coho salmon	x									
Oncorhynchus tshawytscha	Chinook salmon	x									x
Osmerus mordax	Rainbow smelt			x				x			x
Petromyzon marinus	Sea lamprey (I)	x									
Salmo salar	Atlantic salmon	x		x		x		x			
Salmo trutta	Brown trout	x	x	x	x		x	x	x		

Table E.3.4 Fish Species Found Below the Bellaire Dam, cont'd (Source: MDNR 2009b, 2009c, Fuller 2001)

trout/Steelhead (*Onchorynchus mykiss*), Rainbow smelt (*Osmerus mordax*), Atlantic salmon (*Salmo salar*) and Kokanee salmon (*Onchorynchus nerka*). While they successfully reproduce in some of the streams below the Bellaire Dam, their populations are not self-sustaining. Only Atlantic salmon have been stocked since 1996. Kokanee salmon is unlikely to still be in the watershed since they have not been stocked since 1966.

When the Lake Michigan Lake trout fishery collapsed in the 1940s and 1950s, the State of Michigan introduced non-native salmon species to Lake Michigan. All of the non-native salmon species noted above, plus Chinook salmon (*Oncorhynchus tshawytscha*), can be found in Grand Traverse Bay and the lower reaches of the Elk River below the Project.

A summary of the stocking history for the Project Vicinity is set forth below (MDNR 2009c):

Skegemog Lake
Bass were planted in 1932, Perch in 1933, and Great Lakes muskellunge in 1990 and 1994. The lake has not been stocked since.

Elk Lake
Between 1894-1941, Lake trout, Largemouth bass, Smallmouth bass, Walleye, Yellow perch and Bluegill were planted at various times. From 1939-1984, Lake trout, Rainbow trout, Brown trout and Splake were planted. Since 1984¸ only Brown trout and Rainbow trout have been planted in the lake. Brown trout were last planted in 1997 (13,500 fish). Rainbow trout have been planted yearly. Since 2002, yearly planting numbers have been plus or minus 21,000 fish.

Elk River (North Channel, above the Project powerhouse)
Since 1980, MDNR has planted Brown trout and Rainbow trout in the north channel. In 2009, 16,000 Brown trout and 7,269 Rainbow trout were planted.

Elk River (South Channel, within the Kids' Pond)
Between 1980 and 2000, 200-1,000 Rainbow trout were planted annually in the south channel under a private permit in order to provide fishing stock for the Kids' Pond. No fish have been planted since then.

3.3.3 Sport Fishing

MDNR has been stocking game fish in the ERCOL since the 1880s. Stocking plans for all the lakes have been based almost entirely on these fish, especially inland Trout. The main sport fish within the Project Vicinity are set forth in Table E.3.5. Children also fish the Kids' Pond for Panfish, including Pumpkinseed, Sunfish and Bluegill.

3.3.4 Invasive Fish Species

Non-native, invasive aquatic species have wreaked havoc on the ecosystems within the Great Lakes. Invasive species currently plaguing the Great Lakes system include Sea lamprey (*Petromyzon marinus*), Eurasian ruffe (*Gynocephalus cernuus*), Round goby (*Neogobius melanostromus*), alewife (*Alosa pseudoharengus*), Common carp (*Cyprinus carpio*), and White perch (*Monrone Americana*). One study estimates that invasives species impacts cost the Great Lakes region over $200 million annually. This figure includes $123,500,000 in lost income from sport fishing and $47,659,000 in lost income from wildlife watching (Finnof 2008). While losses

Scientific Name	Common Name	Skegemog Lake	Elk Lake	Elk River Above Dam	Elk River Below Dam
Ambloplites rupestris	Rock bass	x	x	x	x
Coregonus artedi	Lake herring		x		
Coregonus clupeaformis	Lake whitefish			x	x
Cyprinus carpio	Common carp (I)				x
Esox lucius	Northern pike	x			
Ictalurus ssp.	Catfish				x
Miocropterus dolomieu	Smallmouth bass	x	x	x	x
Miocropterus salmoides	Largemouth bass	x		x	x
Onchorynchus mykiss	Rainbow trout/Steelhead		x	x	x
Oncorhynchus carpio	Coho salmon				x
Oncorhynchus tshawytscha	Chinook salmon				x
Perca flavescens	Yellow perch	x	x	x	x
Salmo trutta	Brown trout				x
Salvelinus namaycush	Lake trout		x	x	x

Table E.3.5 Major Sport Fish in the Project Vicinity (Source: MDNR 2009, Local Fishermen 2009)

vary among the Great Lakes, reductions to sport fishing and wildlife watching for Lake Michigan due to invasive species impacts are estimated at 11% and 0.8% respectively. Governments around the Great Lakes spend hundred of millions of dollars per year on attempts to control invasive species within the lakes. The annual cost to control water pipe clogging by Quagga and Zebra mussels within the region is estimated at $100 million alone (NRDC 2009).

Thanks to the Project, whose dam prevents invasive species from entering the ERCOL from Lake Michigan via the Elk River, none of these invasive species have been reported in the ERCOL. The Project continues to protect the region’s unique environmental resources and the fishing and wildlife tourism economies on which the region heavily depends at very minimal cost compared to other measures used in the region to protect against the incursion of invasive species. If, as many fear, Asian carp have reached Lake Michigan, the Project’s role as a barrier to invasive species will become even more crucial to the ERCOL’s preservation and health.

3.4. Spatial and Temporal Distribution of Fish within the Project Vicinity

Limited data is available concerning the temporal distribution (abundance, age distribution) and spatial distribution (location of species within a lake, spawning locations, movement) for fish populations within the Project Vicinity or elsewhere below the Bellaire Dam. Most surveys that have been conducted have focused on determining the survival and age classification of stocked Lake trout as a method of evaluating the effectiveness of stocking plans.

3.4.1 Standing Crop and Spatial Distribution

Fish populations in Elk and Skegemog Lakes are very similar, although Elk Lake has more coldwater fish species. The composition of the fish communities within these two lakes has remained consistent over the years, as documented by MDNR surveys. No data was available for the Elk River or other tributaries in the Project Vicinity and no studies were available reviewing seasonal fluctuations in fish populations within the Project Vicinity. Both Elk and Skegemog Lakes freeze early in the winter and stay frozen into the late spring. Fishing occurs year round, with ice fishing occurring in January-March.

3.4.2 Elk Lake

MDNR conducted fish surveys in 1891, 1923, 1956, 1960, 1971, 1975, 1979, 1983, 1986, 1989, 1990, 2005, 2006, and 2008-2009. Fish were collected in 1986 and 1989 in order for the EPA to determine contamination levels in eight fish species found in Elk Lake: Brown trout, White sucker, Lake trout, Lake herring, Lake whitefish, Rainbow trout, Rock bass and Yellow perch.

MDNR's 1990 survey of Elk Lake identified the following dominant fish species (MDNR 1990):

- Smallmouth bass
- Yellow perch
- Black crappie
- Rock bass
- White sucker
- Brown trout
- Rainbow trout
- Lake trout
- Lake whitefish
- Lake herring/Cisco
- Burbot

3.4.3 Skegemog Lake

The most recent fish surveys of Skegemog Lake were conducted by MDNR in 1996 and 2002. The 1996 survey determined the age class of the fish species caught and evaluated the status of Great Lakes muskellunge. The 2002 survey was conducted to determine if there had been a decline in the population of Rock bass in the lake. The 1996 survey of Skegemog Lake identified the following dominant fish species (MDNR 1996):

- Smallmouth bass
- Lake herring/Cisco
- Bluegill
- Pumpkinseed sunfish
- Longnose gar
- White sucker
- Rainbow trout
- Northern pike
- Walleye
- Channel catfish
- Brown trout
- Rock bass
- Largemouth bass
- Bullhead catfish
- Great Lakes Muskellunge

3.4.4 Both Lakes

The most recent Creel Census in 2009 identified fish species, relative abundance, and life stage/age based on length in Elk and Skegemog Lakes (MDNR 2009b). The survey was conducted from April 2008 - March 2009. At present, only a summary of the census is available.

The 2009 Creel Census identified 21 species in Elk and Skegemog Lakes. The most abundant species (2,000-9,000) were Rock bass and White sucker. Yellow perch, Smallmouth bass, Pumpkinseed sunfish, Northern pike, and Bluegill were moderately abundant (300-750). In low abundance (60-170) were Largemouth bass, Lake herring, Walleye, Brown bullhead, and Longnose gar. The least abundant species (1-25) were Lake whitefish, Black bullhead, Lake trout, Atlantic salmon, Creek chub and Brook trout (MDNR 2009b).

3.4.5 Life Stage Composition/Age and Growth Data

While the 2009 Creel Census did include life stage/age data based on length, this data is not yet available. However, the survey summary does include the length range that was found. The range of lengths was fairly wide, indicating that various age classes were represented for most of the fish species captured (Table E.3.6).

In MDNR's 1990 survey of Elk Lake and 1996 survey of Skegemog Lake, fish population data was collected for fish species and length. At the roughest level of analysis, the longer the fish, the older the fish. When the average length data collected from these surveys is compared to a table of the average age-growth relationships (in inches) for selected Michigan fish species, a very rough estimate can be made with respect to the average age of certain of the fish populations within the lakes (Table E.3.7). See Appendix F for supporting data.

3.5. Fish Spawning

Different fish species within the Project Vicinity's lakes and streams spawn at different times of the year and require different spawning habitat (Table E.3.8).

Many fish species feed in one location and spawn in another. For example, Trout live in the deepest parts of oligotrophic lakes but move up into cold tributary streams to spawn. Whitefish feed on the bottom of deep lakes and come into rivers and mesotrophic lakes to spawn. Great Lakes muskellunge, Northern pike, and Walleye live on the bottom of mesotrophic lakes but move into emergent vegetation in the shallows to spawn.

Detailed studies have not been done within the Project Vicinity to track the paths species take to spawn or to identify specific spawning, feeding or wintering habitat locations. Anecdotal reports from anglers indicate that Great Lakes muskellunge spawn in the Torch River but live in Elk and Skegemog Lakes. In 2009, MDNR and the University of Michigan began a jaw tagging project on eight Great Lakes muskellunge in Skegemog Lake to determine their movements. This study will help to identify their spawning locations and timing, as well as their over-wintering habitats.

MDNR has installed brush structures in Elk and Skegemog Lakes to provide spawning shelter for Yellow perch, Rock bass, and other species that spawn in similar habitat. The structures concentrate spawning adults, increasing the chances of successful fertilization. There are 600 such structures within Elk Lake and 100 within Skegemog Lake (see Figures E.2.1 and E.2.2).

3.6. Aquatic Habitats

The aquatic systems within the Project Vicinity provide sufficient fish habitat for spawning, breeding, feeding and growth to maturity for all of the native fish species found in the area. Although assessments of habitat quality have not been formally conducted, thirteen of the tributary streams and two of the rivers in this area are Designated Trout Streams, meaning they provide essential habitat for trout. The high quality of the habitat within the lakes can be further inferred from their high water quality and the healthy, diverse aquatic communities that they continue to support.

In the 1950s, MDNR developed maps of the inland lakes showing depths, contours, aquatic vegetation and shoreline features, as well as the locations of brush shelters installed to improve fish habitat. These maps have not been updated and are still the only lake habitat maps available for Elk and Skegemog Lakes (see Figures E.2.1 and E.2.2).

Species	Total Catch	Length Range (in.)	Average Length (in.)
Rock bass	8,855	2.7-12.0	6.3
White sucker	2,129	6.3-23.1	16.3
Yellow perch	742	4.3-12.2	7.2
Smallmouth bass	512	7.0-21.7	15.6
Pumpkinseed	361	3.2-9.9	6
Northern pike	335	9.4-39.0	21.6
Bluegill	303	3.3-9.9	6.4
Largemouth bass	169	5.9-20.2	15.1
Lake herring	128	4.0-12.5	7.4
Walleye	82	9.5-30.1	25.1
Brown bullhead	63	6.3-13.5	10.8
Longnose gar	60	25.0-44.0	30.5
Brown trout	24	9.1-25.9	19.1
Muskellunge	15	18.1-54.0	42.1
Rainbow trout	13	10.3-25.6	19.1
Lake whitefish	7	13.5-25.2	21.5
Black bullhead	7	10.2-13.0	11.6
Lake trout	2	27.1-27.5	27.3
Atlantic salmon	1	10.8	10.8
Creek chub	1	8.2	8.2
Brook trout	1	11.4	11.4

NOTES: (1) Surveyed April 2008 through March 2009; (2) Effort: 172 trap-net lifts, 124 fyke-net lifts, 2 electrofishing runs; (3) Detailed information on abundance, growth and mortality of Walleyes and Northern pike will be available soon.

Table E.3.6 Summary of Creel Census 2008-2009 (Source: MDNR 2009b)

Scientific Name	Common Name	Average Age (Yrs)
Ambloplites rupestris	Rock Bass	4-6
Catostomus commersoni	White Sucker	4-6
Esox lucius	Northern Pike	1-3
Esox masquinongy	Great Lakes muskellunge	7-11
Lepomis gibbosus	Pumpkinseed sunfish	4-6
Lepomis macrochirus	Bluegill	4-6
Miocropterus dolomieu	Smallmouth Bass	7-11
Miocropterus salmoides	Largemouth Bass	7-11
Perca flavescens	Yellow Perch	4-6

Table E.3.7 Average Age for Selected Species within the Project Vicinity (Data Source: MDNR 1985, 1990, 1996)

Scientific Name	Common Name	Spawning Month(s)	Water Temperature (˚F)	Spawning Habitat	Depth (ft)
Ambloplites rupestris	Rock bass	May, June	60-70	Gravel in very shallow water	<2
Amieurus spp.	Bullhead	April, May, June, July	68	Vegetation, woody debris	2-10
Catostomus commersoni	White sucker	April, May	45	Rivers w/ swift water over gravel	<2
Coregonus artedi	Lake herring (Cisco)	November, December	38-42	bottom free of vegetation	3-6
Esox lucius	Northern Pike	March, April	35	Shallow, marshy shoreline	6-10 inches
Esox masquinongy	Great Lakes muskellunge	April, May	< 63	muck and dead vegetation	6-30
Ictalurus punctatus	Channel catfish	April, May, June, July	75	Undercut banks, hollow logs; concealed	2-10
Lepisosteus osseus	Longnose gar	May, June, July	68	Gravel, rocks, boulders	<2
Lepomis gibbosus	Pumpkinseed sunfish	May, June, July, August	55-63	Shallow water	<24 inches
Lepomis macrochirus	Bluegill	May, June, July, August	67-80	Sand or gravel shoal	<2
Miocropterus dolomieu	Smallmouth Bass	May, June, July	55-64	Gravel, stones	2-5
Miocropterus salmoides	Largemouth Bass	May, June	60-65	Gravel, rock, firm & silt free	<2
Onchorynchus mykiss	Rainbow trout/ Steelhead	March, April, May	-	Gravel streambottoms	<2
Perca flavescens	Yellow Perch	April, May	54-52	Random; submerged vegetation or brush	<2
Salmo trutta	Brown Trout	October, November, December	-	Gravel riffles; can use clay or sand	<2
Salvelinus namaycush	Lake trout	September, October, November	46-52	Rocky bars, silt free	up to 100

Table E.3.8 Spawning Times and Habitats for Selected Fish Species (Fuller 2001)

With respect to the tributaries within the Project Vicinity, no bedform mapping or stream surveying has been done to identify the extent of run, riffle and pool in rivers or streams, or to determine substrate size, percentage of stream covered by aquatic vegetation, or percentage of stream containing woody material. Habitat quality has been formally assessed for only one river system below the Bellaire Dam. In 2001, MDNR conducted a biological survey of the Rapid River and Little Rapid River that assessed fish community, macroinvertebrate community and habitat. Habitat quality was rated at eight stations along the river. The two stations closest to the river's confluence with Torch River were rated as excellent; the stations further upstream were rated as either excellent or good (MDNR 2001).

3.6.1 "Essential Fish Habitat"

The Magnuson-Stevens Fishery Conservation and Management Act covers "fish off the coasts of the United States, highly migratory species of the high seas, the species which dwell on or in the Continental Shelf appertaining to the United States, and the anadromous species which spawn in United States rivers or estuaries." (U.S. Congress 1996). None of the native fish species that live below the Bellaire Dam come under the provisions of the Act. As discussed in Section 3.3.2, the anadromous species found within the Project Vicinity have been introduced for sport fishing. Consequently, the Project Vicinity does not contain any "essential fish habitat" as defined under the Act.

3.6.2 Key Habitat Types

MDNR is currently developing descriptions of essential freshwater fish habitat for Michigan species, but this effort is not yet complete. Table E.3.9 lists the habitats that could be considered essential to the species indicated, although they are not officially listed as essential habitat.

3.6.3 Description of Aquatic Habitats within the Project Vicinity

The Project Vicinity contains four major types of important freshwater habitats:

- Cold and fast streams
- Warm and slow streams
- Cool and moderately deep mesotrophic lakes
- Cold and very deep oligotrophic lakes

There are also many smaller streams that discharge cold, high quality groundwater throughout the year (MDNR 2007). A brief description of the aquatic habitats within the Project Vicinity is provided below. These general observations were made by Douglas Fuller based on the shoreline surveys he conducted and recorded in Fish of the Elk River Chain of Lakes- A Watershed Perspective (Fuller 2001).

Torch River

Torch River is the main tributary of Skegemog Lake. The river is characterized as a warm, slow stream because its water comes from Torch Lake's warm surface outflow. The river generally supports a warmwater fish community, although it can contain trout and coolwater species during colder times of the year. Torch River is about 1.9 miles long and connects Torch Lake and Skegemog Lake. The river's average depth is about 4.5 feet. Rapid River feeds into Torch River about 2,600 feet south of Torch Lake's outlet. As discussed in Section E.1.2, despite its seemingly gentle flow, the Torch River channel has a significant flow restriction which creates a surface level

Scientific Name	Common Name	Lakes	Protected Bays	Rivers	Trout Streams	Non-trout Streams
Ambloplites rupestris	Rock bass	x		x		
Amia calva	Bowfin					
Amieurus melas	Black bullhead	x				x
Amieurus natalis	Yellow bullhead	x		x		
Amieurus nebulosus	Brown bullhead	x		x		
Catostomus commersoni	White sucker	x				x
Coregonus artedi	Lake herring	x				
Coregonus clupeaformis	Lake whitefish	x				
Cottus bairdi	Mottled sculpin	x			x	
Cottus cognatus	Slimy sculpin	x			x	
Esox lucius	Northern pike	x		x		
Esox masquinongy	Great Lakes muskellunge	x	x	x		
Etheostoma exiles	Iowa darter			x		x
Etheostoma nirgum	Johnny darter	x			x	x
Fundulus diaphanus	Banded killifish	x		x		
Hybognathus hankinsoni	Brassy minnow				x	x
Ichthyomyzon fossor	Northern brook lamprey	x				
Ictalurus punctatus	Channel catfish	x		x		
Lepisosteus osseus	Longnose gar	x		x		
Lepomis cyanellus	Green sunfish	x				x
Lepomis gibbosus	Pumpkinseed sunfish	x	x			x
Lepomis macrochirus	Bluegill	x		x		
Lepomis megalotis	Longear sunfish			x		x
Lota lota	Burbot	x		x		
Luxilus cornutus	Common shiner	x			x	x
Miocropterus dolomieu	Smallmouth bass	x		x		
Miocropterus salmoides	Largemouth bass	x	x			
Myoxocephalus thompsoni	Deepwater sculpin	x				
Notemigonus crysoleucas	Golden shiner				stream mouths	stream mouths
Notropis atherinoides	Emerald shiner	x		x		
Notropis heterdon	Blackchin shiner	x				x
Notropis heterolepis	Blacknose shiner	x	x	x	x	
Notropis hudsonius	Spottail shiner					
Notropis rubellus	Rosyface shiner				x	

Table E.3.9 Key Fish Habitat (Fuller 2001)

Scientific Name	Common Name	Lakes	Protected Bays	Rivers	Trout Streams	Non-trout Streams
Notropis stamineus	Sand shiner	x		x		
Notropis volucellus	Mimic shiner		x	x		
Perca flavescens	Yellow perch	x				
Percina caprodes	Logperch	x		x		
Percina maculata	Blackside darter			x		x
Percopsis omiscomaycus	Troutperch	x		x		
Phoxinus eos	Northern redbelly dace					x
Phoxinus neogaeus	Finescale dace					x
Pimephales notatus	Bluntnose minnow	x	x	x	x	x
Pimephales promelas	Fathead minnow					x
Pomoxis nigromaculatus	Black crappie	x	x	x		
Pungitius pungitius	Ninespine stickleback	x			stream mouths	stream mouths
Rhinichthys atratulus	Blacknose dace				x	
Rhinichthys cataractae	Longnose dace	x		x		
Salvelinus fontinalis	Brook trout				x	
Salvelinus namaycush	Lake trout	x				
Semotilus atromaculatus	Creek chub				x	x
Stizostedion vitreum	Walleye	x		x		
Umbra limi	Central mudminnow					x

Table E.3.9 Key Fish Habitat, cont'd (Fuller 2004)

difference between Torch and Skegemog Lakes that keeps the two water bodies separate.

Because of some backwater areas (especially an area at the northeast end known as the Bayou), Torch River's shoreline length is about 5 miles. More than 80% of the shoreline is developed, but the lower reaches of the river flow along the state-owned Skegemog Lake Wildlife Area. Wetlands are present on approximately 75% of the parcels along the river. Because the river's current has the ability to suspend or re-suspend fine sediments, water clarity drops steadily as the river approaches Skegemog Lake. The river contains quite a bit of woody material, along with stumps and standing dead trees which date back to the construction of the original dam at the Project site.
Although Torch River is not classified as a coldwater stream, it is a Designated Trout Stream, most likely due to the seasonal presence of migratory trout heading to and from Rapid River. Atlantic salmon also have been observed trying to spawn in the river during fall. Fishery biologists have raised concern about the impact of recreational boat traffic on the river's fish and aquatic habitat. On busy summer weekends, hundreds of boats per hour have been counted.

Skegemog Lake
Skegemog Lake is classified as a warmwater fishery. It is renowned for its population of huge Great Lakes muskellunge. Good populations of Smallmouth bass and Rock bass are also

present. Walleye are not very abundant. Due to the introduction of the invasive Zebra mussel, the clarity, temperature and fish composition of Skegemog Lake appears to be changing, according to anecdotal reports from sport fishermen. However, no assessment of these changes has been conducted yet.

Skegemog Lake Tributaries

Except for Torch River, Skegemog Lake's tributaries are classified as cold, fast streams. All of the tributaries are Designated Trout Streams, with the exception of Copeland Creek.

Vargason Creek. No information available.

Desmond Creek flows into the east end of Skegemog Lake. It originates about two miles upstream and flows through the flat, swampy lowlands of the Skegemog Lake Wildlife Area for about three-quarters of a mile before emptying into the lake. The stream drops 130 feet in elevation, for an average stream gradient of about 65 feet per mile. The channel is about ten feet wide and 1-2 feet deep. Thermal characteristics indicate that it has high levels of groundwater input. Estimated stream flow is 10 cfs. The stream's water is unstained and clear.

Barker Creek discharges into the south end of Skegemog Lake after traveling 2.5 miles through wooded hills, fallow agricultural land and the swampy terrain of the Skegemog Lake Wildlife Area. The stream drops 169 feet, for an average stream gradient of 67 feet per mile. Barker Creek is about three feet wide and one foot deep. Thermal characteristics indicate that it has moderately high groundwater inputs. Its estimated stream flow is about 4.5 cfs.

Copeland Creek - No information available.

Elk Lake

The deep water community associations found in Elk Lake are reminiscent of Lake Michigan's aquatic communities before disruption by over-fishing, toxic pollution, and non-native and invasive species. Elk Lake is managed specifically for coldwater species. This large lake has cold, deep waters with plenty of oxygen. It supports populations of Lake trout, Lake whitefish, Lake herring (Cisco), Burbot and Deepwater sculpin - all species which require cold, well-oxygenated water. Very few inland lakes in Michigan are able to support these fish species. Non-native coldwater sport fishing species, including Brown trout, Rainbow trout, and Atlantic salmon, have been planted in the lake. Natural recruitment of Lake trout is considered moderate to good. There are also good to excellent natural populations of Lake whitefish and Lake herring (Cisco). Coolwater species such as Smallmouth bass, Yellow perch and Rock bass, are also present but are not as abundant as elsewhere in the ERCOL. Because it is connected to Skegemog Lake at the Narrows, fish populations intermingle between the lakes. Elk Lake is a Designated Trout Lake.

Elk Lake Tributaries

All of Elk Lake's tributaries are classified as cold, fast streams, except for Elk River. Battle Creek and Williamsburg Creek are Designated Trout Streams.

Battle Creek flows into the extreme south end of Elk Lake. The stream flows four miles through mostly forested uplands and then through a large swamp system before discharging into Elk Lake via a marshy estuary. The stream drops 159 feet in elevation, for an average stream gradient of about 39 feet per mile. The stream is twelve feet wide and 1-2 feet deep. Estimated stream flow is 25 cfs. Thermal characteristics indicate it has high levels of groundwater inputs. The water is unstained and slightly turbid.

Maplehurst Creek - No information available.

Williamsburg Creek enters Elk Lake at its southwest shore. Williamsburg Creek is about 5.5 miles long, 15 feet wide and 1-3 feet deep. The creek flows through the town of Williamsburg, where an impoundment known as Bissel Pond is located, and through a swampy forested corridor. There are a series of private ponds in its lower reaches. The creek drops 238 feet in elevation, for an average stream gradient of about 43 feet per mile. The creek contains quite a few logs; the estimated flow is 20 cfs. The water is unstained and slightly turbid. Thermal characteristics indicate it has moderately high groundwater inputs.

Elk River is the main tributary of Elk Lake. Like Torch River, Elk River is classified as a warmwater fishery but may contain trout and coolwater species during the colder times of the year. Coldwater species from Lake Michigan, including Rainbow trout (Steelhead) and other Salmon species, are present in the river's lower reaches below the Project. Elk River is a 5th order stream but it is extremely short - less than one mile long. As previously noted, much of the river's shoreline is armored in seawall and rip-rap; however, wetlands along the river's upper reach provide important fish habitat.

3.7. Fish Mortality

The scope of fish entrainment and mortality impacts from hydroelectric projects can vary from minimal to substantial. The majority of fish mortality studies have been conducted on large, high head hydroelectric projects located in the Pacific Northwest. However, since 1990, about three dozen studies have been done in Wisconsin, Michigan and Indiana at low-head sites with similar characteristics to the Project. Such characteristics include fish species, turbine and facility size, turbine type (Francis runner), and low head. Consequently, these studies are highly suitable analogs for estimating the Project's expected mortality effect on fish populations.

3.7.1 Risk of Entrainment

Fish mortality is dependant upon a number of factors, beginning with fish susceptibility to entrainment. Several factors will tend to prevent fish entrainment. Fish will generally be able to detect increasing water velocity, see trash rack bars, and/or feel vibrating trash rack bars and/or bow waves in front of the bars. Just as a fish will seek to avoid colliding with rocks or other in-stream debris, a fish will try to avoid collision with the trash rack. If possible, fish will steer clear of a hydroelectric project's intake structure and influence entirely (MWH 2003).

The Project's trash rack bar configuration at the intake is ¼-inch thick bars with a two-inch center spacing. This leaves an open space width of 1¾ inches between the bars. When the turbines are operated at full gate, the intake velocity in front of the trash rack is 2.0 feet/sec. When the turbines are operated at less than full gate, the intake velocity is proportionately reduced. Whenever possible (about 98% of the time), the Project's units are run at the maximum efficiency gate setting, which is 90% of full gate.

In studies by Stone and Webster (1992), over 90% of entrained fish were less than about four inches in length. Studies by Bell (1973) have shown that a fish can swim about 10-12 body lengths per second in a burst mode that can last a few seconds, and can maintain a maximum sustained speed of about 6-7 body lengths per second. For a four-inch long fish, this translates into a burst mode of 3.3-4 ft./sec. and a maximum sustained speed of 2-2.3 ft/sec - enough speed to easily avoid entrainment by the Project's intake. Even a three-inch long fish is likely to be able to avoid the increasing velocity in front of the Project's trash racks when the units are at full gate. Using the above estimated speeds, a three-inch fish's burst mode would be 2.5-3 ft/sec. and its maximum sustained speed would be 1.5-1.75 ft/sec. Since the Project is operated at a 90% gate setting the vast majority of the time, entrainment risk is likely to be even lower.

Trash rack bar spacing doesn't seem to have much effect on fish entrainment. Even though many fish three inches and longer would physically fit between the bars, they also have the capability to avoid entrainment by swimming away. Weyerhaeuser (1993) observed no relation between trash rack spacing and catch rates at three Wisconsin hydroelectric projects.

3.7.2 Risk of Mortality

At projects using Francis type runners like the Project, the following factors have been shown to influence fish mortality, with peripheral runner speed being the predominant factor (Eicher and Associates 1987):

- peripheral runner speed
- turbine setting
- fish length
- intake depth
- turbine operating efficiency

Fish Length

As one might expect, longer fish have a greater rate of mortality, due to the greater likelihood that they will be physically injured by a rotating blade within the machine (Cada 1990, Collins and Ruggles 1982). However, this higher mortality rate is offset by the greater ability of larger fish to avoid entrainment in the first place.

The Project's Leffel type "S" units have a 51-inch diameter runner. Runner blade spacing is more than 13 inches at the outer inlet periphery. The average radial clearance between the runner and wicket gates is about 14 inches. As discussed above, the fish most likely to be entrained at the Project are three inches in length or smaller. These fish will generally pass easily through the rather large passages and clearances in the Project's units.

Peripheral Runner Speed

Eicher and Associates (1987) found a correlation (r = 0.73) between fish mortality and peripheral runner speed for Francis type runners. They rated peripheral blade speed as the principal variable causing fish mortality with these runners. The plot of their regression analysis is presented in Figure E.3.5.

The units at Elk Rapids operate at 100 revolutions/minute (1.67 rev. per second) and have a 51-inch (4.25 feet) nominal diameter runner, leading to a peripheral speed of 22.3 ft/sec. Comparing this speed to Eicher and Associates' plot indicates that this speed should yield no fish mortality. Because of the Project's low head and, consequently, very low runner speed, the physical damage caused to any entrained fish by the runner blade should be virtually non-existent.

Turbine Setting/Intake Depth

Cada (1990) in particular indicates that pressure changes have minimal effects on fish, especially at less than 33 feet. The Project's head and maximum change in elevation at Elk Rapids is 10 feet nominal. The Project's intake depth is minimal because it is an open flume arrangement and the turbines are set as high as possible in order to maximize the effect of creating a "vacuum flume" in the sealed turbine pit. This effect is produced through the draft tube, which is as long as possible and creates the partial vacuum in the pit chamber. As turbine settings are elevated, decompression effects on entrained fish as they pass through the runner and into the draft tube and tailrace are further reduced.

Turbine Operating Efficiency

Mortality is lowest when turbines are operating at peak efficiency because turbulence is at a minimum. Water (and fish) flow through the turbine in a streamlined manner. The Leffel type "S" runners installed at the Project achieve peak efficiency at a gate opening of 90% - gate settings less than, or more than, this setting produce additional turbulence and shear forces which reduce project efficiency and can also injure fish. As discussed above, the Project is operated at peak efficiency 98% of the time (i.e., whenever possible). When the Project does operate at reduced gate openings, the increased turbulence is offset by the reduced water flow velocity, which in turn makes it even easier for fish to avoid entrainment in the first place.

As a result of the above factors, the rate of fish mortality at the Project is estimated to be very low to non-existent. It is likely that any fish that become entrained are less than three inches in length and, thus, are highly likely to survive the passage through the turbine runner.

3.8. Macroinvertebrates

Macroinvertebrates are a group of larger, multi-celled animals without backbones which includes insects, worms, mollusks and crustaceans. They generally live on the bottom of lakes and streams or attach to macrophytes (large, non-algae aquatic plants) or woody debris. Aquatic insects are one of the largest groups of macroinvertebrates. Most aquatic insects are actually terrestrial as adults, but spend their larval stage in water. Macroinvertebrate larvae are one of the most important groups in the food chain for fish. Because of their sensitivity to pollution, macroinvertebrates are often used as an indicator of water quality and aquatic habitat quality.

Macroinvertebrate diversity has not been extensively assessed in the water bodies below the Bellaire Dam. TOTM conducted a stream macroinvertebrate diversity study from 2005-2007. The data collected on four streams was used to calculate an average diversity index score for

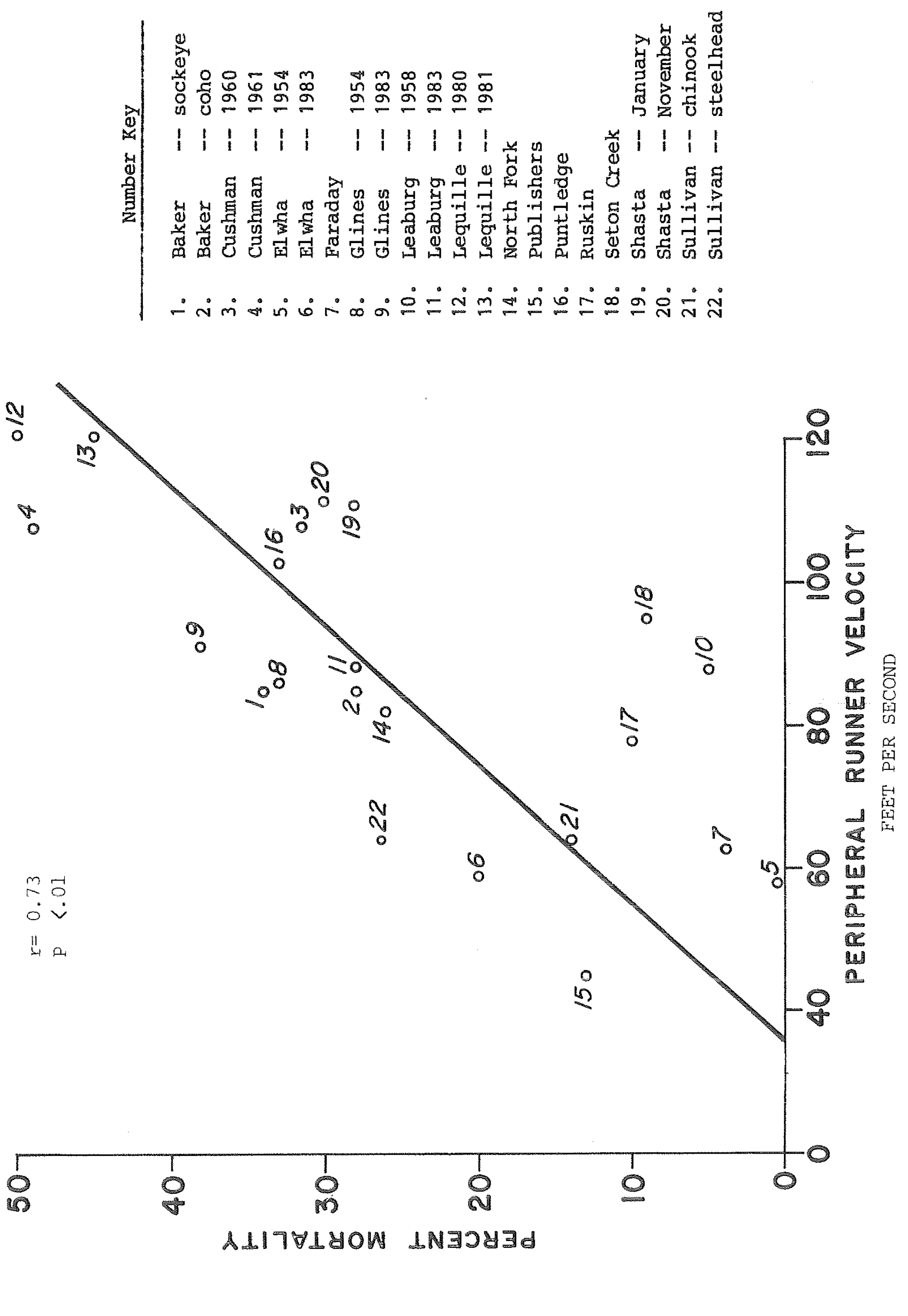

Figure 5-5 Relationship of peripheral runner velocity to mortality Francis turbines.

Figure E.3.5 Relationship of Peripheral Runner Velocity to Mortality Francis Turbines (Source: Eicher and Associates 1987)

each site based on the total taxa (total number of aquatic macroinvertebrate families), EPT (number of families belonging to the Ephemeroptera, Plecoptera and Trichoptera orders), and Sensitive (number of families belonging to the three most sensitive categories in the Hilsenhoff family-level sensitivity system). The Diversity Score for Eastport Creek was 22/30 and Spencer Creek was 16/30. Both creeks are tributaries of Torch Lake, the next lake above Skegemog Lake, (TOTM 2008b).

The MDNR biological survey of Rapid River and Little Rapid River described in Section 4.3.6 included an assessment of the macroinvertebrate community at three sampling stations along the Rapid River. The macroinvertebrate communities at all three sites were rated as excellent (MDNR 2001).

A composite list of aquatic insect species found in surveys conducted in water bodies below the Bellaire Dam since 1966 is presented in Table E.3.10. No surveys or studies have been conducted of crayfish or mollusks in the area.

A number of invasive macroinvertebrates have been introduced into the area by recreational boaters. The non-native Zebra mussel (*Dreissena polymorpha*) invaded the ERCOL in the 1980s. It has practically eliminated the watershed’s native clam, mussel and crayfish populations. Zebra mussels readily attach to most submerged surfaces, including boats, docks, rocks, piers and indigenous species, such as clams. Because they affix themselves to the shells of their own species, they are able to form dense layered colonies of thousands of mussels per square meter. Zebra mussels are voracious filter-feeders that clear the water column of the algae that serve as the major food source of *Diporeia* and *Mysis Relicta.* These two macroinvertebrates are the major food source of the smaller fish in these lakes, which in turn, form the foundation of the sport fishery’s food web. There is no plan to control or eradicate the Zebra mussel in the watershed because it is so pervasive (MDEQ 2002).

The non-native Rusty crayfish (*Orconectes rusticus*) has also been reported throughout the ERCOL. This is an aggressive species that displaces native crayfish by forcing them from the best daytime hiding places, thus making them more vulnerable to fish predation. Rusty crayfish also destroy aquatic plant beds by their consumption, compete with juvenile game fish and forage species for benthic invertebrates, and eat fish eggs, especially Smallmouth bass, Largemouth bass and Sunfish (Minnesota Sea Grant 2002). MDEQ and MDNR have focused efforts on education, outreach and monitoring. There is no plan to control or eradicate the Rusty crayfish because, like the Zebra mussel, once established, it is, to date, impossible to control.

Insecta	Pollution Tolerance	Within the Project Vicinity	Below the Bellaire Dam
Order Ephemeroptera (mayflies)	**intolerant**	**X**	**X**
Baetidae		x	
Ephemerellidae		x	
Ephemeridae (Hexes & Big drakes)		x	x
Heptageniidae		x	
Leptophlebiidae		x	
Order Plecoptera (stoneflies)	**intolerant**	**X**	
Nemouridae		x	
Perlidae		x	
Perlodidae		x	
Pteronarcyidae		x	
Order Megaloptera	**intolerant**	**X**	**X**
Corydalidae (dobson flies)		x	
Sialidae (alder flies)		x	x
Order Trichoptera (caddisflies)	**intolerant**	**X**	**X**
Brachycentridae		x	
Glossosomatidae		x	
Hydropsychidae		x	
Hydroptilidae		x	
Limnephilidae		x	
Philopotamidae		x	
Polycentropodidae		x	
Order Coleoptera (water beetles)	**tolerant**	**X**	**X**
Elmidae		x	x
Order Diptera (trueflies)	**tolerant**	**X**	**X**
Athericidae		x	
Ceratopogonidae (no-see-ums/biting midges)		x	x
Chironomidae (bloodworm)		x	
Simuliidae		x	x
Tendipedidae		x	x

Table E.3.10 Aquatic Insect Species Reported below the Bellaire Dam (Source: Lape 1966-67, TLA 2008a, MDNR 2001, TOTM 2008a, 2008b, 2008c)