BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

SIERRA CLUB, NATURAL RESOURCES DEFENSE COUNCIL, PRAIRIE RIVERS NETWORK, and ENVIRONMENTAL LAW & POLICY CENTER	)	
Petitioners,	)	
	)	PCB 2015-189
v.	)	(Third Party NPDES Appeal)
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY and MIDWEST GENERATION, LLC	)	
Respondents.	)	

NOTICE OF FILING

PLEASE TAKE NOTICE that on September 30, 2016, I filed with the Clerk of the Illinois Pollution Control Board the **Petitioners' Exhibits for Hearing** containing pages (R. 1-5, 217-19, 239-44, 511-15, 618, 656-82, 685-703, 983-93, 1043-87, 1204-36) and Index on behalf of Petitioner, Environmental Law and Policy Center. The Exhibits for Hearing and Index are attached hereto and hereby served upon persons listed in the Service List.

Petitioners provide these exhibits pursuant to the Order of the Board of September 7, 2016, which requested that parties "prepare a list of exhibits, along with the exhibits themselves from the record that they will most likely use during the hearing" in the above-captioned matter to take place on October 5, 2016 at 9:00 a.m. in Chicago.

The following exhibits are excerpted from the administrative record filed in the above-captioned matter on June 26, 2015 as well as the supplemental volume filed on August 7, 2015. Petitioner provides these exhibits in particular because Petitioners are likely to use them at the hearing. However, Petitioner reserves the right to refer to any and all portions of the administrative record at hearing and moving forward.

INDEX

ILLINOIS POLLUTION CONTROL BOARD
August 3, 1978

IN THE MATTER OF:	)	
	)	
PROPOSED DETERMINATION OF	)	PCB 77-82
THERMAL STANDARDS FOR ZION AND	)	
WAUKEGAN GENERATING STATIONS	)	

MESSRS. A. DANIEL FELDMAN & GLEN E. NELSON, OF ISHAM, LINCOLN & BEALE, APPEARED ON BEHALF OF PETITIONER;
MS. BARBARA SIDLER, SENIOR TECHNICAL ADVISOR, APPEARED ON BEHALF OF THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY;
MR. MICHAEL BERMAN APPEARED ON BEHALF OF CITIZENS FOR A BETTER ENVIRONMENT.

OPINION AND ORDER OF THE BOARD (by Mr. Goodman):

This case is before the Board pursuant to Rule 410(c) of the Board's Water Pollution Regulations. In its petition of January 12, 1977 and amended petition of February 1, 1977, Commonwealth Edison Company requests that the Board allow the following standard to apply to Edison's Zion and Waukegan Generating Stations:

> present capability of the Station in terms of maximum heat rejection and water usage.

The present capability for each plant, in terms of heat rejection and water usage, respectively, is: 17.33×10^9 BTU/hr., and 2.236×10^6 gpm for the Zion Station; and approximately 5.301×10^9 BTU/hr. and 0.758×10^6 gpm for the Waukegan station.

The requested determination would relieve both stations from Rule 206(e)(1)(A)(iii) of Chapter 3: Water Pollution Regulations. This rule imposes a limitation on thermal discharges to Lake Michigan of 3°F above natural temperatures beyond the mixing zone. Edison also requested the alternative standard from the USEPA. Pursuant to Section 316(a) of the Federal Water Pollution Control Act (FWPCA), Edison submitted the required demonstration to Region V and to the Board. The Board was notified of Region V's decision to grant the alternative standard on June 30, 1977.

A hearing was held on May 23, 1977 at the Illinois Institute for Environmental Quality. Citizens for A Better Environment (CBE) requested and was granted Leave to Intervene. Neither CBE nor

Illinois Environmental Protection Agency (Agency) presented any evidence or called any witnesses. Members of the public were present, and one, Mr. Clark B. Rose, made a statement and examined witnesses.

Edison's experts were in agreement that virtually no damage was being done to the Lake Michigan environment as a result of heated discharges from the two Edison stations. Evidence from the experts' studies showed no disruption of the zooplankton community (R.17). There was some evidence that chlorination from the Waukegan Station may have a more significant effect on phytoplankton and periphyton than changes in water temperature. However, it was noted that most of the chlorine in the area comes from sewage treatment, and there is only minimal evidence of any chlorine impact (R.81, 83).

Similarly, while some changes in the relative abundance of various kinds of fish have been noted, these changes are more attributable to competition among the species than to thermal changes in the environment (Testimony of Dr. Gerking, P.6). No fish kills were observed as a result of the thermal effluent. At Zion, the thermal mortality rate was approximately 1%; so low that it does not pose a serious threat to the population (R.88). However, fish and their eggs or larvae have been killed when they become entrained in the intake water and are swept into the intake structure. The fish become impinged on cleaning screens and are eventually killed. It was suggested that a design change might remedy the situation (R.108-109).

The Agency recommends granting the alternative standard, but CBE objects to the absence of opinions of recognized independent experts on Lake Michigan. The Board finds that the evidence submitted indicates that the environmental damage to the Lake is minimal, and we note that Edison has promised to continue studying possible damaging effects on the Lake in the future (R.20). For these reasons, the Board grants Edison's request for the alternative standard.

In his statement, Mr. Rose voiced two objections concerning the location and notice of hearing. For the convenience of all interested parties, the hearing was held in Chicago (R.32). The tentative hearing date of April 22, 1977 was set on March 30, 1977 and published in the Environmental Register of April 11, 1977. The final hearing date of May 23, 1977 was set on May 3, 1977 but came too late for publication in the next issue of the Register. However, notice of this date was published in the Chicago Tribune at some date prior to the hearing (R.36). Mr. Rose's main concern was based on the need for public participation at Board hearings. The Board has always been acutely aware of this need and has encouraged openness and public participation. The record was held open until June 25, 1977, and notice of this was published in both the Environmental Register and a Waukegan newspaper with county-wide circulation in Lake County (R.145). No other public comment was received.

This Opinion constitutes the Board's findings of fact and conclusions of law in this matter.

ORDER

It is the Order of the Pollution Control Board that:

1) Pursuant to Rule 410(c) of Chapter 3, Petitioner's present capabilities in terms of heat rejection and water usage shall apply to thermal discharges in lieu of those standards set forth in Rule 206(e)(1)(A)(iii).

2) The Agency shall modify Petitioner's NPDES permit to reflect this change in standard, if the permit does not already reflect such change.

I, Christan L. Moffett, Clerk of the Illinois Pollution Control Board, hereby certify the above Opinion and Order were adopted on the 3rd day of August, 1978 by a vote of 5-0.

Christan L. Moffett /KD
Christan L. Moffett, Clerk
Illinois Pollution Control Board

MOD- ADD'L FLR

MIDWEST GENERATION EME, LLC
An EDISON INTERNATIONAL℠ Company

IEPA EXHIBIT
No. 2

Fred W. McCluskey
Vice President
Technical Services and
Partnership Management

October 18, 2004

Via Overnight Delivery

Mr. Blaine Kinsley
Bureau of Water
Industrial Permits Group
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P. O. Box 19276
Springfield, IL 62794-9276

Subject: Request for Extension to Submit Information Required by 316(b) Phase II Rule

Affected Facility	NPDES Permit No.	Expiration Date
Waukegan	IL 0002259	07/31/05

Dear Mr. Kinsley:

As provided for in Sec. 125.95(a)(2)(ii) of the Phase II rule, Midwest Generation hereby requests that the Agency grant the maximum extension period allowed in order for us to effectively collect and analyze data, evaluate operational and/or technological modifications and explore all reasonable methods of achieving compliance with the requirements of the final 316(b) rule for our Waukegan Generating Station. The grant of this request would effectively make all of the required components of the Comprehensive Demonstration Study (CDS) for this facility due on or before **January 7, 2008**.

The extensive amount of information and data gathering required by the rule, along with the fact that Midwest Generation has a total of six (6) applicable facilities, results in the need for a full extension period. Waukegan Station is our only affected facility that has ever had to do any intake-related monitoring, but that data is now over 30 years old and may no longer be entirely representative of current conditions. As such, we will need sufficient time to collect the required information for this facility and subsequently make determinations regarding site-specific compliance strategies. The biological work for Waukegan Station alone will take more than two years to collect and analyze, in order to account for seasonal and annual variations. Once this data is obtained, we will need sufficient time to determine the most appropriate and cost-effective compliance measures for the site. This will involve both detailed engineering and economic evaluations that will take considerable time to complete, and will involve reliance on knowledgeable contractors and expert consultants.

One Financial Place
440 South LaSalle Street
Suite 3500
Chicago, IL 60605
Tel: 312 583 6097
Fax: 312 788 5453
Cell: 312 925 3882
Email: fmccluskey@mwgen.com

We foresee the need to coordinate closely with IEPA as we collect the necessary information, perform the required analyses and determine what combination of technology, operational measures, and/or restoration measures will best constitute compliance with the 316(b) Phase II rule for Waukegan Station.

We will be preparing the required Proposal for Information Collection (PIC) for Waukegan Station within the next 3 to 6 months, depending upon the level of complexity required to address initial site-specific concerns. We also anticipate meeting with you and your staff prior to official submittal of the PIC, in order to ensure that we are all in agreement with the information and objectives outlined therein. We would, in the interim, appreciate any additional information and/or guidance that you could provide regarding the contents and/or format of the PIC. Other components of the Comprehensive Demonstration Study, including the Impingement Mortality and Entrainment Characterization Study, Design and Construction Technology Plan, Technology Installation and Operation Plan (TIOP), Restoration Plan, Site-Specific Requirements, and/or Verification Monitoring Plan, as deemed necessary and appropriate for Waukegan's particular situation, will also be discussed with the Agency prior to submission on or before the requested extension date of **January 7, 2008**.

Also, until specific 316(b) requirements are incorporated into the facility's permit, we request that Waukegan Station to be allowed to continue to operate its cooling water intake as they have in the past, as it has not been definitely shown that such operation has caused, or can be expected to cause, any adverse environmental impacts to Lake Michigan.

Meeting the many Phase II 316(b) rule requirements will present a significant challenge for both the regulated community, as well as the Agency, and we must all work together to achieve the most practical, environmentally beneficial and cost-effective outcome to best meet the Phase II rule for each of our affected stations. We believe that one of the most important efforts to effect this end is to grant the requested extension period to Midwest Generation's Waukegan Station, as well as to all permittees which require it.

Please contact Ms. Julia Wozniak of my staff at (312) 583-6080 or jwozniak@mwgen.com if you have any questions or comments concerning this matter.

Sincerely,

Fred W. McCluskey
Vice President Technical Services

ILLINOIS POLLUTION CONTROL BOARD
September 21, 1978

IN THE MATTER OF:	)	
	)	
PROPOSED DETERMINATION OF	)	PCB 78-72, -73
NO SIGNIFICANT ECOLOGICAL	)	Consolidated
DAMAGE FOR THE ZION AND WAUKEGAN	)	
GENERATING STATIONS	)	

ROBERT H. WHEELER, ISHAM, LINCOLN AND BEALE, APPEARED ON BEHALF OF PETITIONER;
RUSSELL R. EGGERT, ASSISTANT ATTORNEY GENERAL, APPEARED ON BEHALF OF THE AGENCY.

OPINION AND ORDER OF THE BOARD (by Mr. Dumelle):

These petitions come before the Board for a determination, as required by Rule 203(i)(5) of Chapter 3: Water Regulations, that thermal discharges from Commonwealth Edison's (Edison's) Waukegan and Zion Generating Stations have not caused and cannot be reasonably expected to cause significant ecological damage to the receiving waters of Lake Michigan. Edison filed petitions for each station on March 14, 1978, and pursuant to Procedural Rule 604(d)(4), Edison requested that the record from PCB 77-82, an earlier 410(c) determination decided August 3, 1978, involving the same two stations, be incorporated into the records of the 203(i)(5) determinations. The Board, on its own motion, hereby consolidates these 203(i)(5) proceedings, since experts testifying in PCB 77-82 often made general statements about ecological effects from thermal discharges without making specific references to either station. Mandatory hearings were held, and John R. Hughes, Edison's Director of Water Quality, was the only witness to testify at either proceeding. Mr. Hughes testified that no significant ecological damage occurred to Lake Michigan as a result of the operations of the Waukegan and Zion stations since the close of the record in PCB 77-82 (R. 5 of PCB 78-72 and R. 5 of PCB 78-73).

The Waukegan Generating Station has eight (8) fossil (coal) fired steam generating units, five of which have been retired. Unit 5 was just retired in February of 1978, subsequent to hearings in PCB 77-82. Cooling water is withdrawn from Lake Michigan and flows through the condensers at a rate of 0.758 x 106 gpm, resulting in a temperature rise of approximately 13°F. Occasionally, the 3°F isotherm of the Waukegan plume exceeds 72 acres, but it is impossible to delineate the extent of this occurrence because: a) there is no dependable way of determining ambient temperatures; and, b) it is difficult to identify temperature contour distribution between measured sampling points. The predicted area of the plume is 126 acres for the 3°F isotherm with no cross-current in the lake for the discharge structure. A cross-current of 0.35 ft. sec. yields a calculated area of 867 acres. Both calculations are based on the full operation of four (4) units, not three (3).

The Zion Generating Station consists of two 1,100 MWe (gross) nuclear generating units. Lake water is used for condenser cooling at a rate of 1945 cfs per unit when the station is operating at full capacity, resulting in a mean temperature rise of approximately 18.2°F. Actual and theoretical plume studies, conducted by Hydrocon, Inc., indicate that the 3°F plume ranged from 0.8 acres for summer (best case) to 583 acres for spring - fall (worst case). Lake currents parallel with the shore rapidly bend the plume either north or south.

Expert opinions, relied upon in PCB 77-82 and based on data compiled by Hydrocon, Inc. and Nalco Environmental Sciences, indicated that virtually no damage was being done to the Lake Michigan environment as a result of heated discharges from the Zion and Waukegan stations. While some changes in the Lake Michigan biota were noted, these changes were attributed to factors other than heated discharges. See, Proposed Determination of Thermal Standards for Zion and Waukegan Generating Stations, PCB 77-82; August 3, 1978. The Board considered the evidence presented by Edison in PCB 77-82 to be persuasive and found that environmental damage to Lake Michigan was minimal.

Upon review of the evidence submitted in PCB 77-82 and the proceedings before us now, the Board finds that Edison has provided the information required by Procedural Rule 602. The Board notes that the Agency did not file a Recommendation in either proceeding, but did not contest Edison's showing of no significant ecological damage. It is the Opinion of the Board that Edison's Waukegan and Zion Generating Stations have not caused and cannot be reasonably expected to cause significant ecological damage to receiving waters. Edison has, therefore, satisfied the requirements of Rule 203(i)(5) of Chapter 3 of the Board's Regulations.

This Opinion constitutes the Board's findings of fact and conclusions of law in this matter.

Order

It is the Order of the Pollution Control Board that the Petitioner has complied with Rule 203(i)(5) of Chapter 3 of the Board's Regulations by demonstrating that its thermal discharges from the Waukegan and Zion Generating Stations have not caused and cannot be reasonably expected to cause significant ecological damage to receiving waters.

I, Christan L. Moffett, Clerk of the Illinois Pollution Control Board, hereby certify the above Opinion and Order were adopted on the 21st day of September, 1978 by a vote of 4-0.

Christan L. Moffett, Clerk
Illinois Pollution Control Board

Rabins, Jaime

From:	Williams, Deborah
Sent:	Tuesday, July 17, 2012 8:53 AM
To:	Rabins, Jaime
Cc:	LeCrone, Darin; Sofat, Sanjay
Subject:	FW: MWGen - Waukegan Station NPDES Permits - 316(a) Written Study Reports Search Request and Other NPDES Permit Information
Attachments:	Waukegan 316(a) Demonstration Cover Letter--6-14-1974.pdf; Waukegan Intake Discharge Configuration.pdf

Hi Jaime,
Here is the info I believe we are waiting on to move the Waukegan permit.
As Susan mentions, it is still missing a condition to address what they will do to justify continuation of the 316a variance next cycle.
Let me know if you think they are missing anything else? I'm assuming we don't need to dig deeper into the outfall compliance point issue given the way we are redrafting the permit but I may be misunderstanding that issue.
Thanks!
Debbie

From: Susan Franzetti [mailto:sf@nijmanfranzetti.com]
Sent: Friday, July 13, 2012 4:54 PM
To: Williams, Deborah
Cc: Julia Wozniak
Subject: MWGen - Waukegan Station NPDES Permits - 316(a) Written Study Reports Search Request and Other NPDES Permit Information

Deb - Julia Wozniak was able to find a copy of the June 14, 1974 cover letter from Commonwealth Edison to U.S. EPA for the original 316(a) demonstration for the Waukegan Station, which lists all of the 316(a) reports/studies/etc. that were submitted to USEPA. A copy of this June 14, 1974 letter is attached. However, our understanding is that USEPA no longer has its copy of these reports. We appreciate your having your intern try to search for them at IEPA.

In addition, I believe the attached "Waukegan Intake Discharge Configuration" schematic may be responsive to one of Jaime Rabins requests for additional information regarding the Waukegan Station.

And, with regard to his request for the current megawatt load capability of the Waukegan Station, I've included in paragraphs 1 and 2 below both the heat rejection rate load and water flow rates that (1) the IPCB imposed on the Waukegan Station in its 8/3/78 Order granting the 316(a) variance and (2) the current 2012 capabilities for both of these factors. We also calculated and present in paragraph 3 below what the percentage reduction has been for both of these factors from the allowed levels in the 1978 Order compared to today. We believe this is relevant information to support the continuation of the 316(a) variance.

1. 8/03/1978 Board Order in PCB 77-82 granting 316(a) Relief - Waukegan Station was ordered to be held to the following heat rejection and water flow rates in order to ensure that no adverse impacts to the receiving waters would occur (based on operation of 4 units):

Heat Rejection Rate (entire station): 5.301 x 109 BTU/hour

Water Flow Rate (entire station): 0.758 x 106 gpm

2. Current 2012 Conditions: (Unit 7 and 8 in operation)

   Hear Rejection Rate (both units combined): 3.230 x 109 BTU/hour

   Water Flow Rate (both units combined): 0.476 x 106 gpm

3. Total Reductions from Base Case in Original 316(a):

   Heat Rejection Rate: 39% lower

   Water Flow Rate: 37% lower

Please pass along the above information to Jaime Rabins.

Finally, we are still working on completing draft permit language regarding MWGen's requested continuation of the 316(a) variance based on the completion of additional studies. I will send that to you as soon as we have completed it. I believe that is the only additional piece of information we owe the Agency on the 316(a) issue, but let me know if I missed something.

Regards, Susan

Susan M. Franzetti
Nijman Franzetti LLP
10 S. LaSalle St., Suite 3600
Chicago, IL 60603
(312) 251-5590
fax (312) 251- 4610
sf@nijmanfranzetti.com

KS

Commonwealth Edison
72 West Adams Street, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

June 14, 1974

Mr. A. H. Manzardo
Chief, Permit Branch, Region V
U.S. Environmental Protection Agency
One North Wacker Drive
Chicago, Illinois 60606

Subject: Evidence to Support a 316(a) Demonstration for Waukegan Station

Dear Mr. Manzardo:

The report of Commonwealth Edison Company concerning condenser cooling water discharges in support of the Company's request for the allowance of alternate effluent limits pursuant to §316(a) of the Federal Water Pollution Control Act at the Waukegan Generating Station is submitted herewith. The report is a summary of the evidence the Company has gathered over a four year period that the present discharge does no harm to the indigenous aquatic biota of Lake Michigan, and thus comprises a Type 1 demonstration. Based on the data gathered over that period, the Company's consultants have, in addition, prepared predictions of Zion Station's discharge based on studies conducted at Waukegan. Their testimony, which also serves as a good review of these studies and prediction of future operation of Waukegan, was included in the presentation made by the Company to the U.S. Atomic Energy Commission in connection with the operating license proceeding for Zion Station. This testimony is appended.

We note that no unit at the Waukegan Station operated at a boiler or generator capacity factor as high as 60% during either 1972 or 1973. (See Table 1.2 of the enclosed report). As a result, no unit is required to meet the proposed effluent guidelines prior to July 1, 1983. Nonethless, the Company requests that a determination under Section 316(a) be made in conjunction with the issuance of the current permit. This request is made because the current Illinois Water Quality Standards impose on this station a mixing zone more stringent than is required to assure the propagation of a balanced indigenous population of fish in Lake Michigan. Application of a water quality standard more stringent than necessary to meet the criteria of §316(a) is forbidden by §303(g) of the Federal Water Pollution Control Act. Our specific request is for an effluent limitation allowing a discharge of up to 1600 cfs at combined average temperatures across the condensers for all four units not to exceed 13°F (except for periods when recirculation is used to prevent icing, of approximately 1100 cfs at not more than 30°F above ambient) from a low velocity surface discharge canal.

We request that no specific mixing zone be established for this station, on the ground that stating an effluent limit on the flow and temperature of the discharge insures that the plume size will not increase from what it now is, and there is, as a result, no need to monitor the plume in the Lake for enforcement purposes. The Company will, of course, monitor and report the discharge flow and temperature. In addition, the low velocity of this discharge produces a meandering plume which is difficult to monitor. The specification of a fixed area would, because of plume movement, require a very substantial mixing zone, only a portion of which would actually be used for mixing at any time.

The information and data offered in support of the facts presented in the summary, as listed below are submitted as part of this demonstration.

Industrial Bio Test Laboratories, Inc. (1972) Phytoplankton Study, Project III IBT No. W 8956 18 pp.

Industrial Bio Test Laboratories, Inc. (1972) Intake-Discharge Experiments at Waukegan Generating Station. Project XI, IBT No. W 9861. Biological Section 70 pp.

Industrial Bio Test Laboratories, Inc. (1974) Phytoplankton entrainment study. in Operational environmental monitoring in Lake Michigan near Zion Station, July 1973 through December 1973.

Industrial Bio Test Laboratories, Inc. (1974), Intake-Discharge Studies at Zion Station: Phytoplankton Progress Reports for period January - March 1974.

Industrial Bio Test (1974) Zooplankton entrainment study in Operational environmental monitoring in Lake Michigan near Zion Station July 1973 through December 1973. Vol. II.

Industrial Bio Test Inc. (1974) Intake-Discharge Studies at Zion Station: Zooplankton Progress Reports for Period January - March 1974.

Industrial Bio Test Inc. (1974) Thermal tolerance limit determinations for Lake Michigan zooplankton. Project XVII-B: IBT No. 643-01862 44 pp.

Industrial Bio Test Laboratories, Inc. (1973) Effects of temperature on fish. Project XII; IBT No. 64309862. Interim report to Commonwealth Edison Co.

Industrial Bio Test Laboratories, Inc. (1973) Fish populations and life histories in Southwestern Lake Michigan. April - December 1971 Project IX, IBT NO. W 9493.

Industrial Bio Test Inc. (1973) Meteorological and hydrological monitoring at Waukegan and Zion Generating Stations, Project VI: IBT No. W9859. July 1971 - June 1972.

Hydrocon (1972) A program of thermal plume collection and analysis from Zion Nuclear Power Station's Units Nos. 1 and 2. Study Plan prepared for Commonwealth Edison Co.

Industrial Bio Test Laboratories, Inc. (1974) Phytoplankton study. in Operational Environmental Monitoring in Lake Michigan near Zion Station July 1973 - December 1973.

Industrial Bio Test, Inc. (1974) Phytoplankton Study. in Environmental Monitoring near Zion and Waukegan Generating Stations. January 1972 through December 1972. Vol. 2.

Industrial Bio Test, Inc. (1972) Field Sampling Program: Part C - Fish Study. March 1970 - October 1971. Project VII, IBT No. W8960.

Industrial Bio Test, Inc. (1973) Field Study Program in the Vicinity of the Waukegan and Zion Generating Stations. April 1971 - March 1972. Project X, IBT No. W9860.

Industrial Bio Test, Inc. (1972) Field Sampling Program Part A. Phytoplankton, May 1970 - March 1971. Project VII, IBT No. W8960.

Industrial Bio Test, Inc. (1974) Periphyton Study in Operational Monitoring in Lake Michigan near Zion Station July 1973 through December 1973.

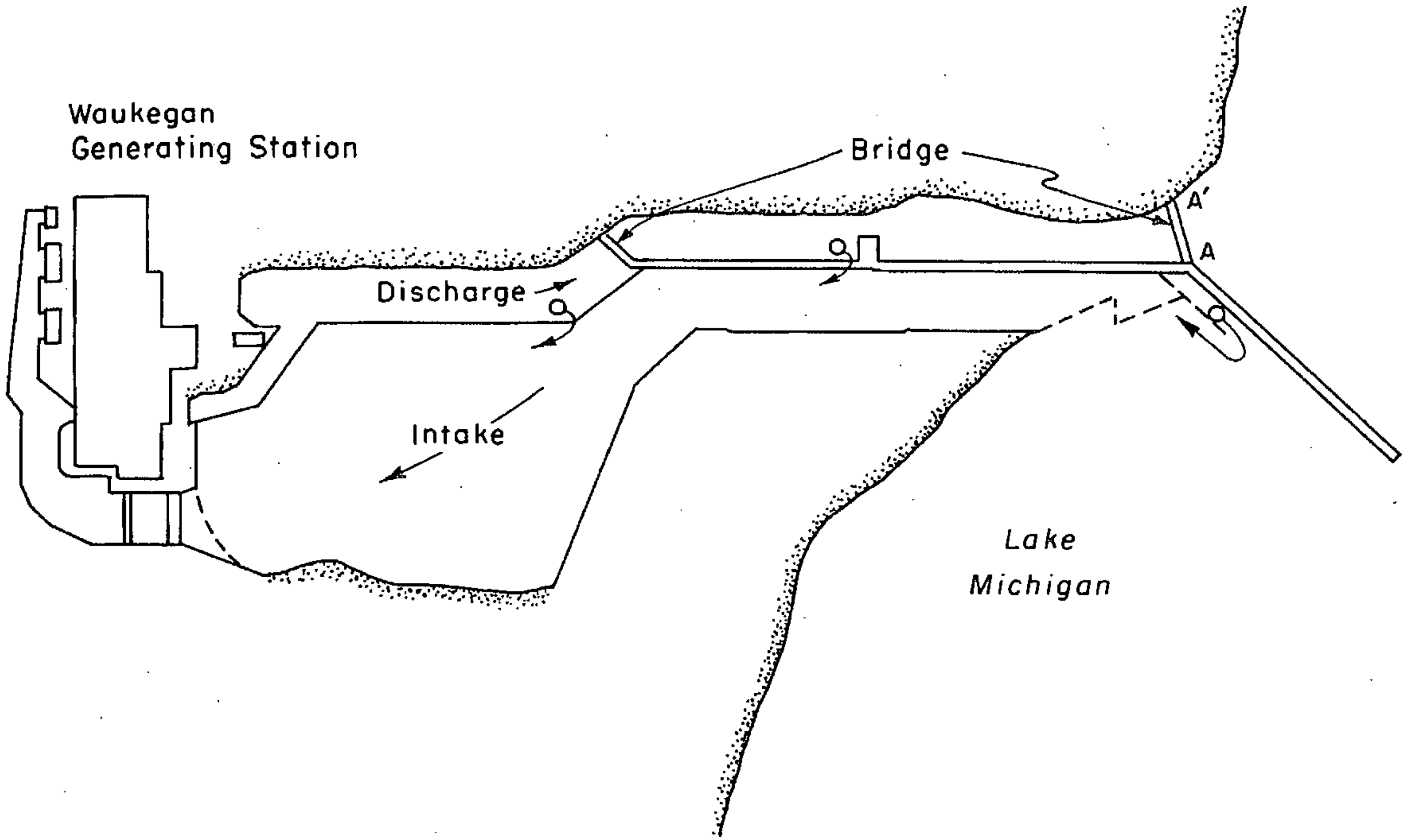
Industrial Bio Test, Inc. (1974) Zooplankton Study in Operational Environmental Monitoring in Lake Michigan near Zion Station. July 1973 through December 1973, Vol. II.

Industrial Bio Test, Inc. (1974) Zooplankton Study in Environmental Monitoring in Lake Michigan near Zion and Waukegan Generating Stations. January 1972 through December 1972 (Vol. II).

Industrial Bio Test, Inc. (1974) Benthos Study in Operational Monitoring in Lake Michigan near Zion Station. July 1973 through December 1973 (Vol. III)

Industrial Bio Test, Inc. (1972) Field Sampling Program. Part B - Benthos Study February 1970 - March 1971. Project VII, IBT No. W8960.

Industrial Bio-Test, Inc. (1974) Benthos Study in Environmental Monitoring in Lake Michigan near Zion and Waukegan Generating Stations. January 1972 through December 1972 (Vol. II).



Sketch of Waukegan Generating Station

Fig. 7

TABLE 3

MIDWEST
GENERATION EME, LLC
An EDISON INTERNATIONAL® Company

Julia P. Wozniak
Environmental Program Manager

July 22, 2013

Mr. Jaime Rabins
Permit Section - Division of Water Pollution Control
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62702

Reference: Midwest Generation LLC – Waukegan Generating Station
NPDES Permit No. IL0002259
Responses to ELPC Questions on Public Notice Draft Permit

Dear Jaime:

In response to your e:mail request of July 10th, 2013, Midwest Generation (MWG) is providing the attached responses to the Environmental Law and Policy Center (ELPC) questions originally contained in their comment letter dated March 11, 2013. This information was also sent to you electronically on July 19th, 2013.

Should you have any questions regarding these responses, or require any additional information, please contact me at jwozniak@mwgen.com or (630) 771-7880. We are planning on having several MWG representatives at the public hearing next week.

Sincerely,

Julia P. Wozniak
Environmental Program Manager

Attachment: MWG Responses to IEPA Request for Information to Address ELPC Questions on Draft Waukegan NPDES Permit

235 Remington Blvd.
Suite A
Bolingbrook, Il 60440
Tel: 630 771 7880
Fax: 312 788 5274
jwozniak@mwgen.com

Midwest Generation (MWG) Responses to IEPA Request for Information to
Address ELPC Questions on Draft Waukegan NPDES Permit (IL0002259)

(1) What cooling water intake structures are operated at this facility?

<u>MWG RESPONSE</u>: Waukegan Station's cooling water intake structure currently provides cooling water to Units 7 and 8. The cooling system for each unit is designed as a once-through system. Cooling water from the Lake is withdrawn from an on-shore location, and passes through an intake canal into a constructed embayment prior to entering the plant through two intakes, one for each of the two units. Bar racks are located in front of the traveling screens at each intake. Each screenhouse is equipped with fixed trash bars, through-flow traveling screens, and a high-pressure wash-water system. All screens are made with #12 gauge wire with 3/8-inch openings. The traveling screens are orientated parallel to the face of the screenhouse. The intake withdraws water from the entire water column.

Two pumps provide cooling water to Unit 8, whereas four pumps provide cooling water to Unit 7, for a total of six pumps. Unit 7 has one traveling screen and pump bay for each pump, whereas, Unit 8 has two bays each containing one pump and protected by two traveling screens. Screen wash water from the traveling screens for each unit flows into separate trash baskets (i.e., there are two trash baskets). The design through screen velocity at critical low water level is 2.0, and 1.8 fps for Units 7, and 8, respectively. Consistent with State of Illinois regulations, trash basket contents are not returned to the waterway. The Waukegan Station cooling water intake system does not have any additional control technologies in place specifically designed to reduce impingement mortality or entrainment . Operational practices and procedures at Waukegan Station are those that would typically be used to support once-through cooling.

(2) Is all runoff described in Outfall 001 treated at the wastewater treatment plant?

<u>MWG RESPONSE</u>: All runoff is collected in station collection systems and treated prior to discharge.

(3) What treatment do these discharges receive prior to discharge?

<u>MWG RESPONSE</u>: Treatment includes settling, sedimentation and oil removal.

(4) Is any stormwater on site *not* treated at the wastewater treatment plant?

<u>MWG RESPONSE</u>: There have been no identified stormwater run-off areas which are not routed through the existing station wastewater treatment systems.

Submitted to IEPA via e:mail on July 19, 2013

(5) Are there ever dry weather discharges from coal piles?

MWG RESPONSE: There are no dry weather discharges from the coal pile. Coal pile run-off is a precipitation-induced discharge.

(6) Is all runoff from coal piles subject to treatment prior to discharge?

MWG RESPONSE: All run-off from the coal pile and associated areas is routed to the existing coal pile runoff collection basin, which is then sent to the station's wastewater treatment system prior to discharge. There are no normal conditions which would result in any coal pile runoff being discharged prior to collection and treatment.

(7) Although this draft permit fact sheet states that two boilers are operating instead of three, the average discharge flows from the outfalls have not changed. Should they be corrected to the flows as stated by Midwest Generation? (Midwest Generation Comment Letter, November 2, 2012, p. 13).

MWG RESPONSE: In MWG's November 2, 2012 comment letter on the draft permit, the following flow corrections were requested. (See annotated portion of excerpt below):

Fact Sheet Page 2, and Permit Pages 2, 4, 5, and 6: The daily average flows for Outfalls 001, B01, C01, and D01 listed in the draft Permit were incorrectly copied from the current NPDES Permit and do not reflect the flows that were submitted in the 2005 permit application renewal forms. The flows for these Outfalls should be listed as:

1. **Outfall 001: ~~765 MGD~~** -- ***The existing flow is correct in both the existing and new draft permit (768.82 MGD)—This flow represents Units 7 &8 only. (It appears that the prior permit application flow information for Outfall 001 inadvertently did not include Unit 6 circulating water flow and thus the existing NPDES permit flow value already addresses the fact that Unit 6 is no longer in operation). The previous total circulating water flow when Unit 6 was in operation was on the order of 900 MGD.***
2. **Outfall B01: 0.079 MGD**
3. **Outfall C01: 1.53 MGD**
4. **Outfall D01: 0.521 MGD**

(8) The April 24, 2012 inspection report states that "The practice has been to dispose water side chemical cleaning wastewaters by on site evaporation in accordance with the IEPA air permit. The permittees are requesting that these wastewaters be treated by the wastewater treatment system before discharge in C01." Are these wastewaters a new waste stream?

MWG RESPONSE: While the 2005 permit application had raised the issue of a potential discharge of this treated wastestream, MWG has since decided not to pursue an authorization to discharge this wastestream.

(9) What was the cause of the April 12, 2012 fish kill in the vicinity of the Waukegan discharge?

MWG RESPONSE: As described in Waukegan's most recent permit renewal submittal to IEPA (dated January 21, 2005, see section captioned "Outfall 001 Condenser Cooling Water and House Service Water"), Waukegan Station uses thermal recirculation as an effective means of zebra mussel control. This is done once or twice per year by isolating the station's discharge canal and recirculating the cooling water flow back into the station's intake, thereby raising the temperature of the water for a period of time necessary (generally 10-12 hours) to kill zebra mussels within the station's cooling water system. During this time, water temperatures are elevated to or above 100 deg F. Following this thermal treatment, the configuration of the cooling water flow is gradually returned to normal and the discharge to Lake Michigan is resumed. During the thermal treatment process, there are often some fish remaining in the intake and/or discharge canals that may inadvertently become trapped during the recirculation process and are inadvertently killed by the short-term high water temperatures. Once the normal flow path is resumed, some of these fish may be found out in the Lake. This is an unfortunate, yet uncontrollable part of the zebra mussel control thermal treatment process. [There was a zebra mussel thermal treatment performed during the early morning hours of April 12, 2012, which resulted in an isolated fish kill within the station's intake/discharge canal system]. In general, the numbers of fish which are negatively impacted by such an event are small, and often dominated by common carp, along with a few older, less tolerant sport species. Illinois Department of Natural Resources (IDNR) personnel have been made fully aware of this situation and MWG routinely notifies IDNR prior to a scheduled zebra mussel control thermal treatment, so that they may respond appropriately to any inquiries that they might receive from the public regarding observations of dead fish. The local IEPA inspector is also notified of these zebra mussel treatments by MWG personnel. Control of zebra mussels using thermal recirculation is the most benign of all types of treatment, as it does not rely on toxic chemicals or the introduction of oxygen scavengers to the system.

(10) Is wastewater generated by a "dry" ash handling system? What systems are in place at this Facility?

MWG RESPONSE: There is no wastewater generated by a "dry" ash handling system. All of the fly ash at the station, as well as the ACI residuals, is handled on a dry basis. Bottom ash is handled wet and is sluiced to the ash pond in service at the time. The ash ponds are periodically dredged and the ash is taken offsite.

(11) Are both fly ash and bottom ash directed to the settling basins? There appears to be some inconsistency between the draft permit (which identifies fly ash and bottom ash as waste streams in Outfall C01), maps included in a report by a RCRA inspector43 (which label the ponds as fly ash and bottom ash settling basins), and statements in the RCRA inspection itself (which states that ponds are bottom ash only and that fly ash is stored in silos).

<u>MWG RESPONSE</u>: **See response above. Fly ash is handled dry and stored in silos for off-site transport and disposal. Bottom ash is sluiced to the ash pond, where it is periodically dredged and the ash is taken off-site for disposal. The statement in the RCRA inspection report is correct; the maps are in error.**

(12) What wastestreams enter the "East Wastewater Basin" identified on the map provided in Exhibit 26. What treatment occurs here? What outfall does this correspond to?

[Note that Exhibit 26 references a CD attachment that ELPC had in their January 13, 2012 comments document].

<u>MWG RESPONSE</u>: **According to the permit renewal application information, the East Yard Runoff Collection Basin (Outfall D01) consists of the following subwastestreams:**

- **East Yard Area Runoff**
- **Units 1-4 Roof and Floor Drainage**
- **East Yard Polymer Building Drains**
- **Demineralizer Filter Backwash**
- **Units 5-8 Roof and Floor Drains**

Treatment includes: Equalization and Sedimentation. Pond sediments are dredged and solids are sent off-site for disposal.

(13) Have any studies been conducted regarding the hydrologic connection between the groundwater affected by the site and Lake Michigan and/or other surface waters?

<u>MWG RESPONSE</u>: **MWG has not conducted such studies.**

Rabins, Jaime

From: Keller, Al
Sent: Tuesday, September 23, 2014 3:44 PM
To: Rabins, Jaime
Subject: FW: Waukegan RS

Make a copy for the record as the source of this information.

From: Twait, Scott
Sent: Tuesday, September 23, 2014 11:30 AM
To: Rabins, Jaime
Cc: Keller, Al
Subject: RE: Waukegan RS

I got the info from:

Steve R Robillard
Project Specialist
Illinois Department of Natural Resources
Lake Michigan Program
9511 Harrrison Street
Des Plaines, IL 60016
(847) 294-4134

From: Rabins, Jaime
Sent: Tuesday, September 23, 2014 10:25 AM
To: Twait, Scott
Subject: Waukegan RS

Al likes the response but wants to know here we got the info? Is the source in the record?

43. Do you know whether the aquatic community in Lake Michigan as a whole experienced any changes since 1978; for example, have species recovered or declined, has the composition of the aquatic community changed over time?(T-64)

There have been significant changes in the aquatic community over the past three decades. Most of the large-scale changes are the result of changes in lake productivity. As productivity declines, there is less available nutrients/energy to move through the food web. Declines in productivity are likely the contributing factor to declines in the yellow perch and alewife populations. Declines in alewife abundance consequently affect salmon and trout populations. These changes in productivity and lower trophic level species composition (i.e., zooplankton and benthic invertebrates) have been largely attributed to effects of invasive species (e.g., zebra and quagga mussels, and spiny and fish hook water fleas).

Midwest Generation L.L.C
Waukegan Generation Station

National Pollutant Discharge Elimination System (NPDES) Permit

Responsiveness Summary

Regarding

July 31, 2013 Public Hearing

Illinois Environmental Protection Agency
Office of Community Relations
March 25, 2015

Midwest Generation L.L.C.
Waukegan Generating Station

National Pollutant Discharge Elimination System (NPDES) Permit Responsiveness Summary

Table of Contents

Final March 25, 2015

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

Midwest Generation L.L.C
Waukegan Generating Station
Renewed Permit
Permit Number IL0002259

ILLINOIS EPA PERMIT DECISION

On March 25, 2015, the Illinois Environmental Protection Agency approved a NPDES permit for Midwest Generation, L.LC.

The following changes were made to the public noticed permit:

1. The compliance schedule for pH in Special Condition 2 was revised to allow for a 6 month monitoring period followed by 12 additional months, if necessary, to design and construct a treatment system.

2. The mercury monitoring requirements for outfall 001 were consolidated into Special Condition 16 and Special Condition 15 was removed.

3. Special Condition 10 was modified to require that changes in the use of water treatment additives be approved by the Illinois EPA.

4. Special Condition 11 clarifies that the discharger may request a reduction or elimination in dissolved oxygen monitoring after two years.

5. The sampling frequency for pH at outfall 001 was changed to 2/month which will provide two samples on the monthly DMR.

6. The sampling frequency at A01 and B01 for TSS and oil and grease was changed to 2/month which will provide two samples on the monthly DMR.

7. Special Condition 7 was revised to require compliance with the new cooling water intake structure existing facilities rule.

8. Special Condition 17 was removed and the language is included in Special Condition 7(B)(3). The remaining special conditions were renumbered.

9. Fly ash sluice water was removed from the permit.

10. The permitted flow and condenser cooling water flow was reduced to 739 MGD and 589 MGD respectively, to reflect the removal of Unit 6 from service on December 21, 2007.

11. The discharger address was changed as requested.

12. An equation was added to Special Condition 4 to determine and report the heat rejection rate.

PRE-HEARING PUBLIC OUTREACH

The notice of the NPDES permit public hearing was published in the *Waukegan Lake County Sun* on June 11, 18, and 25, 2013.

The hearing notice was mailed or e-mailed to:

a) Lake County officials;
b) Municipal officials in: Waukegan as well as State and federal representatives;
c) Parties that filed comments or requested a hearing on the public-noticed draft permit; and,
d) Those who have requested to be notified of water hearings.

The hearing notice was posted on the Illinois EPA website:
http://www.epa.state.il.us/public-notices/2013/midwest-generation-waukegan/hearing-notice.pdf

Hearing notices were posted at the Illinois EPA headquarters in Springfield.

July 31, 2013 PUBLIC HEARING

Hearing Officer, Dean Studer, opened the hearing July 31, 2013, at 6.30 p.m. at the Jane Addams Center-Bowen Park, 95 Jack Benny Drive, Waukegan, Illinois.

Midwest Generation, L.L.C. Hearing Participants:

Mark Nagel

Illinois EPA Hearing Participants:

Deborah Williams, Assistant Counsel, Bureau of Water
Scott Twait, Standards Section, Bureau of Water
Lynn Dunaway, Groundwater Section, Bureau of Water
Jaime Rabins, Industrial Unit, Permits Section, Bureau of Water
Darrin LeCrone, Industrial Unit, Permits Section, Bureau of Water

Illinois EPA Permit Engineer, Jaime Rabins, gave a brief overview of the draft permit.

Comments and questions were received from the audience.

Hearing Officer, Dean Studer, closed the hearing at 9:40 p.m. on July 31, 2013.

Illinois EPA personnel were available before, during and after the hearing to meet with elected officials, news media and concerned citizens.

Approximately 80 persons representing neighbors, local government, businesses, elected officials, environmental groups, interested citizens, and Midwest Generation participated in and/or attended the hearing. A court reporter prepared a transcript of the public hearing which was posted on the Illinois EPA website at:
http://www.epa.state.il.us/public-notices/2013/midwest-generation-waukegan/hearing-transcript.pdf

The hearing record remained open through August 30, 2013.

BACKGROUND of Midwest Generation L.L.C.
Waukegan Generating Station

The Illinois EPA Bureau of Water has prepared a final reissued NPDES permit for Waukegan Generating Station. The address of the discharger is Midwest Generation L.L.C., 401 East Greenwood Ave., Waukegan, Illinois 60087.

The applicant is engaged in operation of a steam electric generating station (SIC 4911). The station operates two coal fired boilers to supply steam to two generating units, designated units 7 and 8, with a combined nominal capacity of 742 megawatts (MW). The station withdraws water from Lake Michigan for condenser cooling, house service water, and boiler feed water. Wastewater is generated from once-through condenser cooling, conditioning boiler feed water, backwashing the condenser cooling water intake screens, non-chemical cleaning of plant equipment, ash handling, and precipitation which contacts the site.

Plant operation results in:

- an average discharge of 739 million gallons per day (MGD) of condenser cooling water and house service water from outfall 001;
- an intermittent discharge of boiler blowdown from outfall A01;
- 0.151 MGD of demineralizer regenerant wastes from outfall B01,
- 8.13 MGD of wastewater treatment system effluent from outfall C01,
- 0.676 MGD of east yard basin overflow from outfall D01;
- an intermittent discharge of unit 7 demineralized water storage tank drain from outfall F03; and,
- an intermittent discharge of non-chemical metal cleaning wastes from outfall G01.

Responses to Comments, Questions and Concerns

Comments, Questions and Concerns in regular text
Illinois EPA responses in bold text

NPDES PERMIT

1. I'm here tonight to urge you to strengthen the draft water pollution permit for the coal plant so that there are proper paths or impacts that can't harm me, my family, my community and our environment. I am a resident of Lake Forest where we draw our drinking water from two intake pipes that are approximately eight miles south of the coal plant. Specifically, I request tonight for the Illinois EPA to strengthen this permit in four ways: Number one, strengthen the coal ash pollution limits that the U.S. EPA has already determined are inadequate. Number two; please include measures to address the ground water contamination that exists near the plant. Number three; please review the Lake Michigan Thermal Water Quality Standards to insure the coal plant is not harming water quality and aquatic life. And number four, please take steps to minimize the fish kills from the plant's intake pipes.

   The permit contains a new monitoring requirement for metals and other pollutants for outfall 001 which includes coal-related discharges.

   The permit does not contain groundwater monitoring requirements because groundwater monitoring is being administered through the compliance commitment agreement (CCA) submitted by Midwest Generation in response to violation notice W-2012-00056. The CCA also requires the installation and monitoring of two additional monitoring wells at the site to further assess groundwater flow and quality.

   The permit controls thermal discharges in accordance with PCB 78-72, -73 Consolidated dated September 21, 1978. Unit 6, rated at 100 MW, was retired on December 21, 2007, eliminating any discharge from the unit and further reducing the thermal load to Lake Michigan. To ensure the nature of the thermal discharge has not changed and the alternative thermal effluent limitation granted by the Board has not caused appreciable harm to a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made, the reissued permit requires specific activities and studies discussed in response to Question #59.

   To determine if additional controls are necessary to minimize impingement and entrainment of fish, the reissued permit requires the submittal of an impingement mortality and entrainment characterization study and an alternatives analysis for the water intake structure.

2. The gentleman from Midwest Generation said that the ponds are not leaking. They may not be leaking, but there are monitoring wells around the perimeter that are coming up with arsenic, and I won't go through all of them. I don't remember all of them, but they are the very types of heavy metals that we have concerns about. The idea that you would find those things in the area around it would imply that the supernatant water above the solids that are in the pond is leaching metals, and it is an item of concern. We would ask that you take a look at those 2010 U.S. EPA Guidelines, which asks people not to monitor alone, but to put BAT technology in place so that these sorts of things can be controlled.

   The permit contains a new monitoring requirement, Special Condition 16, which requires semi-annual monitoring for metals and other pollutants to ensure effluent and water quality limits are being met upon discharge. If data indicates limits are necessary, the permit may be reopened, and additional limitations and provisions will be added to the permit. Based on currently available data, it does not appear that the active ash ponds are the source of contamination. There appears to be some other source. Midwest Generation has engaged their consultants and is evaluating the site. With the removal of Unit 6, fly ash is no longer wet sluiced which will reduce the potential leaching of metals. The facility has installed technology to minimize, if not eliminate, ash pond leaks/seeps. The east pond was relined in 2003 and the west pond was relined in 2005 with a 60 mil HDPE liner, 12 inches of sand, and 6 inches of limestone screenings and the liner is inspected on an annual basis.

3. Is your role to allow a discharge that might further impair the waters of Lake Michigan, which are already impaired from mercury, and then see whether they do; or is it to limit the discharges, to insure that Lake Michigan water is not impaired in the future, and then check to make sure that that goal is achieved? Are you prospective or precautionary? I would like an answer. Is that fair?

   The receiving water, segment QLM-01 of Lake Michigan, is impaired for mercury, but the Illinois EPA does not have any low-level mercury data for the Waukegan Generating Station facility which is necessary to determine if a mercury limit is required. Therefore, the reissued permit contains a new low level mercury monitoring requirement at outfall 001. The discharges at outfall 001 are required to be monitored for mercury monthly for the first two years and quarterly thereafter utilizing USEPA method 1631E. The data will be reviewed during the next permit cycle to perform a reasonable potential analysis to determine if limits are necessary.

4. I understand the USEPA is currently revising their rules as far as coal ash pollution, the pollutant runoff from the ash ponds. Is that correct? Have they asked the Illinois EPA to try to look at changing their standards?

The USEPA Administrator, Gina McCarthy, signed the Disposal of Coal Combustion Residuals from Electric Utilities final rule on December 19, 2014, and it was submitted for publication in the *Federal Register*. The rule will become effective six months after publication in the Federal Register.

5. Is there any change in this permit from the previous permitting to address that there should be a change in the standards?

   This permit requires additional monitoring and is more stringent than the previous permit in the following ways: (1) metals monitoring, (2) dissolved oxygen monitoring, (3) impingement mortality and entrainment characterization study, and an alternatives analysis submittal requirement, (4) biological sampling and thermal modeling, (5) reduction in condenser cooling water discharged due to the retirement of Unit 6 (100 MW), and (6) elimination of fly ash sluice as an authorized discharge. There have not been any changes to the permit based on the proposed steam electric power generating point source category regulations, as they are not currently applicable.

6. Can you guarantee that the coal ash flowing through Lake Michigan will still be safe in the next five to ten years? Can you guarantee that your data in the permit is accurate?

   The permit authorizes the discharge of water which comes into contact with coal ash, not the discharge of untreated coal ash. The Illinois EPA has reviewed the effluent data for this facility and determined that a reasonable potential to exceed water quality standards does not exist nor do any of the reported pollutants exceed effluent standards. To ensure continued compliance with water quality and effluent standards, the permit requires semi-annual monitoring for metals and other pollutants and more frequent monitoring for mercury.

7. When Midwest Generation sells this plant, will the permit automatically transfer to the next owner, with the possibility of more delays in meeting standards, or will the new owner have to reapply for a permit?

   NRG Energy, Inc. acquired Midwest Generation LLC on April 1, 2014. The permits are not being transferred because the plant will continue to be operated by Midwest Generation, L.L.C. However, in the future, if another owner wants to own and operate this plant, they must follow the permit transfer requirements of 40 CFR 122.61.

8. Although the draft permit fact sheet states that two boilers are operating instead of three, the average discharge flows from the asphalt have not changed from earlier permit drafts, as we've seen. Should they be corrected to flows as stated by Midwest Generation in some of their earlier comment letters that were referenced in the

comments we submitted earlier? Does it have any impact on effluent limits that are in the draft permit?

The flow of 768.62 MGD at outfall 001 in the public noticed permit was in error and was reduced to 739 MGD to reflect that Unit 6 was retired on December 21, 2007.

9. Did IEPA change the identified receiving water between the December 2, 2011, draft, and the February 8th, 2013 draft?

   No. The receiving water was listed as Lake Michigan in the previous permit and is listed as Lake Michigan in this reissued permit.

10. The receiving water is still considered an open water of Lake Michigan then?

    Yes, pursuant to 35 Ill. Adm. Code 302.501; the Illinois EPA has determined that the receiving water for outfall 001 is an "Open Waters of Lake Michigan".

11. The draft permit put on public notice in 2011 included thermal limits. Why did IEPA include those thermal limits in that draft permit?

    The previous permit included thermal relief in accordance with Section 316(a) of the Clean Water Act 33 U.S.C. 1326(a). The 2011 public noticed permit omitted thermal relief in error and instead limited the discharges to the State Water Quality Standards of 35 Ill. Adm. Code 302.507. Comments were received from the discharger requesting that the permit reincorporate the thermal relief granted by the Illinois Pollution Control Board Order 77-82, dated August 3, 1978. The Illinois EPA reviewed the matter and agreed to reincorporate the thermal relief in the permit. To ensure the nature of the thermal discharge has not changed and the alternative thermal effluent limitation granted by the Board has not caused appreciable harm to a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made, the reissued permit requires specific activities and studies discussed in response to Question #59.

12. Did anything change between 2011 and 2013, other than finding this variance in the Pollution Control Board that caused IEPA to remove those thermal standards from the permit?

    Subsequent to discovering the omission, the permit was corrected and re-public noticed on October 16, 2012 to recognize the thermal relief granted by the Illinois Pollution Control Board Order 77-82, dated August 3, 1978.

13. In preparation of this draft permit, did IEPA review the documentation presented for the 1978 variance that we're talking about?

The Illinois EPA reviewed the thermal studies from 1975 and 1976 conducted in accordance with 316(a) of the Clean Water Act 33 U.S.C. 1326(a) and determined that there have not been any changes at the facility which would result in additional heat being discharged into the lake. Furthermore, Unit 6, rated at 100 MW, was removed from service on December 21, 2007 thus, decreasing the heat load.

14. Did the 1978 variance delineate the extent of the thermal plume from the Waukegan plant?

    Although, the extent of the thermal plume was not delineated in the 1978 Variance, based on the full operation of four generating units, "the predicted area of the plume is 126 acres for the 3 °F isotherm with no cross-current in the lake for the discharge structure" (Page 1, PCB 78-72, -73 (Consolidated)). Currently, there are only two generating units operating, Unit 7 and Unit 8.

15. Can you explain what cooling water intake structures are operated at this facility?

    The cooling system for each unit is designed as a once-through system. Cooling water from the lake is withdrawn from an on-shore location, and passes through the intake canal into a constructed embayment prior to entering the plant through two intakes, one for Unit 7 and one for Unit 8. Bar racks are located in front of the traveling screens at each intake. Each screenhouse is equipped with fixed trash bars, through-flow traveling screens, and a high pressure wash-water system. All screens are made with #12 gauge wire with ⅜-inch openings. The traveling screens are oriented parallel to the face of the screenhouse. The intake withdraws water from the entire water column.

    Two pumps provide cooling water to Unit 8, whereas four pumps provide cooling water to Unit 7, for a total of six pumps. Unit 7 has one traveling screen and pump bay for each pump, whereas, Unit 8 has two bays each containing one pump and protected by two traveling screens. Screen wash water from the traveling screens for each unit flows into separate trash baskets. The design through screen velocity at critical low water level is 2.0, and 1.8 feet per second for Units 7, and 8, respectively.

16. What current and historical data did IEPA have regarding impingement and/or entrainment at this facility?

    The Illinois EPA used the data provided in the 1975/1976 study conducted in accordance with Section 316(b) of the Clean Water Act 33 U.S.C. 1326(b). Specifically the study provides:

Twenty-four hour impingement samples were collected every fourth day from May 12, 1975 through April 1976 at the Waukegan station. An estimated 898,457 fish comprised of 30 species were impinged during the study.

Weekly entrainment samples were collected from April 2, 1975 through March 1976. An estimated 19.8 million identifiable fish larvae were collected, comprised of only three species: common carp, alewife, and rainbow smelt. An estimated 855.2 million identifiable fish eggs were collected during this study. Consistent with the fish larvae, only three species were identified among the fish eggs: alewife, rainbow smelt, and common carp.

17. Special Condition 15 describes the mercury monitoring method that is to be used. Can you clarify for me that that applies to both outfall 001 and internal outfall C01; and then my question is, this is how I read it, and you can tell me if I'm wrong: Why is there a monthly monitoring required for a year at outfall 001 and then quarterly thereafter, while only quarterly monitoring is required at outfall C01?

    The reference to mercury monitoring at C01 on page 5 was in error and hence was removed from the permit. Mercury monitoring requirements for outfall 001 were consolidated into Special Condition 18 and to eliminate redundancy Special Condition 15 was removed. Mercury monitoring will be monthly at outfall 001 for 24 months and then quarterly thereafter.

18. Has Midwest Gen[eration] provided any mercury monitoring using the method that is described in Special Condition 15? Have they already provided any data using that method to you?

    The Illinois EPA does not have any low-level mercury data for the Waukegan Generating Station facility nor was the discharger required to provide any. However, in the reissued permit, mercury is required to be sampled monthly at outfall 001 for 24 months and quarterly thereafter in the reissued permit.

19. First, in the December 2011 draft permit, there was a requirement that dissolved oxygen not be less than 90-percent saturation. Why was that removed from the most current version of the permit?

    The limit has been removed and replaced with a requirement to monitor the intake and discharge. The Illinois EPA would need this data to determine if a reasonable potential exists to exceed dissolved oxygen standards and if a limit is necessary.

20. Are both fly ash and bottom ash directed to the coal basins, coal ash basins? There appears to be some inconsistency between the draft permit, which identifies fly ash and bottom ash as waste streams to outfall C01.

Fly ash was previously generated from Unit 6 which was retired on December 21, 2007. Currently, only bottom ash is directed to the coal ash basins. The reference to fly ash sluice water for outfall 001 on page 5 of the permit was in error and thus removed.

21. So, will the permit be changed to reflect that? If it's going to allow them to put out fly ash that has more mercury in it than it used to, then you need to do an anti-degradation assessment.

Since, the permit does not authorize the discharge of fly ash sluice water an antidegredation assessment is not necessary. See response #20.

22. Is there a reason why I guess from the studies, it looks like it was from the permit one of the conditions is to study the impact of the plume and do surveys on that, is there a reason why that was not done before this permit?

The thermal relief was granted back in the 1970s. The thermal relief provisions have been incorporated in all previous permits since approval was granted. In order to re-justify or renew that type of relief, the Illinois EPA is requiring the applicant to study the fish species, the health of the lake, mixing for temperature, so that the information can be reviewed during the next permit cycle. See response #59.

23. My question is at what point do you determine that you don't have enough data, and you're going to request more?

The Illinois EPA has reviewed the application and determined that it has adequate data to reissue the permit. In order to make any future permitting decisions during the next permit cycle, the reissued permit requires the following new monitoring requirements/submittals: (1) metals monitoring, (2) dissolved oxygen monitoring, (3) impingement mortality and entrainment characterization study and an alternatives analysis submittal requirement, and (4) biological sampling, and thermal modeling.

24. How often do you perform audits of their data? How do you know how accurate that is, and how often do you do a double check and just audit their information, to make sure that you are getting the correct information?

The information received from applicants is considered to be accurate unless it is known or appears to be in error. Furthermore, applicants must certify under penalty of law that the information submitted is, to the best of their knowledge and belief, is true, accurate, and complete and that they are aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

25. When looking through the Special Condition Number 16, it says, "There shall be no discharge of complex metal-bearing waste streams and associated rinses from chemical metal cleaning, unless this permit has been modified to include the new discharge. Just a point of order, I'm just trying to figure out what the complex metal bearing waste streams are. If it's complex metal, does that mean hexavalent chrome and waste streams? What I'm trying to relate is whether these waste streams are the same as I used to encounter many years ago.

    There are two types of metal cleaning wastes, chemical metal cleaning wastes and non-chemical metal cleaning wastes. Complexed metal cleaning wastes means chemical metal cleaning wastes. Currently only non-chemical metal cleaning wastes are authorized to be discharged.

26. Where does the water that services the plant come from? Does it come from Lake Michigan, or does it come from bottled water or something like that?

    The water to service the plant comes from Lake Michigan.

27. What type of waste water treatment is applied to the effluent from the ash ponds before discharge?

    Sedimentation is the primary treatment method. There is also an oil containment ring located on the outer circumference of the clarifier.

28. In the draft permit released in December 2011, mercury monitoring put a limit on total suspended solids was placed on the one million gallon per day coal pile runoff. Why was that condition removed from the latest draft permit? One million gallons per day is a lot of water. Are there dry weather discharges coming off of the coal pile?

    The coal pile runoff collection basin which receives drainage from the coal pile area, west yard area, car dumper area, main switch yard area, west yard area polymer building drains, peaker sump, and west turbine area roof drains has an approximate discharge of 1.0 MGD. Coal pile runoff only has an approximate flow of 0.5 MGD. Because the coal pile runoff discharges to the wastewater treatment plant, which is limited for TSS, it is not necessary to limit TSS discharges from the coal pile prior to treatment and then have another TSS limit after treatment.

    There are no dry weather discharges from the coal pile.

29. How close are the coal piles to Lake Michigan, or the canal that is hydrologically connected to Lake Michigan?

    The closest proximity of the coal pile is to the station intake canal along the northern (NNE) edge of the pile. It is approximately 125 feet from the

Waukegan Generating Station intake canal. It is important to note that there is a coal pile runoff ditch located between the pile and the canal that will intercept water/coal mixtures. The ditch, which surrounds the pile, directs the coal pile run-off water to the coal pile runoff collection basin.

30. Is it possible for coal to bypass the permitted outfall and discharge coal directly into the lake or the canal?

All runoff from the coal pile and associated areas is designed to be routed to the existing coal pile runoff collection basin, which is then sent to the station's wastewater treatment system prior to discharge.

31. Are there transformers containing PCBs on the site; and if so, do you know how they are stored?

There are four PCBs transformers at the facility, each located inside a secured and covered building constructed with its own secondary containment system and located at least 1,000 feet from the nearest outdoor open water basin.

32. Can you explain why the monthly average effluent limitation for copper on outfall G1 changed from 0.5 milligrams per liter in the 2011 permit, to 1 milligram per liter the 2013 draft permit? Which is the monthly average under the federal guidelines, is it the 0.5 or 1?

Copper was previously limited at outfall C01 pursuant to state effluent standards of 0.5 mg/L monthly average, 1.0 mg/L daily maximum (35 Ill. Adm. Code 304.124). Since the source of copper is the non-chemical metal cleaning wastes, a new internal monitoring point G01 was added to the permit for the existing discharge of non-chemical metal cleaning wastes per 40 CFR 423.12(b)(5). Consistent with 40 CFR 423.12(b)(5) the discharge is limited to a monthly average and daily maximum copper limitation of 1.0 mg/L prior to mixing with other wastestreams.

33. Has Midwest Generation indicated that it's unable to meet pH limits in outfall 1?

The discharges from outfall 001 have not been previously subject to pH limits. Thus, the reissued permit requires pH to be monitored for six months. The data will be used to determine whether treatment is necessary to meet the pH limits.

34. How does one normally treat for pH, what's the process? Is it a particularly difficult chemical to treat for?

pH can be adjusted by adding either an acid (to lower pH) or a base (to raise pH). Carbon dioxide may also be used to reduce pH in alkaline water. If treatment is required to meet the pH limits at outfall 001, the facility will need

time to design, construct, and comply with the pH limits which were not in the previous permit.

35. What is the basis of IEPA's determination as stated in Special Condition 14 that the effluent limits on outfall 001 constitute BAT/BCT for storm water?

Stormwater is treated and subject to effluent limits which are more stringent than requiring only best management practices through a stormwater pollution prevention plan.

36. So, all storm water on site is treated at the wastewater treatment plant? Do you know what treatment those discharges receive?

All runoff is collected in the station's collection system and treated using sedimentation and oil removal prior to discharge.

37. Can you explain why the proposed internal outfall H01 for coal panel discharges was eliminated in this version of the draft permit?

Since coal pile runoff is routed to the wastewater treatment system, which has effluent limitations for total suspended solids, limiting total suspended solids prior to treatment is unnecessary.

38. Given the fact that they are doing dry processing of fly ash and mercury residual, can we presume there is a permit for that?

The permit does not authorize the discharge of fly ash sluice water. See response #20.

Antidegradation Assessment/Water Quality Standards

39. I am concerned how these standards decide upon, how this was considered to be safe. Sometimes we find things later on that science changes and we find some of the things, for example, we had many problems with mercury, nitrogen, asbestos in this area, how the science as to this is supposed to be safe. In addition to this, saying that this is the existing science, and I'm not sure how this will be determined, when I hear that Congress intends to cut fund to get EPA, how do you intend to monitor and enforce these standards, if your budget is reduced?

    Illinois EPA develops water quality standards to protect aquatic life and human health. To keep these water quality standards up to date based on new science or research the Illinois EPA is required to perform a triennial review (every three years) of its standards 33 U.S.C. 1313(c). Illinois EPA uses the USEPA national criteria documents as well as more recent toxicity data to develop water quality standards.

    If funding to the federal EPA is decreased, Illinois water quality standards will remain in force and Illinois EPA will continue to enforce and update these standards as state funding allows.

40. What's involved in the antidegradation study?

    Under the Illinois Pollution Control Board rules at 35 Ill. Adm. Code 302.105, an antidegradation assessment has to be completed when there is a new or expanding facility that is increasing the loading of a parameter to the receiving water. In this case, the Waukegan Generating Station facility is not increasing the loading to the receiving water, therefore, no antidegradation assessment has been completed.

    An antidegradation assessment must comply with the requirements of 35 Ill. Adm. Code 302.105 and must include: identification and characterization of the water body, identification and quantification of the proposed load, purpose and anticipated benefits, assessments of alternatives, any additional information the Illinois EPA requests, and proof that a copy of the application has been provided to IDNR.

41. The idea that they have not increased the load, the bottom line is you don't know what the load is. They haven't been busy measuring it and monitoring it. The new permit asks for all of those sorts of parameters to be incorporated, and what we would ask of you is that you do an antidegradation analysis of this particular plant in regards to that.

    The Waukegan Generating Station facility is not increasing the output of the plant nor are they changing plant processes, therefore, effluent loading to the

receiving water will not increase. Consistent with 35 Ill. Adm. Code 302.105, an antidegradation assessment is not required.

42. Were the limits in the 2011 draft permit based on Lake Michigan Water Quality Standards?

With the exception of one parameter, temperature, the Waukegan Generating Station facility must comply with the Water Quality Standards for Lake Michigan. Temperature limits were based on a study conducted in accordance with Section 316(a) of the Clean Water Act 33 U.S.C. 1326(a) and approved of by the Illinois Pollution Control Board in Order 77-82, dated August 3, 1978.

43. Do you know whether the aquatic community in Lake Michigan as a whole experienced any changes since 1978; for example, have species recovered or declined, has the composition of the aquatic community changed over time?

There have been significant changes in the aquatic community over the past three decades. Most of the large-scale changes are the result of changes in lake productivity. As productivity declines, there is less available nutrients/energy to move through the food web. Declines in productivity are likely the contributing factor to declines in the yellow perch and alewife populations. Declines in alewife abundance consequently affect salmon and trout populations. These changes in productivity and lower trophic level species composition (i.e., zooplankton and benthic invertebrates) have been largely attributed to effects of invasive species (e.g., zebra and quagga mussels, and spiny and fish hook water fleas).

44. Has any equivalent of the monitoring required by Special Condition 18, that's the last condition in the permit, or second to the last, been required in the past? If so, have reasonable potential analyses been conducted based on that data?

Metals monitoring was not required in prior or the currently-effective NPDES permits. However, as part of the application, Midwest Generation has provided one sample result. The Illinois EPA performed a reasonable potential analysis for the Waukegan Generating Station facility. There is no reasonable potential to exceed the water quality standards in the effluent or outside of allowed mixing.

45. Now, we have some information from the files of what Midwest Gen[eration] had submitted to IEPA, and they had their own analysis of their own data that they found that there was a reasonable potential to exceed Water Quality Standards at outfall 001 for iron, lead, mercury and phenols. Why are there no limits on those pollutants in the permit?

Midwest Generation was using the reasonable potential analysis to convince the Illinois EPA that there was no reason to monitor the large majority of

metals. According to the Midwest Generation analysis, the data did not indicate that iron, lead, mercury, and phenols had no reasonable potential to exceed the water quality standards. Therefore, Midwest Generation was willing to accept monitoring of those parameters. The projected effluent quality (PEQ) was above the water quality standards. However, there were no detections of lead, mercury, or phenol in the three samples. Midwest Generation only collected Iron (total) samples and did not collect Iron (dissolved) samples. Lake Michigan has an Iron (dissolved) water quality standard. Therefore, Midwest Generation's data collection cannot be used to determine a reasonable potential to exceed the Iron (dissolved) water quality standard. Based on this information, the Illinois EPA determined that regulation of iron, lead, mercury, and phenols are not necessary but monitoring is required for future analysis.

46. They did not perform their only reasonable potential analysis on other metals that are often found in coal ash. Those include things like aluminum, thallium, silver, arsenic and antimony. Arsenic and antimony both of those have been detected in the ground water near the coal ash compound. So, that raises a concern for me. Selenium, they reported a value of 0.21 milligrams per liter selenium in the effluent from the plant's wastewater treatment system, while the Lake Michigan standard is 5 micrograms per liter. So, my question is: Has IEPA looked at those pollutants and the need for a limit in the permit?

    The Illinois EPA performed a reasonable potential for the Waukegan Generating Station for outfall 001. Any samples taken at an internal outfall, has a large amount of dilution from the condenser cooling water. There is no reasonable potential to exceed the Water Quality Standards in the effluent or outside of allowed mixing.

47. Are facilities allowed to use dilution to meet Water Quality Standards?

    Facilities are allowed to use dilution to meet water quality standards as long as they comply with the mixing regulations at 35 Ill. Adm. Code 302.102.

48. Will the Illinois EPA use the 3.1 nanograms per liter human health standard, or the 1.3 nanograms per liter for wildlife standard for mercury for Lake Michigan in its reasonable potential analysis?

    The Illinois EPA will ensure that the effluent complies with all applicable water quality standards. In this case, as the wildlife standard for mercury of 1.3 nanograms per liter is the most stringent water quality standard applicable, the Waukegan Generating Station facility would be required to comply with 1.3 nanograms per liter standard.

49. Can you determine whether mercury has a reasonable potential to exceed the lake, that very low Lake Michigan water quality standard, if you only have mercury data reported at less than 0.2 milligrams per liter?

The previous permit did not require mercury analysis based on a low level detection method. The one sample that was collected used a method that does not give sufficient information to say whether or not the water quality standard is met. The reissued NPDES permit requires sampling using the low-level mercury monthly for two years and quarterly thereafter.

50. My question is about that monitoring condition, which is in Special Condition 11, why is it requiring that dissolved oxygen be monitored during the daytime? You've set hours that it's supposed to be collected during the daytime, instead of at night, or right before dawn, when we would expect DO to be at its lowest point in the dire one-sentence swing.

The data from Special Condition 11, which requires dissolved oxygen data to be collected in the influent and effluent, will allow the Illinois EPA to determine what impact the facility is having on dissolved oxygen. The Illinois EPA is requiring this data to be monitored during the daytime so that we can compare the results to ambient data that the Illinois EPA collects, which is also monitored during the daytime.

51. Are you allowed, based on science and health standards, to set good standards to be the new standards for the new permit to be as stringent as they need to be to protect the health of the communities?

The Illinois EPA ensures that the NPDES permit will comply with current water quality standards which are approved by the Illinois Pollution Control Board through the Administrative Procedures Act. The current water quality standards are based on the available relevant toxicity data to protect aquatic life, wildlife, and human health. The Illinois EPA uses the triennial review of 33 U.S.C. 1313(c) (every three years) to determine if adequate toxicity data has been generated resulting in a need to recalculate the water quality standards. The Illinois EPA would then need to petition the Illinois Pollution Control Board to modify the water quality standards.

Enforcement/Compliance Issues

52. The State of Illinois has indicated that advocates in favor of denying this permit should be prepared to quote chapter and verse of the state regulations. At the public hearing however it was evident that some very smart folks did not understand either the state or federal regulations. Furthermore state regulations have become increasingly complex through time. Practitioners and consultants that routinely deal with the regulations might have a familiarity and ability to address this complexity but the general public will not. We suggest that a two page summary and explanation of the state and federal statutes under which the permit is written be part of future draft permit applications. We also suggest that it be made part of the responsiveness summary.

The USEPA developed a fact sheet outlining a brief history and introduction to the national water pollution control permitting program as administered by the USEPA and provides an overview of the permitting activities implemented through the NPDES program today. This information can be found at http://www.epa.gov/npdes/pubs/101pape.pdf

The Illinois EPA has been delegated authority to issue NPDES permits in Illinois. The State received this delegated authority, by USEPA, on October 20, 1977 pursuant to Sections 4, 11, and 39 of the Illinois Environmental Protection Act.

53. Midwest Generation is currently in bankruptcy. They will not be interested in extensive modifications of their plant or their unit processes. However, USEPA guidance concerning water treatment at coal plants suggests that state permit writers "anticipate" the intent of the proposed federal rules changes to be finalized in September of this year. The guidelines emphasize timely introduction of BAT technologies. Continuing to "study the issue" does not imply timeliness. We believe that thermal and impingement/entrainment data may already be available. Illinois EPA should confirm this before the permit is finalized.

Section 316(a) of the Clean Water Act applies to the thermal discharges from this facility 33 U.S.C 1326(a). The facility has applied for and was granted thermal relief by the Illinois Pollution Control Board, Order 77-82, dated August 3, 1978. Since that time, thermal discharges have been further reduced with the removal of Unit 6 (100 MW) from service on December 21, 2007. As a condition of the continuation of the facility's 316(a) thermal relief the reissued permit requires biological sampling and thermal modeling. The Illinois EPA will review the data during the next permit cycle to determine if additional limitations are necessary.

Section 316(b) of the Clean Water Act applies to the operation of the cooling water intake structure 33 U.S.C 1326(b). The Illinois EPA used the data provided in the 1975/1976 316(b) study which is summarized in response #16.

To characterize the current effect of the cooling water intake structure operation, the discharger is being required to submit an impingement mortality and entrainment characterization study and a alternatives analysis. Illinois EPA will review this information during the next permit cycle and determine if additional facilities or monitoring is necessary.

Groundwater Issues

54. Is there anything in this permit that would require amending the standards or monitoring or regulation or plans to clean up ground water contamination?

    The permit does not contain groundwater monitoring requirements. However, the approved compliance commitment agreement (CCA) submitted by Midwest Generation in response to violation notice W-2012-00056 does require ongoing groundwater monitoring. The CCA also requires the installation and monitoring of two additional monitoring wells at the site to further assess groundwater flow and quality.

55. Is that a continuous monitoring or how often?

    Groundwater samples are collected and analyzed, and the analytical results are reported quarterly.

56. Could that be increased, I mean quarterly? Can we check that more often, and what kind of plan is there?

    The Illinois EPA has determined that a quarterly sampling frequency is adequate for groundwater monitoring at the site. Based on currently available data, it does not appear that the active ash ponds are the source of contamination. There appears to be some other source. Midwest Generation has engaged their consultants and is evaluating the situation. The site investigation for a source(s) of contaminants up gradient of the active ash ponds is not part of the approved CCA.

57. Have any studies been conducted regarding the hydrologic connection between the ground water affected by the site and Lake Michigan and/or other surface waters?

    No such studies are required under this permit. The proposed regulations for closure of ash ponds under 35 Ill. Adm. Code 841, currently before the Illinois Pollution Control Board, contain provisions that will require facilities like the Waukegan Generating Station to perform modeling and groundwater monitoring of well systems to assess the potential for ash disposal units to impact surface water and groundwater.

Miscellaneous Issues

58. Please strengthen the draft water pollution permit for the Waukegan coal plant so that it properly accounts for pollution that can harm me, my community, Lake Michigan and all the living things in the Lake.

    This permit was strengthened over the previous permit in the following ways: (1) metals monitoring, (2) dissolved oxygen monitoring, (3) impingement mortality and entrainment characterization study and an alternatives analysis submittal requirement, (4) biological sampling and thermal modeling, (5) reduction in condenser cooling water discharged due to the removal of Unit 6 (100 MW), and (6) elimination of fly ash sluice as an authorized discharge.

59. Review the Lake Michigan thermal water quality standards to ensure the coal plant is not harming water quality and aquatic life.

    The facility has an approved thermal demonstration in accordance with Section 316(a) of the Clean Water Act 33 U.S.C. 1326(a) and is not subject to the thermal water quality limits of 35 Ill. Adm. Code 302.507. However, as a condition for the continuation of the facility's 316(a) thermal variance (PCB 72-73 Consolidated, dated September 21, 1978), the permittee is being required to conduct the following activities and studies: (a) complete a literature search for biological studies conducted in Lake Michigan in the general vicinity of the facility, including but not limited to, relevant biological monitoring data from state or federal agencies; (b) prepare a Representative Important Species (RIS) List, including an explanation of the rationale for selection of each species on the list; and (c) based on the results of the biological studies literature search and the RIS List, prepare a study plan for biological sampling and thermal monitoring, including, as appropriate, thermal modeling.

60. Strengthen coal ash pollution limits that the U.S. EPA has already determined are inadequate.

    The permit authorizes the discharge of water which comes into contact with coal ash not the discharge of untreated coal ash. The water which contacts coal ash discharged from this facility is limited to the more stringent of the state or federal standards. The permit also requires metals monitoring to ensure compliance with effluent and water quality standards.

61. Include measures to address the groundwater contamination that already exists near the plant.

    Midwest Generation has voluntarily initiated a site investigation to identify source(s) of contaminants up gradient of the active ash ponds. Because site investigations frequently need to be modified based on preliminary findings,

inclusion in a NPDES permit, is not a good means to respond quickly to modifications of any site investigations.

62. Minimize fish kills from the plant's intake pipes. We have already done such harm to the living things in the water and this does affect us. We need to fix this, not to make it worse.

To characterize the current effect of the cooling water intake structure operation, the discharger is being required to submit an impingement mortality and entrainment characterization study and an alternatives analysis. We will review this information during the next permit cycle and determine if additional limits or monitoring is necessary.

63. Concerns regarding heavy metals such as mercury in Lake Michigan. Concerns for citizens who fish in the lake and eat the fish.

See responses #46 and #49.

Acronyms and Initials

BOD	Biochemical oxygen demand
CCA	Compliance Commitment Agreement
COD	Chemical oxygen demand
CFR	Code of Federal Regulations
DMR	Discharge Monitoring Report
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ILCS	Illinois Compiled Statutes
Ill. Adm. Code	Illinois Administrative Code
mg/L	Milligrams per liter
MGD	Million gallons per day
NPDES	National Pollutant Discharge Elimination System
pH	A measure of acidity or alkalinity of a solution
TDS	Total dissolved solids
TMDL	Total maximum daily load
TSS	Total suspended solids
303(d)	Section of federal Clean Water Act dealing with surface water quality standards.
7Q10	Lowest continuous seven-day flow during a 10-year period

DISTRIBUTION OF RESPONSIVENESS SUMMARY

An announcement, that the NPDES permit decision and accompanying responsiveness summary is available on the Illinois EPA website, is being mailed or e-mailed to all who registered at the hearing and to all who sent in written comments. Printed copies of this responsiveness summary are available from Barb Lieberoff, Illinois EPA, 217-524-3038, e-mail: Barb.Lieberoff@illinois.gov.

WHO CAN ANSWER YOUR QUESTIONS

Illinois EPA NPDES Permit:

Illinois EPA NPDES technical decisions:	Jaime Rabins	217-782-0610
Legal questions	Sara Terranova	217-782-5544
Water quality issues	Scott Twait	217-782-3362
Groundwater Issues	Lynn Dunaway	217-785-2762
Public hearing of July 31, 2013	Dean Studer	217-558-8280

The public hearing notice, the hearing transcript, the NPDES permit and the responsiveness summary are available on the Illinois EPA website (please copy this website into your browser):

http://www.epa.illinois.gov/public-notices/2013/npdes-notices/index#midwest-generation-waukegan

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-2829

BRUCE RAUNER, GOVERNOR LISA BONNETT, DIRECTOR

MAJOR

IEPA EXHIBIT No. 70

217/782-0610

March 25, 2015

Midwest Generation, LLC
401 East Greenwood Ave.
Waukegan, IL 60087

Re: Midwest Generation, LLC
Waukegan Generating Station
NPDES Permit No. IL0002259
Final Permit

Ladies and Gentlemen:

We have reviewed your comments to the public noticed permit and offer the following responses:

The comments on pages 1 to 2 of your letter concerning the Fact Sheet were reviewed and addressed in the permit record. However the Fact Sheet is prepared for the public notice which has been completed, thus a revised Fact Sheet will not be issued.

1. Outfall 001 will be monitored from the zebra mussel gate.

2. The compliance schedule for pH in Special Condition 2 was revised as requested.

3. Outfall 001 discharges to the Open Waters of Lake Michigan defined at 35 Ill. Adm. Code 302.501(b) thus the pH limits of 7.0 to 9.0 standard units will remain in the permit to ensure compliance with 35 Ill. Adm. Code 302.503.

4. The sampling frequency for pH at outfall 001 was changed to weekly as requested.

5. A01 is the internal monitoring point for boiler blowdown and B01 is the internal monitoring point for demineralizer regenerate waste which both meet the definition of low volume wastestreams per 40 CFR 423.11(b) and thus are required to meet TSS and oil and grease limits per 40 CFR 423.12(b)(3).

6. Sampling for TSS and oil and grease at A01 and B01 will be changed to 2/month as requested.

7. 40 CFR 423.11(d) defines metal cleaning wastes as with or without chemical cleaning compounds. 40 CFR 423.12(b)(5) regulates the discharge of metal cleaning wastes. Thus non-chemical metal cleaning wastes discharged from outfall G01 must meet limits before mixture with other waste streams. Compliance schedules under 40 CFR 122.47 are not allowed for technology based effluent limits because CWA compliance deadlines have passed for existing sources.

8. Special Condition 10 was revised to require that only changes in the use of water treatment additives be approved of by the Agency.

9. The dissolved oxygen monitoring requirements of Special Condition 11 are necessary to demonstrate the discharge is not causing or contributing to violations of dissolved oxygen water quality standards in the receiving water. The condition has been revised to specify that a reduction in monitoring may be requested after two years.

10. The reference to mercury monitoring at C01 on page 5 was in error and was removed. Mercury monitoring requirements for outfall 001 were consolidated into Special Condition 16 and Special Condition 15 was removed.

11. The semi-annual metals monitoring requirement listed as Special Condition 16 is necessary to provide sufficient data on effluent quality. A minimum of 10 samples are necessary to conduct a reasonable potential analysis thus the requirement will remain.

12. Non-chemical metal cleaning waste are tributary to C01 and will remain listed as a sub-wastestream on page 5 of the permit.

13. Fly ash sluice water was removed from the permit as requested.

14. Condenser cooling water flow on page 2 was reduced to 589 MGD to reflect the removal of unit 6 from service on December 21, 2007. The outfall 001 flow was also reduced to 739 MGD.

15. The discharger address was changed as requested.

Due to the comments from USEPA an equation was added to Special Condition 4 to determine and report the heat rejection rate.

Special Condition 7 was revised to require compliance with the new cooling water intake structure existing facilities rule.

Attached is the final NPDES Permit for your discharge. The Permit as issued covers discharge limitations, monitoring, and reporting requirements. Failure to meet any portion of the Permit could result in civil and/or criminal penalties. The Illinois Environmental Protection Agency is ready and willing to assist you in interpreting any of the conditions of the Permit as they relate specifically to your discharge.

The Agency has begun a program allowing the submittal of electronic Discharge Monitoring Reports (NetDMR) instead of paper Discharge Monitoring Reports (DMRs). If you are interested in NetDMR, more information can be found on the Agency website, http://www.epa.state.il.us/water/net-dmr/index.html. If your facility is not registered in the NetDMR program, a supply of preprinted paper DMR Forms for your facility will be sent to you prior to the initiation of DMR reporting under the New permit. Additional information and instructions will accompany the preprinted DMRs upon their arrival.

The attached Permit is effective as of the date indicated on the first page of the Permit. Until the effective date of any re-issued Permit, the limitations and conditions of the previously-issued Permit remain in full effect. You have the right to appeal any condition of the Permit to the Illinois Pollution Control Board within a 35 day period following the issuance date.

Should you have questions concerning the Permit, please contact Jaime Rabins at 217/782-0610.

Sincerely,

Alan Keller

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:JAR:11111401.jar

Attachment: Final Permit

cc: Records
Compliance Assurance Section
Des Plaines Region
Billing
CMAP

MAJOR

NPDES Permit No. IL0002259

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Reissued (NPDES) Permit

Expiration Date: March 31, 2020

Issue Date: March 25, 2015
Effective Date: April 1, 2015

Name and Address of Permittee:

Midwest Generation, LLC
401 East Greenwood Ave.
Waukegan, IL 60087

Facility Name and Address:

Midwest Generation, LLC
Waukegan Generating Station
401 East Greenwood Ave.
Waukegan, Illinois 60087
(Lake County)

Discharge Number and Name:

001 Condenser Cooling Water and House Service Water
A01 Boiler Blowdown
B01 Demineralizer Regenerant Wastes
C01 Wastewater Treatment System
D01 East Yard Collection Basin Overflow
F01 Unit 7 Demineralized Water Storage Tank Drain
G01 Non-Chemical Metal Cleaning Wastes

Receiving Waters:

Lake Michigan

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of Ill. Adm. Code, Subtitle C and/or Subtitle D, Chapter 1, and the Clean Water Act (CWA), the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

SAK:JAR:11111401.jar

NPDES Permit No. IL0002259

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall 001: Condenser Cooling Water and House Service Water (DAF = 739 MGD)

This discharge consists of:

1.	Condenser cooling water	589 MGD
2.	House service water	29.7 MGD
3.	Boiler blowdown	Intermittent
4.	Demineralizer regenerant wastes	0.151 MGD
5.	Wastewater treatment system effluent	8.13 MGD
6.	East yard runoff basin overflow/discharge	0.676 MGD
7.	Demineralized water (storage tank drainage and steam relief)	Intermittent
8.	Intake screen backwash	0.172 MGD

PARAMETER	30 DAY AVERAGE (load)	DAILY MAXIMUM (load)	30 DAY AVERAGE (conc.)	DAILY MAXIMUM (conc.)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				Daily	Continuous
pH	See Special Condition 2				Weekly	Grab
Total Residual Chlorine	See Special Condition 3			0.05	*	Grab
Temperature	See Special Condition 4				Daily	Continuous
Heat Rejection Rate				5301 million BTU's per hour	Daily	Continuous

The monthly maximum temperature and the monthly maximum BTU's per hour shall be reported on the DMR under temperature and heat rejection rate, respectively.

*Total Residual Chlorine shall be sampled whenever chlorination or biocide addition is being performed or residuals are likely to be present in the discharge. If chlorination and biocide addition are not used during the month it shall be so indicated on the DMR.

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall A01: Boiler Blowdown (Intermittent Discharge)						
The discharge consists of:				Approximate Flow		
1. Boiler blowdown				0.018 MGD		
2. Boiler drains				0.018 MGD		
Flow (MGD)	See Special Condition 1				2/Month When Discharging	Calculated 24-Hour Total
Total Suspended Solids			15	30	2/Month When Discharging	8-Hour Composite
Oil and Grease			15	20	2/Month When Discharging	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				2/Month	24-Hour Total
Total Suspended Solids			15	30	2/Month	8-Hour Composite
Oil and Grease			15	20	2/Month	Grab

Outfall B01: Demineralizer Regenerant Wastes (DAF = 0.151 MGD)

The discharge consists of:

The discharge consists of:	Approximate Flow
1. Demineralizer regenerant wastes	0.151 MGD
2. Demineralized water (off specification bypass)	Intermittent

Total Suspended Solids and Oil and Grease sampling may obtained using a Grab Sample if the equalization tank is in service.

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall C01: Wastewater Treatment System (DAF = 8.13 MGD)

This Discharge consists of:	Approximate Flow
1. Bottom Ash Sluice	1.6 MGD
2. Ash hopper overflow	Intermittent
3. Coal pile runoff collection basin discharge	1.0 MGD
a. Coal pile area runoff	0.5 MGD
b. West yard area runoff	0.5 MGD
i. West yard area runoff	
ii. Car dumper area runoff	
iii. Main switch yard area runoff	
iv. West yard polymer building drains	
v. Peaker sump discharges	
vi. West turbine area roof drains	
4. Non-chemical metal cleaning waste	Intermittent
5. Supernatant from dredge spoil lagoons	Intermittent
6. Main collection tank discharge	2.0 MGD
a. Unit 8 low point sump (roof, floor, & equipment drains)	Intermittent
b. Ash sluice head tank overflow	Intermittent
c. Slag drain line	Intermittent
d. Slag tank overflows	Intermittent
e. Demineralizer filter backwash (alternate route)	Intermittent
f. Floor drains (alternate route)	Intermittent

PARAMETER	LOAD 30 DAY AVERAGE	LOAD DAILY MAXIMUM	CONC. 30 DAY AVERAGE	CONC. DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				Daily	Continuous
Total Suspended Solids			15	30	2/Month	24-Hour Composite
Oil and Grease			15	20	2/Month	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

Outfall D01: East Yard Collection Basin Overflow (DAF = 0.676 MGD)

This discharge consists of:	Approximate Flow
1. East yard area runoff	Intermittent
2. Units 1-4 roof and floor drainage	Intermittent
3. East yard polymer building drains	Intermittent
4. Demineralizer filter backwash	0.078 MGD
5. Laboratory sink drains	Intermittent
6. Units 5-8 roof and floor drains	Intermittent

PARAMETER	30 DAY AVERAGE (lbs/day)	DAILY MAXIMUM (lbs/day)	30 DAY AVERAGE (mg/l)	DAILY MAXIMUM (mg/l)	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)	See Special Condition 1				1/Week	24-Hour Total
Total Suspended Solids			15	30	2/Month	24-Hour Composite
Oil and Grease			15	20	2/Month	Grab

NPDES Permit No. IL0002259

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF)		CONCENTRATION LIMITS mg/l		SAMPLE FREQUENCY	SAMPLE TYPE
	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM		
Outfall F01: Unit 7 Demineralized Water Storage Tank Drain(Intermittent Discharge)						
Flow (MGD)	See Special Condition 1				1/Week When Discharging	Estimate
Total Suspended Solids			15	30	1/Week When Discharging	Grab
Oil and Grease			15	20	1/Week When Discharging	Grab

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	LOAD LIMITS lbs/day DAF (DMF) DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	CONCENTRATION LIMITS mg/l DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Outfall G01: Non-Chemical Metal Cleaning Wastes (DAF = Intermittent Discharge)						
Flow (MGD)	See Special Condition 1				Daily When Discharging	Continuous
Total Suspended Solids			30	100	Daily When Discharging	24-Hour Composite
Oil and Grease			15	20	Daily When Discharging	Grab
Iron			1.0	1.0	Daily When Discharging	24-Hour Composite
Copper			1.0	1.0	Daily When Discharging	24-Hour Composite

Special Conditions

SPECIAL CONDITION 1. Flow shall be measured in units of Million Gallons per Day (MGD) and reported as a monthly average and a daily maximum value on the monthly Discharge Monitoring Report.

SPECIAL CONDITION 2. The pH shall be in the range 7.0 to 9.0. The monthly minimum and monthly maximum values shall be reported on the DMR form.

The permittee shall achieve compliance with the above pH limitation at outfall 001 as soon as possible but not later than 18 months from the effective date of this permit in accordance with the following schedule:

	ITEM	COMPLETION DATE
1.	Initial Report	6 Months from the Effective Date
2.	Interim Report	12 Months from the Effective Date
3.	Final Report and Compliance	18 Months from the Effective Date

From the effective date of the permit, pH shall be monitored at outfall 001 weekly as specified on page 2 of the permit. The initial report shall include a summary of this data and a determination of whether or not additional treatment is necessary to achieve and maintain compliance with the applicable pH limit. If additional treatment is determined not to be necessary, compliance with the applicable pH limit is required 6 months from the effective date of this permit. All reports shall be submitted to the IEPA at the address in special condition 6.

SPECIAL CONDITION 3. All samples for total residual chlorine (TRC) shall be analyzed by an applicable method contained in 40 CFR 136, equivalent in accuracy to low-level amperometric titration. Any analytical variability of the method used shall be considered when determining the accuracy and precision of the results obtained.

SPECIAL CONDITION 4. Pursuant to Illinois Pollution Control Board Order 77-82, dated August 3, 1978 the discharge is limited to a heat rejection rate of 5301 million BTU's per hour in lieu of the standards of 35 Ill. Adm. Code 302.507. The Permittee's demonstration for the Waukegan Generating Station in accordance with Section 316(a) of the CWA was approved by the Illinois Pollution Control Board in Order PCB 78-72, -73 Consolidated dated September 21, 1978.

Compliance with this part shall be determined on a continuous basis by the following equation:

$$H = 0.0005Q_{CW}\,(T_{CW} - T_{US})$$

H Heat Rejection Rate in million BTU's per hour.

T_{CW} Actual condenser cooling water discharge temperature in degrees Fahrenheit from continuous temperature monitor located at the condenser outlet waterbox.

Q_{CW} Condenser cooling water flow in gallons per minute based on the number of circulating water pumps on at the time in question. Each of Unit 7's four circulating water pumps is rated at 64,000 gpm and each of Unit 8's two circulating water pumps is rated at 110,000 gpm.

T_{US} Intake cooling water temperature in degrees Fahrenheit from the continuous temperature monitor located at the condenser inlet waterbox.

As a condition of the continuation of the facility's 316(a) thermal variance (PCB 72-73 Consolidated, dated September 21, 1978), the permittee shall conduct the following activities and studies:

1. Within six months of the permit issuance date:

   a. Complete a literature search for biological studies conducted in Lake Michigan in the general vicinity of the facility, including but not limited to, relevant biological monitoring data from state or federal agencies.
   b. Prepare a Representative Important Species (RIS) List, including an explanation of the rationale for selection of each species on the list; and
   c. Based on the results of the biological studies literature search and the RIS List, prepare a study plan for biological sampling and thermal monitoring, including as appropriate thermal modeling. The study plan shall be submitted to the Agency for approval prior to initiation. The study plan shall include the RIS List. The permittee shall also send a copy of the study plan and RIS List to the U.S. EPA Region 5 to provide it with an opportunity to review and comment on the study plan prior to commencement of the study.

2. Upon the Agency's approval of the study plan for biological and thermal monitoring, perform thermal plume surveys on the facility's discharge and any appropriate thermal model development and field verification within eighteen months of the receipt of the Agency's approval. In the event that the Agency's approval of the study plan is not received within nine months of the permit issuance date, the permittee may proceed to implement the study plan pending receipt of the Agency's approval.

3. Based on the information obtained from thermal plume surveys, the permittee shall finalize the specific sampling [illegible]ns for, and conduct, the biological monitoring study plan.

Special Conditions

If the permittee intends to request the continuation of the 316(a) thermal variance in its renewed NPDES permit, the permittee shall submit to the Agency a report containing the results of the biological and thermal monitoring, including any applicable thermal modeling, and any other information necessary to comply with 35 Ill. Adm. Code 106.1180 concurrent with its next NPDES permit renewal application.

Alternately, the Permittee may demonstrate to the Agency that alternate thermal standards of PCB 77-82, or other site specific water quality standards for temperature approved by the Illinois Pollution Control Board, and USEPA, meets the requirements of 40 CFR 131 and the Illinois Environmental Protection Act.

SPECIAL CONDITION 5. Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving stream.

SPECIAL CONDITION 6. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) Forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee may choose to submit electronic DMRs (NetDMR) instead of mailing paper DMRs to the IEPA. More information, including registration information for the NetDMR program, can be obtained on the IEPA website, http://www.epa.state.il.us/water/net-dmr/index.html.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 28th day of the following month, unless otherwise specified by the permitting authority.

Permittees not using NetDMR shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

Attention: Compliance Assurance Section, Mail Code # 19

SPECIAL CONDITION 7. Cooling Water Intake Structure. Based on available information, the Agency has determined that the operation of the cooling water intake structure meets the equivalent of Best Technology Available (BTA) in accordance with the Best Professional Judgment provisions of 40 CFR 125.3 and 40 CFR 125.90(b), based on information available at the time of permit reissuance.

However, the Permittee shall comply with the requirements of the Cooling Water Intake Structure Existing Facilities Rule as found at 40 CFR 122 and 125. Any application materials and submissions required for compliance with the Existing Facilities Rule, shall be submitted to the Agency no later than 4 years from the effective date of this permit.

If for any reason, the Cooling Water Intake Structure Existing Facilities Rule is stayed or remanded by the courts, the Permittee shall comply with the requirements below. The information required below is necessary to further evaluate cooling water intake structure operations based on the most up to date information, in accordance with the Best Professional Judgment provisions of 40 CFR 125.3 and 40 CFR 125.90(b), in existence prior to the effective date of the new Existing Facilities Rule:

A. The permittee shall submit the following information/studies within 4 years of the effective date of the permit:

   1. Source Water Physical Data to include:

      a. A narrative description and scaled drawings showing the physical configuration of all source water bodies used by the facility including aerial dimensions, depths, salinity and temperature regimes;

      b. Identification and characterization of the source waterbody's hydrological and geomorphological features, as well as the methods used to conduct any physical studies to determine the intake's area of influence and the results of such studies; and

      c. Location maps.

   2. Source Waterbody Flow Information

      The permittee shall provide the annual mean flow of the waterbody, any supporting documentation and engineering calculations to support the analysis of whether the design intake flow is greater than five percent of the mean annual flow of the river/stream for purposes of determining applicable performance standards. Representative historical data (from a period of time up to 10 years) shall be used, if available.

3. Impingement Mortality and Entrainment Characterization Study

The permittee shall submit an Impingement Mortality and Entrainment Characterization Study whose purpose is to provide information to support the development of a calculation baseline for evaluating impingement mortality and entrainment and to characterize current impingement mortality and entrainment. The Study shall include the following in sufficient detail to support establishment of baseline conditions:

a. Taxonomic identification of all life stages of fish and shellfish and any species protected under Federal, State, or Tribal law (including threatened or endangered species) that are in the vicinity of the cooling water intake structure(s) and are susceptible to impingement and entrainment;

b. A characterization of all life stages of fish and shellfish, and any species protected under Federal, or State law, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structure(s). These may include historical data that are representative of the current operation of the facility and of biological conditions at the site; and

c. Documentation of the current impingement mortality and entrainment of all life stages of fish, shellfish, and any species protected under Federal , State, or Tribal Law (including threatened or endangered species) and an estimate of impingement mortality and entrainment to be used as the calculation baseline. The documentation may include historical data that are representative of the current operation of the facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations required must be collected during periods of representative operational flows for the cooling water intake structure and the flows associated with the samples must be documented.

B. The permittee shall comply with the following requirements:

1. At all times properly operate and maintain the intake equipment as demonstrated in the application material supporting the BTA determination.

2. Inform IEPA of any proposed changes to the cooling water intake structure or proposed changes to operations at the facility that affect impingement mortality and/or entrainment.

3. Debris collected on intake screens is prohibited from being discharged back to the canal. Debris does not include living fish or other living aquatic organisms.

4. Compliance Alternatives. The permittee must evaluate each of the following alternatives for establishing best available technology for minimizing adverse environmental impacts at the facility due to operation of the intake structure:

a. Evaluate operational procedures and/or propose facility modifications to reduce the intake through-screen velocity to less than 0.5 ft/sec. The operational evaluation may consider modified circulating water pump operation; reduced flow associated with capacity utilization, recalculation or determination of actual total water withdrawal capacity. The evaluation report and any implementation plan for the operational changes and/ or facility modification shall be submitted to the Agency with the renewal application for this permit.

b. Complete a fish impingement and entrainment mortality minimization alternatives evaluation. The evaluation may include an assessment of modification of the traveling screens, consideration of a separate fish and debris return system and include time frames and cost analysis to implement these measures. The evaluation report and implementation plan for any operational changes and/ or facility modifications shall be submitted to the Agency with the renewal application for this permit.

C. All required reports shall be submitted to the Industrial Unit, Permit Section and Compliance Assurance Section at the address in special condition 6.

This special condition does not relieve the permittee of the responsibility of complying with any other laws, regulations, or judicial orders issued pursuant to Section 316(b) of the Clean Water Act.

SPECIAL CONDITION 8. If an applicable effluent standard or limitation is promulgated under Sections 301(b)(2)(C) and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act and that effluent standard or limitation is more stringent than any effluent limitation in the permit or controls a pollutant not limited in the NPDES Permit, the Agency shall revise or modify the permit in accordance with the more stringent standard or prohibition and shall so notify the permittee.

SPECIAL CONDITION 9. The use or operation of this facility shall be by or under the supervision of a Certified Class K or

SPECIAL CONDITION 10. In the event that the permittee shall require changes in the use of water treatment additives, the permittee must request a change in this permit in accordance with the Standard Conditions – Attachment H.

SPECIAL CONDITION 11. The cooling water prior to entering the intake structure and at outfall 001 shall be sampled once per week as a grab sample at the same time of day within ½ hour of each other between 9:00 a.m. and 3:00 p.m. in a random fashion for dissolved oxygen. The results in mg/l and the time of day the influent and effluent sample was taken shall be reported to the Agency as an attachment to the DMR. After 2 years of data has been submitted to the Agency, the permittee may apply to Agency to have the monitoring reduced or eliminated.

SPECIAL CONDITION 12. There shall be no discharge of polychlorinated biphenyl compounds.

SPECIAL CONDITION 13. The bypass provisions of 40 CFR 122.41(m) and upset provisions of 40 CFR 122.41(n) are hereby incorporated by reference.

SPECIAL CONDITION 14. The Agency has determined that the effluent limitations for outfall 001 constitute BAT/BCT for storm water which is treated in the existing treatment facilities for purposes of this permit reissuance, and no pollution prevention plan will be required for such storm water. In addition to the chemical specific monitoring required elsewhere in this permit, the permittee shall conduct an annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity, and determine whether any facility modifications have occurred which result in previously-treated storm water discharges no longer receiving treatment. If any such discharges are identified the permittee shall request a modification of this permit within 30 days after the inspection. Records of the annual inspection shall be retained by the permittee for the term of this permit and be made available to the Agency on request.

SPECIAL CONDITION 15. There shall be no discharge of complexed metal bearing wastestreams and associated rinses from chemical metal cleaning unless this permit has been modified to include the new discharge.

SPECIAL CONDITION 16. The Permittee shall monitor the effluent from outfall 001 for the following parameters on a semi-annual basis. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The sample shall be a 24-hour effluent composite except as otherwise specifically provided below and the results shall be submitted to the address in special condition 6 in June and December. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

STORET CODE	PARAMETER	Minimum reporting limit
01002	Arsenic	0.05 mg/L
01007	Barium	0.5 mg/L
01022	Boron	0.1 mg/L
01027	Cadmium	0.001 mg/L
00940	Chloride	0.1 mg/L
01032	Chromium (hexavalent) (grab)	0.01 mg/L
01034	Chromium (total)	0.05 mg/L
01042	Copper	0.005 mg/L
00718	Cyanide (grab) (available *** or amendable to chlorination))	5.0 ug/L
00720	Cyanide (grab not to exceed 24 hours) (total)	5.0 ug/L
00951	Fluoride	0.1 mg/L
01045	Iron (total)	0.5 mg/L
01046	Iron (Dissolved)	0.5 mg/L
01051	Lead	0.05 mg/L
01055	Manganese	0.5 mg/L
71900	Mercury (grab)**	1.0 ng/L*
01067	Nickel	0.005 mg/L
00556	Oil (hexane soluble or equivalent) (Grab Sample only)	5.0 mg/L
32730	Phenols (grab)	0.005 mg/L
01147	Selenium	0.005 mg/L
00945	Sulfate	0.1 mg/L
01077	Silver (total)	0.003 mg/L
01092	Zinc	0.025 mg/L

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

*1.0 ng/L = 1 part per trillion.

**Utilize USEPA Method 1631E and the digestion procedure described in Section 11.1.1.2 of 1631E. Mercury shall 0698 nitored

Special Conditions

monthly for the first two years and quarterly thereafter. This Permit may be modified with public notice to establish effluent limitations if appropriate, based on information obtained through sampling. The quarterly monitoring results shall be submitted on the March, June, September and December DMRs.

***USEPA Method OIA-1677

SPECIAL CONDITION 17. The effluent, alone or in combination with other sources, shall not cause a violation of any applicable water quality standard outlined in 35 Ill. Adm. Code 302.

Attachment H

Standard Conditions

Definitions

Act means the Illinois Environmental Protection Act, 415 ILCS 5 as Amended.

Agency means the Illinois Environmental Protection Agency.

Board means the Illinois Pollution Control Board.

Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) means Pub. L 92-500, as amended. 33 U.S.C. 1251 et seq.

NPDES (National Pollutant Discharge Elimination System) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318 and 405 of the Clean Water Act.

USEPA means the United States Environmental Protection Agency.

Daily Discharge means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Maximum Daily Discharge Limitation (daily maximum) means the highest allowable daily discharge.

Average Monthly Discharge Limitation (30 day average) means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Discharge Limitation (7 day average) means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Aliquot means a sample of specified volume used to make up a total composite sample.

Grab Sample means an individual sample of at least 100 milliliters collected at a randomly-selected time over a period not exceeding 15 minutes.

24-Hour Composite Sample means a combination of at least 8 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over a 24-hour period.

8-Hour Composite Sample means a combination of at least 3 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over an 8-hour period.

Flow Proportional Composite Sample means a combination of sample aliquots of at least 100 milliliters collected at periodic intervals such that either the time interval between each aliquot or the volume of each aliquot is proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot.

(1) **Duty to comply.** The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or for denial of a permit renewal application. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirements.

(2) **Duty to reapply.** If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. If the permittee submits a proper application as required by the Agency no later than 180 days prior to the expiration date, this permit shall continue in full force and effect until the final Agency decision on the application has been made.

(3) **Need to halt or reduce activity not a defense.** It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(4) **Duty to mitigate.** The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(5) **Proper operation and maintenance.** The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems only when necessary to achieve compliance with the conditions of the permit.

(6) **Permit actions.** This permit may be modified, revoked and reissued, or terminated for cause by the Agency pursuant to 40 CFR 122.62 and 40 CFR 122.63. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

(7) **Property rights.** This permit does not convey any property rights of any sort, or any exclusive privilege.

(8) **Duty to provide information.** The permittee shall furnish to the Agency within a reasonable time, any information which the Agency may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also furnish to the Agency upon request, copies of records required to be kept by this permit.

(9) **Inspection and entry.** The permittee shall allow an authorized representative of the Agency or USEPA (including an authorized contractor acting as a representative of the Agency or USEPA), upon the presentation of credentials and other documents as may be required by law, to:

- (a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
- (b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
- (c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
- (d) Sample or monitor at reasonable times, for the purpose of assuring permit compliance, or as otherwise authorized by the Act, any substances or parameters at any location.

(10) **Monitoring and records.**

- (a) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
- (b) The permittee shall retain records of all monitoring information, including all calibration and maintenance records, and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of this permit, measurement, report or application. Records related to the permittee's sewage sludge use and disposal activities shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503). This period may be extended by request of the Agency or USEPA at any time.
- (c) Records of monitoring information shall include:
  - (1) The date, exact place, and time of sampling or measurements;
  - (2) The individual(s) who performed the sampling or measurements;
  - (3) The date(s) analyses were performed;
  - (4) The individual(s) who performed the analyses;
  - (5) The analytical techniques or methods used; and
  - (6) The results of such analyses.
- (d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Where no test procedure under 40 CFR Part 136 has been approved, the permittee must submit to the Agency a test method for approval. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to ensure accuracy of measurements.

(11) **Signatory requirement.** All applications, reports or information submitted to the Agency shall be signed and certified.

- (a) **Application.** All permit applications shall be signed as follows:
  - (1) For a corporation: by a principal executive officer of at least the level of vice president or a person or position having overall responsibility for environmental matters for the corporation:
  - (2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or
  - (3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.
- (b) **Reports.** All reports required by permits, or other information requested by the Agency shall be signed by a person described in paragraph (a) or by a duly authorized representative of that person. A person is a duly authorized representative only if:
  - (1) The authorization is made in writing by a person described in paragraph (a); and
  - (2) The authorization specifies either an individual or a position responsible for the overall operation of the facility, from which the discharge originates, such as a plant manager, superintendent or person of equivalent responsibility; and
  - (3) The written authorization is submitted to the Agency.
- (c) **Changes of Authorization.** If an authorization under (b) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of (b) must be submitted to the Agency prior to or together with any reports, information, or applications to be signed by an authorized representative.
- (d) **Certification.** Any person signing a document under paragraph (a) or (b) of this section shall make the following certification:

  I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

(12) **Reporting requirements.**

- (a) **Planned changes.** The permittee shall give notice to the Agency as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required when:
  - (1) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source pursuant to 40 CFR 122.29 (b); or
  - (2) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements pursuant to 40 CFR 122.42 (a)(1).
  - (3) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.
- (b) **Anticipated noncompliance.** The permittee shall give advance notice to the Agency of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.
- (c) **Transfers.** This permit is not transferable to any person except after notice to the Agency.
- (d) **Compliance schedules.** Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in anv compliance schedule of this permit shall be submitte ter than 14 days following each schedule date.
- (e) **Monitoring reports.** Monitoring results shall be reported at the intervals specified elsewhere in this permit

(1) Monitoring results must be reported on a Discharge Monitoring Report (DMR).
(2) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.
(3) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Agency in the permit.

(f) **Twenty-four hour reporting.** The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24-hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and time; and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The following shall be included as information which must be reported within 24-hours:
(1) Any unanticipated bypass which exceeds any effluent limitation in the permit.
(2) Any upset which exceeds any effluent limitation in the permit.
(3) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Agency in the permit or any pollutant which may endanger health or the environment.
The Agency may waive the written report on a case-by-case basis if the oral report has been received within 24-hours.

(g) **Other noncompliance.** The permittee shall report all instances of noncompliance not reported under paragraphs (12) (d), (e), or (f), at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph (12) (f).

(h) **Other information.** Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to the Agency, it shall promptly submit such facts or information.

(13) **Bypass.**
(a) Definitions.
(1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.
(2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.
(b) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (13)(c) and (13)(d).
(c) Notice.
(1) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.
(2) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in paragraph (12)(f) (24-hour notice).
(d) Prohibition of bypass.
(1) Bypass is prohibited, and the Agency may take enforcement action against a permittee for bypass, unless:
(i) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
(iii) The permittee submitted notices as required under paragraph (13)(c).
(2) The Agency may approve an anticipated bypass, after considering its adverse effects, if the Agency determines that it will meet the three conditions listed above in paragraph (13)(d)(1).

(14) **Upset.**
(a) Definition. Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.
(b) Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (14)(c) are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.
(c) Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
(1) An upset occurred and that the permittee can identify the cause(s) of the upset;
(2) The permitted facility was at the time being properly operated; and
(3) The permittee submitted notice of the upset as required in paragraph (12)(f)(2) (24-hour notice).
(4) The permittee complied with any remedial measures required under paragraph (4).
(d) Burden of proof. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

(15) **Transfer of permits.** Permits may be transferred by modification or automatic transfer as described below:
(a) Transfers by modification. Except as provided in paragraph (b), a permit may be transferred by the permittee to a new owner or operator only if the permit has been modified or revoked and reissued pursuant to 40 CFR 122.62 (b) (2), or a minor modification made pursuant to 40 CFR 122.63 (d), to identify the new permittee and incorporate such other requirements as may be necessary under the Clean Water Act.
(b) Automatic transfers. As an alternative to transfers under paragraph (a), any NPDES permit may be automatically transferred to a new permittee if:
(1) The current permittee notifies the Agency at least 30 days in advance of the proposed transfer date;
(2) The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage and liability between the existing and new permittees; and
(3) The Agency does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement.

(16) All manufacturing, commercial, mining, and silvicultural dischargers must notify the Agency as soon as they know or have reason to believe:
(a) That any activity has occurred or will occur which would result in the discharge of any toxic pollutant identified under Section 307 of the Clean Water Act which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:
(1) One hundred micrograms per liter (100 ug/l);
(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4-dinitrophenol and for 2-methyl-4,6 dinitrophenol; and one milligram per liter (1 mg/l) for antimony.
(3) Five (5) times the maximum concentration value reported for that pollutant in the NPDES permit application; or
(4) The level established by the Agency in this permit.
(b) That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the NPDES permit application.

(17) All Publicly Owned Treatment Works (POTWs) must provide adequate notice to the Agency of the following:
(a) Any new introduction of pollutants into that POTW from an indirect discharge which would be subject to Sections 301 or 306 of the Clean Water Act if it were directly discharging those pollutants; and
(b) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.
(c) For purposes of this paragraph, adequate notice shall include information on (i) the quality and quantity of effluent introduced into the POTW, and (ii) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

(18) If the permit is issued to a publicly owned or publicly regulated treatment works, the permittee shall require any industrial user of such treatment works to comply with federal requirements concerning:
(a) User charges pursuant to Section 204 (b) of the Clean Water Act, and applicable regulations appearing in 40 CFR 35;
(b) Toxic pollutant effluent standards and pretreatment standards pursuant to Section 307 of the Clean Water Act; and
(c) Inspection, monitoring and entry pursuant to Section 308 of the Clean Water Act.

(19) If an applicable standard or limitation is promulgated under Section 301(b)(2)(C) and (D), 304(b)(2), or 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limitation in the permit, or controls a pollutant not limited in the permit, the permit shall be promptly modified or revoked, and reissued to conform to that effluent standard or limitation.

(20) Any authorization to construct issued to the permittee pursuant to 35 Ill. Adm. Code 309.154 is hereby incorporated by reference as a condition of this permit.

(21) The permittee shall not make any false statement, representation or certification in any application, record, report, plan or other document submitted to the Agency or the USEPA, or required to be maintained under this permit.

(22) The Clean Water Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $25,000 per day of such violation. Any person who willfully or negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318 or 405 of the Clean Water Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than one year, or both.
Additional penalties for violating these sections of the Clean Water Act are identified in 40 CFR 122.41 (a)(2) and (3).

(23) The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both.

(24) The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

(25) Collected screening, slurries, sludges, and other solids shall be disposed of in such a manner as to prevent entry of those wastes (or runoff from the wastes) into waters of the State. The proper authorization for such disposal shall be obtained from the Agency and is incorporated as part hereof by reference.

(26) In case of conflict between these standard conditions and any other condition(s) included in this permit, the other condition(s) shall govern.

(27) The permittee shall comply with, in addition to the requirements of the permit, all applicable provisions of 35 Ill. Adm. Code, Subtitle C, Subtitle D, Subtitle E, and all applicable orders of the Board or any court with jurisdiction.

(28) The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit is held invalid, the remaining provisions of this permit shall continue in full force and effect.

MIDWEST GENERATION EME, LLC
An EDISON INTERNATIONAL® Company

Julia P. Wozniak
Environmental Program Manager

August 29, 2013

Mr. Dean Studer
Hearing Officer
Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois, 62794-9276

Subject: Midwest Generation's (MWG) Comments and Clarifications Regarding Public Hearing Transcript for Waukegan Station— NPDES Permit No. IL0002259

Hearing Officer Studer:

Midwest Generation (MWG) appreciates the opportunity to provide comments and clarifications addressing the topics discussed at the public hearing held on July 31, 2013 in Waukegan, Illinois. We have had the opportunity to review the hearing transcript and have included citations, where appropriate, to the transcript to identify the hearing comments we address in this submission. Also included are additional clarifying comments and information that MWG wishes to provide to the Agency regarding our current and future station wastewater management that is responsive to certain of the hearing comments. MWG requests that this response be included in the permit record.

(1) **<u>Clarification regarding fly ash handling (see Hearing Tr. at pps. 25, 33, 76-78)</u>**

There has been no wet fly ash handling at Waukegan Station since the closure of Unit 6 in December, 2007. Any reference to "fly ash sluice" in the draft permit should be deleted, as it is no longer representative of current or future practices for fly ash handling. (This would apply to the currently listed subwaste stream to Outfall C01 on draft permit page 5—and any other documentation which may include this incorrect information). All fly ash from Units 7 and 8 has been, and will continue to be, handled on a dry basis.

(2) **<u>Clarification regarding current circulating water flow rate (see Hearing Tr. at pps. 32-33, 59-60)</u>**

During the Public Hearing, there were comments or questions posed which indicate a concern that there has been a "load increase" at the Waukegan Station since the issuance of the existing NPDES Permit. (See, e.g., Hearing Transcript at pps. 32-33) This is not true. There also were questions indicating that the information concerning the station's circulating water flow rate that the Agency included in the Draft NPDES Permit has contributed to a

235 Remington Blvd.
Suite A
Bolingbrook, Il 60440
Tel: 630 771 7880
Fax: 312 788 5274
jwozniak@mwgen.com

misunderstanding regarding Waukegan Station operating levels since the issuance of its current NPDES Permit, particularly in light of the fact that one of the three Waukegan units, Unit 6, has been shut down during the life of the current NPDES Permit. This has lead members of the public to question why the draft NPDES Permit's circulating flow rate of 768.62 MGD is not lower. MWG has provided below a detailed explanation of the circulating flow rate information for the Waukegan Station in the hope of addressing these concerns and requests that the Agency clarify the circulating flow rate information that is contained in the draft NPDES Permit before it is issued.

The current flow value proposed in the draft February 8, 2013 NPDES Permit (768.62 MGD) was the long-term average flow value provided in the MWG 1999 NPDES permit renewal application. This long-term average flow value was based on flow data from May 1998- April 1999, which covers a period of time when Unit 6 was still operating. The most recent, 2005 NPDES permit renewal application referenced a flow for Outfall 001 of 765 MGD, which was based on flow data from April 2003-March 2004, also a period when Unit 6 was still operating.

Today, Unit 6 is no longer operating and has not been operating since December 2007. The design circulating flow rate for the remaining two units, Units 7 and 8, at Waukegan is 686 MGD. In addition to the Unit 7 and 8 flows, there is also House Service Water Flow. The maximum House Service Water Flow is 53 MGD. Together, the design circulating flow rate for Units 7 and 8 and the maximum House Service Water Flow total 739 MGD, which is close to the 768.62 MGD design average flow (DAF) listed for Outfall 001 in the February 8, 2013 draft NPDES Permit. However, the 768.62 MGD flow value is not the DAF for Units 7 and 8. The 768.62 MGD flow value in the draft NPDES Permit is instead based on a long-term average flow value calculated from flow data during a time period when Unit 6 was still running. The design flow when Unit 6 was operational was 900 MGD, so there has been a reduction in the design flows since Unit 6 was shut down.

MWG has previously requested that the Agency instead include the design flow values in the MWG NPDES permits because these values do not change over time. Long term average flow values can and do change from one permit cycle to the next, depending on how the station was operated during the time period for which the long-term average flow value was calculated. The long-term average flow value for the period from 2008 through 2012, since Unit 6 was shut down, is 588 MGD, which is lower than the Design Flow of 739 MGD, reflecting the variation in electrical generation during this four-year period. If any flow values are to be included in the Waukegan Station's renewed NPDES Permit, MWG requests that the Agency revise the language of the draft NPDES Permit to replace the 768.62 MGD flow value with the current the Design Flow of 739 MGD, which reflects the shutdown of Unit 6. The Agency's proposed inclusion of an outdated, long-term average flow value reflecting a period when Unit 6 was operating appears to be creating confusion and is unnecessary given the absence of any load limits in the proposed NPDES Permit.

Finally, because of the nature of certain of the public hearing comments regarding the issue of antidegradation, the Agency should also clarify in its response to the public comments that a long-term average flow value is not an applicable or relevant criteria for purposes of determining whether an antidegradation review is necessary. The Waukegan Station has been permitted under prior NPDES permits based on the design flow value for its operating units, including the still operating Units 7 and 8. Therefore, it is allowed to continue to operate those two units up to their design flows without triggering antidegradation requirements.

(3) **Clarification regarding designation of receiving stream (see Hearing Tr. at p. 60)**

During the public hearing, counsel for the Environmental Law & Policy Center (ELPC), Jessica Dexter, inquired regarding the appropriate designation of the receiving stream for Waukegan Station's Outfall 001. (Hearing transcript at page 61). (Specifically, the ELPC's questions and the Agency's responses were:

> Ms. Dexter: Okay, thank you. Did IEPA change the identified receiving water between the December 2, 2011 draft, and the February 8, 2013 draft?
>
> Mr. Rabins: No, we did not.
>
> Ms. Dexter: The receiving water is still considered an open water of Lake Michigan then?
>
> Ms.Williams: Yes, that's the EPA's position.

(Hearing Transcript at p. 60, lines 7-14)

MWG requests that in its Responsiveness Summary, it explain the factual basis for its position that the receiving water for the Waukegan Station Outfall 001 discharge is the "Lake Michigan Open Waters" as that term is defined in 35 IAC §302.501(b). As MWG has previously set forth in detail in its written comments dated November 2, 2012 and March 11, 2013, with regard to the application of the appropriate pH water quality standard, the Agency's position on this issue is incorrect and contrary to the regulatory definition of "Lake Michigan Open Waters." The Outfall 001 discharge is not located within the "Lake Michigan Open Waters" and therefore, it is not subject to the Lake Michigan Open Waters water quality standard for pH.

Outfall 001 is located on the Waukegan Station's discharge canal, well inland of the "line drawn across the mouth of tributaries to Lake Michigan", which marks the beginning of the "Open Waters of Lake Michigan." With both its November 2012 and March 2013 comments, MWG previously submitted an aerial photograph showing the location of the Outfall 001 discharge. (See Attachment A to November 2, 2012 comments and Attachment 1 to March 11, 2013 comments) The aerial photograph clearly shows that the Outfall 001 discharge is located within "the line drawn across the mouth of tributaries to Lake Michigan" which is the line of demarcation for the commencement of the area known as the "Lake Michigan Open Waters," as defined by the clear language of section 302.501(b) of the regulations. Further, section 302.501(b) expressly excludes from the definition of "Lake

Michigan Open Waters" those "waters enclosed by constructed breakwaters." Because the discharges from the station go into a discharge canal which is protected by a constructed breakwater, the discharge is not to Lake Michigan Open Waters.

The Agency is incorrectly proposing to apply the 7.0 to 9.0 pH Lake Michigan Open Waters water quality standard to the Outfall 001 discharge. It instead should properly apply the 6.5 to 9.0 pH water quality standard which applies to other waters of the Lake Michigan Basin. (See 35 IAC §302.503). The Agency has not provided MWG with any information, photographic or otherwise, which supports its apparent understanding that the Outfall 001 discharge is located "lakeward from a line drawn across the mouth of tributaries to Lake Michigan" and that it is not "enclosed by constructed breakwaters." MWG requests that the Agency reconsider its position regarding the applicability of the Lake Michigan Open Waters pH water quality standard to Outfall 001 and instead determine that Outfall 001 is subject to the pH standard which applies to other waters of the Lake Michigan Basin. If the Agency maintains its current position on this issue, then MWG requests that in its Responsiveness Summary, the Agency provide the information and reasons on which it relies to find that the pH water quality standard applicable to Lake Michigan Open Waters applies to the Outfall 001 discharge.

(4) Impingement (see Hearing Tr. at pp. 29-30, 54, 65-67)

During the Public Hearing, comments were made contending that "5.2 million fish" are impinged by the Waukegan Station annually. This statement is not factually correct. It appears to originate from projections that assume three units are operating at the station (only two units are now operating) and that they are constantly operating at each of their design maximum flows (which does not reflect actual operating conditions), and that the composition of the fish collected is identical for each and every day of each year, which would provide a gross over-estimate. It should also be noted that based on preliminary studies done in the 2003-2005 timeframe, the majority of the fish impinged/entrained are low value fish, such as alewives and non-native fish, and fish that are moribund or otherwise stressed by osmotic factors which are not the result of MWG's operations.

(5) 316(a) Thermal Variance (Hearing Transcript at pps. 25-26, 30, 62-65)

During the Public Hearing, comments and questions were also raised concerning the Draft NPDES Permit's recognition and continuation of the 316(a) thermal variance for the Waukegan Station which was originally granted on September 21, 1978 by the Illinois Pollution Control Board (the "Board") in the proceeding entitled "Proposed Determination of No Significant Ecological Damage for the Zion and Waukegan Generating Stations," Docket no. PCB 78-72, -73 Consolidated (September 21, 1978). As explained in the Board's Opinion and Order, the § 316(a) variance was granted because the Waukegan Station has not caused and cannot be reasonably expected to cause significant ecological damage to the receiving waters. The Board's determination was based on an exhaustive review of the results of a series of comprehensive biological and thermal monitoring and modeling studies performed in the vicinity of Waukegan Station's thermal discharge to evaluate the effect of its thermal discharges, which included:

1. Thermal Plume Studies (including modeling of thermal levels in Lake Michigan);
2. Lake Current Studies;
3. Water Quality Monitoring;
4. Larval, Young of Year and Adult Fisheries Monitoring;
5. Distribution of Fish Eggs and Larvae in the Vicinity of Waukegan Station;
6. Literature Review of Thermal Tolerances of Fishes in Lake Michigan; and
7. Phytoplankton, Zooplankton and Benthic Sampling and Analysis.

As the Board expressly found in granting the § 316(a) variance, expert opinions based on these studies "indicated that virtually no damage was being done to the Lake Michigan environment as a result of heated discharges" from the Station. (Board Opinion at p. 31-474) It is important to recognize that these studies were done when the Waukegan Station was operating four units. Since these studies were completed, the heat load of the Waukegan Station's thermal discharge has decreased significantly as a result of the retirement of two of these four units Unit 5 (129 MW capability) in January, 1978 and Unit 6 (112 MW capability) in December, 2007. Also, as the historical and current NPDES renewal permit applications for the Waukegan Station have shown, there have not been any adverse changes in the station's operations over the years since these studies were completed that would lend any support to a concern that the findings of those studies are no longer valid. Thus, it is reasonable for the Agency to continue the 316(a) thermal variance while providing MWG with the opportunity to conduct updated thermal studies, as proposed in Special Condition 4 of the Draft NPDES Permit. Under the renewed NPDES Permit, MWG will be providing updated information on thermal plume characteristics and biological community assemblage.

However, in response to the Public Hearing question of whether the aquatic community has changed since the previous 316(a) variance studies were conducted (see Hearing Tr. at p. 64), there is responsive information in the permit record which addresses this question and which supports the continuation of the 316(a) thermal variance pending the completion of the updated studies because it suggests that the composition of the native aquatic community has not fundamentally changed. Certain changes that have occurred, as discussed further below, such as the reduction in abundance of rainbow smelt, are not associated with any effects attributable to the Waukegan Station thermal discharge. (See MWG November 2, 2012 Comments) Further, the field data from the two-year impingement study at the Waukegan Station conducted from July 2003-June 2005) shows that most Lake Michigan open water or deep water species like salmonids, sculpins, and coregonids are impinged in low numbers, indicating that these species generally will not be exposed to the Station's thermal plume and therefore are at minimal risk.

In addition, the USGS trawling program in Lake Michigan, which began in 1973 and continues to the present, provides the lake-wide status of select species, including alewife and rainbow smelt. One of the USGS transects for its trawling program is located off of the City of Waukegan, in close proximity to the Waukegan Station discharge. The most complete and recent report issued by the USGS for its trawling program results, dated March 2010, presents data collected in 2009. (A copy of the USGS March 2010 Report was attached to MWG's November 2, 2012 comments as Exhibit B.) As was the case at the time of the original 316(a) studies, alewife is the numerically dominant species. A major change seems to be that the abundance of rainbow smelt has declined, but the decline in rainbow smelt abundance has occurred throughout Lake Michigan and is therefore not attributable to the Waukegan Station's operations.

Where changes have occurred (e.g., the decline in rainbow smelt abundance, the presence of round goby), those changes are unrelated to Waukegan Station operations. The changes instead have been due primarily to introductions of non-native species which has altered the ecology of the lake. Some of the non-native fish species currently found in Lake Michigan include: common carp, sea lamprey, alewife, rainbow smelt, white perch, ruffe, round goby and three-spine stickleback. Some of the non-native macroinvertebrate species include: zebra mussels, quagga mussels, spiny water flea and fishhook water flea. Species purposely introduced for exotic fish species management or for recreational benefits include the Pacific salmon (e.g., Chinook and Coho salmon), steelhead trout, brown trout, and brook trout. For salmonids, with the exception of lake trout, Lake Michigan is managed entirely as a put and take fishery.

At the Public Hearing, a question also was raised concerning whether the 1978 316(a) variance studies delineated the extent of the thermal plume. (See Hearing Tr. at p. 65) Thermal plume studies were performed at that time. However, due to the fact that those studies were performed when all four units were operating at the Waukegan Station, and only two units are still operating today, the results of those studies would not accurately represent the current delineation of the thermal plume from the Outfall 001 discharge. The additional thermal studies to be conducted under the renewed NPDES Permit will provide a delineation of the thermal plume under today's operating conditions.

(5) **Groundwater Conditions at the Waukegan Station (Hearing Tr. at pps. 25, 34, 40-42, 54, 121)**

Several questions and comments were raised during the Public Hearing concerning groundwater conditions at the Waukegan Station. As stated by the Illinois EPA during the Public Hearing, the active ash ponds at the Waukegan Station are not causing groundwater contamination. Their operation is not the source of impacts that have been detected in on-site groundwater monitoring wells (Hearing Tr. at p. 40-41). Accordingly, there is no reasonable basis for restricting or conditioning the current operation of the ash ponds in the renewed NPDES Permit, nor is this the proper regulatory program to address groundwater impacts from a source that has yet to be identified. As the Agency also correctly stated during the Public Hearing, MWG is investigating the groundwater issue and this is being overseen by the Agency pursuant to non-NPDES programs.

(6) MWG's Analysis Did Not Find that Iron, Lead, Mercury and Phenols had a Reasonable Potential to Exceed the Water Quality Standards (Hearing Transcript at p. 70)

A representative of the Sierra Club incorrectly represented at the Public Hearing that an analysis by MWG showed that iron, lead, mercury and phenols had a reasonable potential to exceed the water quality standards. Although not clearly described in the Sierra Club's comments, MWG believes that this mistaken comment arises from information presented in Exhibit C, Table 2 to MWG's November 2, 2012 comments on the December 2, 2011 Draft NPDES Permit. Table 2 contained the results of a review of three sample results for each of these parameters, as well as for the other parameters for which the Agency was proposing to require monitoring in Special Condition 18 of the December 2, 2011 Draft Permit. Each of these samples had been collected for purposes of providing the required sampling information in prior MWG NPDES renewal applications. Hence, one sample is from 1994, another from 1999 and the last one is from 2004 for the renewal application for the current NPDES Permit. The information in Table 2 does not constitute a "reasonable potential to exceed analysis" as the Sierra Club claims. The purpose of this information was to show that there was no reasonable basis for the Agency to include most of the selected parameters in the proposed monitoring requirement in the renewed NPDES Permit. Although the evaluation was done on only three data points covering a twenty year period of time, it did consistently show for all but a few of the parameters that they were either below the detection limit and/or below any applicable water quality standard based on very conservative assumptions. It is a mischaracterization of the evaluation of this data to jump to the conclusion the Sierra Club did that based on this limited data review, the parameters mentioned in the Sierra Club's comment in fact do have a reasonable potential to exceed applicable water quality standards.

First, as the Agency explained during the Public Hearing (Hearing Tr. at p. 136-137), to do a reliable reasonable potential to exceed (RPE) analysis, the results from ten to twelve data sampling events should be available. Otherwise, there is such a high "coefficient of variation" or "safety factor" applied that it makes the RPE evaluation far less reliable. (See 35 IAC 352.421(a) "Estimation of Projected Effluent Quality"). Clearly here, with only three sampling results being used for the MWG evaluation, it does not provide a reliable basis for completing a reasonable potential to exceed analysis. This is readily apparent if the results of the three sampling events used in the MWG PEQ analysis are closely reviewed. For each of the subject parameters mentioned in the Sierra Club comment, with the sole exception of iron (discussed further below), the results are all reported as less than the detection limit used in the laboratory analysis. Thus, the Sierra Club's contention that this analysis showed a reasonable potential to exceed is based on results that were consistently below the method detection limit.

Second, the MWG evaluation was not intended to and did not provide a RPE analysis in accordance with the requirements of the Part 352 "Procedures for Determining Water Quality Based Permit Limitations for National Pollutant Discharge Elimination System Dischargers to the Lake Michigan Basin, " 35 IAC Part 352. For example, section 352.410(a) of the Part 352 Procedures provides:

> The most recent five years of data shall be used unless the Agency determines that an alternative period better represents the time period for which effluent quality is being projected. Such alternative time periods may include but are not limited to shorter periods that reflect changed discharge characteristics resulting from changes in manufacturing activities or wastewater treatment systems.

MWG's evaluation was not limited to the most recent five years of data. If this applicable limitation were applied, there would only be one data set that could be used to conduct the analysis, making the results of any reasonable potential to exceed even more unreliable as an accurate prediction of effluent quality. In the case of iron, for example, the most recent iron sampling result, a 0.048 mg/L value from 2004, was significantly lower than the 1994 value of 0.07 mg/L and the 1999 value of 0.29 mg/L. The 0.048 mg/L 2004 iron concentration is well below the 1.0 mg/L water quality standard, as are the other two data results. This underscores the highly conservative nature of a RPE analysis that is done on so few data points. It also rebuts the Sierra Club's apparent belief that iron has a reasonable potential to exceed the applicable water quality standard.

Further, the Part 352 Procedures specify that a RPE analysis must include more than simply the calculation of the Projected Effluent Quality (PEQ) values that were the subject of the MWG evaluation. Section 352.401(b) expressly provides that determining the PEQ is only the first step in the RPE analysis because "[t]he assignment of values for WQBELs is dependent on the application of dilution or mixing zones." As section 352.410(b) further provides: "If the PEQ exceeds the applicable standard, criteria or value, the analysis shall proceed to consideration of mixing and dilution pursuant to Section 352.422." MWG did not proceed to consider mixing and dilution because the purpose of its analysis was not to conduct an RPE in accordance with the Part 352 procedures. The issue MWG was addressing was whether the addition of a monitoring requirement in the Waukegan Station's NPDES Permit was reasonable.

While MWG continues to maintain that the additional monitoring requirements proposed by the Illinois EPA are not reasonable based on past monitoring results, it certainly has never concluded from any past analysis that the iron, lead, mercury, oil and grease and phenols levels in its discharge have a "reasonable potential to exceed" the applicable water quality standards within the meaning of the applicable Part 352 procedures for determining whether a water quality-based effluent limit should be included in the Waukegan NPDES Permit.

(7) 2005 NPDES Permit Renewal Application Single Selenium Detection in Wastewater Treatment System Internal Outfall (C01) (Hearing Tr. at p. 71)

A comment was made during the Public Hearing that MWG reported a value for selenium of "0.21" mg/L in the effluent from the station's wastewater treatment system. (Hearing Tr.

at p. 71). This referenced value is incorrect. In MWG's 2005 NPDES Permit Renewal Application, Form 2C, it reported a single detection of 0.021 mg/L of selenium from the internal Wastewater Treatment System Outfall (C01) monitoring. It should also be noted that all other results historically have been below the reported detection limit. The Wastewaster Treatment System internal wastestream is not subject to any effluent discharge standard for selenium. The selenium water quality standard cited in the public comment does not apply to this internal wastestream. Internal Outfall C01 waste stream (8.13 MGD) combines with other waste streams, primarily cooling water (665 MGD), prior to discharge at the main outfall, Outfall 001. The dilution ratio is approximately 60:1 prior to discharge. Selenium has not been detected in the Outfall 001 discharge. There is no reasonable basis on which to impose a discharge limit for selenium either at internal Outfall C01 on the discharge at Outfall 001

(8) Current Wastewater Treatment at the Waukegan Station (Hearing Transcript at p. 120)

A comment was made at the Public Hearing that a "2011 RCRA report" provides that "only the clarifiers" at the Waukegan Station's wastewater treatment plant "have been used." MWG does not know what report this comment is referencing and hence, it does not know what the actual contents of such a report provides. Nevertheless, MWG believes that the comment is inaccurate. The existing wastewater treatment at Waukegan consists of equalization, sedimentation and oil removal, as stated in the NPDES permit renewal application. Chemicals are not used to facilitate the sedimentation process in the ash ponds and the ash pond effluent is directed through the station clarifiers, which provide further treatment without the use of chemicals. This is the treatment afforded to the wastewater effluent from the active ash ponds at the station.

(9) June 19, 2009 Extreme Storm Event (Hearing Transcript at p. 123)

A comment during the Public Hearing referenced a "2009 incident" where coal was discharged into the canal "after a storm." The severity of this 2009 storm evident was not described to the Agency during the Public Hearing. It was a rare upset event caused by an extreme storm event during which almost 4 inches of rain fell within a very short period of time. This event was immediately reported to Illinois EPA, at the same time at which all possible efforts were made at the station to limit/minimize any possible overflow impacts. The severity of this storm required the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) to reverse flows from the Chicago Area Waterway System into Lake Michigan in order to try to minimize flooding throughout the Chicago area. Many other weather-related overflow and flooding incidents also occurred. Neither the Illinois EPA nor the U.S. EPA considered these overflow and flooding incidents to warrant stricter controls to be imposed on facilities based on the recognition that the severity of this storm event exceeded the established criteria that are applied to design and implement storm water runoff prevention measures. Moreover, since 2009 there have been other severe storm events in the Waukegan area, although less extreme than the 2009 event, and the measures in place at the Waukegan Station to contain the coal pile have been effective to prevent what occurred in 2009. Given the history of adequate containment of the coal pile during wet weather events, the 2009 extreme storm event is not a reasonable basis on which to conclude that further containment measures should be required. The Waukegan Station's coal pile is reasonably contained and run-off continues to be collected and treated in accordance with all NPDES Permit limitations.

(10) Waukegan Station Transformers (Hearing Transcript at pps. 125-126)

The only transformers at the Waukegan Station that are considered "PCB-contaminated" (i.e., PCB concentration > 50 ppm) under existing regulations are four transformers which are all located indoors, on the mezzanine level of the boiler room located between Units 7 and 8. Their location provides no basis for concern regarding the risk of a discharge to surface water.

Should you have any questions regarding the contents of this comment letter, please contact me at jwozniak@mwgen.com or (630) 771-7880.

Sincerely,

Julia Wozniak
Environmental Program Manager

cc: Jaime Rabins, Illinois Environmental Protection Agency

bcc: Mark Nagel—Waukegan Station
Fred Veenbaas—"
Mark Wehling—"

USGS
science for a changing world

Lake Michigan Committee
March 19, 2013

Status and Trends of Prey Fish Populations in Lake Michigan, 2012[1]

David B. Bunnell, Charles P. Madenjian, Timothy J. Desorcie,
Melissa J. Kostich, Kelley R. Smith, and Jean V. Adams
U. S. Geological Survey
Great Lakes Science Center
1451 Green Road
Ann Arbor, Michigan 48105

Abstract

The U.S. Geological Survey Great Lakes Science Center has conducted lake-wide surveys of the fish community in Lake Michigan each fall since 1973 using standard 12-m bottom trawls towed along contour at depths of 9 to 110 m at each of seven index transects. The resulting data on relative abundance, size and age structure, and condition of individual fishes are used to estimate various population parameters that are in turn used by state and tribal agencies in managing Lake Michigan fish stocks. All seven established index transects of the survey were completed in 2012. The survey provides relative abundance and biomass estimates between the 5-m and 114-m depth contours of the lake (herein, lake-wide) for prey fish populations, as well as burbot, yellow perch, and the introduced dreissenid mussels. Lake-wide biomass of alewives in 2012 was estimated at 9 kilotonnes (kt, 1 kt = 1000 metric tonnes), which continues the trend of unusually low alewife biomass since 2004 but represented a 20% increase from the 2011 estimate. The age distribution of alewives larger than 100 mm was dominated (i.e., 84%) by age-2. Record low biomass was observed for several species, including bloater (0.4 kt), rainbow smelt (0.1 kt), deepwater sculpin (1.5 kt), and ninespine stickleback (0.01 kt). Slimy sculpin lake-wide biomass was 0.73 kt in 2012, which was the third consecutive year revealing a decline. Estimated biomass of round goby increased by 79% to 3 kt. Burbot lake-wide biomass (0.5 kt in 2012) has remained below 3 kt since 2001. Numeric density of age-0 yellow perch (i.e., < 100 mm) was only 2 fish per ha, which is indicative of a relatively poor year-class. Lake-wide biomass estimates of dreissenid mussels have continued to increase from 2010, from 12 to 95 kt in 2012. Overall, the total lake-wide prey fish biomass estimate (sum of alewife, bloater, rainbow smelt, deepwater sculpin, slimy sculpin, round goby, and ninespine stickleback) in 2012 was 15 kt, which represented the lowest total biomass of the time series.

---

[1] Presented at: Great Lakes Fishery Commission
Lake Michigan Committee Meeting
Duluth, MN
March 19, 2013

The U.S. Geological Survey Great Lakes Science Center (GLSC) has conducted daytime bottom trawl surveys in Lake Michigan during the fall annually since 1973. Estimates from the 1998 survey are not reported, however, given the trawls were towed at non-standard speeds. From these surveys, the relative abundance of the prey fish populations are measured, and estimates of lake-wide biomass available to the bottom trawls (for the region of the main basin between the 5-m and 114-m depth contours) can be generated (Hatch et al. 1981; Brown and Stedman 1995). Such estimates are critical to fisheries managers making decisions on stocking and harvest rates of salmonines and allowable harvests of fish by commercial fishing operations.

The basic unit of sampling in our surveys is a 10-minute tow using a bottom trawl (12-m headrope) dragged on contour at 9-m (5 fathom) depth increments. At most survey locations, towing depths range from 9 or 18 m to 110 m. Age determinations were estimated for alewives (*Alosa pseudoharengus*, using otoliths) and bloaters (*Coregonus hoyi*, using scales) from our bottom trawl catches (Madenjian et al. 2003; Bunnell et al. 2006a). Although our surveys have included as many as nine index transects in any given year, we have consistently conducted the surveys at seven transects. These transects are situated off Manistique, Frankfort, Ludington, and Saugatuck, Michigan; Waukegan, Illinois; and Port Washington and Sturgeon Bay, Wisconsin (Figure 1). All seven transects were completed in 2012.

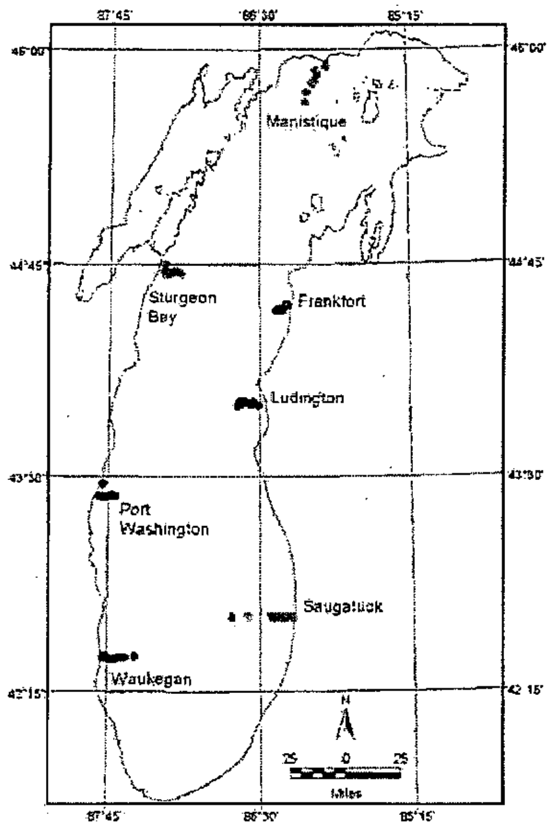


Figure 1. Established sampling locations for GLSC bottom trawls in Lake Michigan.

Lake-wide estimates of fish biomass require (1) accurate measures of the surface areas that represent the depths sampled and (2) reliable measures of bottom area swept by the trawl. A complete Geographical Information System (GIS) based on depth soundings at 2-km intervals in Lake Michigan was developed as part of the acoustics study performed by Argyle et al. (1998). This GIS database was used to estimate the surface area for each individual depth zone surveyed by the bottom trawls. Trawl mensuration gear that monitored net configuration during deployment revealed that fishing depth (D, in meters) influenced the bottom area swept by the trawl. We have corrected the width (W, in meters) of the area sampled according to $W = 3.232 + 7.678(1 - e^{-0.044*D})$, as well as the actual time (AT, in minutes) spent on the bottom according to AT = tow time − 0.945 + (0.056D), based on trawl measurements made during June 2009 (Madenjian et al. 2010a). These relationships, along with boat speed, were used to estimate bottom area swept.

We estimate both numeric (fish per hectare [ha]) and biomass (kg per ha) density, although we display graphical trends mostly in biomass for brevity. A weighted mean density over the entire range of depths sampled (within the 5-m to 114-m depth contours) was estimated by first calculating mean density for each depth zone, and then weighting mean density for each depth zone by the proportion of lake surface area assigned to that depth zone. Standard error (SE) of mean density was estimated by weighting the variances of fish density in each of the depth zones by the appropriate weight (squared proportion of surface area in the depth zone), averaging the weighted variances over all depth zones, and taking the square root of the result.

NUMERIC AND BIOMASS DENSITY BY SPECIES

By convention, we classify "adult" prey fish as age 1 or older, based on total length (TL): alewives ≥ 100 mm, rainbow smelt (*Osmerus mordax*) ≥ 90 mm, bloaters ≥ 120 mm, and yellow perch (*Perca flavescens*) ≥ 100 mm. We assume all fish smaller than the above length cut-offs are age-0; length cut-offs are also aided by aging of alewife (by otoliths) and bloater (by scales). Catches of age-0 alewife are not reliable indicators of future year-class strength (Madenjian et al. 2005a), because their position in the water column makes them less vulnerable to bottom trawls. Catches of age-0 bloater, though biased low, can be used as an index of relative abundance given the positive correlation between density of age-0 bloater and density of age-3 bloater (the age at which catch curves reveal full recruitment to our gear, Bunnell et al. 2006a, 2010). Catch of age-0 yellow perch is likely a good indicator of year-class strength, given that large catches in the bottom trawl during the 1980s corresponded to the strong yellow perch fishery. At the end of this report, we report densities of age-0 yellow perch and other bottom-dwelling species such as burbot (*Lota lota*) and dreissenid mussels that are not necessarily "prey fish" but are caught in sufficient numbers to index. Unfortunately lake whitefish are only rarely sampled in our trawl and the resultant trends are not meaningful.

Alewife – Since its establishment in the 1950s, the alewife has become a key member of the fish community. As a larval predator, adult alewife can depress recruitment of native fishes, including burbot, deepwater sculpin (*Myoxocephalus thompsonii*), emerald shiner (*Notropis atherinoides*), lake trout (*Salvelinus namaycush*), and yellow perch (Smith 1970; Wells and McLain 1973; Madenjian et al. 2005b, 2008; Bunnell et al. 2006b). Additionally, alewife has remained the most important constituent of salmonine diet in Lake Michigan for the last 45 years (Jude et al. 1987; Stewart and Ibarra 1991; Warner et al. 2008; Jacobs et al. 2013). Most of the alewives consumed by salmonines in Lake Michigan are eaten by Chinook salmon (*Oncorhynchus tshawytscha*, Madenjian et al. 2002). A commercial harvest was established in Wisconsin waters of Lake Michigan in the 1960s to make use of the then extremely abundant alewife that had become a nuisance and health hazard along the lakeshore. In 1986, a quota was implemented, and as a result of these restrictions, the estimated annual alewife harvest declined from about 7,600 metric tons in 1985 to an incidental harvest of only 12 metric tons after 1990 (Mike Toneys, Wisconsin Department of Natural Resources, Sturgeon Bay, personnel communication). Lake Michigan currently has no commercial fishery for alewives.

Adult alewife biomass density was 1.4 kg per ha in 2012 (Figure 2a), which was only 20% of the long-term average biomass. Only 2010 yielded a lower adult alewife biomass estimate. Similarly, adult alewife numeric density in 2012 (62.8 fish/ha, Figure 2b) was only 27% of the long-term average. The overall temporal trends in alewife recruitment to age 3 and subsequent adult biomass are likely driven by consumption by salmonines (Madenjian et al. 2002, 2005a).

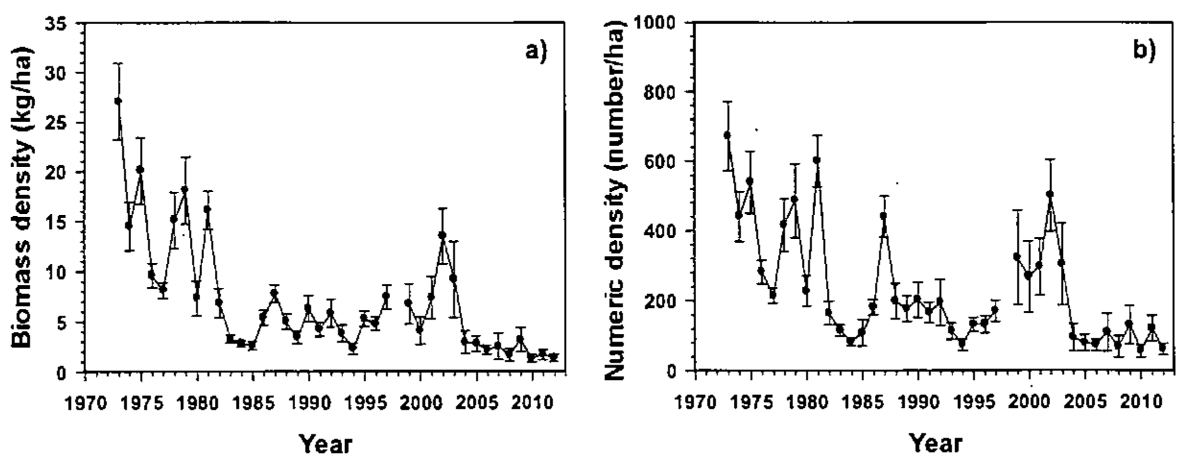


Figure 2. Density of adult alewives as biomass (a) and number (b) per ha (+/- standard error) in Lake Michigan, 1973-2012.

Adult alewife density has remained at low levels during 2004-2012 (Figure 2). This continued depression of adult alewife abundance may reflect a recently intensified amount of predation exerted on the alewife population by Chinook salmon due to four factors: (1) a relatively high percentage of wild Chinook salmon in Lake Michigan (averaging 50% age-1 individuals between 2006-2010, Williams 2012), (2) increased migration of Chinook salmon from Lake Huron in search of alewife (Adlerstein et al. 2007), (3) increased importance of alewives in the diet of Chinook salmon in Lake Michigan between the 1990s and the 2000s (Jacobs et al. 2013), and (4) a decrease in the energy density of adult alewives during the late 1990s (Madenjian et al. 2006).

Of the 123 alewife otoliths aged, two independent readers arrived at the same estimate 90% of the time (and they were able to reach a consensus age on the 12 disagreements). Using an age-length key and a length distribution that corrected for densities, we estimated that 84% of adult alewives captured in the bottom trawl during 2012 were age 2 and classified as the 2010 year-class (Figure 3). This unevenness in age composition was also observed in 2011, as the 2010 year-class comprised 83% of the adults captured. These two years are in stark contrast to the previous four years (2007-2010) when more evenness was estimated among the age-classes, as indicated by at least three age-classes each contributing at least 10% to the catch. One additional change in recent years is a truncation in the age distribution. The maximum age sampled has decreased from age 9 in 2007 to age 7 in 2008-2009 to age 6 in 2010-2011 to age 4 in 2012.

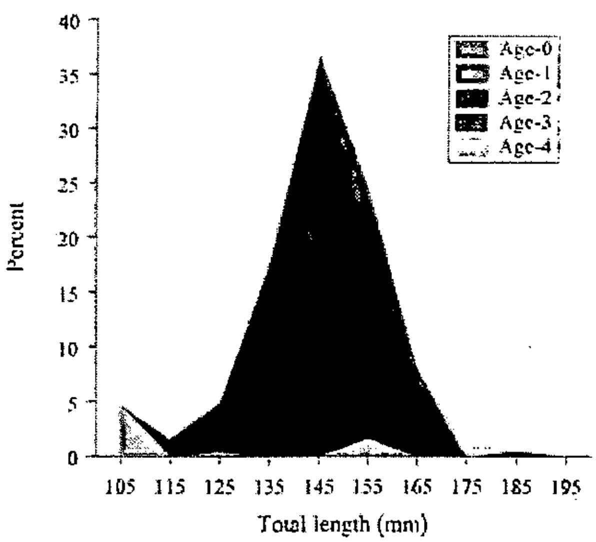


Figure 3. Age-length distribution of alewives ≥100 mm total length caught in bottom trawls in Lake Michigan, 2012. Note that smaller alewives were captured but were not included herein.

Our results for temporal trends in adult alewife density were in partial agreement with results from the lake-wide acoustic survey, which reported biomass of adult alewife during 2004-2012 to be relatively low in comparison to the biomass during 1994-1996 (Warner et al. 2013). However, Warner et al. (2013) did report a substantial increase in adult alewife biomass during 2007-2010 that was not detected by the bottom trawl survey. Comparisons between the age-distributions measured in the two surveys also exhibited commonality in the dominance of the 2010 year-class among the adults (84% in the bottom trawl and 89% in the acoustic survey). The biomass estimate for adult alewife in the acoustic survey, however, is over three times higher than what was estimated in the bottom trawl survey.

Bloater - Bloaters are eaten by salmonines in Lake Michigan, but are far less prevalent in salmonine diets than alewives (Warner et al. 2008; Jacobs et al. 2010, 2013). For large (≥ 600 mm) lake trout, over 30% of the diets offshore of Saugatuck and on Sheboygan Reef were composed of adult bloaters during 1994-1995, although adult bloaters were a minor component of lake trout diet at Sturgeon Bay (Madenjian et al. 1998). For Chinook salmon, the importance of bloater (by wet weight) in the diets has declined between 1994-1995 and 2009-2010. For small (< 500 mm) Chinook salmon the proportion declined from 9% to 6% and for large Chinook salmon the proportion declined from 14% to <1% (Jacobs et al. 2013). The bloater population in Lake Michigan also supports a valuable commercial fishery, although its yield has generally been declining since the late 1990s.

Adult bloater biomass density was 0.11 kg per ha in 2012 (Figure 4a), which was only 0.5% of the long-term average biomass and the lowest estimate of the time series. The estimate for 2012 was also 90%

lower than that measured in 2011. Similarly, adult bloater numeric density in 2012 (2.5 fish/ha) was only 0.5% of the long-term average. Adult bloater numeric and biomass densities have shown an overall declining trend since 1989 (Figure 4a). Numeric density of age-0 bloaters (< 120 mm TL) was only 2 fish per ha in 2012 (Figure 4b). 2012 was the third consecutive year of very low densities of age-0 bloater following relatively high values in 2005, 2008, 2009.

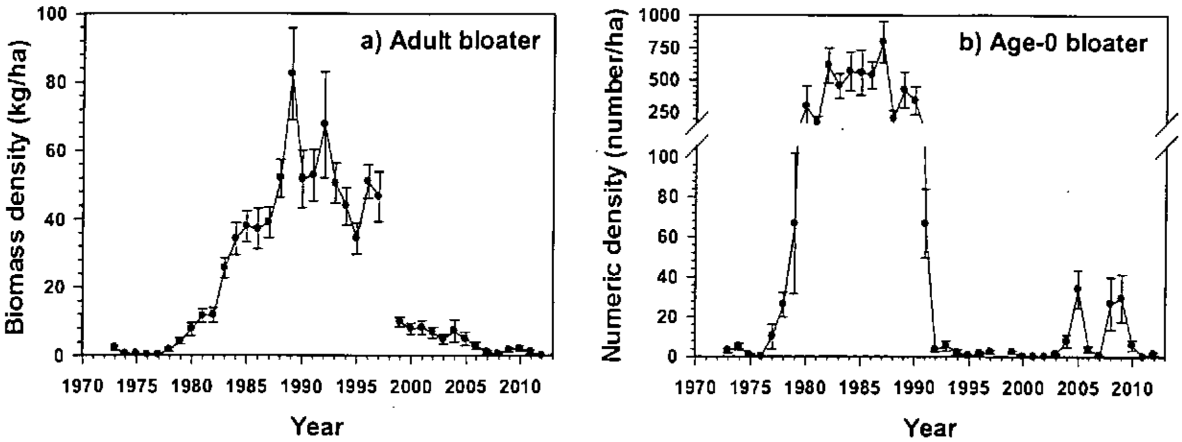


Figure 4. Panel (a) depicts biomass density (+/- standard error) of adult bloater in Lake Michigan, 1973-2012. Panel (b) depicts numeric density (+/- standard error) of age-0 bloater in Lake Michigan, 1973-2012.

The exact mechanisms underlying the relatively poor bloater recruitment since 1992, and the resultant low biomass of adult bloater, remain unknown. Of the mechanisms that have been recently evaluated, reductions in fecundity associated with poorer condition (Bunnell et al. 2009a) and egg predation by slimy and deepwater sculpins (Bunnell et al. 2013) are likely contributing to the reduced bloater recruitment, but none is the primary regulating factor. Another hypothesized mechanism, predation by adult alewife on bloater larvae, has been discounted (Madenjian et al. 2002; Bunnell et al. 2006a). Madenjian et al. (2002) proposed that the Lake Michigan bloater population may be cycling in abundance, with a period of about 30 years, although the exact mechanism by which recruitment is regulated remains unknown. Finally, a regional climate driver was hypothesized to underlie the synchrony in bloater recruitment among lakes Michigan, Huron, and Superior between 1978 and 2006 (Bunnell et al. 2010). The recent asynchrony in bloater recruitment, as measured by the Lake Michigan (relatively poor) and Lake Huron bottom trawl surveys (relatively strong; Roseman et al. 2013), suggests that some factor other than climate is likely important.

One additional consideration when interpreting these bottom trawl survey results is that catchability of bloater may have decreased in recent years, in response to the proliferation of quagga mussels and the associated increased water clarity and decreased *Diporeia* spp. densities. First, bloaters (both age-0 and adult) may be increasingly pelagic, rather than benthic, during the day, as diet information from 2010 revealed an increasing reliance on zooplankton to compensate for fewer *Diporeia* (D. B. Bunnell, unpublished data). Second, bloaters have exhibited plasticity in bottom depth, increasing the depth at which peak densities occurred from 50 m in the 1930s to 85-110 m by 2004-2007 (Bunnell et al. 2012). Hence, not only could bloaters be above the bottom trawl during the day, but some portion of the population also could have shifted to waters deeper than are surveyed by the bottom trawl.

Results from the acoustic survey can provide some insight into catchability concerns raised above. With regard to bloater moving deeper than 110 m, the acoustic survey estimated bloater densities ranging 8-25 fish/ha in depths 125-220 m between 2003 and 2012 (D. M. Warner, unpublished data). However, the survey also documented that the bulk of the bloater population was sampled in depths 30-100 m.

In terms of comparing trends between the two surveys, for the adults an order of magnitude decrease between 1992-1996 and 2001-2012 was revealed by both surveys. Similarly, low densities of age-0 bloaters in the 1990s and strong interannual variability in the 2000s were detected in both surveys. However, the years (2005, 2008, 2009) in which relatively high age-0 densities were estimated by the bottom trawl survey were a subset of the high density years (2001, 2005, 2007-2009, 2012) estimated by the acoustic survey (Warner et al. 2013).

Rainbow smelt – Adult rainbow smelt are an important part of the diet for intermediate-sized (400 to 600 mm) lake trout in the nearshore waters of Lake Michigan (Stewart et al. 1983; Madenjian et al. 1998; Jacobs et al. 2010). For Chinook salmon, rainbow smelt comprised as much as 18% in the diets of small individuals in 1994-1996, but that dropped precipitously to 2% in 2009-2010 and rainbow smelt has been consistently rare in the diets of larger Chinook salmon in all time periods (Jacobs et al. 2013). The rainbow smelt population supports commercial fisheries in Wisconsin and Michigan waters (Belonger et al. 1998; P. Schneeberger, Michigan Department of Natural Resources, Marquette, MI, personal communication).

Adult rainbow smelt biomass density was 0.02 kg per ha in 2012 (Figure 5a), which was only 1% of the long-term average biomass and the lowest estimate of the time series. The estimate for 2012 was also 81% lower than that measured in 2011. Adult rainbow smelt numeric density in 2012 (3 fish/ha) was only 2% of the long-term average. Adult rainbow smelt numeric density was highest from 1981 to 1993, but then declined between 1993 and 2001, and has remained at a relatively low density, except in 2005, since 2001. Age-0 rainbow smelt has been highly variable since 2002 (Figure 5b). Age-0 numeric density in 2012 was 26 fish per ha, which was only 14% of the long-term average. Causes for the general decline in rainbow smelt biomass and production remain unclear. Consumption of rainbow smelt by salmonines was higher in the mid 1980s than during the 1990s (Madenjian et al. 2002), yet adult and age-0 (< 90 mm TL) rainbow smelt abundance remained high during the 1980s (Figure 5b).

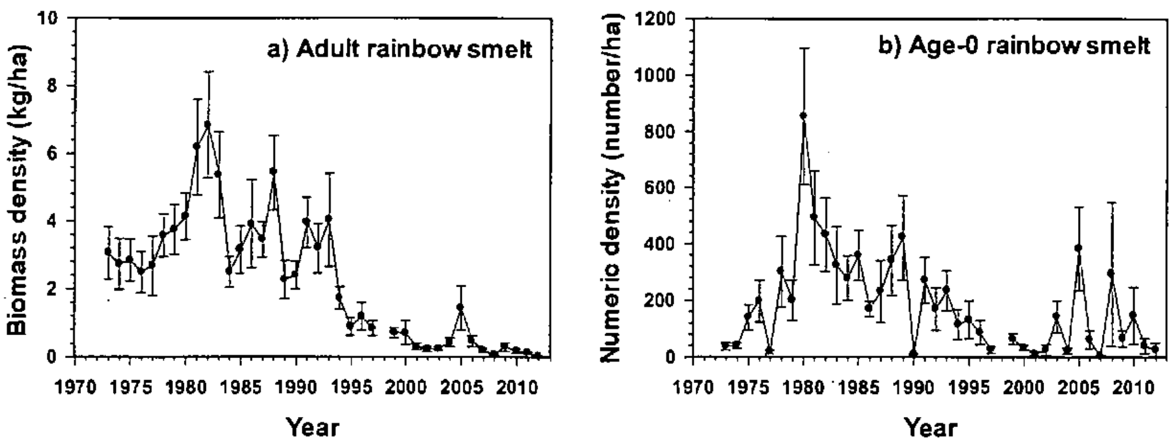


Figure 5. Biomass density (+/- standard error) of adult (a) and age-0 (b) rainbow smelt in Lake Michigan, 1973-2012.

Temporal trends in rainbow smelt biomass from the acoustic and bottom trawl surveys in Lake Michigan have been similar since 2001. The bottom trawl survey has documented relatively low rainbow smelt biomass during 2001-2012, with a minor peak in 2005 (Figure 5a). Similarly, biomass of rainbow smelt in the acoustic survey was relatively low during 2001-2012, with minor peaks occurring during 2005-2006 and 2008-2009 (Warner et al. 2013). Results from both the acoustic and bottom trawl surveys indicated that rainbow smelt biomass in Lake Michigan during 1992-1996 was roughly four times higher than rainbow smelt biomass during 2001-2012.

Sculpins – From a biomass perspective, the cottid populations in Lake Michigan have been dominated by deepwater sculpins, and to a lesser degree, slimy sculpins (*Cottus cognatus*). Spoonhead sculpins (*Cottus ricei*), once fairly common, suffered declines to become rare to absent by the mid 1970s (Eck and Wells 1987). Spoonhead sculpins were encountered in small numbers in our survey between 1990 and 1999 (e.g., Potter and Fleischer 1992), but have not been sampled since 1999.

Slimy sculpin is a favored prey of juvenile lake trout in nearshore regions of the lake (Stewart et al. 1983; Madenjian et al. 1998), but is only a minor part of adult lake trout diets. Deepwater sculpin is an important diet constituent for burbot in Lake Michigan, especially in deeper waters (Van Oosten and Deason 1938; Brown and Stedman 1995; Fratt et al. 1997). A recent study of burbot from northern Lake Michigan sites revealed sculpins to comprise 11% of their diets (Jacobs et al. 2010).

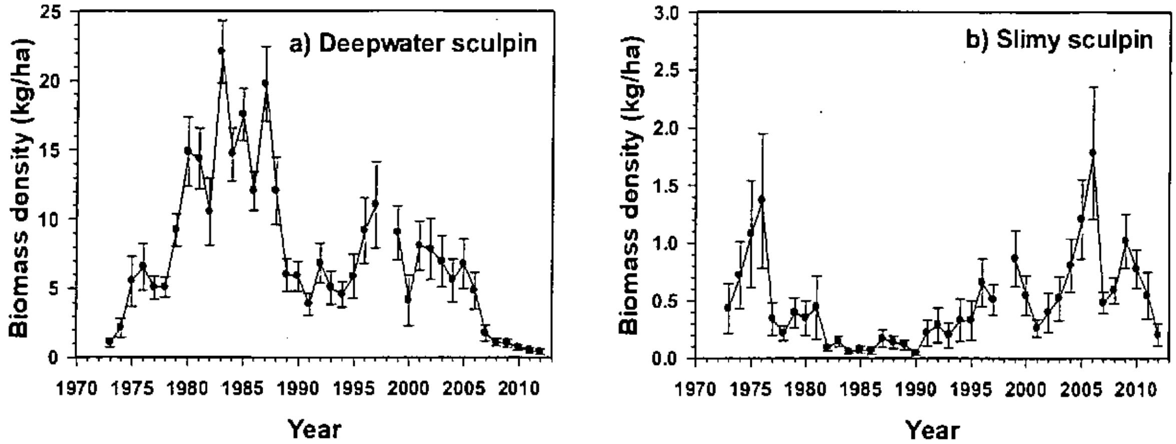


Figure 6. Biomass density (+/- standard error) for deepwater (a) and slimy sculpin (b) in Lake Michigan, 1973-2012.

Deepwater sculpin biomass density was 0.4 kg per ha in 2012 (Figure 6a), which was only 5% of the long-term average biomass and the lowest estimate of the time series. For every year since 2009, this biomass estimate has reached a record low. Similarly, deepwater sculpin numeric density in 2012 (44 fish/ha) was only 11% of the long-term average. During 1990-2005, both deepwater sculpin biomass density and numeric density trended neither downward nor upward. However, biomass of deepwater sculpin sampled in the bottom trawl has declined precipitously since 2005. Madenjian and Bunnell (2008) demonstrated that deepwater sculpins have been captured at increasingly greater depths since the 1980s. Therefore, one potential explanation for the recent declines in deepwater sculpin densities is that an increasing proportion of the population is now occupying depths deeper than those sampled by our survey (i.e., 110 m). Furthermore, because the deepwater sculpin occupies deeper depths than any of the other prey fishes of Lake Michigan, a shift to waters deeper than 110 m would seem to be a reasonable explanation for the recent declines in deepwater sculpin densities. Previous analysis of the time series indicated deepwater sculpin density is negatively influenced by alewife (predation on sculpin larvae) and burbot (predation on juvenile and adult sculpin, Madenjian et al. 2005b). Based on bottom trawl survey results, neither alewife nor burbot increased in abundance during 2007-2012 to account for this decline in deepwater sculpins. Which factor or factors could have driven the bulk of the deepwater sculpin population to move to waters deeper than 110 m during 2007-2011? This shift to deeper water by deepwater sculpins coincided with the population explosion of the profundal form of the quagga mussel (*Dreissena bugensis*) in depths between 60 and 90 m (Bunnell et al. 2009b; T. Nalepa, NOAA Great Lakes Environmental Research Laboratory, personal communication). Perhaps some consequences of the colonization of deeper waters by quagga mussels prompted a move of deepwater sculpins to deeper water. If this hypothesis were correct, then a substantial decline in quagga mussel abundance in the 60-m to 90-m deep waters could lead to a shift of deepwater sculpins back to shallower waters.

Slimy sculpin biomass density was 0.21 kg per ha in 2012 (Figure 6b). Among all of the prey fishes that have been sampled since 1973, the biomass of slimy sculpin was closest to its long-term average of 0.48 kg/ha (i.e., 43% of the long-term average biomass). Numeric density of slimy sculpin was 36 fish per ha in 2012, which was only 33% of the long-term average. Biomass densities of slimy sculpins from 2005-2006 were considerably higher than those estimated in the 1980s and even late 1990s, when slimy sculpins were recovering. Biomass of slimy sculpin has declined annually since 2009, however, with a marked 62% decline between 2011 and 2012. Previous analysis indicated slimy sculpin density was negatively influenced by lake trout, with the putative mechanism identified as predation by juvenile lake trout (Madenjian et al. 2005b). As a result, we attribute the recovery that occurred during the 1990s to, in part, the 1986 decision to emphasize stocking lake trout on offshore reefs (as opposed to the nearshore areas where our survey samples, Madenjian et al. 2002). Likewise, the slimy sculpin decline since 2009 coincided with an increase in lake trout stocking rate (FWS/GLFC 2010).

Round goby – The round goby (*Neogobius melanostomus*) is an invader from the Black and Caspian Seas. Round gobies have been observed in bays and harbors of Lake Michigan since 1993, and were captured in the southern main basin of the lake as early as 1997 (Clapp et al. 2001). Round gobies were not captured in the GLSC bottom trawl survey until 2003, however. By 2002, round gobies had become an integral component of yellow perch diet at nearshore sites (i.e., < 15 m depth) in southern Lake Michigan (Truemper et al. 2006). Round gobies also had become an important constituent of the diet of burbot in northern Lake Michigan by 2005 (Hensler et al. 2008; Jacobs et al. 2010).

Round goby biomass density was 0.9 kg per ha in 2012 (Figure 7a). Mean numeric density was 121 fish per ha. The variability associated with the annual mean is extremely high in some years, such as 2010. Hence, biomass in 2012 did not appear to be substantively different from that measured in 2010 and 2011.

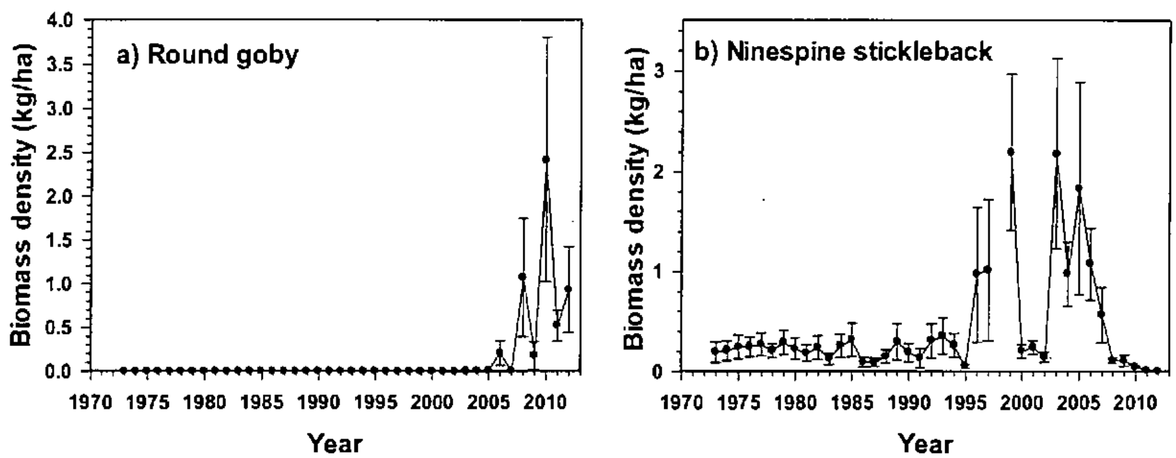


Figure 7. Biomass density (+/- standard error) of round goby (a) and ninespine stickleback (b) in Lake Michigan, 1973-2012.

Ninespine stickleback – Two stickleback species occur in Lake Michigan. Ninespine stickleback (*Pungitius pungitius*) is native, whereas threespine stickleback (*Gasterosteus aculeatus*) is non-native and was first collected in the GLSC bottom trawl survey during 1984 (Stedman and Bowen 1985). Ninespine stickleback is generally captured in far greater densities than the threespine, especially in recent years. Relative to other prey fishes, ninespine sticklebacks are of minor importance to lake trout and other salmonines. In northern Lake Michigan, for example, sticklebacks occur infrequently in the diet of lake trout (Elliott et al. 1996; Jacobs et al. 2010). Biomass density was 3 g per ha in 2012 (Figure 7b), the lowest value of the time series and only 0.9% of the long-term average. Mean numeric density was only 3 fish per ha. Biomass of ninespine stickleback remained fairly low from 1973-1995, increased dramatically in 1996-1997, and exhibited larger interannual variability between 1999 and 2007. Since 2008, however, biomass has been maintained at near record-low levels. An analysis of ninespine stickleback densities in lakes Michigan and Superior revealed that the increase in Lake Michigan in the mid-2000s coincided with the expansion of dreissenid mussels in the lake (Madenjian et al. 2010b). The proposed mechanism was that the prevalence of the green alga *Cladophora*, which increased with dreissenid mussel proliferation, improved spawning habitat quality for ninespine sticklebacks. One plausible explanation for the low ninespine stickleback abundance during 2008-2012 may be that piscivores have begun to incorporate ninespine sticklebacks in their diets as the abundance of alewives has declined. Jacobs et al. (2013) found ninespine sticklebacks to be a rare diet item (i.e., 2% occurrence) among large Chinook salmon in 2009-2010 after a 0% occurrence in 1994-1995. The decrease in ninespine stickleback abundance in Lake Superior between the 1978-1999 and 2000-2007 periods was attributed to increased predation by lake trout (Madenjian et al. 2010b).

LAKE-WIDE BIOMASS

We estimated a total lake-wide biomass of prey fish available to the bottom trawl in 2012 of 15 kilotonnes (kt) (1 kt = 1000 metric tonnes) (Figure 8a, Appendix 1), which was the lowest value in the time series and only 10% of the long-term average total prey fish biomass. Total prey fish biomass was the sum of the population biomass estimates for alewife, bloater, rainbow smelt, deepwater sculpin, slimy sculpin, ninespine stickleback, and round goby. Total prey fish biomass in Lake Michigan has trended downward since 1989 (Figure 8a). This decline was largely driven by the dramatic decrease in bloater biomass. During 2002-2012, decreases in alewife and deepwater sculpin biomasses also contributed to the continued decrease in total prey fish biomass. Total biomass first dropped below 30 kt in 2007, and has remained below 30 kt since that time.

As Figure 8b depicts, the 2012 prey fish biomass was apportioned as: alewife 60.3% (9.2 kt), round goby 21.6% (3 kt), deepwater sculpin 9.7% (1.5 kt), slimy sculpin 4.8% (0.7 kt), bloater 2.7% (0.4 kt), rainbow smelt 0.9% (0.1 kt), and ninespine stickleback < 0.1% (0.01 kt).

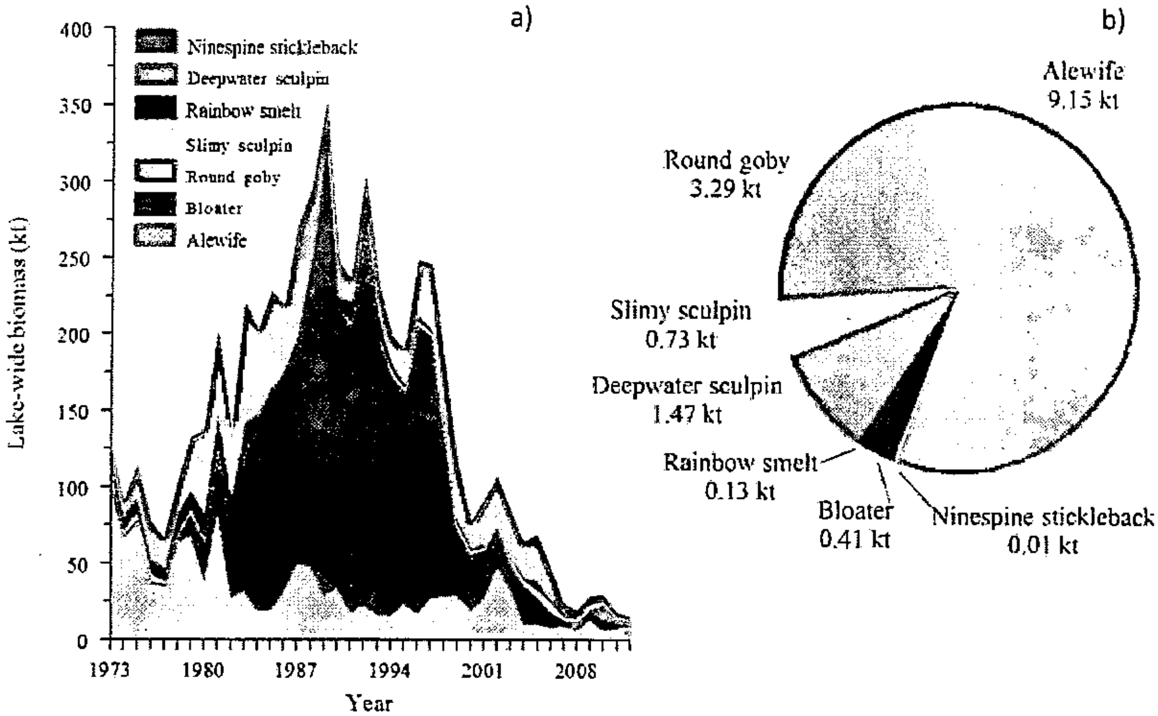


Figure 8. Estimated lake-wide (i.e., 5-114 m depth region) biomass of prey fishes in Lake Michigan, 1973-2012 (a) and species composition in 2012 (b).

OTHER SPECIES OF INTEREST

Burbot – Burbot and lake trout represent the native top predators in Lake Michigan. The decline in burbot abundance in Lake Michigan during the 1950s has been attributed to sea lamprey predation (Wells and McLain 1973). Sea lamprey control was a necessary condition for recovery of the burbot population in Lake Michigan, however Eshenroder and Burnham-Curtis (1999) proposed that a reduction in alewife abundance was an additional prerequisite for burbot recovery.

Burbot collected in the bottom trawls are typically large individuals (>350 mm TL); juvenile burbot apparently inhabit areas not covered by the bottom trawl survey.

Burbot biomass density was 0.1 kg per ha in 2012, which was 15% of the long-term average. After a period of low numeric density in the 1970s, burbot showed a strong recovery in the 1980s (Figure 9a).

Densities increased through 1997, but appear to have declined thereafter and have exhibited relatively stable, but low, levels of biomass since 2003.

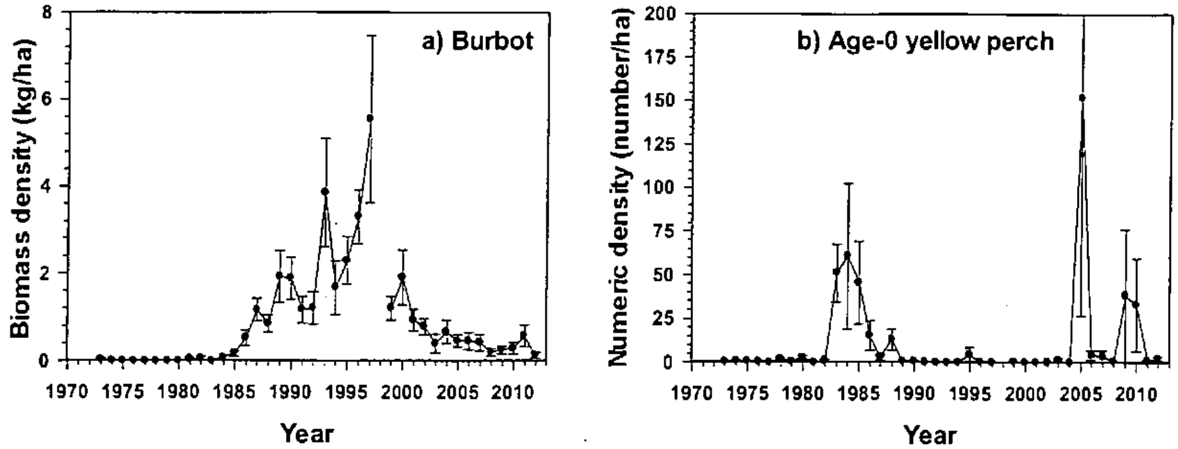


Figure 9. Biomass density (+/- standard error) of burbot (a) and numeric density (+/- standard error) of age-0 yellow perch (b) in Lake Michigan, 1973-2012.

Age-0 yellow perch – The yellow perch population in Lake Michigan has supported valuable recreational and commercial fisheries (Wells 1977). GLSC bottom trawl surveys provide an index of age-0 yellow perch numeric density, which serves as an indication of yellow perch recruitment success. The 2005 year-class of yellow perch was the largest ever recorded (Figure 9b) and the 2009 and 2010 year-classes also were higher than average. Strong yellow perch recruitment in these recent years was likely attributable to a sufficient abundance of female spawners and favorable weather (e.g., Makauskas and Clapp 2000). Numeric density of the 2012 year-class was only 2 fish per ha, indicative of a relatively weak year-class despite a warmer than average year.

Dreissenid mussels – The first zebra mussel (*Dreissena polymorpha*) noted in Lake Michigan was found in May 1988 in Indiana Harbor at Gary, Indiana. By 1990, adult mussels had been found at multiple sites in the Chicago area, and by 1992 were reported to range along the eastern and western shoreline in the southern two-thirds of the lake, as well as in Green Bay and Grand Traverse Bay (Marsden 1992). In 1999, catches of dreissenid mussels in our bottom trawls became significant and we began recording biomass for each tow. Lake Michigan dreissenid mussels include two species: the zebra mussel and the quagga mussel. The quagga mussel is a more recent invader to Lake Michigan than the zebra mussel (Nalepa et al. 2001). According to the GLSC bottom trawl survey, biomass density of dreissenid mussels was highest in 2007 (Figure 10a), which followed an exponential like increase between 2004 and 2006 (Bunnell et al. 2009b). The biomass density of dreissenid mussels in 2012 was 27 kg per ha, the highest value estimated since the peak in 2007 (Figure 10a). Some of the interannual variability is difficult to explain. The exceptionally high densities in 2006 and 2007 were attributable to the expansion of quagga mussels into deeper (> 60 m) waters of Lake Michigan. However, there was no clear explanation for the drastic drop in dreissenid mussel biomass density between 2007 and 2008. According to the results of the benthic macroinvertebrate survey led by Tom Nalepa at NOAA-GLERL, quagga mussel biomass density in Lake Michigan appears to have peaked sometime between 2008 and 2010. This peaking may be in response to the exceeding of the carrying capacity, and a decline in quagga mussel biomass density may be expected in upcoming years.

Over this same period of dreissenid mussel increases, prey fish biomass was declining, which led to a dramatic increase in the percentage of dreissenids in the total bottom trawl catch (Figure 10b). Some authors have attributed the recent decline in prey fish to food-web changes induced by the expansion of dreissenids (Nalepa et al. 2009). However, Bunnell et al. (2009b) proposed that the bulk of the decline in total prey fish biomass may be better explained by factors other than food-web-induced effects by dreissenids, including poor fish recruitment (that preceded the mussel expansion), shifts in fish habitat, and increased fish predation by Chinook salmon and lake trout.

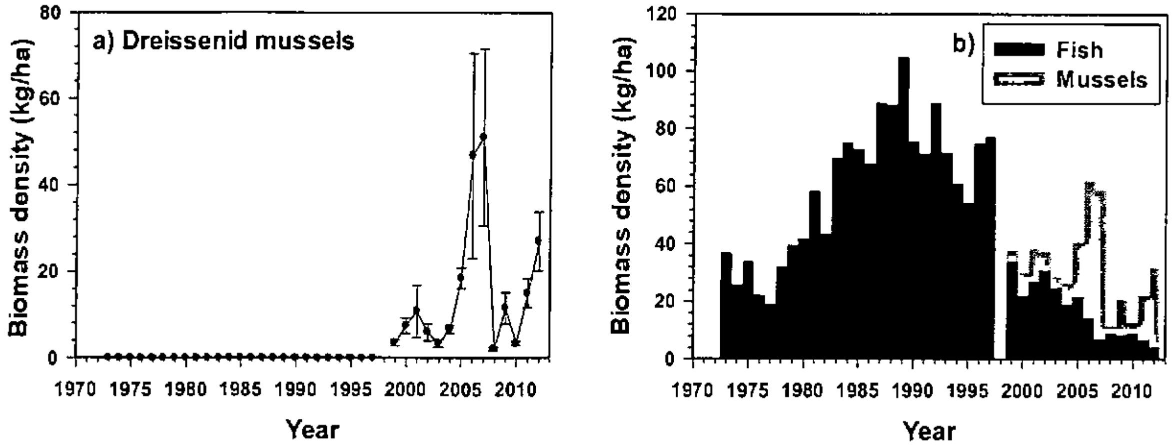


Figure 10. Panel (a) depicts biomass density (+/- standard error) of dreissenid mussels in the bottom trawl in Lake Michigan between 1999 (first year mussels were weighed) and 2012. Panel (b) depicts biomass of dreissenids and total fish biomass estimated by the bottom trawl between 1973 and 2012.

A comparison of the biomass density of dreissenid mussels (27 kg per ha) with biomass density of all species of fish (5 kg per ha) caught in the bottom trawl in 2012 indicated tbat 85% of the daytime benthic biomass available to the bottom trawl was dreissenid mussels (Figure 10b).

CONCLUSIONS

Total prey fish biomass in 2012 was the lowest since our bottom trawl survey began in 1973, and follows five years of sustained, record low biomass estimates. These low prey fish biomass estimates for 2007-2012 were probably due to a suite of factors. We can clearly identify two of these factors as: (1) a prolonged period of poor bloater recruitment since 1992 and (2) intensified predation on alewives by Chinook salmon during the 2000s. Adult alewife density has been maintained at a relatively low level over the last nine years and the age distribution of the adult alewife population has become especially truncated in recent years. As recent as 2007, alewives as old as age 9 were sampled in this survey whereas the oldest alewife sampled in 2012 was age 4. Whether or not the alewife population in Lake Michigan will undergo a collapse in coming years (similar to what occurred in Lake Huron) will depend on several factors. Primarily, the extent to which predation by salmonines influences the survival of the large 2010 year-class is critical. In addition, alewife sustainability will depend on the success of 2010 year-class in producing another strong year-class in the next few years, which will at least partially depend on appropriate environmental factors being met (Madenjian et al. 2005b).

Scientists and managers continue to ask critical questions regarding the importance of "bottom-up" effects on prey fish biomass in Lake Michigan. For example, to what extent do 1) ongoing declines in total phosphorus (Evans et al. 2011), 2) the proliferation in dreissenid mussels, and 3) the resultant diminishment of the spring phytoplankton bloom (Fahnenstiel et al. 2010) reduce the capacity of Lake Michigan to produce the biomass of prey fish that was observed only two decades ago? We point out that Lake Michigan has already demonstrated its capacity to produce a strong year-class of alewives in 2010 despite the changes described above. Nonetheless, having a complete understanding of the answers to these questions will require additional years of surveillance, across-lake comparisons, and food-web analyses.

The GLFC Fish Community Objective for planktivores is not being achieved according to the bottom trawl survey results. The Objective calls for a lake-wide biomass of 500-800 kt, and the total prey fish biomass estimated by the bottom trawl survey was only 15 kt. The Objective also calls for a diversity of prey species. The diversity in 2012 was far less than that measured in recent years, and we note that native prey fishes comprised only 18% of total prey fish biomass. In fact, native bloater, deepwater sculpin, and ninespine stickleback were at record-low levels in 2012 and native slimy sculpin has been trending downward since 2009. In 2013, we plan to add deeper depths (out to 128 m at as many as three ports) to our survey to evaluate the extent to which some of these native species inhabit depths beyond 110 m.

ACKNOWLEDGMENTS

We thank Capt. Shawn Parsons and Engineer Jim Page for their seamanship on our 2012 survey. Reviews provided by Dave Warner and Dale Hanson improved this report.

REFERENCES

Adlerstein, S. A., E. S. Rutherford, D. Clapp, J. A. Clevenger, and J. E. Johnson. 2007. Estimating seasonal movements of Chinook salmon in Lake Huron from efficiency analysis of coded wire tag recoveries in recreational fisheries. N. Am. J. Fish. Manage. 27:792-803.

Argyle, R. L., G. W. Fleischer, G. L. Curtis, J. V. Adams, and R. G. Stickel. 1998. An Integrated Acoustic and Trawl Based Prey Fish Assessment Strategy for Lake Michigan. A report to the Illinois Department of Natural Resources, Indiana Department of Natural Resources, Michigan Department of Natural Resources, and Wisconsin Department of Natural Resources. U. S. Geological Survey, Biological Resources Division, Great Lakes Science Center, 1451 Green Road, Ann Arbor, MI USA.

Belonger, B. B. T. Eggold, P. Hirethota, S. Hogler, B. Horns, T. Kroeff, T. Lychwick, S. Marcquenski, P. Peters, S. Surendonk, and M. Toneys. 1998. Lake Michigan Management Reports, Wisconsin Department of Natural Resources. Lake Michigan Committee Meetings, Great Lakes Fishery Commission, Thunder Bay, Ontario, March 16-17, 1998.

Brown, E. H., Jr., and R. M. Stedman. 1995. Status of forage fish stocks in Lake Michigan, 1994. Pages 81-88 in Minutes of Great Lakes Fishery Commission, Lake Michigan Committee Meeting, Milwaukee, Wisconsin, March 29-30, 1995.

Bunnell, D. B., C. P. Madenjian, and T. E. Croley II. 2006a. Long-term trends of bloater recruitment in Lake Michigan: evidence for the effect of sex ratio. Can. J. Fish. Aquat. Sci. 63:832-844.

Bunnell, D. B., C. P. Madenjian, and R. M. Claramunt. 2006b. Long-term changes of the Lake Michigan fish community following the reduction of exotic alewife (*Alosa pseudoharengus*). Can. J. Fish. Aquat. Sci. 63:2434-2446.

Bunnell, D. B., S. R. David, and C. P. Madenjian. 2009a. Decline in bloater fecundity in southern Lake Michigan after decline of *Diporeia*. J. Great Lakes Res. 35:45-49.

Bunnell, D. B., C. P. Madenjian, J. D. Holuszko, J. V. Adams, and J. R. P. French III. 2009b. Expansion of *Dreissena* into offshore waters of Lake Michigan and potential impacts on fish populations. J. Great Lakes Res. 35:74-80.

Bunnell, D. B., J. V. Adams, O. T. Gorman, C. P. Madenjian, S. C. Riley, E. F. Roseman, and J. S. Schaeffer. 2010. Population synchrony of a native fish across three Laurentian Great Lakes: evaluating the effects of dispersal and climate. Oecologia 162:641-651.

Bunnell, D. B., R. L. Eshenroder, A. E. Krause, and J. V. Adams. 2012. Depth segregation of deepwater ciscoes (*Coregonus* spp.) in Lake Michigan during 1930-1932 and range expansion of *Coregonus hoyi* into deeper waters after the 1990s. Advances in Limnology Series (Biology and Management of Coregonid Fishes – 2008). 63:3-24.

Bunnell, D. B., J. G. Mychek-Londer, J. S. Diana, W. Stott, and C. P. Madenjian. 2013. Evaluating the negative effect of benthic egg predators on bloater recruitment in northern Lake Michigan. Great Lakes Fish. Comm. Completion Report. Available: http://www.glfc.org/research/reports/Bunnell_2012.htm

Clapp, D. F., P. J. Schneeberger, D. J. Jude, G. Madison, and C. Pistis. 2001. Monitoring round goby (*Neogobius melanostomus*) population expansion in eastern and northern Lake Michigan. J. Great Lakes Res. 27:335-341.

Eck, G. W., and L. Wells. 1987. Recent changes in Lake Michigan's fish community and their probable causes, with emphasis on the role of the alewife *Alosa pseudoharengus*. Can. J. Fish. Aquat. Sci. 44(Suppl. 2):53-50.

Elliott, R. F., and eight coauthors. 1996. Conducting diet studies of Lake Michigan piscivores- a protocol. U.S. Fish and Wildlife Service, Fishery Resources Office, Report 96-2, Green Bay, Wisconsin.

Eshenroder, R. L. and M. K. Burnham-Curtis. 1999. Species succession and sustainability of the Great Lakes fish community. Pages 145-184 in W. W. Taylor and C. P. Ferreri (ed) Great Lakes Fisheries Policy and Management: A Binational Perspective. Michigan State University Press, East Lansing, MI.

Evans, M. A., G. Fahnenstiel, and D. Scavia. 2011. Incidental oligotrophication of North American Great Lakes. Environ. Sci. Technol. 45: 3297–3303.

Fahnenstiel, G., S. Pothoven, H. Vanderploeg, D. Klarer, T. Nalepa, and D. Scavia. 2010. Recent changes in primary production and phytoplankton in the offshore region of southern Lake Michigan. J. Great Lakes Res. 36(Suppl. 3):20-29.

Fratt, T. W., D. W. Coble, F. Copes, and R. E. Bruesewitz. 1997. Diet of burbot in Green Bay and western Lake Michigan with comparison to other waters. J. Great Lakes Res. 23:1-10.

FWS/GLFC. 2010. Great Lakes Fish Stocking database. U. S. Fish and Wildlife Service, Region 3 Fisheries Program, and Great Lakes Fishery Commission.

Hatch, R. W., P. M. Haack, and E. H. Brown, Jr. 1981. Estimation of alewife biomass in Lake Michigan, 1967-1978. Trans. Am. Fish. Soc. 110:575-584.

Hensler, S. R., D. J. Jude, and J. He. 2008. Burbot growth and diet in Lakes Michigan and Huron: an ongoing shift from native species to round gobies. Pages 91-107 in V. L. Paragamian and D. H. Bennett (ed) Burbot: Ecology, Management, and Culture. American Fisheries Society, Symposium 59, Bethesda, MD.

Jacobs, G. R., C. P. Madenjian, D. B. Bunnell, and J. D. Holuszko. 2010. Diet of lake trout and burbot in northern Lake Michigan during spring: evidence of ecological interaction. J. Great Lakes Res. 36:312-317.

Jacobs, G. R., C. P. Madenjian, D. B. Bunnell, D. M. Warner, and R. M. Claramunt. 2013. Chinook salmon foraging patterns in a changing Lake Michigan. Trans. Am. Fish. Soc. 142:362-372.

Jude, D. J., F. J. Tesar, S. F. DeBoe, and T. J. Miller. 1987. Diet and selection of major prey species by Lake Michigan salmonines, 1973-1982. Trans. Am. Fish. Soc. 116:677-691.

Madenjian, C. P., and D. B. Bunnell. 2008. Depth distribution dynamics of the sculpin community in Lake Michigan. Trans. Am. Fish. Soc. 137:1346-1357.

Madenjian, C. P., T. J. DeSorcie, and R. M. Stedman. 1998. Ontogenic and spatial patterns in diet and growth of lake trout from Lake Michigan. Trans. Am. Fish. Soc. 127: 236-252.

Madenjian, C. P., G. L. Fahnenstiel, T. H. Johengen, T. F. Nalepa, H. A. Vanderploeg, G. W. Fleischer, P. J. Schneeberger, D. M. Benjamin, E. B. Smith, J. R. Bence, E. S. Rutherford, D. S. Lavis, D. M. Robertson, D. J. Jude, and M. P. Ebener. 2002. Dynamics of the Lake Michigan food web, 1970-2000. Can. J. Fish. Aquat. Sci. 60:736-753.

Madenjian, C. P., J. D. Holuszko, and T. J. Desorcie. 2003. Growth and condition of alewives in Lake Michigan, 1998-2001. Trans. Am. Fish. Soc. 132:1104-1116.

Madenjian, C. P., T. O. Höök, E. S. Rutherford, D. M. Mason, T. E. Croley II, E. B. Szalai, and J. R. Bence. 2005a. Recruitment variability of alewives in Lake Michigan. Trans. Am. Fish. Soc. 134:218-230.

Madenjian, C. P., D. W. Hondorp, T. J. Desorcie, and J. D. Holuszko. 2005b. Sculpin community dynamics in Lake Michigan. J. Great Lakes Res. 31:267-276.

Madenjian, C. P., S. A. Pothoven, J. M. Dettmers, and J. D. Holuszko. 2006. Changes in seasonal energy dynamics of alewife (*Alosa pseudoharengus*) in Lake Michigan after invasion of dreissenid mussels. Can. J. Fish. Aquat. Sci. 63:891-902.

Madenjian, C. P., R. O'Gorman, D. B. Bunnell, R. L. Argyle, E. F. Roseman, D. M. Warner, J. D. Stockwell, and M. A. Stapanian. 2008. Adverse effects of alewives on Laurentian Great Lakes fish communities. N. Am. J. Fish. Manage. 28:263-282.

Madenjian, C. P., D. B. Bunnell, J. D. Holuszko, T. J. Desorcie, and J. V. Adams. 2010a. *Status and Trends of Prey Fish Populations in Lake Michigan, 2009.* A report to the Great Lakes Fishery Commission, Lake Michigan Committee, Windsor, Ontario, March 23, 2010.

Madenjian, C. P., D. B. Bunnell, and O. T. Gorman. 2010b. Ninespine stickleback abundance in Lake Michigan increases after invasion of dreissenid mussels. Trans. Am. Fish. Soc. 139:11-20.

Makauskas, D., and D. Clapp. 2000. Status of yellow perch in Lake Michigan and Yellow Perch Task Group progress report. In Minutes of 2000 Annual Meeting of the Lake Michigan Committee. Great Lakes Fishery Commission, Ann Arbor, Michigan.

Marsden, J. E. 1992. The zebra mussel invasion. Aquaticus 23:19-27.

Nalepa, T. F., D. W. Schloesser, S. A. Pothoven, D. W. Hondorp, D. L. Fanslow, M. L. Tuchman, and G. W. Fleischer. 2001. First finding of the amphipod *Echinogammarus ischmus* and the mussel *Dreissena bugensis* in Lake Michigan. J. Great Lakes Res. 27:384-391.

Nalepa, T. F., D. L. Fanslow, G. A. Lang. 2009. Transformation of the offshore benthic community in Lake Michigan: recent shift from the native amphipod *Diporeia* spp. to the invasive mussel *Dreissena rostriformis bugensis*. Freshwater Biol. 54:466-479.

Potter, R. L. and G. W. Fleischer. 1992. Reappearance of spoonhead sculpins (*Cottus ricei*) in Lake Michigan. J. Great Lakes Res. 18:755-758.

Roseman, E. F., S. C. Riley, S. A. Farha, B. M. Maitland, T. R. Tucker, S. A. Provo, M. W. McLean. 2013. *Status and Trends of the Lake Huron Offshore Demersal Fish Community, 1976-2012.* A report to the Great Lakes Fishery Commission, Lake Huron Committee, Duluth, Minnesota, March 21, 2013.

Smith, S. H. 1970. Species interactions of the alewife in the Great Lakes. Trans. Am. Fish. Soc. 99:754-765.

Stedman, R. M., and Bowen, C. A. 1985. Introduction and spread of the threespine stickleback (*Gasterosteus aculeatus*) in lakes Huron and Michigan. J. Great Lakes Res. 11:508-511.

Stewart, D. J., and M. Ibarra. 1991. Predation and production by salmonine fishes in Lake Michigan, 1978-88. Can. J. Fish. Aquat. Sci. 48:909-922.

Stewart, D. J., D. Weininger, D. V. Rottiers, and T. A. Edsall. 1983. An energetics model for lake trout, *Salvelinus namaycush*: application to the Lake Michigan population. Can. J. Fish. Aquat. Sci. 40:681-698.

Truemper, H. A., T. E. Lauer, T. S. McComish, and R. A. Edgell. 2006. Response of yellow perch diet to a changing forage base in southern Lake Michigan, 1984-2002. J. Great Lakes Res. 32:806-816.

Van Oosten, J., and H. J. Deason. 1938. The food of the lake trout (*Cristivomer namaycush*) and of the lawyer (*Lota maculosa*) of Lake Michigan. Trans. Am. Fish. Soc. 67:155-177.

Warner, D. M., C. S. Kiley, R. M. Claramunt, and D. F. Clapp. 2008. The influence of alewife year-class strength on prey selection and abundance of age-1 Chinook salmon in Lake Michigan. Trans. Am. Fish. Soc. 137:1683-1700.

Warner, D. M., T. P. O'Brien, S. H. Farha, R. M. Claramunt, and D. Hanson. 2013. *Status of Pelagic Prey Fishes in Lake Michigan, 1992-2012.* A report to the Great Lakes Fishery Commission, Lake Michigan Committee, Duluth, MN, March 19, 2013.

Wells, L. 1977. Changes in yellow perch (*Perca flavescens*) populations of Lake Michigan, 1954-75. J. Fish. Res. Board Can. 34:1821-1829.

Wells, L., and A. L. McLain. 1973. Lake Michigan: man's effects on native fish stocks and other biota. Great Lakes Fishery Commission. Technical Report 20. 56 p.

Williams, M. C. 2012. Spatial, temporal, and cohort-related patterns in the contribution of wild Chinook salmon (*Oncorhynchus tshawytscha*) to total Chinook harvest in Lake Michigan. M.S. Thesis. Michigan State University, East Lansing, Michigan.

Appendix 1. Mean numeric and biomass density, as well as lake-wide biomass (defined as biomass available to the bottom trawls for the region of the main basin between the 5-m and 114-m depth contours) estimates for selected fishes and dreissenid mussels in Lake Michigan during 2012. Estimates are based on the bottom trawl survey. Standard error enclosed in parentheses. NA denotes that estimate is not available.

Taxon	Numeric density (fish per ha)	Biomass density (kg per ha)	Lake-wide biomass (kt)
age-0 alewife	843.96 (832.03)	1.225 (1.166)	4.313 (4.106)
adult alewife	62.83 (16.31)	1.375 (0.371)	4.841 (1.308)
age-0 bloater	1.50 (0.97)	0.007 (0.004)	0.023 (0.015)
adult bloater	2.50 (1.19)	0.110 (0.053)	0.386 (0.187)
age-0 rainbow smelt	26.01 (23.74)	0.015 (0.014)	0.054 (0.049)
adult rainbow smelt	2.74 (1.83)	0.022 (0.012)	0.078 (0.043)
deepwater sculpin	43.64 (18.92)	0.417 (0.189)	1.468 (0.667)
slimy sculpin	36.38 (13.50)	0.206 (0.097)	0.725 (0.341)
ninespine stickleback	2.69 (1.68)	0.004 (0.003)	0.014 (0.010)
burbot	0.13 (0.06)	0.132 (0.063)	0.463 (0.222)
age-0 yellow perch	2.23 (1.20)	0.007 (0.004)	0.026 (0.014)
round goby	127.17 (70.87)	0.933 (0.493)	3.285 (1.737)
dreissenid mussels	NA	27.057 (6.803)	95.284 (23.957)

Chapter 11: CWIS Impingement & Entrainment (I&E) Impacts & Potential Benefits

INTRODUCTION

This chapter presents data reported by existing facilities that indicate the magnitude of impingement and entrainment when once-through cooling is used. The data show that the numbers of organisms impinged and entrained under once-through cooling are nontrivial. EPA was unable to conduct a detailed, quantitative analysis of the potential economic benefits of using closed-cycle instead of once-through cooling because much of the information needed to quantify and value potential reductions in I&E was unavailable. At present, EPA has only general information about the location of potential new facilities, and in most cases details of facility and environmental characteristics are unknown. To overcome these limitations, this chapter presents examples of I&E rates and potential regulatory benefits based on a subset of existing facilities for which information was readily available. The focus is on fish species because very large numbers of fish are impinged and entrained compared to other aquatic organisms such as phytoplankton and benthic invertebrates.

The data presented are numbers of organisms that are directly impinged and entrained. While EPA recognizes that impingement and entrainment losses may result in indirect effects on populations and other higher levels of biological organization, this chapter focuses on impingement and entrainment because these are the direct biological impacts that result from withdrawal of cooling water by CWIS. The final section of the chapter presents information on the potential benefits of installing technologies to reduce impingement and entrainment. These benefits may be illustrative of the benefits that would occur at the estimated nine new facilities that would install the Track I flow reduction technology (closed-cycle cooling) as a result of this rule.

CHAPTER CONTENTS:

The chapter

- summarizes factors related to intake location, design, and capacity that influence the magnitude of I&E;
- discusses CWIS I&E impacts for different water body types (rivers, lakes and reservoirs, the Great Lakes, oceans, and estuaries); and
- provides results from studies of existing facilities indicating the potential economic benefits of lower intake flows and other measures taken to reduce impingement and entrainment.

11.1 CWIS Characteristics that Influence the Magnitude of I&E

11.1.1 Intake Location

Two major components of a CWIS's location that influence the relative magnitude of I&E are (1) the type of water body from which a CWIS is withdrawing water, and (2) the placement of the CWIS relative to sensitive biological areas within the water body. EPA's regulatory framework is designed to take both of these factors into account.

Critical physical and chemical factors related to siting of an intake include the direction and rate of water body flow, tidal influences, currents, salinity, dissolved oxygen levels, thermal stratification, and the presence of pollutants. The withdrawal of water by an intake can change ambient flows, velocities, and currents within the source water body, which may cause organisms to concentrate in the vicinity of an intake or reduce their ability to escape a current.

In large rivers, withdrawal of water may have little effect on flows because of the strong, unidirectional nature of ambient currents. In contrast, lakes and reservoirs have small ambient flows and currents, and therefore a large intake flow can significantly alter current patterns. In addition, tidal currents in estuaries or tidally-influenced sections of rivers can carry organisms past intakes multiple times, thereby increasing their probability of entrainment.

Also, species with planktonic (free-floating) early life stages have higher rates of entrainment because they are unable to actively avoid being drawn into the intake flow.

Considerations in siting an intake to reduce the potential for I&E include intake depth and distance from the shoreline in relation to the physical, chemical, and biological characteristics of the source water body. In general, intakes located in nearshore areas (riparian or littoral zones) will have greater ecological impact than intakes located offshore, because nearshore areas are more biologically productive and have higher concentrations of organisms.

Siting of intake withdrawal in relation to the discharge site is also important because if intake withdrawal and discharge are in close proximity, entrained organisms released in the discharge can become re-entrained.

The magnitude of I&E in relation to intake location also depends on biological factors such as species' distributions and the presence of critical habitats within an intake's zone of influence.

11.1.2 Intake Design

Intake design refers to the design and configuration of various components of the intake structure, including screening systems (trash racks, pumps, pressure washes), passive intake systems, and fish diversion and avoidance technologies (U.S. EPA, 1976).

Design intake velocity has a significant influence on the potential for impingement (Boreman, 1977). The biological significance of design intake velocity depends on species-specific characteristics, such as fish swimming ability and endurance. These characteristics are a function of the size of the organism and the temperature and oxygen levels of water in the area of the intake (U.S. EPA, 1976). The maximum velocity protecting most small fish is 0.5 ft/s, but lower velocities will still impinge some fish and entrain eggs and larvae and other small organisms (Boreman, 1977). After entering the CWIS, water must pass through a screening device before entering the power plant. The screen is designed to prevent debris from entering and clogging the condenser tubes. Screen mesh size and velocity characteristics are two important design features of the screening system that influence the potential for impingement and entrainment of aquatic organisms that are withdrawn with the cooling water (U.S. EPA, 1976).

Conventional traveling screens have been modified to improve fish survival of screen impingement and spray wash removal (Taft, 1999). However, a review of steam electric utilities indicated that these alternative screen technologies are usually not much more effective at reducing impingement than the conventional vertical traveling screens used by most steam electric facilities (SAIC, 1994). An exception may be traveling screens modified with fish collection systems (e.g., Ristroph screens). Studies of improved fish collection baskets at Salem Generating Station showed increased survival of impinged fish (Ronafalvy et al., 1999).

Passive intake systems (physical exclusion devices) screen out debris and aquatic organisms with minimal mechanical activity and low withdrawal velocities (Taft, 1999). The most effective passive intake systems are wedge-wire screens and radial wells (SAIC, 1994). A new technology, the Gunderboom, which consists of polyester fiber strands pressed into a water-permeable fabric mat, has shown promise in reducing ichthyoplankton entrainment at the Lovett Generating Station on the Hudson River (Taft, 1999).

Fish diversion/avoidance systems (behavioral barriers) take advantage of natural behavioral characteristics of fish to guide them away from an intake structure or into a bypass system (SAIC, 1994; Taft, 1999). The most effective of these technologies are velocity caps, which divert fish away from intakes, and underwater strobe lights, which repel some species (Taft, 1999). Velocity caps are used mostly at offshore facilities and have proven effective in reducing impingement (e.g., California's San Onofre Nuclear Generating Station, SONGS).

Another important design consideration is the orientation of the intake in relation to the source water body (U.S. EPA, 1976). Conventional intake designs include shoreline, offshore, and approach channel intakes. In addition, intake operation can be modified to reduce the quantity of source water withdrawn or the timing, duration, and frequency of water withdrawal. This is an important way to reduce entrainment. For example, larval entrainment at the San Onofre facility was reduced by 50% by rescheduling the timing of high volume water withdrawals (SAIC, 1996).

11.1.3 Intake Capacity

Intake capacity is a measure of the volume or quantity of water withdrawn or flowing through a cooling water intake structure over a specified period of time. Intake capacity can be expressed as millions or billions of gallons per day (MGD or BGD), or as cubic feet per second (cfs). Capacity can be measured for the facility as a whole, for all of the intakes used by a single unit, or for the intake structure alone. In defining an intake's capacity it is important to distinguish between the *design* intake flow (the maximum possible) and the *actual* operational intake flow. For this regulation, EPA is regulating the total design intake flow of the facility.

The quantity of cooling water needed and the type of cooling system are the most important factors determining the quantity of intake flow (U.S. EPA, 1976). Once-through cooling systems withdraw water from a natural water body, circulate the water through condensers, and then discharge it back to the source water body. Closed-cycle cooling systems withdraw water from a natural water body, circulate the water through the condensers, and then send it to a cooling tower or cooling pond before recirculating it back through the condensers. Because cooling water is recirculated, closed-cycle systems generally use only 3.4% to 28.8% of the water used by once-through systems[1] (Kaplan, 2000). It is generally assumed that this will result in a comparable reduction in I&E (Goodyear, 1977). Systems with helper towers reduce water usage much less. Plants with helper towers can operate in once-through or closed-cycle modes.

Circulating water intakes are used by once-through cooling systems to continuously withdraw water from the cooling water source. The typical circulating water intake is designed to use 0.03-0.1 m^3/s (1.06-3.53 cfs, or 500-1500 gallons per minute, gpm) per megawatt (MW) of electricity generated (U.S. EPA, 1976). Closed-cycle systems use makeup water intakes to provide water lost by evaporation, blowdown, and drift. Although makeup quantities are only a fraction of the intake flows of once-through systems, quantities of water withdrawn can still be significant, especially by large facilities (U.S. EPA, 1976).

Assuming that organisms are uniformly distributed in the vicinity of an intake, the proportion of the source water flow

[1] The difference in water usage in cooling towers results from differences in source water (salinity) and the temperature rise of the system.

supplied to a CWIS is often used to derive a conservative estimate of the potential for adverse impact (e.g., Goodyear, 1977). For example, withdrawal of 5% of the source water flow may be expected to result in a loss of 5% of planktonic organisms. Although the assumption of uniform distribution may not always be met, when data on actual distributions are unavailable, simple mathematical models based on this assumption provide a conservative and easily applied method for predicting potential losses (Goodyear, 1977).

In addition to the relative quantity of intake flow, the potential for aquatic organisms to be impinged or entrained also depends on physical, chemical, and biological characteristics of the surrounding ecosystem and species characteristics that influence the intensity, time, and spatial extent of contact of aquatic organisms with a facility's CWIS. Table 11-1 lists CWIS characteristics and ecosystem characteristics that influence when, how, and why aquatic organisms may become exposed to, and experience adverse effects of, CWIS.

Table 11-1: Partial List of CWIS, Ecosystem, and Species Characteristics Influencing Potential for I&E

CWIS Characteristics[a]	Ecosystem and Species Characteristics

Location
▸ Depth of intake
▸ Distance from shoreline
▸ Proximity of intake withdrawal and discharge
▸ Proximity to other industrial discharges or water withdrawals
▸ Proximity to an area of biological concern
 	
Design
▸ Type of intake structure (size, shape, configuration, orientation)
▸ Design intake velocity
▸ Presence/absence of intake control and fish protection technologies
  ▸ Intake Screen Systems
  ▸ Passive Intake Systems
  ▸ Fish Diversion/Avoidance Systems
▸ Water temperature in cooling system
▸ Temperature change during entrainment
▸ Duration of entrainment
▸ Use of intake biocides and ice removal technologies
▸ Scheduling of timing, duration, frequency, and quantity of water withdrawal.
 	
Capacity
▸ Type of withdrawal — once-through vs. recycled (cooling water volume and volume per unit time)
▸ Ratio of cooling water intake flow to source water flow
	Ecosystem Characteristics (abiotic environment)
	▸ Source water body type
	▸ Water temperatures
	▸ Ambient light conditions
	▸ Salinity levels
	▸ Dissolved oxygen levels
	▸ Tides/currents
	▸ Direction and rate of ambient flows
	
	Species Characteristics (physiology, behavior, life history)
	▸ Density in zone of influence of CWIS
	▸ Spatial and temporal distributions (e.g., daily, seasonal, annual migrations)
	▸ Habitat preferences (e.g., depth, substrate)
	▸ Ability to detect and avoid intake currents
	▸ Swimming speeds
	▸ Mobility
	▸ Body size
	▸ Age/developmental stage
	▸ Physiological tolerances (e.g., temperature, salinity, dissolved oxygen)
	▸ Feeding habits
	▸ Reproductive strategy
	▸ Mode of egg and larval dispersal
	▸ Generation time

[a] All of these CWIS characteristics can potentially be controlled to minimize adverse environmental impacts (I&E) of new facilities.

If the quantity of water withdrawn is large relative to the flow of the source water body, a larger number of organisms will potentially be affected by a facility's CWIS.

11.2 Methods for Estimating Potential I&E Losses

11.2.1 Development of a Database of I&E Rates

To estimate the relative magnitude of I&E for different species and water body types, EPA compiled I&E data from 107 documents representing a variety of sources, including previous section 316(b) studies, critical reviews of section 316(b) studies, biomonitoring and aquatic ecology studies, and technology implementation studies. In total, data were compiled for 98 steam electric facilities (36 riverine facilities, 9 lake/reservoir facilities, 19 facilities on the Great Lakes, 22 estuarine facilities, and 12 ocean facilities). Design intake flows at these facilities ranged from a low of 19.7 to a high of 3,315.6

MGD.

EPA notes that most of these studies were completed by the facilities in the mid-1970s using methods that are now outmoded. A number of the methods used at that time probably resulted in an underestimate of losses. For example, many studies did not adjust I&E sampling data for factors such as collection efficiency. Because of such methodological weaknesses, EPA used these only to gauge the relative magnitude of impingement and entrainment losses. Any further analysis of the data should be accompanied by a detailed evaluation of study methods and supplemented with additional data as needed.

In order to understand the potential magnitude of I&E, EPA aggregated the data in the studies in a series of steps to derive average annual impingement and entrainment rates, on a per facility basis, for different species and water body types.

First, the data for each species were summed across all units of a facility and averaged across years (e.g., 1972 to 1976). Losses were then averaged by species for all facilities in the database on a given water body type to derive species-specific and water body-specific mean annual I&E rates. Finally, mean annual I&E rates were ranked, and rates for the top 15 species were used for the data presented below.

11.2.2 Data Uncertainties and Potential Biases

A number of uncertainties and potential biases are associated with the annual I&E estimates that EPA developed. Most important, natural environmental variability makes it difficult to detect ecological impacts and identify cause-effect relationships even in cases where study methods are as accurate and reliable as possible. For example, I&E rates for any given population will vary with annual changes in environmental conditions. As a result, it can be difficult to determine the relative role of I&E mortality in population fluctuations.

In addition to the influence of natural variability, data uncertainties result from measurement errors, some of which are unavoidable. Much of the data presented here does not account for the inefficiency of sampling gear, variations in collection and analytical methods, or changes in the number of units in operation or technologies in use.

Potential biases were also difficult to control. For example, many studies presented data for only a subset of "representative" species, which may lead to an underestimation of total I&E. On the other hand, the entrainment estimates obtained from EPA's database do not take into account the high natural mortality of egg and larval stages and therefore are likely to be biased upwards. However, this bias was unavoidable because most of the source documents from which the database was derived did not estimate losses of early life stages as an equivalent number of adults, or provide information for making such calculations.[2] In the absence of information for adjusting egg losses on this basis, EPA chose to include eggs and larvae in the entrainment estimates to avoid underestimating age 0 losses.

With these caveats in mind, the following sections present the results of EPA's data compilations. The data are grouped by water body type and are presented in summary tables that indicate the range of losses for the 15 species with the highest I&E rates based on the limited subset of data available to EPA. I&E losses are expressed as mean annual numbers on a per facility basis. Because the data do not represent a random sample of I&E losses, it was not appropriate to summarize the data statistically. It is also important to stress that because the data are not a statistical sample, the data presented here may not represent the true magnitude of losses. Thus, the data should be viewed only as general indicators of the potential range of I&E.

11.3 CWIS Impingement and Entrainment Impacts in Rivers

Freshwater rivers and streams are free-flowing bodies of water that do not receive significant inflows of water from oceans or bays. Current is typically highest in the center of a river and rapidly drops toward the edges and at depth because of increased friction with river banks and the bottom (Hynes, 1970; Allan, 1995). Close to and at the bottom, the current can become minimal. The range of flow conditions in undammed rivers helps explain why fish with very different habitat requirements can co-exist within the same stretch of surface water (Matthews, 1998).

[2] For species for which sufficient life history information is available, the Equivalent Adult Model (EAM) can be used to predict the number of individuals that would have survived to adulthood each year if entrainment at egg or larval stages had not occurred (Horst, 1975; Goodyear, C.P., 1978). The resulting estimate is known as the number of "equivalent adults."

In general, the shoreline areas along river banks support a high diversity of aquatic life. These are areas where light penetrates to the bottom and supports the growth of rooted vegetation. Suspended solids tend to settle along shorelines where the current slows, creating shallow, weedy areas that attract aquatic life. Riparian vegetation, if present, also provides cover and shade. Such areas represent important feeding, resting, spawning, and nursery habitats for many aquatic species. In temperate regions, the number of impingeable and entrainable organisms in the littoral zone of rivers increases during the spring and early summer when most riverine fish species reproduce. This concentration of aquatic organisms along river shorelines in turn attracts wading birds and other kinds of wildlife.

The data compiled by EPA indicate that fish species such as common carp (*Cyprinus carpio*), yellow perch (*Perca flavescens*), white bass (*Morone chrysops*), freshwater drum (*Aplodinotus grunniens)*, gizzard shad (*Dorosoma cepedianum*), and alewife are the main fishes harmed by CWIS located in rivers. Table 11-2 shows, in order of the greatest to least impact, the annual entrainment of eggs, larvae, and juvenile fish in rivers. Table 11-3 shows, in order of greatest to least impact, the annual impingement in the rivers for <u>all</u> age classes. These species occur in nearshore areas and/or have pelagic early life stages, traits that greatly increase their susceptibility to I&E.

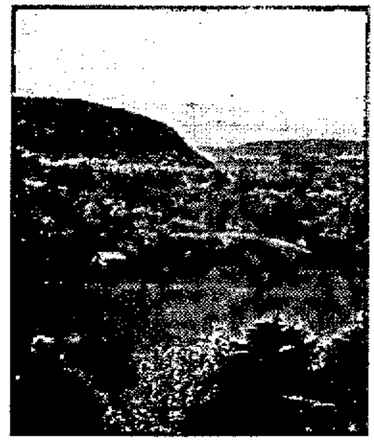


Table 11-2: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Rivers

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)	Range
common carp	*Cyprinus carpio*	7	20,500,000	859,000 - 79,400,000
yellow perch	*Perca flavescens*	4	13,100,000	434,000 - 50,400,000
white bass	*Morone chrysops*	4	12,800,000	69,400 - 49,600,000
freshwater drum	*Aplodinotus grunniens*	5	12,800,000	38,200 - 40,500,000
gizzard shad	*Dorosoma cepedianum*	4	7,680,000	45,800 - 24,700,000
shiner	*Notropis* spp.	4	3,540,000	191,000 - 13,000,000
channel catfish	*Ictalurus punctatus*	5	3,110,000	19,100 - 14,900,000
bluntnose minnow	*Pimephales notatus*	1	2,050,000	---
black bass	*Micropterus* spp.	1	1,900,000	---
rainbow smelt	*Osmerus mordax*	1	1,330,000	---
minnow	*Pimephales* spp.	1	1,040,000	---
sunfish	*Lepomis* spp.	5	976,000	4,230 - 4,660,000
emerald shiner	*Notropis atherinoides*	3	722,000	166,000 - 1,480,000
white sucker	*Catostomus commersoni*	5	704,000	20,700 - 2,860,000
mimic shiner	*Notropis volucellus*	2	406,000	30,100 - 781,000

Source: Hicks, 1977; Cole, 1978; Geo-Marine Inc., 1978; Goodyear, C.D., 1978; Potter, 1978; Cincinnati Gas & Electric Company, 1979; Potter et al., 1979a, 1979b, 1979c, 1997d; Cherry and Currie, 1998; Lewis and Seegert, 1998.

Table 11-3: Annual Impingement in the Rivers for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
threadfin shad	*Dorosoma petenense*	3	1,030,000	199 - 3,050,000
gizzard shad	*Dorosoma cepedianum*	25	248,000	3,080 - 1,480,000
shiner	*Notropis* spp.	4	121,000	28 - 486,000
alewife	*Alosa pseudoharengus*	13	73,200	199 - 237,000
white perch	*Morone americana*	3	66,400	27,100 - 112,000
yellow perch	*Perca flavescens*	18	40,600	13 - 374,000
spottail shiner	*Notropis hudsonius*	10	28,500	10 - 117,000
freshwater drum	*Aplodinotus grunniens*	24	19,900	8 - 176,000
rainbow smelt	*Osmerus mordax*	11	19,700	7 - 119,000
skipjack herring	*Alosa chrysochons*	7	17,900	52 - 89,000
white bass	*Morone chrysops*	19	11,500	21 - 188,000
trout perch	*Percopsis omiscomaycus*	13	9,100	38 - 49,800
emerald shiner	*Notropis atherinoides*	17	7,600	109 - 36,100
blue catfish	*Ictalurus furcatus*	2	5,370	42 - 10,700
channel catfish	*Ictalurus punctatus*	23	3,130	3 - 25,600

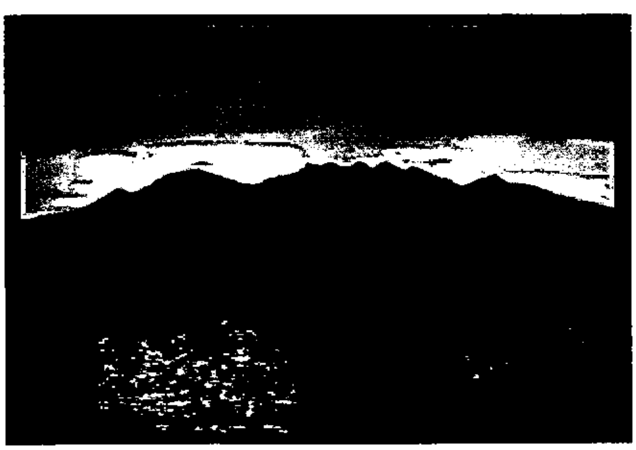
Source: Benda and Houtcooper, 1977; Freeman and Sharma, 1977; Hicks, 1977; Sharma and Freeman, 1977; Stupka and Sharma, 1977; Energy Impacts Associates Inc., 1978; Geo-Marine Inc., 1978; Goodyear, C.D., 1978; Potter, 1978; Cincinnati Gas & Electric Company, 1979; Potter et al., 1979a, 1979b, 1979c, 1979d; Van Winkle et al., 1980; EA Science and Technology, 1987; Cherry and Currie, 1998; Michaud, 1998; Lohner, 1998.

11.4 CWIS IMPINGEMENT AND ENTRAINMENT IMPACTS IN LAKES AND RESERVOIRS

Lakes are inland bodies of open water located in natural depressions (Goldman and Horne, 1983). Lakes are fed by rivers, streams, springs, and/or local precipitation. Water currents in lakes are small or negligible compared to rivers, and are most noticeable near lake inlets and outlets.

Larger lakes are divided into three general zones — the littoral zone (shoreline areas where light penetrates to the bottom), the limnetic zone (the surface layer where most photosynthesis takes place), and the profundal zone (relatively deeper and colder offshore area) (Goldman and Horne, 1983). Each zone differs in its biological productivity and species diversity and hence in the potential magnitude of CWIS I&E impacts. The importance of these zones in relation to potential impacts of CWIS are discussed below.

The highly productive littoral zone extends farther and deeper in clear lakes than in turbid lakes. In small, shallow lakes, the littoral zone can be quite extensive and even include the entire water body. As along river banks, this zone supports high primary productivity and biological diversity. It is used by a host of fish species, benthic invertebrates, and zooplankton for feeding, resting, and reproduction, and as nursery habitat. Many fish species adapted to living in the colder profundal zone also move to shallower in-shore areas to spawn, e.g., lake trout (*Salmo namycush*) and various deep water sculpin species (*Cottus* spp.).



Many fish species spend most of their early development in and around the littoral zone of lakes. These shallow waters warm up rapidly in spring and summer, offer a variety of different habitats (submerged plants, boulders, logs, etc.) in which to hide or feed, and stay well-oxygenated throughout the year. Typically, the littoral zone is a major contributor to the total primary productivity of lakes (Goldman and Home, 1983).

The limnetic zone accounts for the vast majority of light that is absorbed by the water column. In contrast to the high biological activity observed in the nearshore littoral zone, the offshore limnetic zone supports fewer species of fish and invertebrates. However, during certain times of year, some fish and invertebrate species spend the daylight hours hiding on the bottom and rise to the surface of the limnetic zone at night to feed and reproduce. Adult fish may migrate through the limnetic zone during seasonal spawning migrations. The juvenile stages of numerous aquatic insects — such as caddisflies, stoneflies, mayflies, dragonflies, and damselflies — develop in sediments at the bottom of lakes but move through the limnetic zone to reach the surface and fly away. This activity attracts foraging fish.

The deeper, colder profundal zone of a lake does not support rooted plants because insufficient light penetrates at these depths. For the same reason, primary productivity by phytoplankton is minimal. However, a well-oxygenated profundal zone can support a variety of benthic invertebrates or cold-water fish, e.g., brown trout (*Salmo trutta*), lake trout, and ciscoes (*Coregonus* spp.). With few exceptions (such as cisces or whitefish), these species seek out shallower areas to spawn, either in littoral areas or in adjacent rivers and streams, where they may become susceptible to CWIS.

Most of the larger rivers in the United States have one or more dams that create artificial lakes or reservoirs. Reservoirs have some characteristics that mimic those of natural lakes, but large reservoirs differ from most lakes in that tbey obtain most of their water from a large river instead of from groundwater recharge or from smaller creeks and streams.

The fish species composition in reservoirs may or may not reflect the native assemblages found in the pre-dammed river. Dams create two significant changes to the local aquatic ecosystem that can alter the original species composition: (1) blockages that prevent anadromous species from migrating upstream, and (2) altered riverine habitat that can eliminate species that cannot readily adapt to the modified hydrologic conditions.

Reservoirs typically support littoral zones, limnetic zones, and profundal zones, and the same concepts outlined above for lakes apply to these bodies of water. For example, compared to the profundal zone, the littoral zone along the edges of reservoirs supports greater biological diversity and provides prime habitat for spawning, feeding, resting, and protection for numerous fish and zooplankton species. However, there are also several differences. Reservoirs often lack extensive shallow areas along their edges because their banks have been engineered or raised to contain extra water and prevent flooding. In mountainous areas, the banks of reservoirs may be quite steep and drop off precipitously with little or no littoral zone. As with lakes and rivers, however, CWIS located in shallower water have a higher probability of entraining or impinging organisms.

Results of EPA's data compilation indicate that fish species most commonly affected by CWIS located on lakes and reservoirs are the same as the riverine species that are most susceptible, including alewife (*Alosa pseudoharengus*), drum (*Aplondinotus* spp.), and gizzard shad (*Dorsoma cepedianum*) (Tables 11-4 and 11-5).

Table 11-4: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Reservoirs and Lakes (excluding the Great Lakes)

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)
drum	*Aplondinotus* spp.	1	15,600,000
sunfish	*Lepomis* spp.	1	10,600,000
gizzard shad	*Dorosoma cepedianum*	1	9,550,000
crappie	*Pomoxis* spp.	1	8,500,000
alewife	*Alosa pseudoharengus*	1	1,730,000

Source: Michaud, 1998; Spicer et al., 1998.

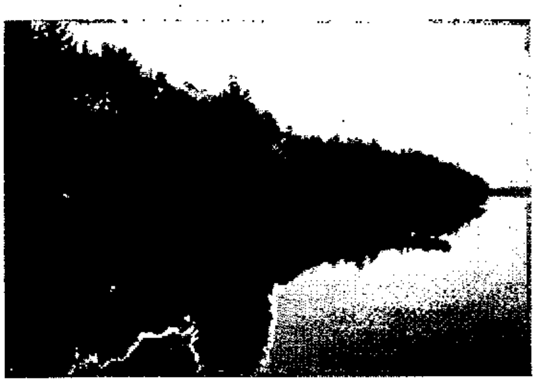
Table 11-5: Annual Impingement in Reservoirs and Lakes (excluding the Great Lakes) for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
threadfin shad	*Dorosoma petenense*	4	678,000	203,000 - 1,370,000
alewife	*Alosa pseudoharengus*	4	201,000	33,100 - 514,000
skipjack herring	*Alosa chrysochons*	1	115,000	---
bluegill	*Lepomis macrochirus*	6	48,600	468 - 277,000
gizzard shad	*Dorosoma cepedianum*	5	41,100	829 - 80,700
warmouth sunfish	*Lepomis gulosus*	4	39,400	31 - 157,000
yellow perch	*Perca flavescens*	2	38,900	502 - 114,000
freshwater drum	*Aplodinotus grunniens*	4	37,500	8 - 150,000
silver chub	*Hybopsis storeriana*	1	18,200	---
black bullhead	*Ictalurus melas*	3	10,300	171 - 30,300
trout perch	*Percopsis omiscomaycus*	2	8,750	691 - 16,800
northern pike	*Esox lucius*	2	7,180	154 - 14,200
blue catfish	*Ictalurus furcatus*	1	3,350	---
paddlefish	*Polyodon spathula*	2	3,160	1,940 - 4,380
inland (tidewater) silverside	*Menidia beryllina*	1	3,100	---

Source: Tennessee Division of Forestry, Fisheries, and Wildlife Development, 1976; Tennessee Valley Authority, 1976; Benda and Houtcooper, 1977; Freeman and Sharma, 1977; Sharma and Freeman, 1977; Tennessee Valley Authority, 1977; Spicer et al., 1998; Michaud, 1998.

11.5 CWIS Impingement and Entrainment Impacts in the Great Lakes

The Great Lakes were carved out by glaciers during the last ice age (Bailey and Smith, 1981). They contain nearly 20% of the earth's fresh water, or about 23,000 km^3 (5,500 cu. mi.) of water, covering a total area of 244,000 km^2 (94,000 sq. mi.). There are five Great Lakes: Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario. Although part of a single system, each lake has distinct characteristics. Lake Superior is the largest by volume, with a retention time of 191 years, followed by Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario.



Water temperatures in the Great Lakes strongly influence the physiological processes of aquatic organisms, affecting growth, reproduction, survival, and species temporal and spatial distribution. During the spring, many fish species inhabit shallow, warmer waters where temperatures are closer to their thermal optimum. As water temperatures increase, these species migrate to deeper water. For species that are near the northern limit of their range, the availability of shallow, sheltered habitats that warm early in the spring is probably essential for survival (Lane et al., 1996a). For other species, using warmer littoral areas increases the growing season and may significantly increase production.

Some 80% of Great Lakes fish use the littoral zone for at least part of the year (Lane et al., 1996a). Of 139 Great Lakes fish species reviewed by Lane et al. (1996b), all but the deepwater ciscoes (*Coregonus* spp.) and deepwater sculpin (*Myxocephalus thompsoni*) use waters less than 10 m deep as nursery habitat.

A large number of thermal-electric plants located on the Great Lakes draw their cooling water from the littoral zone, resulting in high I&E of several fish species of commercial, recreational, and ecological importance, including alewife, gizzard shad, yellow perch, rainbow smelt, and lake trout (Tables 11-6 to 11-9).

Table 11-6: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in the Great Lakes				
Common Name	**Scientific Name**	**Number of Facilities**	**Mean Annual Entrainment per Facility (fish/year)**	**Range**
alewife	*Alosa pseudoharengus*	5	526,000,000	3,930,000 - 1,360,000,000
rainbow smelt	*Osmerus mordax*	5	90,500,000	424,000 - 438,000,000
lake trout	*Salmo namaycush*	1	116,000	---

Source: Texas Instruments Inc., 1978; Michaud, 1998.

Table 11-7: Annual Entrainment of Larval Fish in the Great Lakes by Lake		
Lake	**Number of Facilities**	**Total Annual Entrainment (fish/year)**
Erie	16	255,348,164
Michigan	25	196,307,405
Ontario	11	176,285,758
Huron	6	81,462,440
Superior	14	4,256,707

Source: Kelso and Milburn, 1979.

Table 11-8: Annual Impingement of Fish in the Great Lakes for All Age Classes Combined				
Common Name	**Scientific Name**	**Number of Facilities**	**Mean Annual Impingement per Facility (fish/year)**	**Range**
alewife	*Alosa pseudoharengus*	15	1,470,000	355 - 5,740,000
gizzard shad	*Dorosoma cepedianum*	6	185,000	25 - 946,000
rainbow smelt	*Osmerus mordax*	15	118,000	78 - 549,000
threespine stickleback	*Gasterosteus aculeatus*	3	60,600	23,200 - 86,200
yellow perch	*Perca flavescens*	9	29,900	58 - 127,000
spottail shiner	*Notropis hudsonius*	8	22,100	5 - 62,000
freshwater drum	*Aplodinotus grunniens*	4	18,700	2 - 74,800
emerald shiner	*Notropis atherinoides*	4	7,250	3 - 28,600
trout perch	*Percopsis omiscomaycus*	5	5,630	30 - 23,900
bloater	*Coregonus hoyi*	2	4,980	3,620 - 6,340
white bass	*Morone chrysops*	1	4,820	--
slimy sculpin	*Cottus cognatus*	4	3,330	795 - 5,800
goldfish	*Carassius auratus*	3	2,620	4 - 7,690
mottled sculpin	*Cottus bairdi*	3	1,970	625 - 3,450
common carp	*Cyprinus carpio*	4	1,110	16 - 4,180
pumpkinseed	*Lepomis gibbosus*	4	1,060	14 - 3,920

Source: Benda and Houtcooper, 1977; Sharma and Freeman, 1977; Texas Instruments Inc., 1978; Thurber and Jude, 1985; Lawler Matusky & Skelly Engineers, 1993a; Michaud, 1998.

Table 11-9: Annual Impingement of Fish in the Great Lakes by Lake

Lake	Number of Facilities	Total Annual Impingement (fish/year)
Erie	16	22,961,915
Michigan	25	15,377,339
Ontario	11	14,483,271
Huron	6	7,096,053
Superior	14	243,683

Source: Kelso and Milburn, 1979.

The I&E estimates of Kelso and Milburn (1979) presented in Tables 11-7 and 11-9 were derived using methods that differed in a number of ways from EPA's estimation methods, and therefore the data are not strictly comparable. First, the Kelso and Milburn (1979) data represent total annual losses per lake, whereas EPA's estimates are on a per facility basis. In addition, the estimates of Kelso and Milburn (1979) are based on extrapolation of losses to facilities for which data were unavailable using regression equations relating losses to plant size.

Despite the differences in estimation methods, when converted to an annual average per facility, the impingement estimates of Kelso and Milburn (1979) are within the range of EPA's estimates. For example, the average annual impingement of 675,980 fish per facility based on Kelso and Milburn's (1979) data is comparable to EPA's high estimate of 1,470,000 for alewife.

On the other hand, EPA's entrainment estimates include eggs and larvae and are therefore substantially larger than those of Kelso and Milburn (1979), which result from converting eggs and larvae to an equivalent number of fish. Because of the high natural mortality of fish eggs and larvae, entrainment losses expressed as the number that would have survived to become fish are much smaller than the original number of eggs and larvae entrained (Horst, 1975; Goodyear, 1978). Viewed together, the two types of estimates give an indication of the possible upper and lower bounds of annual entrainment per facility (e.g., an annual average of 8,018,657 fish based on Kelso and Milburn's data compared to EPA's highest estimate of 526,000,000 organisms based on the average for alewife).

11.6 CWIS Impingement and Entrainment Impacts in Estuaries

Estuaries are semi-enclosed bodies of water that have an unimpaired natural connection with the open ocean and within which sea water is diluted with fresh water derived from land. Estuaries are created and sustained by dynamic interactions among oceanic and freshwater environments, resulting in a rich array of habitats used by both terrestrial and aquatic species (Day et al., 1989). Because of the high biological productivity and sensitivity of estuaries, adverse environmental impacts are more likely to occur at CWIS located in estuaries than in other water body types.

Numerous commercially, recreationally, and ecologically important fish and shellfish species spend part or all of their life cycle within estuaries. Marine fish that spawn offshore take advantage of prevailing inshore currents to transport their eggs, larvae, or juveniles into estuaries where they hatch or mature. Inshore areas along the edges of estuaries support high rates of primary productivity and are used by numerous aquatic species for feeding and as nursery habitats. This high level of biological activity makes these shallow littoral zone habitats highly susceptible to I&E impacts from CWIS.

Estuarine species that show the highest rates of I&E in the studies reviewed by EPA include bay anchovy (*Anchoa mitchilli*), tautog (*Tautoga onitis*), Atlantic menhaden (*Brevoortia tyrannus*), gulf menhaden (*Brevoortia patronus*), winter flounder (*Pleuronectes americanus*), and weakfish (*Cynoscion regalis*) (Tables 11-10 and 11-11).

During spring, summer, and fall, various life stages of these and other estuarine fish show considerable migratory activity. Adults move in from the ocean to spawn in the marine, brackish, or freshwater portions of estuaries or their associated rivers; the eggs and larvae can be planktonic and move about with prevailing currents or by using selective tidal transport; juveniles actively move upstream or downstream in search of optimal nursery habitat; and young adult anadromous fish move out into the ocean to reach sexual maturity. Because of the many complex movements of estuarine-dependent species, a CWIS located almost anywhere in an estuary can harm both resident and migratory species as well as related freshwater, estuarine, and marine food webs.

Table 11-10: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Estuaries

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)	Range
bay anchovy	*Anchoa mitchilli*	2	18,300,000,000	12,300,000,000 - 24,400,000,000
tautog	*Tautoga onitis*	1	6,100,000,000	---
Atlantic menhaden	*Brevoortia tyrannus*	2	3,160,000,000	50,400,000 - 6,260,000,000
winter flounder	*Pleuronectes americanus*	1	952,000,000	---
weakfish	*Cynoscion regalis*	2	339,000,000	99,100,000 - 579,000,000
hogchoker	*Trinectes maculatus*	1	241,000,000	---
Atlantic croaker	*Micropogonias undulatus*	1	48,500,000	---
striped bass	*Morone saxatilis*	4	19,200,000	111,000 - 74,800,000
white perch	*Morone americana*	4	16,600,000	87,700 - 65,700,000
spot	*Leiostomus xanthurus*	1	11,400,000	---
blueback herring	*Alosa aestivalis*	1	10,200,000	---
alewife	*Alosa pseudoharengus*	1	2,580,000	---
Atlantic tomcod	*Microgadus tomcod*	3	2,380,000	2,070 - 7,030,000
American shad	*Alosa sapidissima*	1	1,810,000	—

Source: U.S. EPA, 1982; Lawler Matusky & Skelly Engineers, 1983; DeHart, 1994; PSE&G, 1999.

Table 11-11: Annual Impingement in Estuaries for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
gulf menhaden	*Brevoortia patronus*	2	76,000,000	2,990,000 - 149,000,000
smooth flounder	*Liopsetta putnami*	1	3,320,000	--
threespine stickleback	*Gasterosteus aculeatus*	4	866,000	123 - 3,460,000
Atlantic menhaden	*Brevoortia tyrannus*	12	628,000	114 - 4,610,000
rainbow smelt	*Osmerus mordax*	4	510,000	737 - 2,000,000
bay anchovy	*Anchoa mitchilli*	9	450,000	1,700 - 2,750,000
weakfish	*Cynoscion regalis*	4	320,000	357 - 1,210,000
Atlantic croaker	*Micropogonias undulatus*	8	311,000	13 - 1,500,000
spot	*Leiostomus xanthurus*	10	270,000	176 - 647,000
blueback herring	*Alosa aestivalis*	7	205,000	1,170 - 962,000
white perch	*Morone americana*	14	200,000	287 - 1,380,000
threadfin shad	*Dorosoma petenense*	1	185,000	---
lake trout	*Salmo namaycush*	1	162,000	---
gizzard shad	*Dorosoma cepedianum*	6	125,000	2,058 - 715,000
silvery minnow	*Hybognathus nuchalis*	1	73,400	---

Source: Consolidated Edison Company of New York Inc., 1975; Lawler Matusky & Skelly Engineers, 1975, 1976; Stupka and Sharma, 1977; Lawler et al., 1980; Texas Instruments Inc., 1980; Van Winkle et al., 1980; Consolidated Edison Company of New York Inc. and New York Power Authority, 1983; Normandeau Associates Inc., 1984; EA Science and Technology, 1987; Lawler Matusky & Skelly Engineers, 1991; Richkus and McLean, 1998; PSE&G, 1999; New York State Department of Environmental Conservation, No Date.

11.7 CWIS Impingement and Entrainment Impacts in Oceans

Oceans are marine open coastal waters with salinity greater than or equal to 30 parts per thousand (Ross, 1995). CWIS in oceans are usually located over the continental shelf, a shallow shelf that slopes gently out from the coastline an average of 74 km (46 miles) to where the sea floor reaches a maximum depth of 200 m (660 ft) (Ross, 1995). The deep ocean extends beyond this region. The area over the continental shelf is known as the Neritic Province and the area over the deep ocean is the Oceanic Province (Meadows and Campbell, 1978).

Vertically, the upper, sunlit epipelagic zone over the continental shelf averages about 100 m in depth (Meadows and Campbell, 1978). This zone has pronounced light and temperature gradients that vary seasonally and influence the temporal and spatial distribution of marine organisms.

In oceans, the littoral zone encompasses the photic zone of the area over the continental shelf. As in other water body types, the littoral zone is where most marine organisms concentrate. The littoral zone of oceans is of particular concern in the context of section 316(b) because this biologically productive zone is also where most coastal utilities withdraw cooling water.

The morphology of the continental shelf along the U.S. coastline is quite varied (NRC, 1993). Along the Pacific coast of the United States the continental shelf is relatively narrow, ranging from 5 to 20 km (3 to 12 miles), and is cut by several steep-sided submarine canyons. As a result, the littoral zone along this coast tends to be narrow, shallow, and steep. In contrast, along most of the Atlantic coast of the United States, there is a wide, thick, and wedge-shaped shelf that extends as much as 250 km (155 miles) from shore, with the greatest widths generally opposite large rivers. Along the Gulf coast, the shelf ranges from 20 to 50 km (12 to 31 miles).

The potential for I&E in coastal areas can be quite high, not only because CWIS are located in the productive areas over the continental shelf where many species reproduce, but also because nearshore areas within bays, estuaries, wetlands, or coastal rivers provide nursery habitat. In addition, the early life stages of many species are planktonic, and tides and currents can carry these organisms over large areas. The abundance of plankton in temperate regions is seasonal, with greater numbers in spring and summer and fewer numbers in winter.

An additional concern for CWIS in coastal areas pertains to the presence of marine mammals and reptiles, including threatened and endangered species of sea turtles. These species are known to enter submerged offshore CWIS and can drown once inside the intake tunnel.

In addition to many of the species discussed in the section on estuaries, other fish species found in near coastal waters that are of commercial, recreational, or ecological importance and are particularly vulnerable to I&E include silver perch (*Bairdiella chrysura*), cunner (*Tautogolabrus adspersus*), several anchovy species, scaled sardine (*Harengula jaguana)*, and queenfish (*Seriphus politus*) (Tables 11-12 and 11-13).

Table 11-12: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Oceans				
Common Name	**Scientific Name**	**Number of Facilities**	**Mean Annual Entrainment per Facility (fish/year)**	**Range**
bay anchovy	*Anchoa mitchilli*	2	44,300,000,000	9,230,000,000 - 79,300,000,000
silver perch	*Bairdiella chrysura*	2	26,400,000,000	8,630,000 - 52,800,000,000
striped anchovy	*Anchoa hepsetus*	1	6,650,000,000	---
cunner	*Tautogolabrus adspersus*	2	1,620,000,000	33,900,000 - 3,200,000,000
scaled sardine	*Harengula jaguana*	1	1,210,000,000	---
tautog	*Tautoga onitis*	2	911,000,000	300,000 - 1,820,000,000
clown goby	*Microgobius gulosus*	1	803,000,000	---
code goby	*Gobiosoma robustum*	1	680,000,000	---
sheepshead	*Archosargus probatocephalus*	1	602,000,000	---
kingfish	*Menticirrhus* spp.	1	542,000,000	---
pigfish	*Orthopristis chrysoptera*	2	459,000,000	755,000 - 918,000,000
sand sea trout	*Cynoscion arenarius*	1	325,000,000	---
northern kingfish	*Menticirrhus saxatilis*	1	322,000,000	---
Atlantic mackerel	*Scomber scombrus*	1	312,000,000	---
Atlantic bumper	*Chloroscombrus chrysurus*	1	298,000,000	---

Source: Conservation Consultants Inc., 1977; Stone & Webster Engineering Corporation, 1980; Florida Power Corporation, 1985; Normandeau Associates Inc., 1994; Jacobsen et al., 1998; Northeast Utilities Environmental Laboratory, 1999.

Table 11-13: Annual Impingement in Oceans for All Age Classes Combined				
Common Name	**Scientific Name**	**Number of Facilities**	**Mean Annual Impingement per Facility (fish/year)**	**Range**
queenfish	*Seriphus politus*	2	201,000	19,800 - 382,000
polka-dot batfish	*Ogcocephalus radiatus*	1	74,500	---
bay anchovy	*Anchoa mitchilli*	2	49,500	11,000 - 87,900
northern anchovy	*Engraulis mordax*	2	36,900	26,600 - 47,200
deepbody anchovy	*Anchoa compressa*	2	35,300	34,200 - 36,400
spot	*Leiostomus xanthurus*	1	28,100	---
American sand lance	*Ammodytes americanus*	2	20,700	886 - 40,600
silver perch	*Bairdiella chrysura*	2	20,500	12,000 - 29,000
California grunion	*Caranx hippos*	1	18,300	---
topsmelt	*Atherinops affinis*	2	18,200	4,320 - 32,300
alewife	*Alosa pseudoharengus*	2	16,900	1,520 - 32,200
pinfish	*Lagodon rhomboides*	1	15,200	---
slough anchovy	*Anchoa delicatissima*	3	10,900	2,220 - 27,000
walleye surfperch	*Hyperprosopon argenteum*	1	10,200	---
Atlantic menhaden	*Brevoortia tyrannus*	3	7,500	861 - 20,400

Source: Stone & Webster Engineering Corporation, 1977; Stupka and Sharma, 1977; Tetra Tech Inc., 1978; Stone and Webster Engineering Corporation, 1980; Florida Power Corporation, 1985; Southern California Edison Company, 1987; SAIC, 1993; EA Engineering, Science and Technology, 1997; Jacobsen et al., 1998.

11.8 Summary of Impingement and Entrainment Data

The data evaluated by EPA indicate that fish species with free-floating, early life stages are those most susceptible to CWIS impingement and entrainment impacts. Such planktonic organisms lack the swimming ability to avoid being drawn into intake flows. Species that spawn in nearshore areas, have planktonic eggs and larvae, and are small as adults experience even greater impacts because both new recruits and the spawning adults are affected (e.g., bay anchovy in estuaries and oceans).

EPA's data review also indicates that fish species in estuaries and oceans experience the highest rates of I&E. These species tend to have planktonic eggs and larvae, and tidal currents carry planktonic organisms past intakes multiple times, increasing the probability of I&E. In addition, fish spawning and nursery areas are located throughout estuaries and near coastal waters, making it difficult to avoid locating intakes in areas where fish are present.

11.9 Potential Benefits of Section 316(b) Regulation

11.9.1 Benefits Concepts, Categories, and Causal Links

This section provides a qualitative description of the types of benefits that are expected from the section 316(b) New Facility Rule. Although valuing the changes in environmental quality that arise from the rule is a principal desired outcome for the Agency's policy assessment framework, time and data constraints do not permit a quantified assessment of the economic benefits of the final rule.

As noted in previous sections of this chapter, changes in CWIS design, location, or capacity can reduce I&E rates. These changes in I&E can potentially yield significant ecosystem improvements in terms of the number of fish that avoid premature mortality. This in turn is expected to increase local and regional fishery populations, and ultimately contribute to the enhanced environmental functioning of affected water bodies (rivers, lakes, estuaries, and oceans). Finally, the economic welfare of human populations is expected to increase as a consequence of the improvements in fisheries and associated aquatic ecosystem functioning. Potential ecological outcomes and related economic benefits from anticipated reductions in adverse effects of CWIS are identified below along with an explanation of the basic economic concepts applicable to the economic benefits, including benefit categories and taxonomies, service flows, and market and nonmarket goods and services.

11.9.2 Applicable Economic Benefit Categories

Key challenges in benefits assessment include uncertainties and data gaps, as well as the fact that many of the goods and services beneficially affected by the change in new facility I&E are not traded in the marketplace. Thus there are numerous instances — including this final section 316(b) rule for new facilities — when it is not feasible to confidently assign monetary values to some beneficial outcomes. In such instances, benefits are described and considered qualitatively. This is the case for the rule for new facility CWIS. At this time, there is only general information about the location of most new facilities, and in most cases details of facility and environmental characteristics are unknown. As a result, it is not possible to do a detailed analysis of potential monetary benefits associated with the final regulations.

11.9.3 Benefit Category Taxonomies

The term "economic benefits" here refers to the dollar value associated with all the expected positive impacts of the section 316(b) New Facility Rule. Conceptually, the monetary value of benefits is the sum of the predicted changes in "consumer and producer surplus." These surplus measures are standard and widely accepted terms of applied welfare economics, and reflect the degree of well-being derived by economic agents (e.g., people or firms) given different levels of goods and services, including those associated with environmental quality.[3]

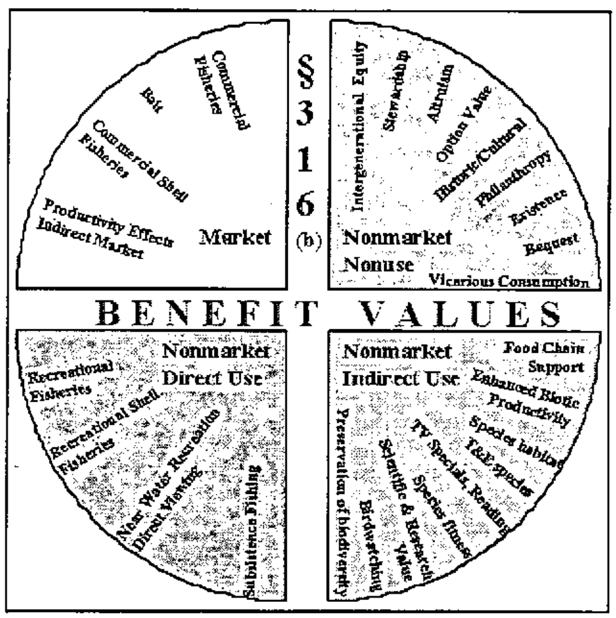
[3] Technically, consumer surplus reflects the difference between the "value" an individual places on a good or service (as reflected by the individual's "willingness to pay" for that unit of the good or service) and the "cost" incurred by that individual to acquire it (as reflected by the "price" of a commodity or service, if it is provided in the marketplace). Graphically, this is the area bounded from above by the demand curve and below by the market clearing price. Producer surplus is a similar concept, reflecting the difference between the market price a producer can obtain for a good or service and the actual cost of producing that unit of the commodity.

The economic benefits of activities that improve environmental conditions can be categorized in many different ways. The various terms and categories offered by different authors can lead to some confusion with semantics. However, the most critical issue is to try not to omit any relevant benefit, and at the same time avoid potential double counting of benefits.

One common typology for benefits of environmental programs is to divide them into three main categories: (1) economic welfare (e.g., changes in the well-being of humans who derive use value from market or nonmarket goods and services such as fisheries); (2) human health (e.g., the value of reducing the risk of premature fatality due to changing exposure to environmental exposure); and (3) nonuse values (e.g., stewardship values for the desire to preserve threatened and endangered species). For the section 316(b) New Facility Rule, however, this typology does not convey all the intricacies of how the rule might generate benefits. Further, human health benefits are not anticipated. Therefore, another categorization may be more informative.

Figure 11-1 outlines the most prominent categories of benefit values for the section 316(b) New Facility Rule. The four quadrants are divided by two principles: (1) whether the benefit can be tracked in a market (i.e., market goods and services) and (2) how the benefit of a nonmarket good is received by human beneficiaries (either from direct use of the resource, from indirect use, or from nonuse).

Figure 11-1: Section 316(b) Benefit Values



Market benefits are best typified by commercial fisheries, where a change in fishery conditions will manifest itself in the price, quantity, and/or quality of fish harvests. The fishery changes thus result in changes in the marketplace, and can be evaluated based on market exchanges.

Direct use benefits include the value of improved environmental goods and services used and valued by people (whether or not they are traded in markets). A typical nonmarket direct use would be recreational angling, in which participants enjoy a welfare gain when the fishery improvement results in a more enjoyable angling experience (e.g., higher catch rates).

Indirect use benefits refer to changes that contribute, through an indirect pathway, to an increase in welfare for users (or nonusers) of the resource. An example of an indirect benefit would be when the increase in the number of forage fish enables the population of valued predator species to improve (e.g., when the size and numbers of prized recreational or commercial fish increase because their food source has been improved). In such a context, the I&E impacts on a forage species will indirectly result in welfare gains for recreational or commercial anglers..

Nonuse benefits — also known as passive use values — reflect the values individuals assign to improved ecological conditions apart from any current, anticipated, or optional use by them. Some economists consider option values to be a part of nonuse values because the option value is not derived from actual current use, whereas other writers place it in a use category (because the option value is associated with preserving opportunity for a future use of the resource). For convenience, we place option value in the nonuse category.

11.9.4 Direct Use Benefits

Direct use benefits are the simplest to envision. The welfare of commercial, recreational, and subsistence fishermen is improved when fish stocks increase and their catch rates rise. This increase in stocks may be induced by reduced I&E of species sought by fishermen, or through reduced I&E of forage and bait fish, which leads to increases in populations of commercial and recreational species. For subsistence fishermen, the increase in fish stocks may reduce the amount of time spent fishing for their meals or increase the number of meals they are able to catch. For recreational anglers, more fish and higher catch rates may increase the enjoyment of a fishing trip and may also increase the number of fishing trips taken. For commercial fishermen, larger fish stocks may lead to increased revenues through increases in total landings and/or increases in the catch per unit of effort (i.e., lower costs per fish caught). Increases in catch may also lead to growth in related commercial enterprises, such as commercial fish cleaning/filleting, commercial fish markets, recreational charter fishing, and fishing equipment sales.

Evidence that these use benefits are valued by society can be seen in the market. For example, in 1996 about 35 million recreational anglers spent nearly $38 billion on equipment and fishing trip related expenditures (US DOI, 1997) and the 1996 GDP from fishing, forestry, and agricultural services (not including farms) was about $39 billion (BEA, 1998). Clearly, these data indicate that the fishery resource is very important. Although these baseline values do not give us a sense of how benefits change with changes in environmental quality such as reduced I&E and increased fish stocks, even a change of 0.1% would translate into potential benefits of $40 million per year.

Commercial fishermen. The benefits derived from increased landings by commercial fishermen can be valued by looking at the market in which the fish are sold. The ideal measure of commercial fishing benefits is the producer surplus generated by the marginal increase in landings, but often the data required to compute the producer surplus are unavailable. In this case, revenues may be used as a proxy for producer surplus, with some assumptions and an adjustment. The assumptions are that (1) there will be no change in harvesting behavior or effort, but existing commercial anglers will experience an increase in landings, and (2) there will be no change in price. Given these assumptions, benefits can be estimated by calculating the expected increase in the value of commercial landings, and then translating the landed values into estimated increases in producer surplus. The economic literature (Huppert, 1990) suggests that producer surplus values for commercial fishing have been estimated to be approximately 90% of total revenue (landings values are a close proxy for producer surplus because the commercial fishing sector has very high fixed costs relative to its variable costs). Therefore, the marginal benefit from an increase in commercial landings can be estimated to be approximately 90% of the anticipated change in revenue.

Recreational users. The benefits of recreational use cannot be tracked in the market. However, there is extensive literature on valuing fishing trips and valuing increased catch rates on fishing trips. While it is likely that nearwater recreational users will gain benefits, it is unlikely that swimmers would perceive an important effect on their use of the ecosystem. Boaters may receive recreational value to the degree that enjoyment of their surroundings is an important part of their recreational pleasure or that fishing is a secondary reason for boating. Passive use values to these and other individuals are discussed below.

Primary studies of sites throughout the United States have shown that anglers value their fishing trips and that catch rates are one of the most important attributes contributing the quality of their trips.

Higher catch rates may translate into two components of recreational angling benefits: an increase in the value of existing recreational fishing trips, and an increase in recreational angling participation. The most promising approaches for quantifying and monetizing these two benefits components are benefits transfer (as a secondary method) and random utility modeling or RUM (as a primary research method).

To estimate the value of an improved recreational fishing experience, it is necessary to estimate the existing number of angling trips or days that are expected to be improved by reducing I&E. As with the commercial fishing benefits, it is important to identify the appropriate geographic scope when estimating these numbers. Once the existing angling numbers have been estimated, the economic value of an improvement (consumer surplus) can be estimated. The specific approach for estimating the value will depend on the economic literature that is most relevant to the specific characteristics of the study site. For example, some economic studies in the literature can be used to infer a factor (percentage increase) that can be applied to the baseline value of the fishery for specific changes in fishery conditions. Other primary studies simply provide an estimate of the incremental value attributable to an improvement in catch rate.

In some cases it may be reasonable to assume that increases in fish abundance (attributable to reducing I&E) will lead to an increase in recreational fishing participation. This would be particularly relevant in a location that has experienced such a severe impact to the fishery that the site is no longer an attractive location for recreational activity. Estimates of potential recreational activity post-regulation can be made based on similar sites with healthy fishery populations, on conservative estimates of the potential increase in participation (e.g., a 5% increase), or on recreational planning standards (densities or level of use per acre or stream mile). A participation model (as in a RUM application) could also be used to predict changes in the net addition to user levels from the improvement at an impacted site. The economic benefit of the increase in angling days then can be estimated using values from the economic literature for a similar type of fishery and angling experience.

Subsistence anglers. Subsistence use of fishery resources can be an important issue in areas where socioeconomic conditions (e.g., the number of low income households) or the mix of ethnic backgrounds make such angling economically or culturally important to a component of the community. In cases of Native American use of impacted fisheries, the value of an improvement can sometimes be inferred from settlements in similar legal cases (including natural resource damage assessments, or compensation agreements between impacted tribes and various government or other institutions in cases of resource acquisitions or resource use restrictions). For more general populations, the value of improved subsistence fisheries may be estimated from the costs saved in acquiring alternative food sources (assuming the meals are replaced rather than foregone).

11.9.5 Indirect Use Benefits

Indirect use benefits refer to welfare improvements that arise for those individuals whose activities are enhanced as an indirect consequence of the fishery or habitat improvements generated by the final new facility standards for CWIS. For example, the rule's positive impacts on local fisheries may, through the intricate linkages in ecologic systems, generate an improvement in the population levels and/or diversity of bird species in an area. This might occur, for example, if the impacted fishery is a desired source of food for an avian species of interest. Avid bird watchers might thus obtain greater enjoyment from their outings, as they are more likely to see a wider mix or greater numbers of birds. The increased welfare of the bird watchers is thus a legitimate but indirect consequence of the final rule's initial impact on fish.

There are many forms of potential indirect benefits. For example, a rule-induced improvement in the population of a forage fish species may not be of any direct consequence to recreational or commercial anglers. However, the increased presence of forage fish may well have an indirect affect on commercial and recreational fishing values because it enhances an important part of the food chain. Thus, direct improvements in forage species populations may well result in a greater number (and/or greater individual size) of those fish that are targeted by recreational or commercial anglers. In such an instance, the relevant recreational and commercial fishery benefits would be an indirect consequence of the final rule's initial impacts on lower levels of the aquatic ecosystem.

The data and methods available for estimating indirect use benefits depend on the specific activity that is enhanced. For example, an indirect improvement to recreational anglers would be measured in essentially the same manner discussed under the preceding discussion on direct use benefits (e.g., using a RUM model). However, the analysis requires one additional critical step — that of indicating the link between the direct impact of the final rule (e.g., improvements in forage species populations) and the indirect use that is ultimately enhanced (e.g., the recreationally targeted fish). Therefore, what is typically required for estimating indirect use benefits is ecologic modeling that captures the key linkages between the initial impact of the rule and its ultimate (albeit indirect) effect on use values. In the example of forage species, the change in forage fish populations would need to be analyzed in a manner that ultimately yields information on responses in recreationally targeted species (e.g., that can be linked to a RUM analysis).

11.9.6 Nonuse Benefits

Nonuse (passive use) benefits arise when individuals value improved environmental quality apart from any past, present, or anticipated future use of the resource in question. Such passive use values have been categorized in several ways in the economic literature, typically embracing the concepts of existence (stewardship) and bequest (intergenerational equity) motives. Passive use values also may include the concept that some ecological services are valuable apart from any human uses or motives. Examples of these ecological services may include improved reproductive success for aquatic and terrestrial wildlife, increased diversity of aquatic and terrestrial wildlife, and improved conditions for recovery of threatened and endangered species.

Passive values can only be estimated in primary research through the use of direct valuation techniques such as contingent valuation method (CVM) surveys and related techniques (e.g., conjoint analysis using surveys). In the case of the final section 316(b) New Facility Rule, no primary research was feasible within the constraints faced by the Agency. If estimates were to be developed, EPA would need to rely on benefits transfer, with appropriate care and caveats clearly recognized.

One typical approach for estimating passive values is to apply a ratio between certain use-related benefits estimates and the passive use values anticipated for the same site and resource change. Freeman (1979) applied a rule of thumb in which he inferred that national-level passive benefits of water quality improvements were 50% of the estimated recreational fishing benefits. This was based on his review of the literature in those instances where nonuse and use values had been estimated for the same resource and policy change. Fisher and Raucher (1984) undertook a more in-depth and expansive review of the literature, found a comparable relationship between recreational angling benefits and nonuse values, and concluded that since nonuse values were likely to be positive, applying the 50% "rule of thumb" was preferred over omitting nonuse values from a benefits analysis entirely.

The 50% rule has since been applied frequently in EPA water quality benefits analyses (e.g., effluent guidelines RIAs for the iron and steel and pulp and paper sectors, and the RIA for the Great Lakes Water Quality Guidance). At times the rule has been extended to ratios higher than 50% (based on specific studies in the literature). However, the overall reliability and credibility of this type of approach is, as for any benefits transfer approach, dependent on the credibility of the underlying study and the comparability in resources and changes in conditions between the research survey and the section 316(b) New Facility Rule's impacts at selected sites. The credibility of the nonuse value estimate also is contingent on the reliability of the recreational angling estimates to which the 50% rule is applied.

A second potential approach to deriving estimates for section 316(b) passive use values is to use benefits transfer to apply an annual willingness-to-pay estimate per nonuser household (e.g., Mitchell and Carson, 1986; Carson and Mitchell, 1993) to all the households with passive use motives for the impacted water body. The challenges in this approach include defining the appropriate "market" for the impacted site (e.g., what are the boundaries for defining how many households apply), as well as matching the primary research scenario (e.g., "boatable to fishable") to the predicted improvements at the section 316(b)-impacted site.

For specific species, some nonuse valuation may be deduced using restoration-based costs as a proxy for the value of the change in stocks (or for threatened and endangered species the value of preserving the species). Where a measure of the approximate cost per individual can be deduced, and the number of individuals spared via BTA can be estimated, this may be a viable approach.

11.9.7 Summary of Benefits Categories

Table 11-14 displays the types of benefits categories expected to be affected by the section 316(b) New Facility Rule and the various data needs, data sources, and estimation approaches associated with each category. As described in sections 11.9.4 to 11.9.6, economic benefits can be broadly defined according to three categories: (1) direct use, (2) indirect use, and (3) nonuse (passive use) benefits. These benefits can be further categorized according to whether or not they are traded in the market. As indicated in Table 11-14, "direct use" benefits include both "marketed" and "nonmarketed" goods, whereas "nonuse" and "indirect use" benefits include only "nonmarketed" goods.

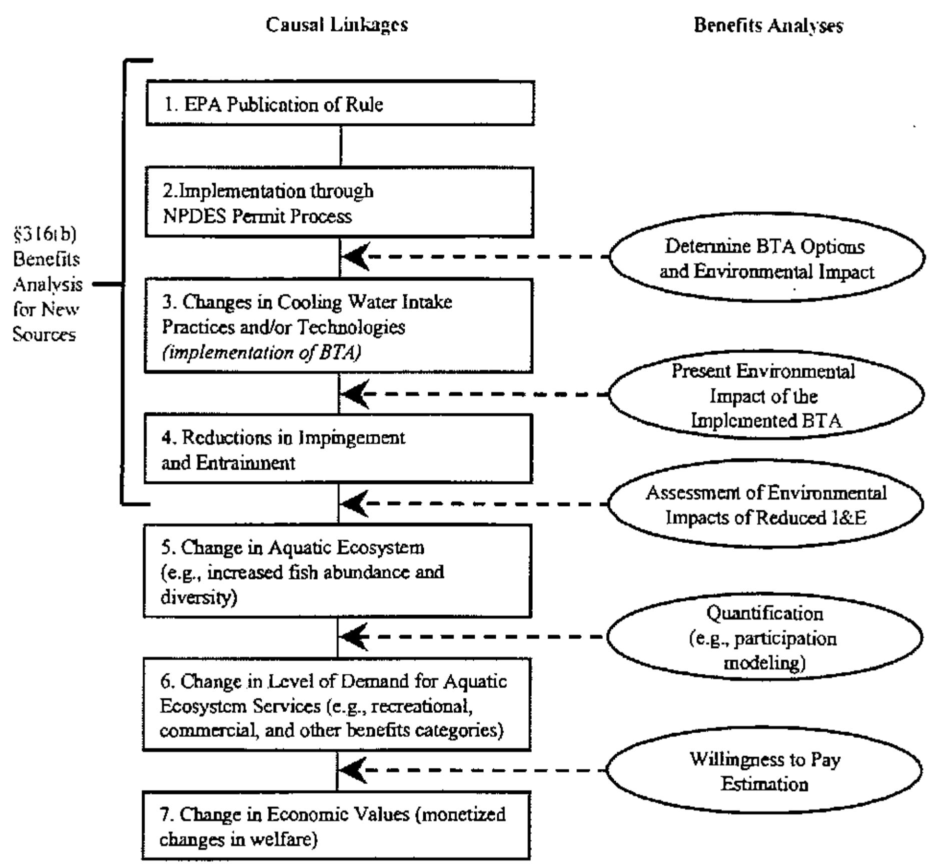
Table 11-14: Summary of Benefit Categories, Data Needs, Potential Data Sources, and Approaches

Benefits Category	Basic Data Needs	Potential Data Sources/Approaches
	Direct Use, Marketed Goods	
Increased commercial landings (fishing, shellfishing, and aquaculture)	▸ Estimated change in landings ▸ Estimated producer surplus	▸ Based on ecological modeling ▸ Based on available literature or 50% rule
	Direct Use, Nonmarketed Goods	
Improved value of a recreational fishing experience	▸ Estimated number of affected anglers ▸ Value of an improvement in catch rate, and possibly, value of an angling day	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
Increase in recreational fishing participation	▸ Estimated number of affected anglers or estimate of potential anglers ▸ Value of an angling day	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
Increase in subsistence fishing	▸ Estimated number of affected anglers or estimate of potential anglers ▸ Value of an angling day	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
	Nonuse and Indirect Use, Nonmarketed	
Increase in indirect values	▸ Estimated changes in ecological services (e.g., reproductive success of aquatic species) ▸ Restoration based on costs	▸ Based on ecological modeling ▸ Site-specific studies, national or statewide surveys
Increase in passive use values	▸ Apply stated preference approach, or benefits transfer	▸ Site-specific studies, national or statewide stated preference surveys

11.9.8 Causality: Linking the Section 316(b) Rule to Beneficial Outcomes

Understanding the anticipated economic benefits arising from changes in I&E requires understanding a series of physical and socioeconomic relationships linking the installation of Best Technology Available (BTA) to changes in human behavior and values. As shown in Figure 11-2, these relationships span a broad spectrum, including institutional relationships to define BTA (from policy making to field implementation), the technical performance of BTA, the population dynamics of the aquatic ecosystems affected, and the human responses and values associated with these changes.

Figure 11-2: Causal Linkages in the Benefits Analysis



The first two steps in Figure 11-2 reflect the institutional aspects of implementing the section 316(b) New Facility Rule. In step 3, the anticipated applications of BTA (or a range of BTA options) must be determined for the regulated entities. This technology forms the basis for estimating the cost of compliance, and provides the basis for the initial physical impact of the rule (step 4). Hence, the analysis must predict how implementation of BTAs (as predicted in step 3) translates into changes in I&E at the regulated CWIS (step 4). These changes in I&E then serve as input for the ecosystem modeling (step 5).

In moving from step 4 to step 5, the selected ecosystem model (or models) are used to assess the change in the aquatic ecosystem from the preregulatory baseline (e.g., losses of aquatic organisms before BTA) to the postregulatory conditions (e.g., losses after BTA implementation). The potential output from these steps includes estimates of reductions in I&E rates, and changes in the abundance and diversity of aquatic organisms of commercial, recreational, ecological, or cultural value, including threatened and endangered species.

In step 6, the analysis involves estimating how the changes in the aquatic ecosystem (estimated in step 5) translate into changes in level of demand for goods and services. For example, the analysis needs to establish links between improved fishery abundance, potential increases in catch rates, and enhanced participation. Then, in step 7, as an example, the value of the increased enjoyment realized by recreational anglers is estimated. These last two steps typically are the focal points of the economic benefits portion of the analysis. However, because of data and time constraints, this benefits analysis is limited to only the first four steps of the process.

11.10 EMPIRICAL INDICATIONS OF POTENTIAL BENEFITS

The following discussion provides examples from existing facilities that offer some indication of the relative magnitude of monetary benefits that may be expected to result from the final new facility regulations.

The potential benefits of lower intake flows and 100% recirculation of flow are illustrated by comparisons of once-through and closed-cycle cooling (e.g., Brayton Point and Hudson River facilities). The potential benefits of additional requirements defined by regional permit directors are demonstrated by operational changes implemented to reduce impingement and entrainment (e.g., Pittsburg and Contra Costa facilities). The potential benefits of reducing losses of forage species are demonstrated by analysis of the biological and economic relationships among forage species and commercial and recreational fishery species (e.g., Ludington facility on Lake Michigan). Finally, the potential benefits of implementing additional technologies to increase survival of organisms impinged or entrained are illustrated by the application of modified intake screens and fish return systems (e.g., Salem Nuclear Generating Facility). These cases are discussed below.

An example of the potential benefits of minimizing intake flow is provided by data for the Brayton Point facility, located on Mt. Hope Bay in Massachusetts (NEPMRI, 1981, 1995; U.S. EPA, 1982). In the mid-1980s, the operation of Unit 4 at Brayton Point was changed from closed-cycle to once-through cooling, increasing flow by 48% from an average of 703 MGD before conversion to an average of 1045 MGD for the first 6 years post-conversion (Lawler, Matusky, and Skelly Engineers, 1993b). Although conversion to once-through cooling increased coolant flow and the associated heat load to Mt. Hope Bay, the facility requested the change because of electrical problems associated with Unit 4's saltwater spray cooling system (U.S. EPA, 1982). An analysis of fisheries data by the Rhode Island Division of Fish and Wildlife using a time series-intervention model indicated that there was an 87% reduction in finfish abundance in Mt. Hope Bay coincident with the Unit 4 modification (Gibson, 1996). The analysis also indicated that, in contrast, species abundance trends have been relatively stable in adjacent coastal areas and portions of Narragansett Bay that are not influenced by the operation of Brayton Pt.

Another example of the potential benefits of low intake flow is provided by an analysis of I&E losses at five Hudson River power plants. Estimated fishery losses under once-through compared to closed-cycle cooling indicated that an average reduction in intake flow of about 95% at the three facilities responsible for the greatest impacts would result in a 30-80% reduction in fish losses, depending on the species involved (Boreman and Goodyear, 1988). An economic analysis estimated monetary damages under once-through cooling based on the assumption that annual percent reductions in year classes of fish result in proportional reductions in fish stocks and harvest rates (Rowe et al., 1995). A low estimate of per facility damages was based on losses at all five facilities and a high estimate was based on losses at the three facilities that account for most of the impacts. Damage estimates under once-through cooling ranged from about $1.3 million to $6.1 million annually in 1999 dollars.

A third example demonstrates how I&E losses of forage species can lead to reductions in economically valued species. Jones and Sung (1993) applied a RUM to estimate fishery impacts of I&E by the Ludington Pumped-Storage plant on Lake Michigan. This method estimates changes in demand as a function of changes in catch rates. The Ludington facility is responsible for the loss of about 1-3% of the total Lake Michigan production of alewives, a forage species that supports valuable trout and salmon fisheries. Jones and Sung (1993) estimated that losses of alewife result in a loss of nearly 6% of the angler catch of trout and salmon each year. Based on RUM analysis, they estimated that if Ludington operations ceased, catch rates of trout and salmon species would increase by 3.3 to 13.7% annually, amounting to an estimated recreational angling benefit of $0.95 million per year (in 1999 dollars) for these species alone.

A fourth example indicates the potential benefits of operational BTA that might be required by regional permit Directors. Two plants in the San Francisco Bay/Delta, Pittsburg and Contra Costa, have made changes to their intake operations to reduce impingement and entrainment of striped bass (*Morone saxatilis*). These operational changes have also reduced incidental take of several threatened and endangered fish species, including the delta smelt (*Hypomesus transpacificus*) and several runs of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*). According to technical reports by the facilities, operational BTA reduced striped bass losses by 78% to 94%, representing an increase in striped bass recreational landings averaging about 100,000 fish each year (PG&E, 1996, 1997, 1998, 1999; Southern Energy California, 2000). A local study estimated that the consumer surplus of an additional striped bass caught by a recreational angler is $8.87 to $13.77 (Huppert, 1989). This implies a benefit to the recreational fishery, from reduced impingement and entrainment of striped bass alone, in the range of $887,000 to $1,377,000 annually. The monetary benefit of reduced impingement and entrainment of threatened and endangered species might be substantially greater.

The final example indicates the benefits of technologies that can be applied to maximize survival. In their 1999 permit renewal application, the Salem Nuclear Generating Station in the Delaware Estuary evaluated the potential benefits of dual-flow, fine-mesh traveling screens designed to achieve an approach velocity of 0.5 fps (PSEG, 1999). The facility estimated that use of this technology would have a total economic benefit of $3.64 million in 2000 dollars (Appendix F, Section IX, Table 12).

REFERENCES

Allan, J.D. 1995. *Stream Ecology, Structure and Function of Running Waters*. Chapman & Hall, New York.

Bailey, R.M. and G.E. Smith. 1981. Origin and geography of the fish fauna of the Laurentian Great Lakes. *Canadian Journal of Fisheries and Aquatic Science* 38:1539–1561.

BEA. 1998. Bureau of Economic Analysis National Accounts Data: Gross Product by Industry. http://www.bea.doc.gov/bea/dn2/gpoc.htm

Benda, R.S. and W.C. Houtcooper. 1977. Impingement Studies at 16 Electric-Generating Plants in Michigan. In: Ecological Analysts Inc. Third National Workshop on Entrainment and Impingement: Section 316(b) — Research and Compliance. L.D. Jensen (eds.). Third National Workshop on Entrainment and Impingement: Section 316(b) — Research and Compliance, New York, NY. 425 pp.

Boreman, J. 1977. Impacts of Power Plant Intake Velocities on Fish. FWS/OBS-76/20.1, March 1977. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program.

Boreman, J. and C.P. Goodyear. 1988. Estimates of entrainment mortality for striped bass and other fish species inhabiting the Hudson River Estuary. *American Fisheries Society Monograph* 4:152-160.

Carson, R.T. and R.C. Mitchell. 1993. The value of clean water: The public's willingness to pay for boatable, fishable, and swimmable quality water. *Water Resources Research* 29(7):2445-2454.

Cherry, D.A. and R.J. Currie. 1998. Effects of Impingement/Entrainment at the Kanawha River Plant on the Fish Community Structure of the Kanawha River: Reflections on the 20 Year Study. In: EPRI Clean Water Act Section 316(b) Technical Workshop. D. Dixon and K. Zammit (eds.). EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, Berkeley Springs, WV.

Chorley, R.J., S.A. Schumm, and D.E. Sugden. 1984. *Geomorphology*. Methuen & Co., New York.

Cincinnati Gas & Electric Company. 1979. 316(b) Demonstration, Walter C. Beckjord and Miami Fort Power Stations. Submitted to Ohio Environmental Protection Agency.

Cole, R.A. 1978. Entrainment at a Once-Through Cooling System on Western Lake Erie, Volume I. EPA-600/3-78-070. July.

Conservation Consultants Inc. 1977. Ecological Studies at Big Bend Steam Electric Station (Tampa Electric Company): An Analysis and Summary of Studies on the Effects of the Cooling Water System on Aquatic Fauna: A 316 Demonstration Biological Study. Volume III.

Consolidated Edison Company of New York Inc. 1975. Environmental Report to Accompany Application for Facility License Amendment for Extension of Operation with Once-Through Cooling for Indian Point Unit No. 2.

Consolidated Edison Company of New York Inc. and New York Power Authority. 1983. Hudson River Ecological Study in the Area of Indian Point: 1982 Annual Report.

Day, J.W., Jr., C.A.S. Hall, W.M. Kemp, and A. Yáñez-Arancibia. 1989. *Estuarine Ecology*. John Wiley & Sons, New York.

DeHart, R.E. 1994. Brayton Point Station Technical Advisory Committee Meeting Summary, October 20, 1994.

EA Engineering, Science and Technology. 1997. Encina Power Plant Supplemental 316(b) Assessment Report. Final. Prepared for San Diego Gas & Electric.

EA Science and Technology. 1987. Final Report: Clifty Creek Station Impingement Study and Impact Assessment. Prepared for Indiana-Kentucky Electric Corporation. May. 46 pp.

Energy Impact Associates Inc. 1978. Fish Impingement and Entrainment Studies at Tanners Creek Power Plant: Final Report (Tanners Creek Plant Demonstration Document for P.L. 92-500 316(b), Volume II, Appendix B). Prepared for Indiana & Michigan Electric Company.

Fisher, A. and R.S. Raucher. 1984. Intrinsic benefits of improved water quality: Conceptual and empirical perspectives. *Advances in Applied Microeconomics* Vol. 3. V.K. Smith (ed.). JAI Press.

Florida Power Corporation. 1985. Crystal River Units 1, 2 and 3Section316 Demonstration. Final Report — Appendix.

Freeman, A.M. 1979. "The Benefits of Air and Water Pollution Control: A Review and Synthesis of Recent Estimates." Council on Environmental Quality, Washington, DC, December.

Freeman, R.F. and R.K. Sharma. 1977. Survey of Fish Impingement at Power Plants in the United States Volume II: Inland Waters. Prepared by Argonne National Laboratory. ANL/ES-56 Volume II. March. 323 pp.

Geo-Marine Inc. 1978. 316(b) Demonstration for the W.H. Sammis Generating Station. Prepared for Ohio Edison Company. September 8. 122 pp.

Gibson, M. 1996. Comparison of Trends in the Finfish Assemblages of Mt. Hope Bay and Narragansett Bay in Relation to Operations of the New England Power Brayton Point Station. Rhode Island Division of Fish and Wildlife, Marine Fisheries Office, June 1995 and revised August 1996.

Goldman, C.R. and A.R. Horne. 1983. *Limnology*. McGraw-Hill, Inc., New York.

Goodyear, C.D. 1978. Evaluation of 316(b) Demonstration Detroit Edison's Monroe Power Plan. Administrative Report No. 83-3, Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service.

Goodyear, C.P. 1977. Mathematical methods to evaluate entrainment of aquatic organisms by power plants. FWS/OBS-76/20.3. U.S. Department of the Interior, Fish & Wildlife Service, Washington, DC.

Goodyear, C.P. 1978. Entrainment impact estimates using the equivalent adult approach. FWS/OBS - 78/65. U.S. Department of the Interior, Fish & Wildlife Service, Washington, DC.

Hicks, D.B. 1977. Statement of Findings for the Coleman Power Plant, Henderson, Kentucky. October 14. 5 pp.

Horst, T.J. 1975. The Equivalent Adult Model. A General Model for Fisheries Impact Assessment.

Huppert, D.D. 1989. Measuring the value of fish to anglers: Application to central California anadromous species. *Marine Resource Economics* 6:89-107.

Huppert, D.D. 1990. "Economic Benefits from Commercial Fishing." Draft report to National Marine Fisheries Service.

Hynes, H.B.N. 1970. *The Ecology of Running Water*. University of Toronto Press. 555 pp.

Jacobson, P.M., E. Lorda, D.J. Danilla, J.D. Miller, C.A. Tomichek, and R.A. Sher. 1998. Studies of Cooling Water Intake Effects at Two Large Coastal Nuclear Power Stations in New England. In D. Dixon and K. Zammit (eds.) EPRI Clean Water Act Section 316(b) Technical Workshop. EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, Berkeley Springs, WV.

Jones, C.A., and Y.D. Sung. 1993. Valuation of Environmental Quality at Michigan Recreational Fishing Sites: Methodological Issues and Policy Applications. Prepared under EPA Contract No. CR-816247 for the U.S. EPA, Washington, DC.

Kaplan, C.H. 2000. Personal communication to Martha Segall, Project Manager Tetra Tech, Inc., from Charles Kaplan, CK Environmental. April 18.

Kelso, J.R.M. and G.S. Milburn. 1979. Entrainment and impingement of fish by power plants in the Great Lakes which use the once-through cooling process. *Journal of Great Lakes Research* 5:182–194.

Lane, J.A., C.B. Portt, and C.K. Minns. 1996a. Habitat characteristics of adult fishes of the Great Lakes. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2358.

Lane, J.A., C.B. Portt, and C.K. Minns. 1996b. Nursery habitat characteristics of Great Lakes fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2338.

Lawler J.P., W.T. Hogarth, B.J. Copeland, M.P. Weinstein, R.G. Hodson, and H.Y. Chen. 1980. Techniques for Assessing the Impact of Entrainment and Impingement as Applied to the Brunswick Steam Electric Plant. Pages 3-307 in L.D. Jensen (ed.) Paired Position Papers, Issues Associated with Impact Assessment: Proceedings of the Fifth National Workshop on Entrainment and Impingement. Ecological Analysts Inc. and Electric Power Research Institute, Palo Alto, CA.

Lawler, Matusky & Skelly Engineers. 1975. 1974 Hudson River Aquatic Ecology Studies - Bowline Point and Lovett Generating Stations. Prepared for Orange and Rockland Utilities, Inc.

Lawler, Matusky & Skelly Engineers. 1976. 1975 Hudson River Aquatic Ecology Studies — Bowline Point and Lovett Generating Stations: Vol. I: Chapters I-IX. Prepared for Orange and Rockland Utilities, Inc.

Lawler, Matusky & Skelly Engineers. 1983. 1979 and 1980 Data Analyses and Application of Empirical Models of Hudson River Fish Populations. Prepared for Consolidated Edison Company of New York, Inc. August.

Lawler, Matusky & Skelly Engineers. 1991. 1990 Impingement Studies at the Bowline Point Generating Station. Prepared for Orange and Rockland Utilities Inc.

Lawler, Matusky & Skelly Engineers. 1993a. Impingement and Entrainment Study at Zion Nuclear Generating Station July 1991 - July 1993. Prepared for Commonwealth Edison Company. October.

Lawler, Matusky & Skelly Engineers. 1993b. Population Dynamics of Winter Flounder in Mt. Hope Bay in Relation to Operations at the Brayton Point Electric Plant — A Review and Stock Assessment. Prepared for New England Power Company. September 1993.

Lewis R. and G. Seegert. 1998. Entrainment and impingement studies at two powerplants on the Wabash River in Indiana. In EPRI Clean Water Act Section 316(b) Technical Workshop. D. Dixon and K. Zammit (eds.). EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, Berkeley Springs, WV.

Lohner, T. 1998. Fish Entrainment, Impingement, and Long-term Monitoring Studies at Ohio River Power Plants. Presentation at EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, 1998, Berkeley Springs, WV.

Matthews, W.J. 1998. Patterns in Freshwater Fish Ecology. Chapman & Hall, New York.

Meadows, P.S. and J.I. Campbell. 1978. An Introduction to Marine Science. John Wiley and Sons, New York, NY.

Michaud D.T. 1998. Wisconsin Electric's Experience with Fish Impingement and Entrainment Studies. In EPRI Clean Water Act Section 316(b) Technical Workshop. Dixon, D. and K. Zammit (eds.). EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, Berkeley Springs, WV.

Mitchell, R.C. and R.T. Carson. 1986. "The Use of Contingent Valuation Data for Benefit/Cost Analysis of Water Pollution Control." Resources for the Future, Washington, DC. September.

NEPMRI (New England Power Company and Marine Research Inc). 1981. Final Environmental Impact Report and Section 316(a) and 316(b) Demonstrations Made in Connection with the Proposed Conversion of Generating Unit No. 4 from Closed-Cycle Cooling to Once-Through Cooling.

NEPMRI (New England Power Company and Marine Research Inc). 1995. Brayton Point Station Annual Biological and Hydrological Report, January-December 1994.

New York State Department of Environmental Conservation. No Date. Unpublished tables of impingement data for steam electric stations in New York. Provided to U.S. EPA by Ed Radle, New York State Department of Environmental Conservation, January 2000.

Normandeau Associates Inc. 1984. Hudson River Ecological Study in the Area of Indian Point: 1983 Annual Report. Prepared for Consolidated Edison Company of New York, Inc., and New York Power Authority.

Normandeau Associates Inc. 1994. Seabrook Environmental Studies 1993: A Characterization of Environmental Conditions in the Hampton-Seabrook Area during the Operation of Seabrook Station. Prepared for North Atlantic Energy Service Corporation.

Northeast Utilities Environmental Laboratory. 1999. Monitoring the Marine Environment of Long Island Sound at Millstone Nuclear Power Station 1998 Annual Report. 274 pp.

NRC (National Research Council). 1993. Managing Wastewater in Costal Urban Areas. National Academy Press, Washington, DC.

PG&E (Pacific Gas & Electric Company). 1996. Best Technology Available: 1995 Technical Report for the Contra Costa and Pittsburg Power Plants. Prepared for Central Valley and San Francisco Bay Regional Water Quality Control Boards.

PG&E (Pacifie Gas & Electric Company). 1997. Best Technology Available: 1996 Technical Report for the Contra Costa and Pittsburg Power Plants. Prepared for Central Valley and San Francisco Bay Regional Water Quality Control Boards.

PG&E (Pacific Gas & Electric Company). 1998. Best Technology Available: 1997 Technical Report for the Contra Costa and Pittsburg Power Plants. Prepared for Central Valley and San Francisco Bay Regional Water Quality Control Boards.

PG&E (Pacific Gas & Electric Company). 1999. Best Technology Available: 1998 Technical Report for the Contra Costa and Pittsburg Power Plants. Prepared for Central Valley and San Francisco Bay Regional Water Quality Control Boards.

Potter, W.A. 1978. Assessment of the Effects of Impingement and Entrainment on the Fish Community of the New River, Virginia. Master's thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA. 70 pp.

Potter, W.A., E.D. Maruhnich, R.L. Shema, and C.J. Cook. 1979a. Cardinal Plant Fish Impingement and Entrainment Studies. Prepared by Northern Environment Services Division for American Electric Power Service Corporation.

Potter, W.A., E.D. Maruhnich, R.L. Shema, and C.J. Cook. 1979b. Kammer Plant Demonstration Document for P.L. 92-500 Section 316(b) Volume II: Kammer Plant Fish Impingement and Entrainment Studies. Prepared by NUS Corporation for the Ameriean Electric Power Service Corporation.

Potter, W.A., E.D. Maruhnich, R.L. Shema, and C.J. Cook. 1979c. Kyger Creek Station Fish Impingement and Entrainment Studies. Prepared by Northern Environment Services Division for American Electric Power Service Corporation. October

Potter, W.A., E.D. Maruhnich, R.L. Shema, and C.J. Cook. 1979d. Philip Sporn Plant Demonstration Document for P.L. 92-500 Section 316(b) Volume II, Appendix B: Philip Sporn Plant Fish Impingement and Entrainment Studies. Prepared by NUS Corporation for the American Electric Power Service Corporation.

PSEG (Public Service Electric and Gas Company). 1999. Appendix F, 1999 Permit Renewal Application, NJPDES Permit No. NJ0005622.

PSE&G. 1999. Salem NPDES Permit Application, Appendix H.

Richkus, W.A. and R. McLean. 1998. Historical Overview of the Efficacy of Two Decades of Power Plant Fisheries Impact Assessment Activities in Chesapeake Bay. In EPRI Clean Water Act Section 316(b) Technical Workshop. D. Dixon and K. Zammit (eds.). EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, Berkeley Springs, WV.

Ronafalvy, J.P., R.R. Cheesman, and W.M. Matejek. 1999. Circulating water traveling screen modifications to improve impinged fish survival and debris handling at Salem Generating Station. Presentation at Power Generation Impacts on

Aquatic Resources Conference, Atlanta, GA. April 12-15.

Ross, D.A. 1995. *Introduction to Oceanography*. Harper Collins College Publishers. 496 pp.

Rowe, R.D., C.M. Lang, L.G. Chestnut, D.A. Latimer, D.A. Rae, S.M. Bernow, and D.E. White. 1995. The New York Electricity Externality Study, Volume 1. Empire State Electric Energy Research Corporation.

SAIC. 1993. Review of San Diego Gas & Electric Encina Power Plant 316(b) Demonstration. Draft. Prepared for U.S. EPA Region 9. 18 pp.

SAIC. 1994. Background Paper Number 3: Cooling Water Intake Technologies. Prepared for U.S. EPA Office of Wastewater Enforcement and Compliance, Permits Division by Science Applications International Corporation, Falls Church, VA.

SAIC. 1996. Background Paper Number 2: Cooling Water Use for Selected U.S. Industries. Prepared for U.S. EPA Office of Wastewater Enforcement and Compliance, Permits Division by Science Applications International Corporation, Falls Church, VA.

Sharma, R.K. and R.F. Freeman. 1977. Survey of Fish Impingement at Power Plants in the United States Volume I: The Great Lakes. ANL/ES-56 Volume I. Argonne National Laboratory, Argonne, IL. 218 pp.

Southern California Edison Company. 1987. Report on 1987 Data: Marine Environmental Analysis and Interpretation: San Onofre Nuclear Generating Station. 27 pp.

Southern Energy California. 2000. Best Technology Available: 1999 Technical Report for the Contra Costa and Pittsburg Power Plants. Prepared for Central Valley and San Francisco Bay Regional Water Quality Control Boards.

Spicer G., T. O'Shea, and G. Pichler. 1998. Entrainment, Impingement and BTA Evaluation for an Intake Located on a Cooling Water Reservoir in the Southwest. In: EPRI Clean Water Act Section 316(b) Technical Workshop. EPRI Clean Water Act Section 316(b) Technical Workshop, September 22-24, Berkeley Springs, WV. Dixon, D. and K. Zammit (eds.).

Stone & Webster Engineering Corporation. 1977. Supplemental Assessment in Support of the 316 Demonstration, Pilgrim Nuclear Power Station Units 1 and 2, Boston Edison Company.

Stone & Webster Engineering Corporation. 1980. 316(A) and (B) Demonstration Big Bend Station — Unit 4. Tampa Electric Company. Prepared for Tampa Electric Company.

Stupka, R.C. and R.K. Sharma. 1977. Survey of Fish Impingement at Power Plants in the United States Volume III: Estuaries and Coastal Waters. ANL/ES-56 Volume III. Argonne National Laboratory, Argonne, IL. 305 pp.

Taft, E.P. 1999. Fish protection technologies: A status report. Presentation at Power Generation Impacts on Aquatic Resources Conference, Atlanta, GA, April 12-15.

Tennessee Division of Forestry, Fisheries, and Wildlife Development. 1976. Volume 5: Effects of the Gallatin Steam Plant Cooling Water Intake on the Fish Populations of Old Hickory Reservoir. Tennessee Division of Forestry, Fisheries, and Wildlife Development, Fisheries and Waterfowl Resources Branch, Norris, TN.

Tennessee Valley Authority. 1976. Volume 5: Effects of the Gallatin Steam Plant Cooling Water Intake on the Fish Populations of Old Hickory Reservoir. June 30.

Tennessee Valley Authority. 1977. 316 (a) and 316(b) Demonstration, Cumberland Steam Plant: Volume 5, Effects of the Cumberland Steam Plant Cooling Water Intake on the Fish Populations of Barkley Reservoir.

Tetra Tech Inc. 1978. Biological Effects of Once-Through Cooling Part I, Volume 2: The Marine Environment. Prepared by the Utility Water Act Group. Submitted to U.S. EPA. June.

Texas Instruments Inc. 1978. Biological Effects of Once-Through Cooling Part I, Volume 5: Great Lakes Basin and Connecting Water Bodies. Prepared for the Utility Water Act Group. Submitted to U.S. EPA.

Texas Instruments Inc. 1980. Hudson River Ecological Study in the Area of Indian Point: 1979 Annual Report. Prepared for Consolidated Edison Company on New York, Inc.

Thurber, N.J. and D.J. Jude. 1985. Impingement Losses at the D.C. Cook Nuclear Power Plant during 1975-1982 with a Discussion of Factors Responsible and Possible Impact on Local Populations. Special Report No. 115 of the Great Lakes Research Division, Great Lakes and Marine Waters Center, University of Michigan.

U.S. DOI. 1997. U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of the Census. *1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.* U.S. Government Printing Office, Washington, DC.

U.S. EPA. 1976. Development Document for Best Technology Available for the Location, Design, Construction, and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact. Office of Water and Hazardous Materials, Effluent Guidelines Division, U.S. Environmental Protection Agency, Washington, DC.

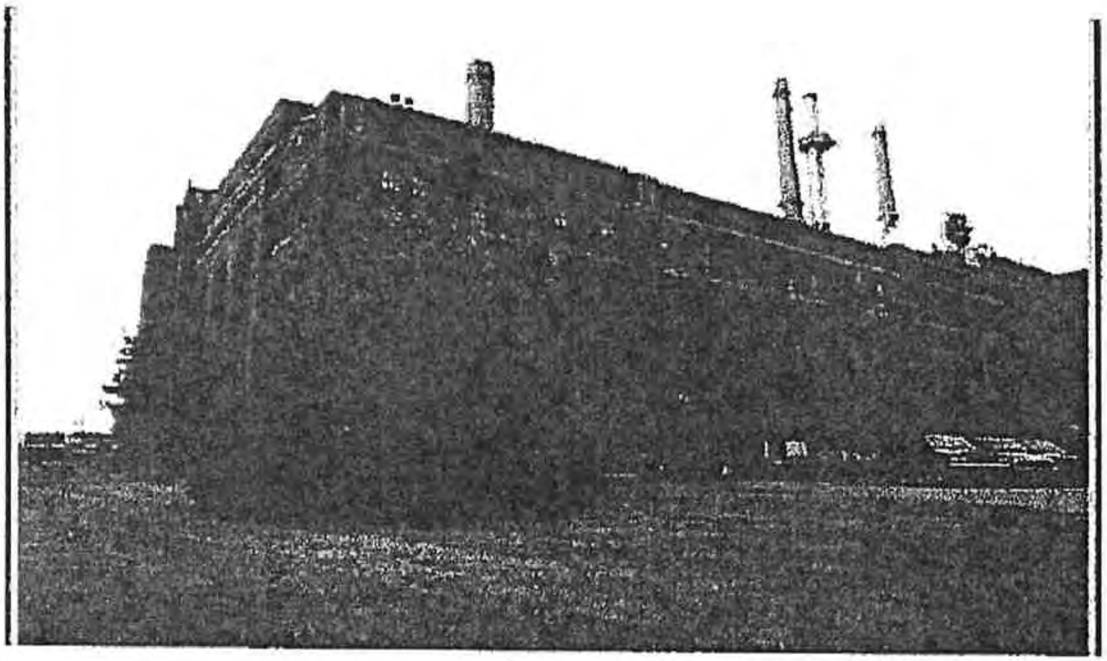
U.S. EPA. 1982. Determination Regarding Modification of NPDES Permit No. MA0003654 for Brayton Point Station, Somerset, MA. 107 pp.

Van Winkle, W., L.W. Barnthouse, B.L. Kirk, and D.S. Vaughan. 1980. Evaluation of Impingement Losses of White Perch at the Indian Point Nuclear Station and Other Hudson River Power Plants. Prepared by Oak Ridge National Laboratory for the U.S. Nuclear Regulatory Commission. Environmental Sciences Division Publication No. 1480. NUREG/CR-1100. 133 pp.

THIS PAGE INTENTIONALLY LEFT BLANK

Proposal for Information Collection

Waukegan Station
Waukegan, Illinois



Prepared for:

Midwest Generation EME, LLC
Chicago, Illinois

June 2005

Prepared by:

EA Engineering, Science, and Technology
444 Lake Cook Road, Suite 18
Deerfield, IL 60015

61393.17

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

W0971900021

Document 22 IEPA EXHIBIT No. 5

316(b) Phase II Existing Facility Intake Performance Standards

Proposal for Information Collection

Waukegan Station

NPDES Permit No. IL002259

Introduction

Waukegan Station is located at 10 Greenwood Ave. in Waukegan, Lake County, Illinois. The station has three (3) coal-fired generating units: Units 6-8, with a combined generating capacity of 758 MW. All units utilize a once-through circulating water system for condenser cooling.

Waukegan Station is a Phase II Existing Facility as defined in 40 CFR 129.91. The facility is a point source discharger, has a design intake flow of more than 50 MGD, withdraws water from waters of the United States, and uses at least 25 percent of the water withdrawn for cooling purposes. The facility has a cooling water screenhouse for each unit on Lake Michigan to the north of Waukegan Harbor. The intake for Unit 6 is located at N42° 22' 58" latitude and W87° 48' 56 longitude. The intake for Unit 7 is located at N42° 22' 56" latitude and W87° 48' 55" longitude. The intake for Unit 8 is located at N42° 25' 55" latitude and W87° 48' 52" longitude. The cooling water intake system includes nine circulating water pumps (847 MGD) and six house service water pumps (53 MGD) for a total design intake flow of 900 MGD (625,000 gpm).

Facilities that obtain their cooling water from the Great Lakes are subject to the Phase II 316(b) impingement mortality performance standards, but are excluded from the entrainment performance standards if the capacity utilization rate is less than 15 percent.[1] The capacity utilization rate for each unit can be looked at individually, however, at Waukegan each of the units has a capacity utilization rate greater than 15 percent.

If the maximum design through-screen velocity is 0.5 fps or less, a facility meets the impingement performance standards. The through-screen velocity at each of the Waukegan Units is greater than 0.5 fps. Therefore, Waukegan Station will be required to meet both the impingement mortality and entrainment performance standards.

NPDES Permit No. IL002259 for the facility was issued by the Illinois Environmental Protection Agency (IEPA) on July 19, 2000 and became effective on July 31, 2000. The permit will expire on July 31, 2005. As required, a NPDES renewal application was submitted six months prior to the expiration of the permit

Midwest Generation plans to evaluate all available options for complying with the applicable Phase II 316(b) performance standards, including reduced flow, reduced through-screen velocity, design and construction technologies, operational measures, and/or restoration measures. Midwest Generation will also evaluate the feasibility of seeking a site-specific BTA

[1] See 40 CFR 125.94(b).

determination based on cost-cost or cost-benefit issues. Depending on the compliance option chosen, Midwest Generation may be required to submit a Comprehensive Demonstration Study (CDS) to characterize impingement mortality and entrainment, and confirm that the technologies, operational measures, and/or restoration measures selected and installed will meet the applicable performance standards. Midwest Generation submitted a letter to the IEPA on October 18, 2004 requesting an extension of the CDS submittal until January 7, 2008 as permitted by 40 CFR 125.95(a)(2)(ii). IEPA approved the extension in a letter dated March 14, 2005 from A. Keller, Manager Permit Section. Midwest Generation is submitting this Proposal for Information (PIC) as the first component of the facility's CDS. This PIC includes the information required by 40 CFR 125.95(b)(1).

Based on the criteria established within the draft Phase II Rule and the pre-publication copy of the final Phase II Rule, which was originally signed on February 16, 2004, Midwest Generation determined that Waukegan Station would be subject to both the impingement and entrainment performance standards. Midwest Generation decided to be proactive and began an impingement study in 2003 and entrainment study in 2004. Study plans for both programs are included in this PIC.

1.0 Technologies, Operational Measures, and Restoration Measures [40 CFR 125.95(b)(1)(i)]

This section provides a description of the existing and proposed impingement mortality and entrainment control technologies, operational measures, and restoration measures that Midwest Generation will evaluate for Waukegan Station in its CDS. This section also includes the information required by 40 CFR 125.95(b)(1)(i).

1.1 Existing Control Technologies

Waukegan Station's cooling water intake structure currently provides cooling water to Units 6, 7 and 8 (Figure 1). The cooling system for each unit is designed as a once-through system. Cooling water from the Lake is withdrawn from an on-shore location, and passes through an intake canal into a constructed embayment prior to entering the plant through three intake screenhouses. Each screenhouse is equipped with fixed trash bars, through-flow traveling screens, and a high-pressure wash-water system. All screens are made with #12 gauge wire with 3/8-inch openings. The traveling screens are oriented parallel to the face of the screenhouse (represents shoreline). The intake withdraws water from the entire water column.

The Waukegan Station cooling water intake system does not appear to include any control technologies specifically designed to reduce impingement mortality or entrainment below the calculation baselines.

1.2 Existing Operational Measures

The number of fish and shellfish entrained or impinged is a function of several variables, including the species, season, and community dynamics, as well as cooling water intake volume and through-screen velocity. Within a given waterbody, reducing the volume of water pumped through the intake structure is expected to reduce the number of fish impinged or entrained. Reducing the through-screen velocity is expected to reduce the number of fish impinged.

Waukegan Station does not appear to use any operational measures specifically designed to reduce impingement mortality or entrainment.

1.3 Existing Restoration Measures

Waukegan Station has opened areas in the discharge canal and provided a fishing pier to the public for recreation. Midwest Generation works together with the Illinois Department of Natural Resources (IDNR) to manage the program. Midwest Generation works with IDNR by providing access to the site and maintaining recreational areas.

The IDNR indicated that from 1987 through 2003 fisherman expanded almost 425,000 angler hours at the Waukegan public fishing area and made over 102,000 angling trips spending close to one million dollars (Trudeau, 2005). The area has been closed since 2004 due to issues outside of Midwest Generation's control. As soon as the issues are resolved, Midwest Generation plans to reopen the recreational area.

The impact that impingement and entrainment at the Station's cooling water intake structure may have on the Lake Michigan fisheries management program will be characterized during the impingement and entrainment characterization studies. Restoration measures such as fish stocking, habitat enhancements, and recreational improvements may be used in lieu of, or in combination with technologies and/or operational measures, if they produce ecological benefits at a level that is substantially similar to or greater than the level that would be achieved by reducing intake impacts. Ecological benefits include maintenance or protection of community structure and function in the source waterbody. Continuing to work with IDNR on enhancing the existing fisheries management program may be the most environmentally desirable way of maintaining the fish community structure and function in Lake Michigan.

1.4 Existing Credits

The Waukegan Station cooling water intake structure is designed as a surface intake located on a manmade embayment. The intake screenhouse is equipped with fixed trash bars and through-flow traveling screens oriented parallel to the face of the screenhouse. The cooling water intake structure is not designed with control technologies that will reduce impingement mortality or entrainment below the calculation baselines. Operational practices and procedures at Waukegan Station are those that would typically be used to support once-through cooling. Whether the Station has implemented any operational controls, including flow or velocity reductions, which reduce impingement mortality or entrainment, will be evaluated as part of the CDS. The facility has had a long-term commitment to provide public fishing on the site, allowing access to the discharge canal and a pier into Lake Michigan. Prior to 1993, the recreational program was operated by the prior owner of the station, Commonwealth Edison (ComEd), and after this date operated jointly with the IDNR. Midwest Generation has continued to operate the pier jointly with IDNR since purchasing the station in late 1999.

1.5 Potential Controls, Operational Measures and/or Restoration Measures

The Phase II 316(b) regulations require Midwest Generation to reduce impingement mortality at the cooling water intake structure for all life stages of fish and shellfish by 80 – 95 percent from the calculation baseline and reduce entrainment by 60 – 90 percent from the calculation baseline. The impingement performance standard may be met by reducing the maximum through-screen intake velocity to 0.5 fps or less, whereas, both performance standards may be met by installing control technologies, and/or implementing operational measures, and/or restoration measures. Midwest Generation will evaluate several potentially viable strategies to meet the Phase II 316(b) performance standards, including control technologies, operational measures, and restoration measures.

Midwest Generation reviewed information available from USEPA, technical consultants, and equipment vendors to identify possible impingement and entrainment control technologies. Based on this review, a list of impingement control technologies was compiled. A summary of the potentially available control technologies, including a brief description of each technology, is provided in Table 1.

A two-tiered approach will be used to evaluate the feasibility of using impingement control technologies at Waukegan Station. In the first-level, potential alternatives will be evaluated to determine whether the design has been operated successfully at a power plant similar in size and environmental setting to Waukegan Station and their commercial availability. Technologies that are considered ineffective under the site-specific conditions and/or not available will be eliminated from further evaluation.

In the second-level evaluation, those alternative intake technologies that meet the site-specific reliability and availability criteria will be further analyzed according to the following technical, biological, and economic criteria.

- Technical Review: Technical review will address the compatibility of each alternative intake technology with the existing facility layout, including space availability, engineering feasibility, operations, and reliability.
- Potential Biological Benefits: Each technology and operational alternative that would reduce impingement mortality or entrainment will be evaluated using current impingement and entrainment data.
- Economic Review: Capital costs and incremental annual operating and maintenance (O&M) costs will be calculated for each potentially feasible control option. Cost estimates will be developed based on EPA Technology Cost Modules,[2] and supported with information from technology vendors.

The control technologies selected from Table 1 and any other potentially feasible control technologies identified during the preliminary review will be evaluated more thoroughly in the

[2] USEPA §316(b) Phase II Final Rule – Technical Development Document, Chapter 1: Technology Cost Modules.

facility's Compliance Demonstration Study. In addition to control technologies, the facility will evaluate the effectiveness of existing and potentially feasible operational or restoration measures. Examples of operational measures include, but are not limited to, diel and/or seasonal reductions in flow, and continuous or more frequent rotation of traveling screens coupled with a fish return system. Examples of restoration measures include, but are not limited to, working with the State of Illinois to provide recreational opportunities and/or improve the recreational experience at Waukegan, produce and/or stock fish, and improve fish habitat.

Potential compliance options, including control technologies, operational measures, and restoration measures, will be evaluated more thoroughly in the facility's CDS. Compliance options will be evaluated for technical feasibility, effectiveness, and cost. Information obtained during the facility's Impingement Mortality and Entrainment Characterization Study, adjusted as needed to account for any differences between the standard cooling water intake system described in the rule and Waukegan Station's cooling water intake system, will be used to develop the calculation baseline as defined below. The calculation baseline is an estimate of impingement mortality or entrainment that would occur at Waukegan Station assuming that the cooling water system has been designed as a once-through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh traveling screen is oriented parallel to, the shoreline near the surface of the source waterbody. In addition, the baseline practices, procedures, and structural configuration are those that the facility would maintain in the absence of any structural or operational controls, including flow or velocity reductions, implemented in whole or in part for the purposes of reducing impingement mortality or entrainment (40 CFR Part 125.93). The impingement and entrainment reductions called for in the performance standards are from these calculated baselines.

If it is determined there are reductions in impingement mortality or entrainment as a result of any design, technologies, and/or operational measures already implemented, these reductions will be added to the reductions expected to be achieved by any additional control technologies and operational measures that may be implemented.

Midwest Generation will also evaluate the feasibility of potential restoration projects to mitigate potential impacts. Restoration projects will be evaluated to determine whether restoration measures, used in lieu of or in combination with reductions in impingement mortality or entrainment, will maintain fish and shellfish in Lake Michigan at a level comparable to or greater than that which would be achieved by implementing control technologies or operational measures. Any restoration demonstration will address species or issues of interest identified by IEPA in consultation with the appropriate Federal, State, and Tribal fish and wildlife management agencies.

Based on a **preliminary** review of potentially available compliance strategies, it appears that several options are available to Waukegan Station to meet the Phase II 316(b) performance standards. Compliance strategies include installing fine mesh screens and a fish return system, implementing operational measures, and/or implementing restoration measures. However, most (or all) of these options may not be cost effective. Cost effectiveness will depend on the biological benefits associated with each control strategy. Biological benefits can only be assessed based on the impingement mortality and entrainment associated with the cooling water intake structure. Current impingement mortality and entrainment rates are being determined by ongoing studies and will be used to calculate the baselines as part of the Impingement Mortality and Entrainment Characterization Study.

Depending on results of the Impingement Mortality and Entrainment Characterization Study (e.g., annual rates, species impacted, seasonal variations, etc.), potential compliance strategies may be modified. For example, technologies or operational measures may only be necessary during specific months to meet the performance standards. Furthermore, if the biological benefits associated with impingement mortality and entrainment reductions are determined to be minimal, Midwest Generation retains the option of requesting a site-specific best technology available (BTA) determination in accordance with 40 CFR 125.95(b)(6).

Waukegan Station will develop a 316(b) compliance strategy based on: (1) results of the Impingement Mortality and Entrainment Characterization Study; and (2) an evaluation of the feasibility, effectiveness, and cost of the potential control technologies, operational measures, and restoration measures. Once the compliance strategy is determined, Midwest Generation will prepare and submit all applicable sections of the CDS.

If Midwest Generation chooses to use design and construction technologies and/or operational measures, in whole or in part to meet the performance standard, Midwest Generation will submit a Design and Construction Technology Plan and a Technology Installation and Operation Plan as required by §125.95(b)(4). If the facility proposes to use restoration measures, in whole or in part, to meet the impingement mortality standards, Midwest Generation will submit a Restoration Plan as required by §125.95(b)(5). Midwest Generation will use the compliance costs USEPA provided in the rule for Waukegan Station. If Midwest Generation determines that it is appropriate to seek a site-specific BTA determination because of compliance costs significantly greater than those considered by EPA or costs significantly greater than the benefits of meeting the applicable performance standards, Midwest Generation will submit information to support a site-specific BTA determination, including a Comprehensive Cost Evaluation Study, Benefits Valuation Study, and Site-Specific Technology Plan as required by §125.95(b)(6).

2.0 Historical Studies [40 CFR 125.95(b)(1)(ii)]

This section provides a brief description and summary of historical studies, which will help characterize impingement and entrainment in the vicinity of the Waukegan Station cooling water intake structures located in Waukegan, Illinois on the southwest shores of Lake Michigan.

Commonwealth Edison (ComEd), the prior owners of the station, conducted entrainment and impingement studies at Waukegan Station in 1975-76. The following is a brief description of the studies and a summary of those data.

Twenty-four hour impingement samples were collected every fourth day from May 12, 1975 through April 1976 at Waukegan Station. An estimated 898,457 fish comprised of 30 species were impinged during this study (CDM/Limnetics 1977). The impingement catch was strongly dominated by alewife (97 percent of the catch), and to a much lesser extent, rainbow smelt (1.4 percent). The majority of alewife was collected in April (20 percent), May (24 percent), and

June (31 percent), whereas rainbow smelt were most abundant in April (69 percent) and July (15 percent). All Salmonids combined (excluding Coregonids) accounted for less than 1 percent of the total estimated impingement catch from 1975 through 1976 (CDM/Limnetics 1977).

Weekly entrainment samples were collected from April 2, 1975 through March 1976. Twenty-four hour samples were collected with two centrifugal pumps, which pumped at a rate of 100 GPM, placed in the discharge canal. Samples were removed at six-hour intervals. Concurrently, replicate samples were collected with a 526-micron mesh plankton net every six hours. A minimum water volume of 50 m^3 was collected for each sample. An estimated 19.8 million identifiable fish larvae were collected, comprised of only three species: common carp, alewife, and rainbow smelt (CDM/Limnetics 1977). Common carp larvae were most abundant (68 percent), followed by alewife (29 percent), and rainbow smelt (3 percent). All common carp larvae were collected in June (19 percent), July (40 percent), and August (41 percent). All alewife larvae were collected in July (50 percent), August (15 percent), and September (35 percent), whereas the vast majority of rainbow smelt larvae were collected in May (14 percent) and June (85 percent). An estimated 855.2 million identifiable fish eggs were collected during this study. Consistent with the fish larvae, only three species were identified among the fish eggs: alewife, rainbow smelt, and common carp. Interestingly, alewife comprised 97 percent of those eggs identified, followed by rainbow smelt (2 percent) and common carp (1 percent). Fish eggs of the aforementioned species were collected in June, July, and August.

No threatened or endangered species were collected during entrainment or impingement studies conducted in 1975-76. Table 2 provides the endangered and threatened fish and crayfish species listed by the State of Illinois. No mussel species are listed for Lake County.

3.0 Consultations with Federal, State and Tribal Fish and Wildlife Agencies [40 CFR 125.95(b)(1)(iii)]

Midwest Generation is not currently engaged in consultations with any State, Federal, or Tribal fish and wildlife agencies on issues related to the implementation of Section 316(b) at Waukegan Station.

A request for an Agency Action Report was sent to the Illinois Department of Natural Resources on May 4, 2005 (Appendix A). The Agency Action Report will evaluate intake-structure effects in terms of the potential for impact to threatened or endangered species.

4.0 New Field Studies [40 CFR 125.95(b)(1)(iv)]

To support Midwest Generation's 316(b) permitting needs for Waukegan Station, impingement and entrainment studies are being conducted at the station's cooling water intake structure on Lake Michigan. The programs described herein will provide Midwest Generation with the data needed to make appropriate decisions regarding compliance alternatives to ensure the facility is in compliance with the new 316(b) performance standards.

4.1 Waukegan Station Impingement Characterization Study–Sampling Plan

Study Area Description

Cooling water from the Lake is withdrawn from an on-shore location, and passes through an intake canal into a constructed embayment prior to entering the plant through three separate intakes, one for each of the three units. Bar racks are located in front of the traveling screens at each intake. Two pumps each provide cooling water to Units 6 and 8, whereas four pumps provide cooling water to Unit 7, for a total of eight pumps. The Unit 6 pumps draw from a common bay and are protected by three traveling screens. Unit 7 has one traveling screen and pump bay for each pump, whereas, Unit 8 has two bays each containing one pump and protected by two traveling screens. Screen wash water from the traveling screens for each unit flows into separate trash baskets (i.e., there are three trash baskets). The design through screen velocity at critical low water level is 1.8, 2.0, and 1.8 fps for Unit 6, 7, and 8, respectively. Consistent with State of Illinois regulations, trash basket contents are not returned to the waterway.

The rule indicates that the sampling plan should include a description of the study area including the area of influence (hydrologic zone of influence) of the cooling water intake structure. This information is used to show the relationship of the sampling location(s) to the area expected to be impacted by cooling water withdrawal. Although this can be an important consideration for entrainment or source water ichthyoplankton studies, it is typically only a minor concern for impingement studies. Unlike entrainable organisms, which are carried along with the current, organisms of concern for impingement at intake structures are larger and can actively respond to a current. It is expected that the screenhouse and embayment areas will be within the areas of influence up to the point where the water velocity is <0.5 ft/sec., at which point, the rule assumes potentially impingeable organisms will be able to avoid impingement.

The rule also indicates that entrainment and impingement characterization studies should include descriptions of the temporal characteristics in the vicinity of the cooling water intake structure of fish and shellfish susceptible to impingement and entrainment. The rule goes on to say that the Director (permitting agency) should ensure **where appropriate** (emphasis added) that any required monitoring will allow for the detection of any annual, seasonal, and diel variations in the species or numbers of individuals that are impinged or entrained (Federal Register 2004 page 41642). Seasonal and annual variations are expected for entrainment and impingement due to changes in the biological populations, climatological, physiochemical, and plant operating conditions. Diel differences are also a characteristic of ichthyoplankton drift and therefore entrainment. However, in inland river and lake systems, diel differences in impingement are minor. Therefore, the impingement monitoring program is based upon processing a 24-hour sample.

Overview

Twenty-four hour impingement samples have or will be collected weekly at the screenhouse for two years. The impingement program described below began in July 2003 and will continue through June of 2005.

The preliminary results from the first year (July 2003 through June 2004) of the impingement study indicate that although 45 species were collected, the combined collection was dominated by alewife (97 percent). Gizzard shad represented 1.1 percent of those fish impinged and the remaining 43 species comprised less than 1.9 percent of the catch. All salmonids combined (excluding coregonids) accounted for less than 0.05 percent of all fish impinged (Table 3). Eight exotic species (alewife, coho salmon, Chinook salmon, rainbow trout, brown trout, goldfish, common carp, and three spine stickleback) were collected during this study. As shown in Table 3, one longnose sucker and eight banded killifish, both Illinois threatened species, were actually impinged during this study.

Species composition was very similar in the 1975-76 and 2003-04 studies. Percent abundance of alewife was identical (97 percent). Species richness was greater during the 2003-04 study (45 species) than during the 1975-76 study (30 species).

During the first three months (July through September 04) of the year-two impingement study, the preliminary results indicate that although 28 species were collected, numerically alewife (76 percent) and threespine stickleback (14 percent) comprise approximately 90 percent of the impinged fish. Salmonids (coho salmon, Chinook salmon, rainbow trout, brown trout) comprised less than 0.25 percent while yellow perch accounted for just over 0.50 percent.

Specifications for this study are described below:

Sampling Effort

Impingement collections at each of the three intake screenhouses have been or will be conducted once a week, for 24 hours, from July 2003 through June 2005. The same day will be sampled each week. Station staff will rotate and rinse the traveling screens, dump the trash baskets, and set clean trash baskets in place just prior to the beginning of the sample period for each intake. At the end of each sampling period, Station staff will again rinse the traveling screens and empty the trash baskets into intake-specific numbered trash dumpsters and move them to designated areas for processing. During the 24-hour sampling period, station staff will be responsible for monitoring the trash basket to prevent it from overflowing. If traveling screens are always rotating, there is not a need to manually operate the traveling screens either before the sample begins or when it ends. However, should the traveling screens be operated in any fashion other than continual (e.g., manually, automatic, and/or based on differential), the traveling screens will be manually operated at the start and end of each 24-hour sample period as described above. The fish and debris from each intake dumpster will be processed and recorded separately. All impingement processing will be conducted by qualified biologists that have the ability to identify fish.

The mesh size of the trash/collection baskets will be the same size or smaller than the mesh size of the traveling screens (3/8-inch square mesh).

Operating data for each intake will be supplied by Midwest Generation and will include, where possible, water temperature, number and duration of pumps operating, and volume by hour for each sample date, as well as daily, weekly, and monthly flow totals.

Sample Processing

Midwest Generation acknowledges, as does USEPA, that a number of aquatic organisms (i.e. fish, fish larvae and eggs, crustaceans, shellfish, sea turtles, marine mammals, and other forms of aquatic life) can be affected by cooling water intakes, but most impacts are to fish and shellfish (EPA-821-F-04-003, February 2004). Obviously, in inland waters, we do not have to be concerned with organisms such as sea turtles, marine mammals, lobsters, oysters, or shrimp. The 316(b) study efforts at Waukegan Station will focus on fish, fish eggs and larvae, and shellfish, as this term has traditionally been interpreted by resource agencies. Beginning in February 2005, the impingement program includes processing crayfish and freshwater mussels, excluding the exotic taxa *Corbicula* (Asiatic clam) and *Dreissena* (zebra and quagga mussels).

Shortly after the 24-hour collection is complete, fish and shellfish will be separated from the debris and identified, counted, weighed (grams) and measured (total length in mm) subject to the following subsampling protocols. If less than 20 individuals of a single species are collected, all will be individually measured and batch weighed. If more than 20 individuals of a single species are present, 20 representative individuals will be measured and batch weighed, and the remaining individuals of that species will be counted and batch weighed. If there are noticeably more than 100 specimens of a single species left after the initial 20 individuals are processed, 100 representative specimens will be selected and batch weighed. The remainder of the specimens of that species will then be batch weighed and the number of fish and shellfish in that sample will be determined by dividing the batch weight by the average weight of the 120 previously processed individuals.

If fish and shellfish numbers and/or debris loads are excessive, a maximum of 20 representative gallons of specimens and debris will be removed, sorted, and the specimens processed as discussed above. The volume (in gallons) of the unprocessed portion will be measured, recorded, and examined for species or sizes of species not encountered within the processed 20 gallons. If such a species or specimen is encountered, it will be processed as described above and noted as "do not extrapolate" on the data sheet. In order to account for specimens within the unprocessed portion of a sample, a multiplication factor will be calculated by dividing the total gallons of a sample by the gallons processed, and this factor will be applied to all specimens processed within the 20-gallon subsample.

To the extent possible, the impingement sample will be processed on site. Fish and shellfish that are not positively identified in the field will be preserved, labeled, and returned to the laboratory for taxonomic verification. All specimens collected will be identified to the lowest practical taxon, usually species, using standard identification keys as needed. Specimens determined to be obviously dead more than 24 hours (e.g., advanced decomposition, missing scales and eyes, excessive fungus, etc., as compared to other fish within a particular sample) prior to being impinged will not be processed. A voucher collection of rare, unusual, or taxonomically difficult species will be compiled. The voucher collection will consist of preserved specimens that have been positively identified by an experienced taxonomist.

Health and Safety

The field staff visited the site to receive safety training and tour the site before the first sample was collected. When on Station property, appropriate safety gear (e.g., hard hats, safety glasses, and ear protection) is used.

Data Management and Analysis

Data processing activities will be recorded on a log sheet for each batch of data. Field and laboratory data for each sample will be recorded on forms compatible for computer entry. Following serialization, diga-coding, and QA/QC checks, the data will be manually entered into a spreadsheet. All (i.e., 100 percent) of the manually entered data will be compared against the hard copy field and laboratory data forms. If any errors are encountered, they will be corrected in the database. Once the data have been cleared of errors, the approved data file is ready for the production of summary tables. Summary tables will be proofed to the extent deemed necessary in order to determine that the summary program is working properly. The editor will sign and date each proofed summary table and include notations as to which values were verified.

Circulating water (CW) volumes and temperatures for each unit will be supplied by plant personnel. CW volumes will be summed on a per-sample and per-week (i.e., Sunday through Saturday) basis. Mean, minimum, and maximum water temperatures will be calculated for each sampling period.

Tabular results will be prepared that provide the number and weight of each taxon collected during each 24-hr period. These daily results will be expanded based on circulating water flow to yield weekly estimates and these estimates summed to yield annual estimates (by species). The weekly (i.e., Sunday through Saturday) species-specific impingement estimates, both by number and by weight, will be calculated using the following formula:

$$\text{Weekly Estimate} = \frac{\begin{array}{c}\text{Number or weight}\\\text{Collected}\end{array}}{\text{CW Volume Sampled}} \times \text{Weekly CW Volume}$$

These weekly and annual estimates will be used to calculate the Calculation Baseline as defined in EPA's Phase II 316(b) Rule. The calculation baseline is developed using a standard intake configuration. Percent reduction is then measured against the baseline value.

Impingement Characterization Report

The report will include the tabular summaries and the expanded estimates described above. In addition, the report will present and discuss data as follows:

- Describe the fish and shellfish taxa composition in the impingement samples;

- Note the presence of any rare or listed species and the significance of such collections;

- As appropriate, note and discuss the presence of unusually large numbers of recreationally important fish or shellfish species (e.g., black bass, yellow perch, channel catfish, etc.);

- Provide size (length) distributions of the commonly impinged fish species;

- Describe temporal patterns of the impingement rates;

- Provide annual impingement estimates by number and weight for all species combined and for each species;

- Describe the overall contribution of invasive species or taxa;

- Describe QA/QC procedures (including field audits) that were followed to ensure the accuracy of all data collected and calculations made; and

- Provide appendices that include all raw data collected, including plant operating and water temperature data.

Quality Assurance/Quality Control

A Quality Assurance Plan (QAP) will provide the guidance with respect to overall QA/QC for this study. In accordance the QAP, a Standard Operating Procedure (SOP) will be prepared for this study. The SOP will integrate the general methodologies and guidance given in the aforementioned documents with the detailed specifications of the studies described above. The SOP will cover all aspects of sampling and will include the following elements:

- Personnel (including contact information);
- Mobilization procedures;
- Site security and safety procedures (including contact information);
- Equipment needed and calibration procedures;
- Field collection procedures;
- Sample handling and labeling procedures;
- Sample sorting procedures;
- Sample identification procedures;
- Data management and analysis; and
- Report preparation.

Specific QC activities to be performed for this study will include:

- Training – Staff collecting and processing the samples will be adequately trained for their tasks. This includes familiarization with and adherence to the SOP/Study Plan and any additional aspects that may be required (equipment operation, processing/identification, site security and safety procedures, etc.).

- Equipment – All equipment used during this study will be calibrated and maintained as per the contractors Quality Control and Procedures Manual or manufacturer's recommendations. Calibrations will be appropriately documented.

- Laboratory – All samples will be recorded on project-specific sample control sheets. Staff conducting identification of specimens will have access to relevant taxonomic literature and a reference collection. A voucher collection of rare or unusual specimens will be maintained and a taxonomic expert will verify them.

- Data Management and Analysis – Data processing activities will be recorded on a log sheet for each batch of data. Field and laboratory data for each sample will be recorded on forms compatible for computer entry. Following serialization, diga-coding, and QA/QC checks, the data will be manually entered into a spreadsheet. All (i.e., 100 percent) of the manually entered data will be compared against the hard copy field and laboratory data forms. If any errors are encountered, they will be corrected in the database. Once the data have been cleared of errors, the approved data file is ready for the production of summary tables. Summary tables will be proofed to the extent deemed necessary in order to determine if the summary program is working properly. The editor will sign and date each proofed summary table and include notations as to which values were verified.

- Report – A senior contractor staff member will review the draft final report before it is provided to Midwest Generation.

- Technical Assessments – An experienced senior contractor staff member will accompany field personnel during the first sampling event to observe sampling activities and to verify that the SOP/Study Plan is being followed properly. In addition, senior staff will also observe initial laboratory and data management activities to verify the same. Variances from approved procedures will be documented and corrected, either by modifying the SOP/Study Plan to address any systematic problems or by testing and/or retraining staff, as necessary. Prior to the first scheduled sampling, a readiness review will be conducted to ensure that trained personnel, required equipment, and procedural controls (e.g., SOP/Study Plan) are in place. One technical audit will be conducted during the course of the study and will cover all appropriate aspects of the SOP/Study Plan. Results of the technical audit will be provided to supervisory staff and Midwest Generation.

4.2 Waukegan Station Entrainment Characterization Study – Sampling Plan

Study Area Description

Cooling water from Lake Michigan enters the intake embayment through an intake canal, which is protected by metal pilings to break up ice and keep out large debris (Figure 1). Water exits the embayment into an intake channel along which the three screenhouses are located. There are several bridges, which cross this channel. The channel is approximately 10 ft in depth and the maximum velocity is approximately 2.0 fps.

Overview

To provide information on species composition, life stages impacted, and abundance, as well as annual, seasonal, spatial, and diel characteristics of the fish populations at-risk, entrainment samples were collected in the intake channel from April 2004 through March 2005. In the 2004-2005 study, samples were collected bi-weekly in March - April and October - November; weekly from May through September; and once in December, resulting in 29 sampling dates. Replicate samples were collected at two depths, six times on each date. A second year of sampling will be conducted from April 2005 through October 2005. Based on the first year results, the second year program was modified to include collecting samples on 22 dates (bi weekly in April and September, weekly May through August, and one mid-month sample in October) and by not collecting replicate samples. The replicate samples were dropped because there were basically no differences between the replicates. The following sections describe, in detail, the specific sampling design, equipment, and methodology that will be followed throughout all phases of Waukegan Station Entrainment Characterization Study.

Sampling Effort

Ichthyoplankton samples were collected using 0.5 m, conical, plankton nets with 335µ mesh suspended from the intake channel bridge that is closest to Lake Michigan. This point is upstream of the three screenhouses and is within the hydraulic influence of the plant. Any organisms collected here will be assumed to be entrained. The original study plan for year one called for collections once a month in January and February, every other week in March - April and October - December, and weekly from May through September. However based on the almost total lack of ichthyoplankton present in the fall samples and the results of a two year entrainment study (July 1991-July 1993) conducted at Zion Station (Lawler, Matusky & Skelly Engineers 1993), a consultation was held with the IDNR office responsible for Lake Michigan concerning the need for winter sampling. Zion Station, which is no longer operating, is located on Lake Michigan approximately three miles north of Waukegan Station. During the first year of the Zion study, no ichthyoplankton were collected during the winter months and the IDNR agreed that winter sampling was not required during the second year of the program. Based on the results of the Waukegan and Zion programs, the IDNR representative stated that the Waukegan winter sampling effort could be reduced (Trudeau 2004). The study plan was modified to make one collection in December and no collections in January or February.

The first year of sampling began in April 2004 and continued through March 2005. Replicate samples were collected at two depths (20 and 80 percent total depth), six times during a 24-hour sampling event, resulting in a total of 768 samples collected (2 samples x 2 depths x 6 sample times x 32 sampling dates = 768). Two nets were deployed at each depth, one approximately at 1/3 the width of the channel and the other at approximately 2/3 the width, on each sampling date thereby obtaining an estimate of the variability in the channel. Within a 24-hour sampling event, one set of samples (i.e., two nets near surface and near bottom) were collected at dawn (i.e., centered on sunrise), one set of samples were collected at dusk (i.e., centered on sunset), two sets were collected during the day, and two sets were collected at night. The two-day and two night sampling periods were evenly spaced between sunrise and sunset. Samples from these six periods (i.e., dusk, dawn, day [2 periods], and night [2 periods]) were not composited so that diel periodicity could be examined.

A minimum of 50 m^3 of water was filtered for each sample. The volume of water sampled was determined by a General Oceanics (GO) Model 2030R flow meter placed at the mouth of each net. At the conclusion of sample collection, the nets were washed down to concentrate all eggs and larvae into the attached collection cup, and preserved in 5-10 percent formalin containing rose bengal. Prior to sample collection, water temperature and velocity were measured at the aforementioned intake canal bridge at 20 and 80 percent total water depth and recorded for each sampling event. Water temperature was measured using an YSI Model 85 temperature meter; velocity was measured using a Marsh-McBirney Model 2000 velocity meter (or equivalent).

Sample Processing

All fish eggs, larvae, and juveniles were handpicked from the samples with the aid of an illuminated magnifier or dissecting scope. Beginning in March 2005, samples will be represerved and saved for possible future analysis for shellfish. Fish eggs, larvae, and juveniles will be identified using a dissecting scope equipped with a polarizing lens. Ichthyoplankton identifications will be made to the lowest practical taxonomic level using current references and taxonomic keys (e.g., Auer 1982, Wallus et al. 1990, Kay et al. 1994, Simon and Wallus 2004, etc.). Readers not familiar with larval fishes should understand that their taxonomy is not nearly so well developed as that for adult fishes. Many species are either undescribed or are not adequately described for all life stages (e.g., Hoyt 1988, Fuiman et al. 1983, Holland-Bartels et al. 1990, etc.). Characters used to describe larval fish are qualitative, rather subjective, and change as the larvae develop (e.g., pigmentation patterns). Quantitative characters such as myomere counts often show considerable overlap among species and can vary geographically and temporally for a given species (Bosley and Connor 1984). Thus, identifications (IDs) will be made to the lowest practical taxon, which, for larvae, sometimes is species, but often is genus (e.g., *Lepomis* or *Moxostoma* cannot be separated to species), and occasionally higher levels (e.g., family). On occasion, "species type" IDs will be made. The use of the word "type" will indicate that the specimen in question agrees well with the species to which it was assigned, but the taxonomist could not be 100 percent certain that it in fact was that species. Thus, a small probability may exist that any "species type" designation was not the species indicated, but rather a species that shares many of the same larval characteristics with that species. Fish eggs typically cannot be identified to species or genus, but an attempt will be made to provide family level IDs.

Life stages of fish will be categorized as egg, yolk-sac larvae, post yolk-sac larvae, and juveniles. Counts will be made by taxon and life stage. Up to 20 specimens per taxon and life stage will be measured to the nearest 0.1 mm.

Ancillary Data

Operating data for each intake will be supplied by Midwest Generation and will include, when possible, water temperature (intake), number and duration of pumps operating, and cooling water volume (CW) pumped by hour for each 24-hour sampling event, as well as daily, weekly, and monthly CW volume totals. CW volume data will be used to extrapolate entrainment sample densities to total entrainment estimates based on per unit volume of CW pumped.

Data Analysis

Tabular summaries will be provided that include total numbers, densities (number of organisms per 100 cubic meters or million gallons), and relative abundance by species or taxon. CW volumes will be summarized on a per-sample basis, as well as on a weekly (i.e., Sunday through Saturday), biweekly, and/or monthly basis. Mean, minimum, and maximum water temperature and DO values will be calculated for each sampling event. Tabular results will also be prepared that provide the average density of each taxon collected during each 24-hr sampling event. These daily densities will be expanded based on CW volume to yield period-specific (i.e., weekly, biweekly, or monthly) estimates and these estimates summed to yield annual (i.e., April through August) estimates. The period-specific and taxon-specific entrainment estimates will be calculated using the following formula:

Period Estimate = Daily Density x Period CW Volume

The period-specific and/or annual estimates will be used to establish the Calculation Baseline as defined in the Phase II 316(b) Rule.

Entrainment Characterization Report

The report will include the tabular summaries and annual estimates described above. In addition, it will present and discuss the following:

- Describe the fish larvae and egg composition in the entrainment samples;
- Note the presence of any rare or listed species and the significance of such collections;
- As appropriate, note and discuss the presence of unusually large numbers of recreationally important species or taxa (e.g., black bass, yellow perch, channel catfish, etc.);
- Provide size (length) distributions of the commonly entrained taxa;
- Characterize the entrainment of each taxon according to life stage;
- Describe temporal entrainment patterns;
- Provide entrainment estimates for all taxa combined and by taxon and life stage;
- Describe overall contribution of invasive species;

- Describe QA/QC procedures that were followed to ensure the accuracy of all data collected and calculations made. This will include a listing of the taxonomic references that were used to identify the fish eggs and larvae collected; and

- Provide appendices that include all raw data, including plant operating and water temperature data.

Quality Assurance/Quality Control

A Quality Assurance Plan (QAP) will provide the guidance with respect to overall QA/QC for this study. In accordance the QAP, a Standard Operating Procedure (SOP) will be prepared for this study. The SOP will integrate the general methodologies and guidance given in the aforementioned documents with the detailed specifications of the study described above. The SOP will cover all aspects of sampling and will include the following elements:

- Personnel (including contact information);
- Mobilization procedures;
- Site security and safety procedures (including contact information);
- Equipment needed and calibration procedures;
- Field collection procedures;
- Sample handling and labeling procedures;
- Sample sorting procedures;
- Sample identification procedures;
- Data management and analysis; and
- Report preparation.

Specific QC activities to be performed for these studies will include:

- Training – Staff collecting and processing the samples will be adequately trained for their tasks. This includes familiarization with and adherence to the SOP and any additional aspects that may be required (equipment operation, processing/identification, site security and safety procedures, etc.).

- Equipment – All equipment used during these studies will be calibrated and maintained as per the contractors Quality Control and Procedures Manual or manufacturer's recommendations. Calibrations will be appropriately documented.

- Laboratory – All samples will be recorded on project-specific sample control sheets. Ten percent of the entrainment samples will be resorted. If they do not meet an average quality limit of 10 percent, another ten percent will be resorted. Staff conducting identification of specimens will have access to relevant taxonomic literature and a reference collection. Station-specific voucher collections will be developed and a taxonomic expert will verify them.

- Data Management and Analysis – Data processing activities will be recorded on a log sheet for each batch of data. Field and laboratory data for each sample will be recorded on forms compatible for computer entry. Following serialization, diga-coding, and QA/QC checks, the data will be manually entered into a spreadsheet. All (i.e., 100 percent) of the manually entered data will be compared against the hard copy field and laboratory data forms. If any errors are encountered, they will be corrected in the database. Once the data have been cleared of errors, the approved data file is ready for the production of summary tables. Summary tables will be proofed to the extent deemed necessary in order to determine if the summary program is working properly. The editor will sign and date each proofed summary table and include notations as to which values were verified.

- Report – A senior contractor staff member will review the draft final report before it is provided to Midwest Generation.

- Technical Assessments – An experienced senior contractor staff member will accompany field personnel during the first sampling event to observe sampling activities and to verify that the SOP is being followed properly. In addition, senior staff will also observe initial laboratory and data management activities to verify the same. Variances from approved procedures will be documented and corrected, either by modifying the SOP to address any systematic problems or by testing and/or retraining staff, as necessary. Prior to the first scheduled sampling, a readiness review will be conducted to ensure that trained personnel, required equipment, and procedural controls (e.g., SOP) are in place. One technical audit will be conducted during the course of the study and will cover all appropriate aspects of the SOP. Results of the technical audit will be provided to supervisory staff and Midwest Generation.

5.0 References

Auer, N.A. (editor). 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Committee Special Publication 82-3. Ann Arbor, Michigan. 744 pp.

Bosley, T.R. and J.V. Connor. 1984. Geographic and temporal variation in numbers of myomeres in fish larvae from the lower Mississippi River. Trans. Amer. Soc. 113:238-242.

CDM/LIMNETICS. 1977. The lake-wide effects of impingement and entrainment on the Lake Michigan Fish populations. Report by CDM to Commonwealth Edison Company, Northern Indiana Public Service Company, Indiana and Michigan Power Company, and Consumers Power Company.

Federal Register, Volume 69, No. 131, Friday, July 9, 2004, 40 CFR 9, 122 et al.

Fuiman, L.A., J.V. Conner, B.F. Lathrop, G.L. Buynak, D.E. Snyder and J.J. Loss. 1983. State of the art of identification for cyprinid fish larvae from eastern North America. Trans. Amer. Fish. Soc. 112: 319-332.

Holland-Bartels, L.E., S.K. Littlejohn, and M.L. Huston. 1990. A guide to larval fishes of the upper Mississippi River. U.S. Fish Wildl. Serv. Natl. Fish Res. Ctr. LaCrosse, Wisconsin. 107 pp.

Hoyt, R.D. 1988. A bibliography of the early life history of fishes; Volume I: List of Titles and Volume II: Index. Dept. of Biology, Western Kentucky University, Bowling Green, Kentucky.

Illinois Department of Natural Resources. 2001. Illinois Natural Heritage Database. List of Endangered & Threatened Species by County. 142 pp.

__________. 2004. Illinois Endangered Species Protection Board. 2004 Endangered and Threatened Species List (http://dnr.state.il.us/espb/datelist.htm).

__________. 2004. Tom Trudeau. Lake Michigan Fisheries Unit Supervisor. Personal Communication

__________. 2005. Tom Trudeau. Lake Michigan Fisheries Unit Supervisor. Personal Communication

Kay, L.K., R. Wallus, and B.L. Yeager. 1994. Reproductive biology and early life history of fishes in the Ohio River drainage. Volume 2: Catostomidae. Tennessee Valley Authority, Chattanooga, Tennessee, USA.

Lawler, Matusky & Skelly Engineers (LMS). 1993. Impingement and entrainment study at Zion Nuclear Generating Station July 1991-July 1993. Report by LMS to Commonwealth Edison Company, Chicago, IL.

Simon, T.P, R. Wallus. 2004. Reproductive biology and early life history of fishes in the Ohio River drainage, Volume 3: Ictaluridae – Catfish and Madtoms. CRC Press. 204 pp.

U.S. Environmental Protection Agency, Fact Sheet for Cooling Water Intake Structures – Section 316(b) Final Regulations for Cooling Water Intake Structures at Large Power Plants. EPA-821-F-04-003, February, 2004.

__________. Technical Development Document for the Final Section 316(b) Phase II Existing Facilities Rule. EPA 821-R-04-007, DCN 6-0004, February 12, 2004.

Wallus, R., B.L. Yeager, and T.P. Simon. 1990. Reproductive biology and early life history of fishes in the Ohio River drainage, Volume 1: Acipenseridae through Esocidae. Tennessee Valley Authority, Chattanooga, Tennessee. 273 pp.

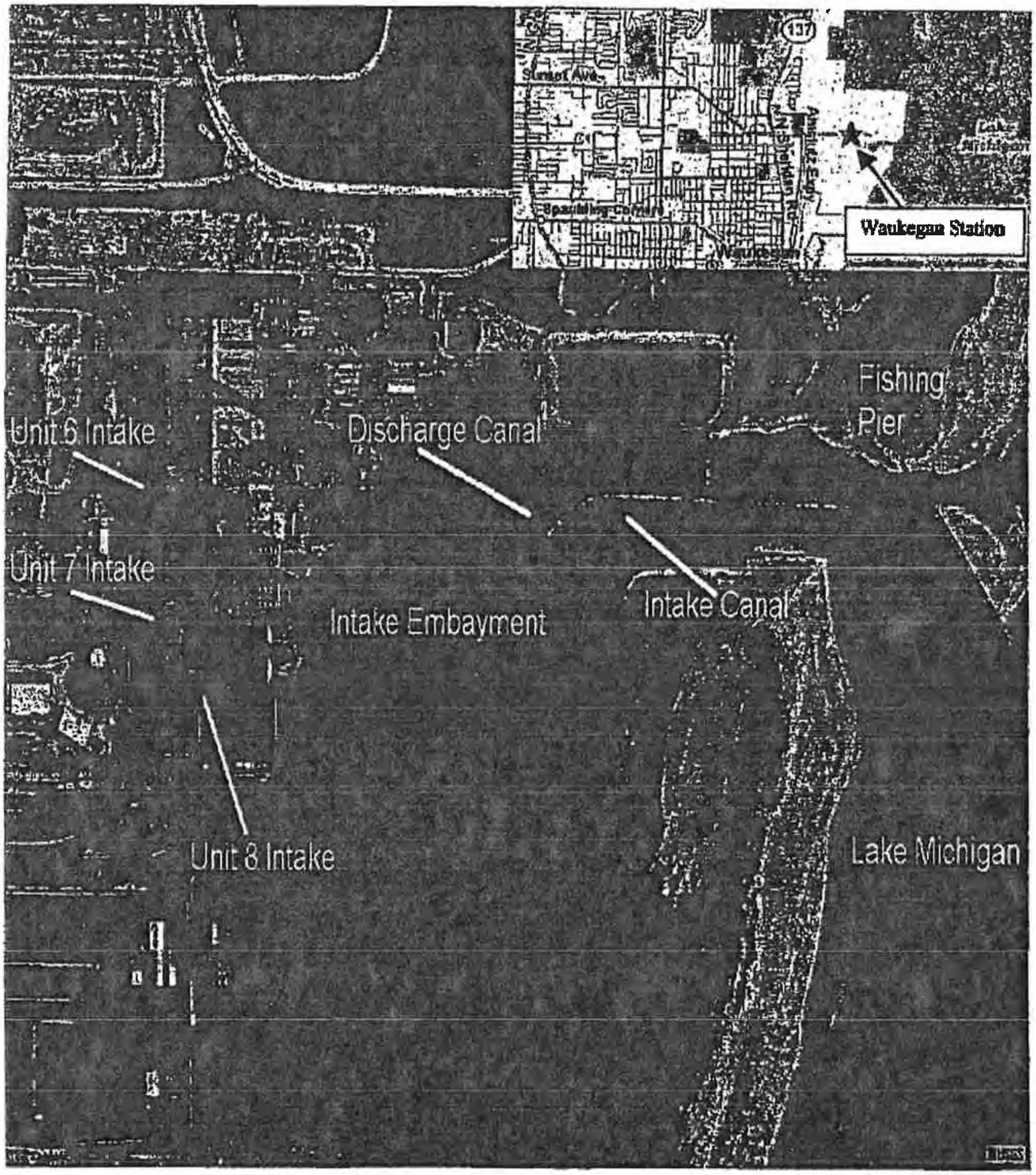


Figure 1. Waukegan Station Intake and Discharge Area

Table 1
Summary of Potentially Available Control Technologies

Control Technology		Description
Behavioral Barriers		
a.	Sound Barriers	Non-contact barrier that generates various sound patterns to elicit avoidance responses in fish.
b.	Strobe Light	Light barriers consist of controlled application of strobe lights or mercury vapor lights to lure fish away from cooling water intake structures or alter natural migration patterns.
c.	Air Bubble Curtains	Air bubble barriers consist of an air header and jets arranged to provide a continuous curtain of air bubbles over a cross section area to repel fish that approach the face of an intake structure.
d.	Velocity Caps	A device placed over vertical inlets at offshore intake structures to convert vertical flow into horizontal flow at the entrance into the intake.
e.	Other Behavioral Barriers Electrical Barriers Chemicals Barriers Magnetic Fields Chains and Cables	Non-contact barriers designed to create environmental conditions that will elicit avoidance responses from fish.
Physical Barriers		
a.	Vertical Traveling Screens	Screen panels mounted on a rotating belt structure – the belt rotates through the water column vertically keeping fish and debris out of the circulating water system.
b.	Modified Vertical Traveling Screen (Ristroph)	Vertical traveling screens fitted with a collection bucket beneath the screen panel and a fish recovery/return system.
c.	Rotary Drum Screens	In a rotary drum screen, water passes through screen mesh that covers the rotating cylinder. Debris is carried over the screen as it rotates and is washed off the screen on the downstream side. Drum screens are generally used in gravity diversion canals but can also be designed for use to deliver water to pumping plants.

Table 1 continued

d.	Center-Flow / Dual-Flow Screen	Dual-flow screens are designed to allow water intake through both the ascending and descending side of the vertical screen. Dual-flow screens increase the screen size for a given intake water flow, thus reducing the through-screen velocity.
e.	Fine Mesh Screens Mounted on Traveling Screens	Fine mesh screens mounted on traveling screens are used for screening eggs, larvae, and juvenile fish from cooling water intake systems and used with an organism return system.
f.	Stationary Screens (Vertical Fixed-Plate Screen)	Vertical fixed-plate stationary screens can be located in the cooling water intake channel such that through-screen velocity is very low – reducing impingement mortality. Debris removal is an important consideration, and vertical fixed-plate screens generally require a mechanical cleaning system for debris removal.
g.	Velocity Gradient (Angled or Louvered Screens)	Angled screens and louvered screens are designed to provide an abrupt change in both the flow direction and velocity of the cooling water – creating a barrier that fish will avoid. These systems are often combined with a fish bypass or other fish handling/return system.
h.	Fish Barrier Net	Fish barrier nets are wide mesh nets placed in front of the entrance to an intake structure to keep fish from entering the intake structure.
i.	Aquatic Filter Barrier (Gunderboom)	Barriers that employ a fabric filter designed to allow for passage of water into a cooling water intake structure, but exclude fish and shellfish including early life stages.
j.	Porous Dikes/Leaky Dams	Porous dikes, also known as leaky dams, are filters resembling a breakwater surrounding a cooling water intake structure. Water passes through the dike while the dike acts as a physical and behavioral barrier to aquatic organisms.
k.	Cylindrical Wedge-Wire Screen	Cylindrical wedge-wire screens can have a mesh size that is smaller than the organisms susceptible to entrainment and can be designed with a through-screen velocity that is low enough to minimize impingement.

Table 2. Endangered and Threatened Fish and Crayfish Species Listed for the State of Illinois and Mussel Species Listed for Lake County, Illinois (Illinois Department of Natural Resources 2001 and 2004)

ENDANGERED		THREATENED	
Acipenser fulvescens	(lake sturgeon)	*Ammocrypta pellucidum*	(eastern sand darter)
Ammocrypta clarum	(western sand darter)	*Catostomus catostomus*	(longnose sucker)
Etheostoma camurum	(bluebreast darter)	*Coregonus artedi*	(cisco)
Etheostoma histrio	(harlequin darter)	*Erimystax x-punctatus*	(gravel chub)
Hybognathus hayi	(cypress minnow)	*Etheostoma exile*	(Iowa darter)
Hybopsis amblops	(bigeye chub)	*Fundulus diaphanus*	(banded killifish
Hybopsis amnis	(pallid shiner)	*Fundulus dispar*	(starhead topminnow)
Ichthyomyzon fossor	(northern brook lamprey)	*Lampetra aepyptera*	(least brook lamprey)
Macrhybopsis gelida	(sturgeon chub)	*Lepomis miniatus*	(redspotted sunfish)
Moxostoma valenciennesi	(greater redhorse)	*Lepomis symmetricus*	(bantam sunfish)
Nocomis micropogon	(river chub)	*Moxostoma carinatum*	(river redhorse)
Notropis anogenus	(pugnose shiner)	*Notropis heterodon*	(blackchin shiner)
Notropis boops	(bigeye shiner)	*Notropis chalybaeus*	(ironcolor shiner)
Notropis heterolepis	(blacknose shiner)		
Notropis maculatus	(taillight shiner)	No mussel species listed	
Notropis texanus	(weed shiner)		
Noturus stigmosus	(northern madtom)		
Scaphirhynchus albus	(pallid sturgeon)*		
Orconectes indianenis	(Indiana crayfish)		
Orconectes kentuckiensis	(Kentucky crayfish)		
Orconectes lancifer	(shrimp crayfish)		
Orconectes placidus	(bigclaw crayfish)		
No mussel species listed			

* Federally listed species.

TABLE 3. NUMBER AND BIOMASS OF FISH COLLECTED DURING IMPINGEMENT SAMPLING AT UNITS 6, 7, AND 8 OF THE WAUKEGAN STATION, JULY 2003 - JUNE 2004

SPECIES	6				7				8				UNITS COMBINED			
	NUMBER CAUGHT		WEIGHT CAUGHT		NUMBER CAUGHT		WEIGHT CAUGHT		NUMBER CAUGHT		WEIGHT CAUGHT		NUMBER CAUGHT		WEIGHT CAUGHT	
	#	%	KG	%	#	%	KG	%	#	%	KG	%	#	%	KG	%
LONGNOSE GAR	--	--	--	--	1	0.00	0.005	0.00	--	--	--	--	1	0.00	0.005	0.00
BOWFIN	--	--	--	--	1	0.00	1.270	0.09	--	--	--	--	1	0.00	1.270	0.05
UNID CLUPEIDAE	1	0.00	0.017	0.01	39	0.02	0.089	0.01	13	0.01	0.021	0.00	53	0.01	0.127	0.01
ALEWIFE	39,272	98.93	227.649	95.64	201,179	96.31	1,323.504	88.69	120,271	97.50	638.038	94.23	360,721	96.99	2,189.191	90.94
GIZZARD SHAD	221	0.56	6.794	2.85	2,953	1.41	116.846	7.83	931	0.75	22.371	3.30	4,104	1.10	146.012	6.07
LAKE WHITEFISH	--	--	--	--	3	0.00	0.021	0.00	--	--	--	--	3	0.00	0.021	0.00
BLOATER	1	0.00	0.003	0.00	83	0.04	0.146	0.01	8	0.01	0.019	0.00	92	0.02	0.168	0.01
COHO SALMON	--	--	--	--	2	0.00	0.163	0.01	--	--	--	--	2	0.00	0.163	0.01
CHINOOK SALMON	--	--	--	--	20	0.01	1.783	0.12	3	0.00	1.036	0.15	23	0.01	2.819	0.12
RAINBOW TROUT	--	--	--	--	6	0.00	2.220	0.15	4	0.00	1.490	0.22	10	0.00	3.710	0.15
BROWN TROUT	1	0.00	0.034	0.01	13	0.01	4.413	0.30	12	0.01	1.294	0.19	26	0.01	5.741	0.24
BROOK TROUT	--	--	--	--	2	0.00	0.048	0.00	2	0.00	0.077	0.01	4	0.00	0.125	0.01
RAINBOW SMELT	14	0.04	0.011	0.00	101	0.05	0.470	0.03	53	0.04	0.155	0.02	168	0.05	0.636	0.03
CENTRAL MUDMINNOW	--	--	--	--	--	--	--	--	1	0.00	0.007	0.00	1	0.00	0.007	0.00
GOLDFISH	--	--	--	--	1	0.00	0.010	0.00	--	--	--	--	1	0.00	0.010	0.00
COMMON CARP	--	--	--	--	2	0.00	0.770	0.05	--	--	--	--	2	0.00	0.770	0.03
GOLDEN SHINER	1	0.00	0.009	0.00	8	0.00	0.059	0.00	3	0.00	0.046	0.01	12	0.00	0.114	0.00
EMERALD SHINER	--	--	--	--	1	0.00	0.003	0.00	--	--	--	--	1	0.00	0.003	0.00
SPOTTAIL SHINER	66	0.17	0.400	0.17	2,032	0.97	15.663	1.05	1,630	1.32	9.232	1.36	3,728	1.00	25.295	1.05
SPOTFIN SHINER	--	--	--	--	--	--	--	--	4	0.00	--	--	4	0.00	--	--
SAND SHINER	3	0.01	0.011	0.00	1	0.00	0.002	0.00	3	0.00	0.007	0.00	7	0.00	0.020	0.00
BLUNTNOSE MINNOW	--	--	--	--	2	0.00	0.003	0.00	1	0.00	0.005	0.00	3	0.00	0.008	0.00
FATHEAD MINNOW	--	--	--	--	4	0.00	0.013	0.00	2	0.00	0.006	0.00	6	0.00	0.019	0.00
LONGNOSE DACE	--	--	--	--	1	0.00	0.004	0.00	2	0.00	0.016	0.00	3	0.00	0.020	0.00
LONGNOSE SUCKER	--	--	--	--	1	0.00	0.640	0.04	--	--	--	--	1	0.00	0.640	0.03
WHITE SUCKER	5	0.01	2.568	1.08	28	0.01	14.896	1.00	23	0.02	1.733	0.25	56	0.02	19.167	0.80
BLACK BULLHEAD	--	--	--	--	4	0.00	0.147	0.01	1	0.00	0.066	0.01	5	0.00	0.213	0.01
YELLOW BULLHEAD	--	--	--	--	2	0.00	0.065	0.00	--	--	--	--	2	0.00	0.065	0.00
FLATHEAD CATFISH	--	--	--	--	1	0.00	0.980	0.07	--	--	--	--	1	0.00	0.980	0.04
TROUT-PERCH	--	--	--	--	4	0.00	0.022	0.00	3	0.00	0.022	0.00	7	0.00	0.044	0.00
BANDED KILLIFISH	1	0.00	0.005	0.00	2	0.00	0.008	0.00	5	0.00	0.015	0.00	8	0.00	0.028	0.00
THREESPINE STICKLEBACK	93	0.23	0.126	0.05	2,190	1.05	4.137	0.28	230	0.19	0.330	0.05	2,514	0.68	4.593	0.19
NINESPINE STICKLEBACK	8	0.02	0.020	0.01	62	0.03	0.142	0.01	29	0.02	0.053	0.01	100	0.03	0.215	0.01
ROCK BASS	--	--	--	--	2	0.00	0.122	0.01	2	0.00	0.032	0.00	4	0.00	0.154	0.01
GREEN SUNFISH	1	0.00	0.002	0.00	5	0.00	0.015	0.00	3	0.00	0.013	0.00	9	0.00	0.030	0.00
PUMPKINSEED	--	--	--	--	3	0.00	0.148	0.01	1	0.00	0.026	0.00	4	0.00	0.174	0.01
WARMOUTH	--	--	--	--	1	0.00	0.018	0.00	--	--	--	--	1	0.00	0.018	0.00
BLUEGILL	3	0.01	0.153	0.06	17	0.01	0.326	0.02	19	0.02	0.489	0.07	39	0.01	0.968	0.04
SMALLMOUTH BASS	1	0.00	0.005	0.00	48	0.02	0.690	0.05	49	0.04	0.227	0.03	98	0.03	0.922	0.04
LARGEMOUTH BASS	--	--	--	--	8	0.00	0.986	0.07	10	0.01	0.065	0.01	18	0.00	1.051	0.04
BLACK CRAPPIE	--	--	--	--	1	0.00	0.026	0.00	1	0.00	0.043	0.01	2	0.00	0.069	0.00
JOHNNY DARTER	--	--	--	--	--	--	--	--	2	0.00	0.086	0.00	2	0.00	0.006	0.00
YELLOW PERCH	5	0.01	0.213	0.09	37	0.02	0.881	0.06	17	0.01	0.058	0.01	59	0.02	1.152	0.05
FRESHWATER DRUM	--	--	--	--	1	0.00	0.460	0.03	--	--	--	--	1	0.00	0.460	0.02
MOTTLED SCULPIN	--	--	--	--	9	0.00	0.103	0.01	11	0.01	0.114	0.02	20	0.01	0.217	0.01
DEEPWATER SCULPIN	--	--	--	--	1	0.00	0.002	0.00	--	--	--	--	1	0.00	0.002	0.00
TOTAL FISH	39,697	100.00	238.020	100.00	208,882	100.00	1,492.320	100.00	123,349	100.00	677.081	100.00	371,928	100.00	2,407.421	100.00
TOTAL SPECIES	16				42				32				45			

NOTE: 0.00 DENOTES VALUES LESS THAN 0.05.

APPENDIX A

REQUEST FOR CONSULTATION AGENCY ACTION REPORT

EA Engineering, Science, and Technology

444 Lake Cook Road, Suite 18
Deerfield, IL 60015
Telephone: 847-945-8010
Fax: 847-945-0296

May 4, 2005

Mr. Mike Branham
Division of Resource Review and Coordination
Illinois Department of Natural Resources
One Natural Resources Way
Springfield, Illinois 92702-1271

Re: Consultation Agency Action Report for Threatened and Endangered Species at Midwest Generation's Waukegan Generating Station, Waukegan, Illinois NPDES Permit IL 0002259

Dear Mr. Branham:

On behalf of Midwest Generation EME, LLC, enclosed is an application for a Consultation Agency Action Report for threatened and endangered aquatic species that may occur in the vicinity of the cooling water intake for the Waukegan Generating Station. The facility is located on Lake Michigan to the north of Waukegan Harbor. Also enclosed is an aerial photo of Waukegan Station with a map indicating the site location.

Our request for this Action Report is prompted by the United States Environmental Protection Agency's (USEPA) July 9, 2004 publication of "National Pollutant Discharge Elimination System – Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities" as a supplement to Section 316(b) of the Clean Water Act (CWA). The Phase II Rule established performance standards for cooling water intake structures requiring reductions in entrainment (60 to 90%) and/or impingement mortality (80 to 90%).

The first step in the process is the submittal of a Proposal for Information Collection (PIC) to the Illinois Environmental Protection Agency (IEPA). The PIC indicates what data will be collected and/or evaluated to determine compliance with the performance standards. At this stage of the process, Midwest Generation will be evaluating various operational, technological, and restorative options aimed at addressing the performance standard for both fish impingement and entrainment. No construction activities will be undertaken at this initial stage.

As the licensing agency responsible for review and compliance with the Phase II Rule, Illinois Environmental Protection Agency (IEPA) has stated that a Consulting Agency

Action Report should be included with our Proposal for Information Collection (PIC) when submitted to IEPA within the next 30 days. Thus, the reason for this request.

Once any needed studies are completed and reviews are completed, Midwest Generation will decide what options they plan to use to meet the performance standards. The plans(s) and supporting information are required to be submitted to IEPA in the CDS (Comprehensive Demonstration Study) on or before Jan 7, 2008. Once IEPA has reviewed the CDS and approved the plans, the NPDES permit will include a compliance schedule. If any construction activities are required, it is likely that they would not begin until 2009 or later.

If you have any questions regarding this request or require any additional information, please contact me at (847) 945-8010.

Sincerely,

Rich Monzingo

Richard Monzingo Ph.D.
Senior Project Manager

Enclosures: Consultation Agency Action Report Application
Aerial photo of Waukegan Generating Station

Cc: Julia Wozniak, Midwest Generation

Illinois Department of
Natural Resources
One Natural Resources Way - Springfield, Illinois 62702-1271
http://dnr.state.il.us

Rod R. Blagojevich, Governor
Joel Brunsvold, Director

CONSULTATION AGENCY ACTION REPORT

(Illinois Administrative Code Title 17 Part 1075)
Division of Resource Review and Coordination
Todd Rettig, Division Manager

Date Submitted: May 04, 2005
If this is a resubmittal, include previous IDNR response if available.

FOR DEPARTMENT USE ONLY
PROJCODE: ____________ DUE DATE: ____________

Applicant: EA Engineering, Science, and Technolgy for Midwest Generation, LLC
Contact Person: Dr. Richard Monzingo ______________________
Applicant Address: 444 Lake Cook Road Suite 18
______________ Deerfield, Il 60015
Phone: 847 945-8010
Fax: 847 945-0296
Email: rmonzing@eaest.com

LOCATION OF PROPOSED ACTION

~~A MAP SHOWING LOCATION OF PROPOSED ACTION IS REQUIRED~~

Project Name: Waukegan Generating Station ____________ County: Lake County ______________
Project Address (if available): 10 Greenwood Ave ______________________________
City, State, Zip: Waukegan, Il 60087 ______________________________
Township/Range/Section (e.g. T45N,R9E,S2): the Waukegan Station intake is at lat./long. 42°, 22', 58"N; 87°, 48', 56"W
Brief Description of Proposed Action: A Proposal for Information Collection (PIC) needs to be submitted to the IEPA for approval. The IEPA needs to review the document and decide to approve, modify, or reject. The document discusses how Midwest Generation may comply with the Phase II performance standards for cooling water intake structures and studies
Projected Start Date and End Date of Proposed Action: Submit PIC May 2005, IEPA Approve PIC Summer 2005___
Will state funds or technical assistance support this action? [I No] If Yes, the Interagency Wetland Policy Act may apply. Contact funding agency or this Division for details.

Local/State Agency with Project Jurisdiction: Illinois Environmental Protection Agency ______________
Contact: Mr. Mark Joseph ______________ Phone: 217 558 0416 ______________
Address: 1021 North Grand Ave. Springfield, Il 62794-9276 _____ Fax: 217 785 1255 ______________

FOR DEPARTMENT USE ONLY

Are endangered/threatened species or Natural Areas present in the vicinity of the action? [Yes | No]
Could the proposed action adversely affect the endangered/threatened species or Natural Area? [Yes | No]
Is consultation terminated? [Yes | No]
Comments: ______________________________

____

Evaluated by:

______________________________ ______________
Division of Resource Review & Coordination (217)785-5500 Date

Visit our website at http://dnr.state.il.us/orep/NRRC

Printed on recycled and recyclable paper

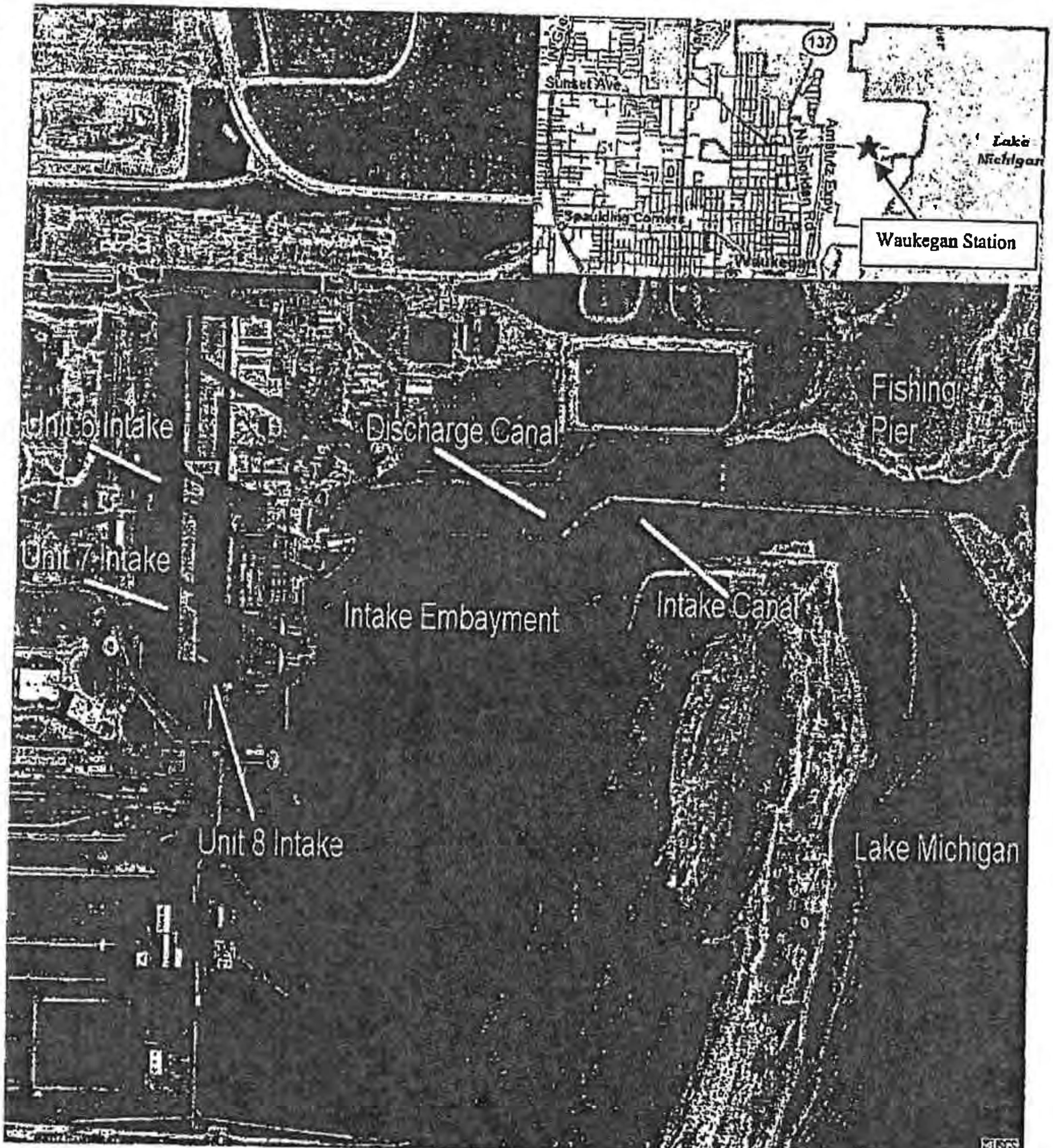


Figure 1. Waukegan Station Intake and Discharge Area

CERTIFICATE OF SERVICE

I hereby certify that the foregoing **Petitioners' Exhibits for Hearing** was served to all parties of record listed below via mail and electronic mail, on September 30, 2016.

Matthew Glover
Legal Assistant
Environmental Law and Policy Center
35 E Wacker Drive. Suite 1600
Chicago, Illinois 60601
312-795-3719

PCB 15-189 SERVICE LIST:

Bradley P. Halloran, Hearing Officer
Illinois Pollution Control Board
100 West Randolph Street, Suite 11-500
Chicago, IL 60601

Susan M. Franzetti
Vincent R. Angermeier
Nijman Franzaetti LLP
10 South LaSalle Street, Suite 3600
Chicago, IL 60603

Robert W. Petti
Angad Nagra
Office of the Attorney General
69 West Washington Street, Suite 1800
Chicago, IL 60602

Greg Wannier
Sierra Club
2101 Webster Street, Suite 1300
Oakland, CA, 94612

Midwest Generation, LLC
401 East Greenwood Avenue
Waukegan, IL 60087