National Pollutant Discharge Elimination System (NPDES) Permit Program

FACT SHEET

Regarding an NPDES Permit to Discharge to Waters of the State of Ohio
for American Electric Power

Public Notice No.: 14-03-047
Public Notice Date: March 26, 2014
Comment Period Ends: April 25, 2014

Ohio EPA Permit No.: **0IB00003*PD**
Application No.: **OH0006149**

<u>Name and Address of Applicant:</u>

American Electric Power
Plant
1 Riverside Plaza
Columbus, Ohio 43215

<u>Name and Address of Facility Where Discharge Occurs:</u>

AEP Generation Resources – Muskingum River

1501 Sparling Road
Waterford, Ohio 45786

Receiving Water:
Muskingum River

Subsequent
Stream Network: **Ohio River**

<u>Introduction</u>

Development of a Fact Sheet for NPDES permits is mandated by Title 40 of the Code of Federal Regulations (CFR), Section 124.8 and 124.56. This document fulfills the requirements established in those regulations by providing the information necessary to inform the public of actions proposed by the Ohio Environmental Protection Agency (Ohio EPA), as well as the methods by which the public can participate in the process of finalizing those actions.

This Fact Sheet is prepared in order to document the technical basis and risk management decisions that are considered in the determination of water quality based NPDES Permit effluent limitations. The technical basis for the Fact Sheet may consist of evaluations of promulgated effluent guidelines, existing effluent quality, instream biological, chemical and physical conditions, and the relative risk of alternative effluent limitations. This Fact Sheet details the discretionary decision-making process empowered to the Director by the Clean Water Act (CWA) and Ohio Water Pollution Control Law (Ohio Revised Code [ORC] 6111). Decisions to award variances to Water Quality Standards (WQS) or promulgated effluent guidelines for economic or technological reasons will also be justified in the Fact Sheet where necessary.

Effluent limits based on available treatment technologies are required by Section 301(b) of the CWA. Many of these have already been established by the United States Environmental Protection Agency (U.S. EPA) in the effluent guideline regulations (a.k.a. categorical regulations) for industry categories in 40 CFR Parts 405-499. Technology-based regulations for publicly-owned treatment works are listed in the Secondary Treatment Regulations (40 CFR Part 133). If regulations have not been established for a category of dischargers, the director may establish technology-based limits based on best professional judgment (BPJ).

Ohio EPA reviews the need for water-quality-based limits on a pollutant-by-pollutant basis. Wasteload allocations (WLAs) are used to develop these limits based on the pollutants that have been detected in the discharge, and the receiving water's assimilative capacity. The assimilative capacity depends on the flow in the water receiving the discharge, and the concentration of the pollutant upstream. The greater the upstream flow, and the lower the upstream concentration, the greater the assimilative capacity is. Assimilative capacity may represent dilution (as in allocations for metals), or it may also incorporate the break-down of pollutants in the receiving water (as in allocations for oxygen-demanding materials).

The need for water-quality-based limits is determined by comparing the WLA for a pollutant to a measure of the effluent quality. The measure of effluent quality is called Projected Effluent Quality (PEQ). This is a statistical measure of the average and maximum effluent values for a pollutant. As with any statistical method, the more data that exists for a given pollutant, the more likely that PEQ will match the actual observed data. If there is a small data set for a given pollutant, the highest measured value is multiplied by a statistical factor to obtain a PEQ; for example if only one sample exists, the factor is 6.2, for two samples - 3.8, for three samples - 3.0. The factors continue to decline as samples sizes increase. These factors are intended to account for effluent variability, but if the pollutant concentrations are fairly constant, these factors may make PEQ appear larger than it would be shown to be if more sample results existed.

Summary of Permit Conditions

American Electric Power submitted a request with their renewal application to make the following changes in the new permit:

1. There have been no discharges through Outfall 013 since pumps were installed in 1998 to redirect all storm water flow from this area; however, since there is still a chance of an emergency discharge through Outfall 013 American Electric Power requests that monitoring requirements for Outfall 013 be excluded from this permit rather that removal of Outfall 013 from all permit language.
   Ohio EPA left the table for Outfall 013 in the permit, however monitoring frequencies at this station have been changed to "when discharging".

2. American Electric Power requests that language in the Thermal Management Plan be changed to specifically state the maximum river temperature values to the tenth degree at station 0IB00003901.
   This change has been made.

3. American Electric Power requests a renewal of the 316 (a) thermal discharge variance that was originally granted on June 1, 1994.
   Ohio EPA has granted the renewal.

4. American Electric Power requests a renewal of the 316 (b) determination that was based on the previously submitted 316 (b) demonstration.
   Ohio EPA has evaluated this information, and at this time, has determined that the cooling water intake structure represents BTA in accordance with Section 316(b) of the Clean Water Act.

5. For Outfalls 009, 012, 013 and 014, American Electric Power requests a footnote language change from " These outfalls shall be limited to storm runoff free from industrial or process-related contaminants present due to plant operations" to " These outfalls shall be limited to storm

runoff free from industrial or process-related contaminants present due to plant operations with the following exceptions: discharges from fire fighting activities; fire hydrant flushings; potable water sources including waterline flushings; irrigation drainage; lawn watering; routine external building wash down which does not use detergents; pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred and where detergents are not used; air conditioning condensate; uncontaminated boiler condensate; springs; uncontaminated ground water; and foundation of footing drains where flows are not contaminated by industrial activity."
This change has been made.

6. The period for monitoring and reporting temperature and flow rate at Outfall 801 is "Summer", specifically the months of May 1 to October 31. American Electric Power requests that this monitoring period be changed to specifically state "Water temperature limitations and monitoring requirements apply June 1 to October 15. Daily temperature values are to be determined in accordance with the thermal management plan contained in Part II." This would make the monitoring period consistent with the monitoring period requirements of the downstream monitoring period and thermal management plan.
This change has been made.

7. American Electric Power requests the continuation of reporting Exclusion 2 for the following hazardous substances present at the Muskingum River Plant in excess of EPA's reportable quantity: ammonium hydroxide, calcium hypochlorite, sodium bisulfite, sodium hydroxide, sodium hypochlorite and sulfuric acid.
Consistent with Exclusion 2 of Section 311 of the Clean Water Act, American Electric Power is still relieved of the reporting requirements for the parameters above in the proposed permit.

Outfall 0IB00003001
The effluent limits and monitoring requirements proposed for all parameters are the same as in the current permit, although total residual oxidants, total residual chlorine and chlorination/bromination duration have been removed and a footnote prohibiting chlorination/dechlorination has been added.

Outfall 0IB00003002
The effluent limits and monitoring requirements proposed for pH, oil and grease, ammonia, zinc, copper, flow rate, chlorine and mercury are the same as in the current permit.

New monitoring is proposed for total filterable residue.

A slightly lower daily maximum limit is propose for total suspended solids because the FEG daily maximum limit for coal pile run off was taken into account when calculating the limit.

Current monitoring requirements for whole effluent toxicity (WET) are being removed from the permit because AEP Generation Resources – Muskingum River Plant (Muskingum River Plant) is placed in Category 4 with respect to whole effluent toxicity. Monitoring is not required for facilities placed in Category 4.

Outfall 0IB00003003
The effluent limits and monitoring requirements proposed for pH, total suspended solids, oil and grease and flow rate are the same as in the current permit.

A new daily maximum limit is proposed for chlorine because effluent data show there is reasonable potential for violation of water quality standards.

New monitoring is proposed for zinc.

Outfalls 0IB00003007, 0IB00003008, 0IB00003009, 0IB00003012 and 0IB00003013
The effluent limits and monitoring requirements proposed for all parameters are the same as in the current permit, although some monitoring frequencies have changed.

0IB00003014
Outfall 0IB00003014 has been removed from the draft permit. As part of the facility's expansion of the 138 kV Substation, Outfall 014 was removed and no longer is a point source discharge.

0IB00003602
The effluent limits and monitoring requirements proposed for flow, TSS, fecal coliform and $CBOD_5$ are the same as in the current permit. New limits are proposed for pH, based on 40 CFR 133.

0IB00003603
Outfall 0IB00003603 has been removed from the draft permit. The sewage treatment plant no longer functions as a treatment facility and there has been no discharge since October 2012.

In Part II of the permit, special conditions are included that address storm water compliance, outfall signage and section 316 (b) compliance.

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<u>Procedures for Participation in the Formulation of Final Determinations</u>

The draft action shall be issued as a final action unless the Director revises the draft after consideration of the record of a public meeting or written comments, or upon disapproval by the Administrator of the U.S. Environmental Protection Agency.

Within thirty days of the date of the Public Notice, any person may request or petition for a public meeting for presentation of evidence, statements or opinions. The purpose of the public meeting is to obtain additional evidence. Statements concerning the issues raised by the party requesting the meeting are invited. Evidence may be presented by the applicant, the state, and other parties, and following presentation of such evidence other interested persons may present testimony of facts or statements of opinion.

Requests for public meetings shall be in writing and shall state the action of the Director objected to, the questions to be considered, and the reasons the action is contested. Such requests should be addressed to:

Legal Records Section
Ohio Environmental Protection Agency
P.O. Box 1049
Columbus, Ohio 43216-1049

Interested persons are invited to submit written comments upon the discharge permit. Comments should be submitted in person or by mail no later than 30 days after the date of this Public Notice. Deliver or mail all comments to:

Ohio Environmental Protection Agency
Attention: Division of Surface Water
Permits Processing Unit
P.O. Box 1049
Columbus, Ohio 43216-1049

The Ohio EPA permit number and Public Notice numbers should appear on each page of any submitted comments. All comments received no later than 30 days after the date of the Public Notice will be considered.

Citizens may conduct file reviews regarding specific companies or sites. Appointments are necessary to conduct file reviews, because requests to review files have increased dramatically in recent years. The first 250 pages copied are free. For requests to copy more than 250 pages, there is a five-cent charge for each page copied. Payment is required by check or money order, made payable to Treasurer State of Ohio.

For additional information about this fact sheet or the draft permit, contact Ashley Ward, (614) 644-4852, Ashley.Ward@epa.ohio.gov.

Information Regarding Certain Water Quality Based Effluent Limits

This draft permit may contain proposed water quality based effluent limitations for parameters that **are not** priority pollutants. (See the following link for a list of the priority pollutants: http://epa.ohio.gov/portals/35/pretreatment/Pretreatment_Program_Priority_Pollutant_Detection_Limits.pdf .) In accordance with ORC Section 6111.03(J)(3), the Director established these water quality based effluent limits after considering, to the extent consistent with the Federal Water Pollution Control Act, evidence relating to the technical feasibility and economic reasonableness of removing the polluting properties from those wastes and to evidence relating to conditions calculated to result from that action and their relation to benefits to the people of the state and to accomplishment of the purposes of this chapter. This determination was made based on data and information available at the time the permit was drafted, which included the contents of the timely submitted NPDES permit renewal application, along with any and all pertinent information available to the Director.

This public notice allows the permittee to provide to the Director for consideration during this public comment period additional site-specific pertinent and factual information with respect to the technical feasibility and economic reasonableness for achieving compliance with the proposed final effluent limitations for these parameters. The permittee shall deliver or mail this information to:

Ohio Environmental Protection Agency
Attention: Division of Surface Water
Permits Processing Unit
P.O. Box 1049
Columbus, Ohio 43216-1049

Should the applicant need additional time to review, obtain or develop site-specific pertinent and factual information with respect to the technical feasibility and economic reasonableness of achieving compliance with these limitations, written notification for any additional time shall be sent to the above address no later than 30 days after the Public Notice Date on Page 1.

Should the applicant determine that compliance with the proposed water quality based effluent limitations for parameters other than the priority pollutants is technically and/or economically unattainable, the permittee may submit an application for a variance to the applicable water quality standard(s) used to develop the proposed effluent limitation in accordance with the terms and conditions set forth in Ohio Administrative Code (OAC) Rule 3745-33-07(D). The permittee shall submit this application to the above address no later than 30 days after the Public Notice Date.

Alternately, the applicant may propose the development of site-specific WQS pursuant to OAC 3745-1-35. The permittee shall submit written notification regarding their intent to develop site specific water quality standards for parameters that are not priority pollutants to the above address no later than 30 days after the Public Notice Date.

Location of Discharge/Receiving Water Use Classification

Muskingum River Plant's primary outfalls discharge to Muskingum River at River Mile (RM) 29. There are two emergency overflow outfalls that discharge to Millstone Creek and an unnamed tributary to Millstone Creek. In the past five years there has been no discharge to Millstone Creek or the unnamed tributary to Millstone Creek. Figure 1 shows the approximate location of the facility.

This segment of the Muskingum River is described by Ohio EPA River Code: 17-001, U.S. EPA River Reach #: 05040004-011, County: Washington, Ecoregion: Western Allegheny Plateau. The Muskingum River is designated for the following uses under Ohio's WQS (OAC 3745-1-24): Warmwater Habitat (WWH), Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Class A Primary Contact Recreation (PCR).

Use designations define the goals and expectations of a waterbody. These goals are set for aquatic life protection, recreation use and water supply use, and are defined in the Ohio WQS (OAC 3745-1-07). The use designations for individual waterbodies are listed in rules -08 through -32 of the Ohio WQS. Once the goals are set, numeric WQS are developed to protect these uses. Different uses have different water quality criteria.

Use designations for aquatic life protection include habitats for coldwater fish and macroinvertebrates, warmwater aquatic life and waters with exceptional communities of warmwater organisms. These uses all meet the goals of the federal CWA. Ohio WQS also include aquatic life use designations for waterbodies which cannot meet the CWA goals because of human-caused conditions that cannot be remedied without causing fundamental changes to land use and widespread economic impact. The dredging and clearing of some small streams to support agricultural or urban drainage is the most common of these conditions. These streams are given Modified Warmwater or Limited Resource Water designations.

Recreation uses are defined by the depth of the waterbody and the potential for wading or swimming. Uses are defined for bathing waters, swimming/canoeing (PCR) and wading only (Secondary Contact - generally waters too shallow for swimming or canoeing).

Water supply uses are defined by the actual or potential use of the waterbody. Public Water Supply designations apply near existing water intakes so that waters are safe to drink with standard treatment. Most other waters are designated for agricultural and industrial water supply.

Facility Description

Muskingum River Plant is a pulverized coal-fired steam electric generating facility consisting of five units with a total generating capacity of 1425 megawatts. The process operations at this facility are defined by the standard industrial classification (SIC) category 4911 – Electric Services. The wastewaters are regulated by the federal effluent guidelines (FEG) listed in 40 CFR Part 423, Steam Electric Power Generating Point Source Category. See Table 1 for the applicable FEG and calculations.

American Electric Power has planned to shut down the Muskingum River Plant in mid-2015. Two units have been shut done since August 2012 and a third unit is operating at a reduced generation rate.

Description of Existing Discharge

The Muskingum River Plant has a total of nine outfalls which discharge directly to the Muskingum River or a small tributary of the Muskingum River. In addition, there are three internal outfalls.

Outfall 0IB00003001

Outfall 0IB00003001 discharges cooling water from condenser units 1 through 4 to the Muskingum River. From September 2008 through August 2013 the mean flow was 530.9 million gallons per day (MGD) and the 50th percentile flow was 532.79 MGD. Treatment prior to discharge includes screening, disinfection and dechlorination. Wastewater from this outfall is regulated by FEG listed in 40 CFR 423.13 (b).

Outfall 0IB00003002

Outfall 0IB00003002 discharges water from unit 5 ash pond to the Muskingum River. This pond receives flow from fly ash, bottom ash, cooling tower blowdown, coal pile runoff, intermittent discharge from the metal cleaning waste tank, storm water and treated sanitary wastewater. From September 2008 through August 2013 the mean flow was 4.10 MGD and the 50th percentile flow was 4.32 MGD. Treatment prior to discharge includes sedimentation, neutralization, chemical oxidation, chemical precipitation, reuse and skimming. Wastewater from cooling tower blowdown, which is ultimately discharged through this outfall is regulated by 40 CFR 423.13(d)(1). Wastewater from this outfall is regulated by FEG listed in 40 CFR 423.12(b).

Outfall 0IB00003003

Outfall 0IB00003003 discharges water from units 1-4 bottom ash pond to the Muskingum River. This pond receives flow from units 1-4 bottom ash sluice and units 1-4 wastewater and treated sanitary wastewater. From September 2008 through August 2013 the mean flow was 4.68 MGD and the 50^{th} percentile flow was 4.75 MGD. Treatment prior to discharge includes sedimentation, neutralization, chemical oxidation, chemical precipitation and skimming. Wastewater from this outfall is regulated by FEG listed in 40 CFR 123.12(b)(4).

Outfalls 0IB00003007 and 0IB00003008

Outfalls 0IB00003007 and 0IB00003008 are emergency overflow discharges from collection ponds for seepage from the two ash ponds. Outfall 0IB00003007 discharges to an unnamed tributary to Millstone Creek and outfall 0IB00003008 discharges to Millstone Creek. Seepage collected is normally pumped back into the fly ash pond and subsequently discharged through outfall 0IB00003002. From September 2008 through August 2013 there have been no discharges from either outfall. Treatment prior to discharge includes sedimentation and neutralization. Wastewater from these outfalls is regulated by FEG listed in 40 CFR 123.12(b)(4).

Outfalls 0IB00003009, 0IB00003012 and 0IB00003013

Outfalls 0IB00003009, 0IB00003012 and 0IB00003013 are stormwater outfalls that discharge to the Muskingum River. From September 2008 through August 2013 the mean flow from 0IB00003009 was 0.0035MGD and the mean flow from 0IB00003012 was 0.000926.

Outfall 0IB00003602

Outfalls 0IB00003602 is an internal outfall that discharges water from the unit 5 sewage treatment plant. From September 2008 through August 2013 the mean flow from outfall 0IB00003002 was 3,290 gallons per day (GPD). Treatmentprior to discharge includes grinding, screening, pre-aeration, aerobic digestion, activated sludge, flocculation, sedimentation and chlorine disinfection.

The facility obtains its water for cooling purposes from an intake located in the Muskingum River.

Table 2 represents chemical specific data compiled from the NPDES renewal application and data collected by Ohio EPA for outfalls 0IB00003002 and 0IB00003003.

Table 3 presents a summary of unaltered Discharge Monitoring Report (DMR) data for outfalls 0IB00003002, 0IB00003003, 0IB00003009 and 0IB00003012. Data are presented for the period September 2008 through August 2013, and current permit limits are provided for comparison.

Table 4 summarizes the chemical specific data for outfalls 0IB00003002 and 0IB00003003 by presenting the average and maximum PEQ values.

Tables 5 and 6 summarize the results of WET tests of outfall 0IB00003002 effluent.

<u>Assessment of Impact on Receiving Waters</u>

An assessment of the impact of a permitted point source on the immediate receiving waters includes an evaluation of the available chemical/physical, biological, and habitat data which have been collected by Ohio EPA pursuant to the Five-Year Basin Approach for Monitoring and NPDES Reissuance. Other data may be used provided it was collected in accordance with Ohio EPA methods and protocols as specified by the Ohio WQS and Ohio EPA guidance documents. Other information which may be evaluated includes, but is not limited to: NPDES permittee self-monitoring data; effluent and mixing zone bioassays conducted by Ohio EPA, the permittee, or U.S. EPA.

In evaluating this data, Ohio EPA attempts to link environmental stresses and measured pollutant exposure to the health and diversity of biological communities. Stresses can include pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. Indicators of exposure to these stresses include WET tests, fish tissue chemical data, and fish health biomarkers (for example, fish blood tests).

Use attainment is a term which describes the degree to which environmental indicators are either above or below criteria specified by the Ohio WQS (OAC 3745-1). Assessing use attainment status for aquatic life uses primarily relies on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These criteria apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on measuring several characteristics of the fish and macroinvertebrate communities; these characteristics are combined into multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which indicate the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numerical criteria are broken down by ecoregion, use designation, and stream or river size. Ohio has five ecoregions defined by common topography, land use, potential vegetation and soil type.

Three attainment status results are possible at each sampling location -full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails meet the biocriteria. Nonattainment means that either none of the applicable indices meet the biocriteria or one of the organism groups indicates poor or very poor performance. An aquatic life use attainment table (see Table 7) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (i.e., full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location.

During 2006, Ohio EPA conducted a water resource assessment of the entire 112 miles of the Muskingum River. The Muskingum River is in full attainment downstream of the Muskingum River Plant. However, the temperature results between upstream and downstream of the Muskingum River Plant are substantially different. Nearly all of the August downstream temperature results exceeded the maximum temperature criterion. The fish community downstream of Muskingum River Plant is rated as "very good" and the macroinvertebrate community is rated as "exceptional" when a mid sample was taken and "fair" when an edge sample was taken. For more information please see the *2006 Biological and Water Quality Study of Muskingum River*, located at: http://epa.ohio.gov/portals/35/documents/MuskingumTSD2007.pdf.

Development of Water-Quality-Based Effluent Limits

Determining appropriate effluent concentrations is a multiple-step process in which parameters are identified as likely to be discharged by a facility, evaluated with respect to Ohio water quality criteria, and examined to determine the likelihood that the existing effluent could violate the calculated limits.

Parameter Selection Effluent data for the Muskingum River Plant were used to determine what parameters should undergo WLA. The parameters discharged are identified by the data available to Ohio EPA DMR data submitted by the permittee, compliance sampling data collected by Ohio EPA, and any other data submitted by the permittee, such as priority pollutant scans required by the NPDES application or by pretreatment, or other special conditions in the NPDES permit. The sources of effluent data used in this evaluation are as follows:

Self-monitoring data (DMR)	September 2008 through August 2013
NPDES Application data	January 2011
Ohio EPA compliance sampling data	November 2009

This data is evaluated statistically, and PEQ values are calculated for each pollutant. Average PEQ (PEQ_{avg}) values represent the 95th percentile of monthly average data, and maximum PEQ (PEQ_{max}) values represent the 95th percentile of all data points. The average and maximum PEQ values are presented in Table 4.

The PEQ values are used according to Ohio rules to compare to applicable WQS and allowable WLA values for each pollutant evaluated. Initially, PEQ values are compared to the applicable average and maximum WQS. If both PEQ values are less than 25 percent of the applicable WQS, the pollutant does not have the reasonable potential to cause or contribute to exceedances of WQS, and no WLA is done for that parameter. If either PEQ_{avg} or PEQ_{max} is greater than 25 percent of the applicable WQS, a WLA is conducted to determine whether the parameter exhibits reasonable potential and needs to have a limit or if monitoring is required. See Tables 8A and 8B for summaries of the screening results for outfalls 0IB00003002 and 0IB00003003, respectively.

Wasteload Allocation For those parameters that require a WLA, the results are based on the uses assigned to the receiving waterbody in OAC 3745-1. Dischargers are allocated pollutant loadings/concentrations based on the Ohio WQS (OAC 3745-1). Most pollutants are allocated by a mass-balance method because they do not degrade in the receiving water. WLAs using this method are done using the following general equation: Discharger WLA = (downstream flow x WQS) - (upstream flow x background concentration). Discharger WLAs are divided by the discharge flow so that the allocations are expressed as concentrations.

The applicable waterbody uses for this facility's discharge and the associated stream design flows are as follows:

Aquatic life (WWH)		
Toxics (metals, organics, etc.)	Average	Annual 7Q10
	Maximum	Annual 1Q10
Ammonia	Average	Summer 30Q10
		Winter 30Q10
AWS		Harmonic mean flow
Human Health (nondrinking)		Harmonic mean flow

Allocations are developed using a percentage of stream design flow as specified in Tables 9A and 9B, and allocations cannot exceed the Inside Mixing Zone Maximum (IMZM) criteria.

Ohio's WQS implementation rules [OAC 3745-2-05(A)(2)(d)(iv)] required a phase out of mixing zones for bioaccumulative chemicals of concern (BCCs) as of November 15, 2010. This rule applied statewide. Mercury is a BCC. The mixing zone phase-out means that as of November 15, 2010 all dischargers requiring mercury limits in their NPDES permit must meet WQS at the end-of-pipe, which are 12 mg/L (average) and 1700 mg/L (maximum) in the Ohio River basin .

The draft permit contains a thermal management plan in accordance with the provisions in ORC 6111.031 (b). The thermal management plan was developed as a part of the 316(a) variance granted on June 1,

1994. The thermal management plan was continued in the permit renewals that occurred prior to this renewal. Because the Muskingum River Plant is shutting down in mid-2015, a new 316(a) demonstration is not required. However, if the Muskingum River Plant remains open, a new 316(a) demonstration is required to be submitted with the next permit application.

PEQs have been calculated for the thermal load of the water discharged from Outfall 001 and are compared to the temperature standards found in OAC Rule 3745-1 for the Muskingum River. The calculations are summarized in Attachment I.

The PEQs for both the average and maximum temperature are 75% or greater than the average and maximum temperature standards for the Muskingum River. The Muskingum River Plant therefore has reasonable potential to exceed temperature standards on the Muskingum River, and relief under the Section 316 (a) is proposed to be continued.

The data used in the WLA are listed in Tables 9A, 9B and 10. The WLA results to maintain all applicable criteria are presented in Table 11. The current ammonia data has been evaluated using the wasteload allocation procedures and no limits are necessary to be protective of WQS for ammonia toxicity

Whole Effluent Toxicity WLA WET is the total toxic effect of an effluent on aquatic life measured directly with a toxicity test. Acute WET measures short term effects of the effluent while chronic WET measures longer term and potentially more subtle effects of the effluent.

WQS for WET are expressed in Ohio's narrative "free from" WQS rule [OAC 3745-1-04(D)]. These "free froms" are translated into toxicity units (TUs) by the associated WQS Implementation Rule (OAC 3745-2-09). WLAs can then be calculated using TUs as if they were water quality criteria.

The WLA calculations for WET are similar to those for aquatic life criteria - using the chronic toxicity unit (TU_c) and 7Q10 flow for the average and the acute toxicity unit (TU_a) and 1Q10 flow for the maximum. These values are the levels of effluent toxicity that should not cause instream toxicity during critical low-flow conditions. For Muskingum River Plant outfall 0IB00003002, the WLA values are 42.24 TU_a and 115.19 TU_c.

The chronic toxicity unit (TU_c) is defined as 100 divided by the estimate of the effluent concentration which causes a 25% reduction in growth or reproduction of test organisms (IC_{25}):

$$TU_c = 100/IC_{25}$$

This equation applies outside the mixing zone for warmwater, modified warmwater, exceptional warmwater, coldwater, and seasonal salmonid use designations except when the following equation is more restrictive (*Ceriodaphnia dubia* only):

$$TU_c = 100/\text{geometric mean of No Observed Effect Concentration and Lowest Observed Effect Concentration}$$

The acute toxicity unit (TU_a) is defined as 100 divided by the concentration in water having 50% chance of causing death to aquatic life (LC_{50}) for the most sensitive test species:

$$TU_a = 100/LC_{50}$$

This equation applies outside the mixing zone for warmwater, modified warmwater, exceptional warmwater, coldwater, and seasonal salmonid use designations.

<u>Reasonable Potential/ Effluent Limits/Hazard Management Decisions</u>

After appropriate effluent limits are calculated, the reasonable potential of the discharger to violate the WQS must be determined. Each parameter is examined and placed in a defined "group". Parameters that do not have a WQS or do not require a WLA based on the initial screening are assigned to either group 1 or 2. For the allocated parameters, the preliminary effluent limits (PEL) based on the most restrictive average and maximum WLAs are selected from Table 11. The average PEL (PEL_{avg}) is compared to the average PEQ (PEQ_{avg}) from Table 4, and the PEL_{max} is compared to the PEQ_{max}. Based on the calculated percentage of the allocated value [($PEQ_{avg} \div PEL_{avg}$) X 100, or ($PEQ_{max} \div PEL_{max}$) X 100)], the parameters are assigned to group 3, 4, or 5. The groupings are listed in Tables 8A and 8B.

The final effluent limits are determined by evaluating the groupings in conjunction with other applicable rules and regulations.

Outfall 0IB00003001
Table 12A presents the final effluent limits and monitoring requirements proposed for Muskingum River Plant outfall 0IB00003001 and the basis for their recommendation.

Water temperature, thermal discharge and flow rate
Monitoring for water temperature, thermal discharge and flow rate are proposed to continue from the existing permit. Although the data show that the thermal WLA is exceeded, this section of the Muskingum River is meeting its attainment criteria, indicating that the higher thermal load is not adversely impacting the stream ecology. Part II, Item M includes monitoring requirements and standards for the amount of heat which can be discharged to the river.

pH
Limits for pH are proposed to continue from the existing permit and based on WQS.

Oxidants, chlorine and chlorine/bromination duration
Limits for oxidants, chlorine and chlorine/bromination are proposed to continue from the existing permit and are based on the FEG Best Available Technology (BAT) limits from the steam electric guidelines (40 CFR Part 423). These limits are consistent with Ohio WQS because the duration of chlorination discharges is limited to two hours per day. By minimizing the time that aquatic life is exposed to chlorine (compared with the assumptions of the WQS), the effluent concentrations may be higher than water quality criteria and still meet WQS in the river.

Outfall 0IB00003002
Table 12B presents the final effluent limits and monitoring requirements proposed for Muskingum River Plant outfall 0IB00003002 and the basis for their recommendation.

Ammonia and flow rate
Monitoring for ammonia and flow rate are proposed to continue from the existing permit.

Oil and grease and pH
Limits for oil and grease and pH are proposed to continue from the existing permit. The limits for oil and grease are based on the FEG limits from the steam electric guidelines (40 CFR Part 423). Limits for pH are based on WQS.

Total suspended solids
A lower daily maximum limit is proposed for total suspended solids. The FEG daily maximum limit for coal pile runoff is 50 mg/L. The FEG daily maximum limit for the rest of the wastewater from the unit 5 bottom ash pond is 100 mg/L. Coal pile runoff comprises 0.38 % of the water flowing to the unit 5 bottom ash pond. The following calculation was used to determine the daily maximum limit:
(50 mg/L * 0.0038) + (100 mg/L * 0.9962) = 99.81 mg/L.

Chromium and zinc
Limits for chromium and zinc re based on the FEG limits from the stream electric guidelines (40 CFR 423.13 (d) (1).

Chlorine
The Ohio EPA risk assessment (Table 8A) places chlorine in group 5. This placement as well as the data in Tables 2 and 3 indicate that the reasonable potential to exceed WQS exists and limits are necessary to protect water quality. For this parameter, the PEQ is greater than 100 percent of the wasteload allocation or the PEQ is between 75 and 100 percent of the WLA. Pollutants that meet this requirement must have permit limits under OAC Rule 3745-33-07(A)(1). The daily maximum limit for chlorine is based on the wasteload allocation as limited by the IMZM. The IMZM is a value calculated to avoid rapidly lethal conditions in the effluent mixing zone. The average cooling tower blowdown flow is 1.44 MGD. Using the FEG of 0.2 mg/L and multiplying by the flow gives 1090 kg/day. Dividing by the total discharge flow of 0IB00003002, 4.74 MGD gives a concentration limit of 0.061 mg/L, which is less stringent than the wasteload allocation of 0.038 mg/L.

Copper
Ohio EPA risk assessment (Table 8A) places copper in group 4. This placement, as well as the data in Tables 2, 3 and 4, support that this parameter does not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. Monitoring for Group 4 pollutants (where PEQ exceeds 50 percent of the WLA) is required by OAC 3745-33-07(A)(2).

Mercury
Ohio EPA risk assessment (Table 8A) places arsenic, barium, boron, bromomethane, cadmium, chromium, cobalt, iron, mercury, molybdenum, nickel, selenium, strontium, thallium, total filterable residue (dissolved solids) and zinc in groups 2 and 3. This placement, as well as the data in Tables 2, 3 and 4, support that these parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. Monitoring at a low frequency is proposed for mercury to document that this pollutant continues to remain at low levels.

Outfall 0IB00003003
Table 12C presents the final effluent limits and monitoring requirements proposed for Muskingum River Plant outfall 0IB00003003 and the basis for their recommendation.

Total suspended solids, oil and grease and pH
Limits for total suspended solids, oil and grease and pH are proposed to continue from the existing permit. The limits for total suspended solids and oil and grease are based on the FEG limits from the steam electric guidelines (40 CFR Part 423). Limits for pH are based on WQS.

Chlorine
The Ohio EPA risk assessment (Table 8B) places chlorine in group 5. This placement as well as the data in Tables 2 and 3 indicate that the reasonable potential to exceed WQS exists and limits are necessary to protect water quality. For this parameter, the PEQ is greater than 100 percent of the WLA or the PEQ is between 75 and 100 percent of the WLA. Pollutants that meet this requirement must have permit limits

under OAC 3745-33-07(A)(1). The daily maximum limit for chlorine is based on the WLA as limited by the IMZM.

Zinc
Ohio EPA risk assessment (Table 8B) places arsenic, barium, boron, cobalt, iron, molybdenum, nickel, selenium, thallium and zinc in groups 2 and 3. This placement, as well as the data in Tables 2, 3 and 4, support that these parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. Monitoring at a low frequency is proposed for zinc to document that this pollutant continues to remain at low levels.

Outfalls 0IB00003007 and 0IB00003008
Table 12D presents the final effluent limits and monitoring requirements proposed for Muskingum River Plant outfalls 0IB00003007 and 0IB00003008 and the basis for their recommendation. These outfalls serve as emergency discharges for the fly ash collection pond dam seepage.

Total suspended solids, oil and grease and pH
Limits for total suspended solids, oil and grease and pH are proposed to continue from the existing permit. The limits for total suspended solids and oil and grease are based on the FEG limits from the steam electric guidelines (40 CFR Part 423). Limits for pH are based on WQS.

Flow, arsenic, cobalt, iron and nickel
Based on best engineering judgment, monitoring for flow, arsenic and iron are proposed to continue from the existing permit for both outfalls. Monitoring for cobalt and nickel are proposed to continue at outfall 0IB00003008 from the existing permit.

Outfalls 0IB00003009, 0IB00003012 and 0IB00003013
Table 12E presents the final effluent limits and monitoring requirements proposed for Muskingum River Plant outfalls 0IB00003009, 0IB00003012 and 0IB00003013 and the basis for their recommendation. These outfalls discharge stormwater.

Flow, total suspended solids, zinc and copper
Monitoring for flow, total suspended solids, zinc and copper is proposed to continue from the existing permit.

Benchmark concentrations are proposed at outfalls 0IB00003009 and 0IB00003012 for total suspended solids, zinc and copper. The PEQ for zinc and copper are greater than 100 percent of the WLA. The benchmark concentrations for zinc and copper are based on the WLA as limited by the IMZM.

The benchmark concentrations are not effluent limitations; a benchmark exceedance, therefore, is not a permit violation. Benchmark monitoring data are used to determine the overall effectiveness of the control measures and to assist in knowing when additional corrective action(s) may be necessary to comply with the control measures/best management practices (BMPs) in Part IV, Items A-C.

Outfall 0IB00003602
Table 12F presents the final effluent limits and monitoring requirements proposed for Muskingum River Plant outfall 0IB00003602 and the basis for their recommendation. This outfall discharges wastewater from an on-site sanitary sewage treatment plant.

Total suspended solids, pH and $CBOD_5$
Limits for total suspended solids, pH and $CBOD_5$ are based on secondary treatment standards found in Part 133 of the FEG.

Fecal coliform
Limits proposed for fecal coliform are proposed to continue from the existing permit and are based on WQS.

Whole Effluent Toxicity Reasonable Potential
Based on evaluating the WET data presented in Tables 5 and 6, and other pertinent data under the provisions of OAC 3745-33-07(B), the Muskingum River Plant is placed in Category 4 with respect to WET and testing requirements have been removed from the draft permit.

Sludge
Limits and monitoring requirements proposed for the disposal of sewage sludge by the following management practices are based on OAC 3745-40: land application, removal to sanitary landfill or transfer to another facility with an NPDES permit.

Additional monitoring requirements proposed at the final effluent, influent and upstream/downstream stations are included for all facilities in Ohio and vary according to the type and size of the discharge. In addition to permit compliance, this data is used to assist in the evaluation of effluent quality and treatment plant performance and for designing plant improvements and conducting future stream studies.

Upstream station 0IB00003804 and downstream station 0IB00003902 have been removed from the draft permit. Toxicity was the only parameter measured at these stations and toxicity requirements have been removed from the draft permit.

Intake monitoring station 0IB00003803 has been removed from the draft permit. The only parameter measured at this station was total suspended solids, which is unnecessary.

Other Requirements

Polychlorinated biphenyl compounds (PCBs)
With one exception, all transformers at Muskingum River Plant are classified as non-PCB under the TSCA PCB program at Muskingum River Plant. One transformer contains mineral oil dielectric fluid at 50 ppm PCB. Muskingum River Plant currently maintains a SPCC plan under 40 CFR 112 which includes regular equipment inspections and containment provisions. No addition of PCBs from the facility is likely to occur.

Storm Water Compliance
Parts IV, V, and VI have been included with the draft permit to ensure that any storm water flows from the facility site are properly regulated and managed.

Outfall Signage
Part II of the permit includes requirements for signs to be placed at each outfall to the Muskingum River, Millstone Creek and the unnamed tributary to Millstone Creek, providing information about the discharge. Signage at outfalls is required pursuant to Ohio Administrative Code 3745-33-08(A).
Section 316(b) Compliance
Under rules which were promulgated July 9, 2004 under Section 316(b) of the federal Clean Water Act (33 U.S.C. section 1326), the permittee was required to collect and/or compile the following information pertaining to the facility's cooling water intake structure(s):

- source water physical data [40 CFR 122.21(r)(2)];
- cooling water intake structure data [40 CFR 122.21(r)(3)];
- cooling water system data [40 CFR 122.21(r)(5)]; and
- rates of impingement and/or entrainment of fish and shellfish at the facility's cooling water intake structure(s) based upon sampling conducted at the facility.

The permit requires all of this information listed above to be submitted with the permittee's next NPDES permit renewal application unless federal rules are promulgated which require the submittal of the information at an earlier date.

Under Section 316(b) of the federal Clean Water Act (33 U.S.C. section 1326), cooling water intakes are required to use best technology available (BTA) to minimize adverse environmental impact resulting from the operation of the intake. Information supplied from the permittee regarding the intake structure and other pertinent data include the following:

- **Intake description:** The facility uses four once-through cooling water condensers for Units 1-4 and a closed-cycle, natural draft cooling tower for Unit 5. Each condenser transfers heat from turbine exhaust steam to once-through circulating cooling water, which is withdrawn from the Muskingum River through a screenhouse located directly at the river's edge on the southwest shoreline. The screenhouse for intake water is divided into four sections, one for each unit, with a dividing wall between each section. Each section has three sluice gates, three trash grills, and three traveling screens. Water from the Muskingum River enters each section of the screenhouse through three sluice gates, at the rate of 140,000 gal/minute for Units 1 and 2 and 160,000 gal/minute for Units 3 and 4. Once the water enters the screenhouse, it flows through a trash rack composed of 3-in. × 0.50-in. vertical steel bars spaced 3 in. on center, which leaves a 2.75-in. space between the bars. A mechanical rake controlled from the screenhouse operations floor removes trash on the racks.

  After the trash racks, the water is further screened by one of three traveling water screens. Each traveling screen is a continuous belt (No. 14 W&M stainless steel wire with 0.375-in. square openings) of screen frames 6-ft wide and approximately 2.5-ft high. The traveling screen is motorized and geared to travel in a vertical direction at the upstream face. Leaves, trash, twigs, and other objects, including fish, small enough to pass through the trash racks and collect on the screen are removed from the screen panels by a high pressure water spray and sluiced to the trash flume. The trash flume passes in front of all traveling screens, collects screenwash, and exits the west side of the screenhouse, where the water is discharged near the end of the cooling water discharge canal. A two-speed motor is used to drive the traveling water screen, making it possible to operate the screen at low speeds (5 ft/minute) during periods when only a small amount of trash accumulates and at high speeds (10 ft/minute) debris loading is high.
- **Design intake flow of the cooling water intake structures (CWIS):** Units 1-4 = 140,000 gpm each. Unit 5= 12,000 gpm.
- **Percentage of intake flow used for cooling purposes:** 99%.
- **Estimate of the intake flow reduction at the facility based upon the use of a 100 percent (or some lesser percentage) closed-cycle re-circulating cooling water system compared to a conventional once-through cooling water system:** (12,000/140,000) = 8.6%. 100% - 8.6% = 91.4%.
- **Through screen design intake flow velocity:** 1.52 fps
- **Impingement and entrainment data based on the operation of the facility's CWIS:** Please see Attachment II for the results of an Impingement Mortality and Entrainment Characterization Study Report submitted by AEP and made final in August 2007.

- **A detailed description of any changes in the operation of the CWIS, or changes in the type of technologies used at the CWIS such as screens or other technologies affecting the rates of impingement and/or entrainment of fish and shellfish:** None have been made.

Ohio EPA has evaluated this information, and at this time, has determined that the cooling water intake structure represents BTA in accordance with Section 316(b) of the CWA.

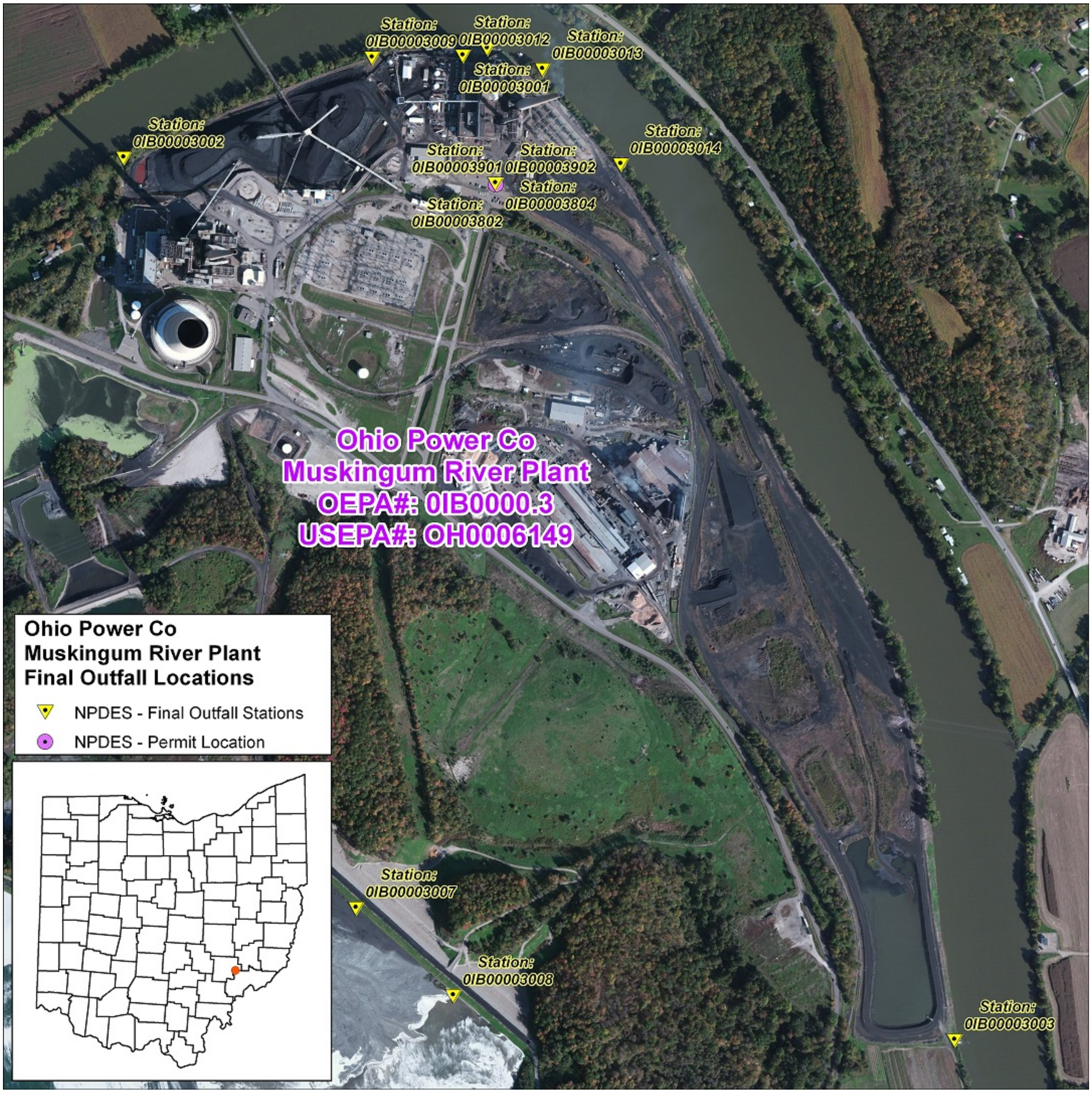

Figure 1. Location of Muskingum River Plant.

Table 1. Federal Effluent Guidelines and Calculations Applicable to the Muskingum River Plant.

40 CFR 423.13(b) Steam Electric Power Generating Point Source Category
Best Available Technology Economically Achievable (BAT)

Parameter	Daily Maximum	30-Day Average
Total Residual Chlorine	0.2 mg/L	

40 CFR 423.13(d)(1) Steam Electric Power Generating Point Source Category
Best Available Technology Economically Achievable (BAT)

Parameter	Daily Maximum	30-Day Average
Free Available Chlorine	0.5 mg/L	0.2 mg/L
Chromium, total	0.2 mg/L	0.2 mg/L
Zinc, total	1.0 mg/L	1.0 mg/L

Chlorine Calculations:
1.44 MGD = 5,450,993 L/day Cooling tower blowdown flow goes to outfall 0IB00003002
5,450,993 L/day * 0.2 mg/L = 1,090,199 mg/day
4.74 MGD = 17,942,852 L/day Discharge flow from outfall 0IB00003002
1,090,199 mg/day divided by 17,942,852 L/day = **0.061 mg/L**

40 CFR 423.13(e) Steam Electric Power Generating Point Source Category
Best Available Technology Economically Achievable (BAT)

Parameter	Daily Maximum	30-Day Average
Copper, total	1.0 mg/L	1.0 mg/L
Iron, total	1.0 mg/L	1.0 mg/L

40 CFR 423.12(b)(4) Steam Electric Power Generating Point Source Category
Best Practicable Control Technology Currently Available (BPT)

Parameter	Daily Maximum	30-Day Average
Total suspended solids	100 mg/L	30.0 mg/L
Oil and grease	20.0 mg/L	15.0 mg/L

40 CFR 423.12 (b)(9) Steam Electric Power Generating Point Source Category
Best Practicable Control Technology Currently Available (BPT)

Parameter	Daily Maximum	30-Day Average
Total Suspended Solids	50 mg/L	

Table 2. Effluent Characterization Using Data from Ohio EPA and NPDES Application Form 2C.

Parameter	Outfall 0IB00003002 Application Data 1/28/2011	Outfall 0IB00003002 Ohio EPA Bioassay 11/2/2009	Outfall 0IB00003003 Application Data 1/28/2011
Aluminum (µg/L)	560	354	1110
Arsenic (µg/L)	35	17.1	12
Barium (µg/L)	122	NT	52
Boron (µg/L)	1100	NT	160
Cobalt (µg/L)	3	NT	2
Bromomethane (µg/L)	NT	0.68	NT
Cadmium (µg/L)	< 0.2	0.42	NT
Chromium (µg/L)	< 0.2	7.3	NT
Copper (µg/L)	NT	12.5	NT
Iron (µg/L)	850	425	1915
Molybdenum (µg/L)	132	NT	3
Nickel (µg/L)	18	18.4	8
Selenium (µg/L)	7	11.3	2
Strontium (µg/L)	NT	1550	NT
Titanium (µg/L)	19	NT	89
Thallium (µg/L)	2	NT	0.53
Total Filterable Residue (mg/L)	NT	1090	NT
Zinc (µg/L)	86.0	<10	12.3

Definitions: NT = Not tested.

Table 3. Effluent Characterization Using Self-Monitoring Data.

Summary of current permit limits and unaltered discharge monitoring report data for Muskingum River Plant (September 2008 - August 2013). All values are based on annual records unless otherwise indicated. * = For minimum pH, 5th percentile shown in place of 50th percentile; ** = For dissolved oxygen, 5th percentile shown in place of 95th percentile; a = weekly average.

			Current Permit Limits			Percentiles			Decision Criteria		
Parameter	**Season**	**Units**	**30 day**	**Daily**	**# Obs.**	**50^{th}**	**95^{th}**	**Data Range**	**# Obs.**	**PEQ_{ave}**	**PEQ_{max}**
Outfall 001											
Water Temperature	Annual	F	Monitor		1812	69.8	97.5	33.8-109	1812	75.685	104.35
Thermal Discharge	Annual	Million BTU/Hr	Monitor		990	2990	7350	0-19800	990	7746.5	18610
pH	Annual	S.U.	6.5 min	9.0 max	242	8.15	8.61	7.64-8.87			
Oxidants, Total Residual	Annual	mg/L	--	0.05	592	0	0.02	0-0.05	592	0.010735	0.023219
Flow Rate	Annual	MGD	Monitor		1822	533	795	141-864			
Chlorine, Total Residual	Annual	mg/L	--	0.2	100	0	0.02	0-0.03	100	0.009508	0.018048
Chlorination/Bromination Duration	Annual	Minutes	--	120	745	20	40	0-40			
Outfall 002											
pH	Annual	S.U.	6.5 min	9.0 max	479	8.04	8.48	7.32-8.89			
Total Suspended Solids	Annual	mg/L	30	100	724	11	27.9	1-49	724	19.337	37.793
Oil and Grease, Hexane Extr Method	Annual	mg/L	15	20	120	0	0	0-0	120	--	--
Nitrogen, Ammonia (NH3)	Summer	mg/L	Monitor		60	0.24	1.13	0-2.58	40	0.69605	1.1048
Nitrogen, Ammonia (NH3)	Winter	mg/L	Monitor		50	0.442	1.04	0.06-1.45	24	1.3378	2.2232
Zinc, Total Recoverable	Annual	µg/L	Monitor		121	8	82	0-155	121	73.867	101.78
Copper, Total Recoverable	Annual	µg/L	Monitor		121	14.1	32	0-46.2	122	26.98	36.96
Flow Rate	Annual	MGD	Monitor		1264	4.32	7.6	0-13.6			
Chlorine, Total Residual	Annual	mg/L	Monitor		60	0	0.0205	0-0.07	53	0.0511	0.07
Mercury, Total (Low Level)	Annual	ng/L	Monitor		20	3.2	5.98	1.3-7.4	20	5.9258	9.1782
Acute Toxicity, Ceriodaphnia dubia	Annual	TU_a	Monitor		5	0	0	0-0			

Table 3. Effluent Characterization Using Self-Monitoring Data - Continued.

Parameter	Season	Units	Current Permit Limits		# Obs.	Percentiles		Data Range	Decision Criteria		
			30 day	Daily		50th	95th		# Obs.	PEQ_{ave}	PEQ_{max}
Acute Toxicity, Pimephales promelas	Annual	TU_a	Monitor		5	0	0	0-0			
Outfall 003											
pH	Annual	S.U.	6.5 min	9.0 max	240	7.99	8.61	6.92-8.98			
Total Suspended Solids	Annual	mg/L	30	100	240	0	8	0-23	240	7.4162	9.4378
Oil and Grease, Hexane Extr Method	Annual	mg/L	15	20	121	0	0	0-0	121	--	--
Flow Rate	Annual	MGD	Monitor		1266	4.75	8.15	0.25-10.8			
Chlorine, Total Residual	Annual	mg/L	Monitor		121	0	0.03	0-0.05	121	0.0292	0.04
Outfall 009											
Total Suspended Solids	Annual	mg/L	Monitor		16	317	988	9-1240	16	2501.6	4286.2
Zinc, Total Recoverable	Annual	µg/L	Monitor		16	114	372	8.01-416	16	760.24	1355.6
Copper, Total Recoverable	Annual	µg/L	Monitor		16	16.8	67.5	0-96	16	112.15	201.39
Flow Rate	Annual	MGD	Monitor		1267	0.0007	0.014	0-0.36			
Outfall 012											
Total Suspended Solids	Annual	mg/L	Monitor		79	0	398	0-984	79	646.5	885.6
Zinc, Total Recoverable	Annual	µg/L	Monitor		16	285	662	60-872	16	732.2	1260.8
Copper, Total Recoverable	Annual	µg/L	Monitor		16	42.5	99	14-105	16	88.37	139.9
Flow Rate	Annual	MGD	Monitor		1203	0	0.0007	0-0.841			
Outfall 014											
Flow Rate	Annual	MGD	Monitor		400	0	0	0-0			

Table 3. Effluent Characterization Using Self-Monitoring Data - Continued.

Parameter	Season	Units	Current Permit Limits		# Obs.	Percentiles		Data Range	Decision Criteria		
			30 day	Daily		50th	95th		# Obs.	PEQ_{ave}	PEQ_{max}
Outfall 602											
Flow Rate	Annual	GPD	Monitor		1826	3000	5500	3000-10500			
Total Suspended Solids	Annual	mg/L	30	45	62	8	22.8	0-45	62	28.348	44.082
Fecal Coliform	Annual	#/100 ml	1000	2000	35	0	276	0-5100			
CBOD 5 day	Summer	mg/L	25	40	30	3.62	16.3	0-23.3	20	22.289	36.918
CBOD 5 day	Winter	mg/L	25	40	33	7.2	30.3	0-44.5	16	46.094	83.822
Outfall 603											
Total Suspended Solids	Annual	mg/L	30	45	54	4.5	17.8	1-24	54	15.129	24.166
Fecal Coliform	Annual	#/100 ml	1000	2000	26	0	264	0-1160			
Flow Rate	Annual	MGD	Monitor		1433	0.005	0.012	0.0003-0.12			
CBOD 5 day	Summer	mg/L	25	40	29	1.2	10.8	0-15.3	20	26.582	31.623
CBOD 5 day	Winter	mg/L	25	40	32	4.54	44.2	0-56.2	20	86.471	131.78

Definitions: CBOD = Carbonaceous biochemical oxygen demand
PEQ = Projected Effluent Quality.

Table 4. Projected Effluent Quality Values.

Parameter Name	Units	Min. Value	Max. Value	PEQ average	PEQ max
<u>Outfall 002</u>					
Total Suspended Solids	mg/L	1	49	19.337	37.793
Oil and Grease	mg/L	0	0	--	--
Winter Nitrogen, Ammonia (NH3)	mg/L	0.13	1.45	1.3378	2.2232
Summer Nitrogen, Ammonia (NH3)	mg/L	0.1	2.58	0.69605	1.1048
Zinc, Total Recoverable	µg/L	2	155	73.867	101.78
Copper, Total Recoverable	µg/L	3.22	46.2	26.98	36.96
Chlorine, Total Residual	mg/L	0.01	0.07	0.0511	0.07
Mercury, Total (Low Level)	mg/L	1.3	7.4	5.9258	9.1782
Residue, Total Filterable	mg/L	1090	1090	4933	6758
Arsenic, Total	µg/L	17.1	35	97.09	133
Cadmium, Total	µg/L	0.42	0.42	1.901	2.604
Chromium, Total	µg/L	7.3	7.3	20.25	27.74
Nickel, Total	µg/L	18	18.4	51.04	69.92
Selenium, Total	µg/L	7	11.3	31.35	42.94
Aluminium, Total	µg/L	354	560	1553	2128
Iron, Total	µg/L	425	850	2358	3230
Strontium, Total	µg/L	1550	1550	7015	9610
Bromomethane	µg/L	0.68	0.68	3.078	4.216
Titanium, Total	µg/L	19	19	85.99	117.8
<u>Outfall 003</u>					
Total Suspended Solids	mg/L	0	23	7.4162	9.4378
Oil and Grease	mg/L	0	0	--	--
Chlorine, Total Residual	mg/L	0	0.05	0.0292	0.04
Aluminium, Total	µg/L	1111	1111	5028	6888
Iron, Total	µg/L	1915	1915	8667	11870
Titanium, Total	µg/L	89	89	402.8	551.8
Arsenic, Total	µg/L	12	12	54.31	74.4
Nickel, Total	µg/L	8	8	36.21	49.6
Zinc, Total Recoverable	µg/L	12.3	12.3	55.67	76.26

Definitions: PEQ = Projected effluent quality.

Table 5. Summary of Acute Toxicity at Outfall 0IB00003002, Tests Taken by American Electric Power.

Date	*Ceriodaphnia Dubia*	*Pimephales promelas*
9/9/08	AA	AA
9/11/09	AA	AA
9/13/10	AA	AA
9/6/11	AA	AA
9/12/12	AA	AA

Definitions: TU_a = acute toxicity units
AA = below detection limit (0.2 TU_{a},)

Table 6. Summary of Acute Toxicity of Outfall 0IB00003002, Tests Taken Ohio EPA.

	Ceriodaphnia dubia								*Pimephales promelas*							
	24 Hours				48 Hours				24 Hours				48 Hours			
Collection Date	UP	C	%M	TU_a	UP	C	%M	TU_a	UP	C	%M	TU_a	UP	C	%M	TU_a
11/02/2009	0	0	0	ND	0	0	10	ND	0	0	0	ND	0	0	0	ND
11/03/2009	ND	0	0	ND	ND	0	5	ND	ND	0	0	ND	ND	0	0	ND
11/2/09-11/3/09[a]	ND	0	0	ND	ND	0	10	ND	ND	0	0	ND	ND	0	0	ND

Definitions:
[a] = 24-hour composite sample
C = laboratory control water
%M = percent mortality in 100% effluent
ND = not determined
TU_a = acute toxicity units
UP = percent mortality in upstream control water

Table 7. Aquatic Life Use Attainment Status

Sample Site River Mile	Attainment Status	IBI	Miwb	ICI	QHEI	Location	Cause	Source
29.2	Full	48	10.2	50	64	Upstream Muskingum River Plant	None	None
26.2	Full	44	9.3	46	64.5	Downstream Muskingum River Plant	None	None

Ecoregion Biocriteria: Western Alleghany Plateau (WAP)		
INDEX - Site Type	**WWH**	**EWH**
IBI: Boat	40	48
Miwb: Boat	8.6	9.6
ICI	36	46

Definitions: EWH = Exceptional Warmwater Habitat;
IBI = Index of Biotic Integrity;
ICI = Invertebrate Community Index;
QHEI = Qualitative Habitat Evaluation Index;
MIwb = Modified Index of Well-Being;
WWH = Warmwater Habitat.

Table 8A. Parameter Assessment for Outfall 0IB00003002.

Group 1: Due to a lack of criteria, the following parameters could not be evaluated at this time.

Aluminum	Titanium	Magnesium

Group 2: PEQ < 25 percent of WQS or all data below minimum detection limit.
WLA not required. No limit recommended; monitoring optional.

Bromomethane	Chromium	Molybdenum

Group 3: PEQ_{max} < 50 percent of maximum PEL and PEQ_{avg} < 50 percent of average PEL.
No limit recommended; monitoring optional.

Arsenic	Cadmium	Dissolved solids
Iron	Mercury	Nickel
Selenium	Strontium	Zinc
Barium	Boron	Cobalt
Thallium		

Group 4: PEQ_{max} >= 50 percent, but < 100 percent of the maximum PEL or
PEQ_{avg} >= 50 percent, but < 100 percent of the average PEL. Monitoring is appropriate.

Copper

Group 5: Maximum PEQ >= 100 percent of the maximum PEL or average PEQ >= 100 percent of the average PEL, or either the average or maximum PEQ is between 75 and 100 percent of the PEL and certain conditions that increase the risk to the environment are present. Limit recommended.

Limits to Protect Numeric Water Quality Criteria

Parameter	Units	Recommended Effluent Limits Average	Maximum
Chlorine	mg/L	--	0.038

Definitions: PEL = Projected effluent limitation;
PEQ = Projected effluent quality;
WLA = Wasteload allocation;
WQS = Water quality standards.

Table 8B. Parameter Assessment for Outfall 0IB00003003.

Group 1: Due to a lack of criteria, the following parameters could not be evaluated at this time.

Aluminum	Titanium

Group 2: PEQ < 25 percent of WQS or all data below minimum detection limit.
WLA not required. No limit recommended; monitoring optional.

Boron	Molybdenum

Group 3: PEQ_{max} < 50 percent of maximum PEL and PEQ_{avg} < 50 percent of average PEL.
No limit recommended; monitoring optional.

Arsenic	Iron	Nickel
Zinc	Barium	Cobalt
Selenium	Thallium	

Group 4: PEQ_{max} >= 50 percent, but < 100 percent of the maximum PEL or
PEQ_{avg} >= 50 percent, but < 100 percent of the average PEL. Monitoring is appropriate.

Group 5: Maximum PEQ >= 100 percent of the maximum PEL or average PEQ >= 100 percent of the average PEL, or either the average or maximum PEQ is between 75 and 100 percent of the PEL and certain conditions that increase the risk to the environment are present. Limit recommended.

Limits to Protect Numeric Water Quality Criteria

		Recommended Effluent Limits	
Parameter	Units	Average	Maximum
Chlorine	mg/L	--	0.038

Definitions: PEL = Projected effluent limitation;
PEQ = Projected effluent quality;
WLA = Wasteload allocation;
WQS = Water quality standards.

Table 9A. Instream Conditions and Discharger Flow for Outfall 0IB00003002.

Parameter	Units	Season	Value	Basis
Stream Flows				
1Q10	cfs	annual	533.2	USGS 03150000 and 03150250
7Q10	cfs	annual	642.5	USGS 03150000 and 03150250
30Q10	cfs	summer	737.2	USGS 03150000 and 03150250
		winter	737.2	USGS 03150000 and 03150250
Harmonic Mean	cfs	annual	2933	USGS 03150000 and 03150250
Mixing Assumption	%	average	86.16335034	
	%	maximum	86.16335034	
Hardness	mg/L	annual	222	OEPA Station 611780, n=5, 2006-07
pH	S.U.	summer	8	BWQR, n=540
		winter	8.2	BWQR, n=46
Temperature	C	summer	28.67	Station 901, n=870
		winter	5	BWQR, n=57
AEP Muskingum flow	cfs	annual	11.76	95th percentile from 002 eDMR.
Background Water Quality				
Aluminum	µg/L		274	OEPA; 2006; n=5; 3<MDL; Station R16P01
Ammonia, Summer	mg/L		0.0328	OEPA; 2006; n=5; 4<MDL; Station R16P01
Ammonia, Winter	mg/L		0.21	BWQR; 1988; n=45; 16<MDL; Muskingum Basin
Arsenic	µg/L		2.66	OEPA; 2006; n=5; 0<MDL; Station R16P01
Bromomethane	µg/L		0	No representative data available.

Table 9A. Instream Conditions and Discharger Flow for Outfall 0IB00003002 - Continued.

Parameter	Units	Season	Value	Basis
Cadmium	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Chlorine	mg/L		0	No representative data available.
Chromium	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Copper	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Dissolved solids	mg/L		371.2	OEPA; 2006; n=5; 0<MDL; Station R16P01
Iron	µg/L		692	OEPA; 2006; n=5; 0<MDL; Station R16P01
Mercury	mg/L		0	No representative data available.
Nickel	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Selenium	µg/L		0	No representative data available.
Strontium	µg/L		251.8	OEPA; 2006; n=5; 0<MDL; Station R16P01
Titanium	µg/L		0	No representative data available.
Zinc	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Barium	µg/L		52.2	OEPA; 2006; n=5; 5<MDL; Station R16P01
Boron	µg/L		0	No representative data available.
Cobalt	µg/L		0	No representative data available.
Molybdenum	µg/L		0	No representative data available.
Thallium	µg/L		0	No representative data available.

Definitions: BWQR = *Analysis of Unimpacted Stream Data for the State of Ohio*, 1988;
eDMR = Electronic Discharge Monitoring Report;
MDL = method detection limit;
OEPA = Ohio Environmental Protection Agency;
USGS = United States Geological Survey.

Table 9B. Instream Conditions and Discharger Flow for Outfall 0IB00003003.

Parameter	Units	Season	Value	Basis
Stream Flows				
1Q10	cfs	annual	521.8	USGS 03150000 and 03115400
7Q10	cfs	annual	631.2	USGS 03150000 and 03115400
30Q10	cfs	summer	726.8	USGS 03150000 and 03115400
		winter	726.8	USGS 03150000 and 03115400
Harmonic Mean	cfs	annual	2924.5	USGS 03150000 and 03115400
Mixing Assumption	%	average	83.5328	
	%	maximum	83.5328	
Hardness	mg/L	annual	222	OEPA Station 611780, n=5, 2006-07
pH	S.U.	summer	8	BWQR n=540
		winter	8.2	BWQR n=46
Temperature	C	summer	28.67	Station 901, n=870
		winter	5	BWQR n=57
AEP Muskingum flow	cfs	annual	10	95th percentile from 003 eDMR.
Background Water Quality				
Aluminum	µg/L		274	OEPA; 2006; n=5; 3<MDL; Station R16P01
Arsenic	µg/L		2.66	OEPA; 2006; n=5; 0<MDL; Station R16P01
Chlorine	mg/L		0	No representative data available.
Iron	µg/L		692	OEPA; 2006; n=5; 0<MDL; Station R16P01

Table 9B. Instream Conditions and Discharger Flow for Outfall 0IB00003003 - Continued.

Parameter	**Units**	**Season**	**Value**	**Basis**
Nickel - TR	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Titanium	µg/L		0	No representative data available.
Zinc - TR	µg/L		0	OEPA; 2006; n=5; 5<MDL; Station R16P01
Barium	µg/L		52.2	OEPA; 2006; n=5; 5<MDL; Station R16P01
Boron	µg/L		0	No representative data available.
Cobalt	µg/L		0	No representative data available.
Molybdenum	µg/L		0	No representative data available.
Selenium - TR	µg/L		0	No representative data available.
Thallium	µg/L		0	No representative data available.

Definitions: BWQR = *Analysis of Unimpacted Stream Data for the State of Ohio*, 1988;
eDMR = Electronic Discharge Monitoring Report;
MDL = method detection limit;
OEPA = Ohio Environmental Protection Agency;
USGS = United States Geological Survey.

Table 10. Water Quality Criteria in the Study Area.

		Outside Mixing Zone Criteria				Inside
		Average			Maximum	Mixing
		Human	Agri-	Aquatic	Aquatic	Zone
Parameter	**Units**	**Health**	**culture**	**Life**	**Life**	**Maximum**
Ammonia, Summer	mg/L	--	--	0.8	--	--
Ammonia, Winter	mg/L	--	--	2.3	--	--
Arsenic	µg/L	--	100	150	340	680
Bromomethane	µg/L	4000	--	16	38	75
Cadmium	µg/L	--	50	4.6	11	22
Chlorine	mg/L	--	--	0.011	0.019	0.038
Chromium	µg/L	--	100	170	3500	6900
Copper	µg/L	1300	500	18	30	59
Total Filterable Residue (Dissolved solids)	mg/L	--	--	1500	--	--
Iron	µg/L	--	5000	--	--	--
Mercury	mg/L	12	10000	910	1700	3400
Nickel	µg/L	4600	200	100	920	1800
Selenium	µg/L	11000	50	5	--	--
Strontium	µg/L	--	--	21000	40000	81000
Titanium	µg/L	--	--	--	--	--
Zinc	µg/L	69000	25000	240	240	470
Barium	µg/L	--	--	220	2000	4000
Boron	µg/L	--	--	3900	33000	65000
Cobalt	µg/L	--	--	24	220	440
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--
Molybdenum	µg/L	--	--	20000	190000	370000
Thallium	µg/L	6.3	--	17	79	160

Table 11. Summary of Effluent Limits to Maintain Applicable Water Quality Criteria.

		Outside Mixing Zone Criteria				Inside
		Average			Maximum	Mixing
		Human	Agri-	Aquatic	Aquatic	Zone
Parameter	Units	Health	culture	Life	Life	Maximum
Outfall 0IB00003002:						
Arsenic	µg/L	--	21018	7086	13519	680
Bromomethane	µg/L	863582	--	769	1523	75
Cadmium	µg/L	--	10795	221	441	22
Chlorine	mg/L	--	--	0.53	0.76	0.038
Chromium	µg/L	--	21590	8173	140233	6900
Copper	µg/L	280664	107948	865	1202	59
Total Filterable Residue (Dissolved solids)	mg/L	--	--	54638	--	--
Iron	µg/L	--	930770	--	--	--
Mercury	mg/L	12	10000	910	1700	3400
Nickel	µg/L	993119	43179	4807	36861	1800
Selenium	µg/L	2374850	10795	240	--	--
Strontium	µg/L	--	--	997717	1592826	81000
Titanium	µg/L	--	--	--	--	--
Zinc	µg/L	14896789	5397387	11538	9616	470
Barium	µg/L	--	--	8119	78094	4000
Boron	µg/L	--	--	187492	1322197	65000
Cobalt	µg/L	--	--	1154	8815	440
Molybdenum	µg/L	--	--	961496	7612650	370000
Thallium	µg/L	1360	--	817	3165	160
Outfall 0IB00003003:						
Arsenic	µg/L	--	23879	7919	15044	680
Chlorine	mg/L	--	--	0.59	0.85	0.038
Iron	µg/L	--	1057409	--	--	--
Nickel	µg/L	1128342	49058	5373	41020	1800
Titanium	µg/L	--	--	--	--	--
Zinc	µg/L	16925125	6132292	12894	10701	470
Barium	µg/L	--	--	9067	86900	4000
Boron	µg/L	--	--	209531	1471385	65000
Cobalt	µg/L	--	--	1289	9809	440
Molybdenum	µg/L	--	--	1074518	8471609	370000
Selenium	µg/L	2698208	12265	269	--	--
Thallium	µg/L	1545	--	913	3522	160

Table 12A. Final Effluent Limits and Monitoring Requirements for Outfall 0IB00003001.

Parameter	Units	Effluent Limits				Basis
		Concentration		Loading (kg/day)		
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Flow	MGD	Monitor		--	--	M
Temperature	°F	Monitor		--	--	M, 316(a) Demo
Thermal discharge	MBTU/hr	Monitor		--	--	M
pH	S.U.	6.5 min	9.0 max	--	--	EP/WQS

Table 12B. Final Effluent Limits and Monitoring Requirements for Outfall 0IB00003002.

Parameter	Units	Effluent Limits				Basis
		Concentration		Loading (kg/day)		
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Flow	MGD	Monitor		--	--	M
pH	S.U.	6.5 min	9.0 max	--	--	EP/WQS
Total Suspended Solids	mg/L	30	99.8	623.4	2080	FEG/EP
Oil and Grease	mg/L	15	20	--	--	FEG/EP
Nitrogen, Ammonia	mg/L	1000	1000	--	--	FEG
Chromium	µg/L	200	200	--	--	FEG
Zinc	µg/L	Monitor		--	--	M
Copper	µg/L	Monitor		--	--	M
Chlorine, Total Residual	mg/L		0.038	--	--	RP/WLA
Mercury	mg/L	Monitor		--	--	M

Effluent loadings based on a flow of 5.49 MGD.

Table 12C. Final Effluent Limits and Monitoring Requirements for Outfall 0IB00003003.

Parameter	Units	Effluent Limits				Basis
		Concentration		Loading (kg/day)		
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Flow	MGD	Monitor		--	--	M
pH	S.U.	6.5 min	9.0 max	--	--	EP/WQS
Total Suspended Solids	mg/L	30	100	616.6	2055	EP/FEG
Oil and Grease	mg/L	15	20	--	--	EP/FEG
Zinc	µg/L	Monitor		--	--	BEJ
Chlorine, Total Residual	mg/L	--	0.038	--	--	RP/WLA

Effluent loadings based on a flow of 5.43 MGD.

Table 12D. Final Effluent Limits and Monitoring Requirements for Outfall 0IB00003007 and 0IB00003008.

Parameter	Units	Effluent Limits				Basis
		Concentration		Loading (kg/day)		
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Parameters Common to Outfalls 0IB00003007 and 0IB00003008						
Flow	MGD	Monitor		--	--	M
pH	S.U.	6.5 min	9.0 max	--	--	WQS
Total Suspended Solids	mg/L	30	100	--	--	FEG
Oil and Grease	mg/L	15	20	--	--	FEG
Arsenic	µg/L	Monitor		--	--	EP/BEJ
Iron	µg/L	Monitor		--	--	EP/BEJ
Additional Parameters Monitored at Outfall 0IB00003008						
Cobalt	µg/L	Monitor		--	--	EP/BEJ
Nickel	µg/L	Monitor		--	--	EP/BEJ

Table 12E. Final Effluent Limits and Monitoring Requirements for Outfall 0IB00003009, 0IB00003012 and 0IB00003013.

Parameter	Units	Effluent Limits				Basis
		Concentration		Loading (kg/day)		
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Flow	MGD	Monitor		--	--	M/EP
Total Suspended Solids	mg/L	Monitor		--	--	M/EP
Copper	mg/L	Monitor		--	--	M/EP
Zinc	mg/L	Monitor		--	--	M/EP

Table 12F. Final Effluent Limits and Monitoring Requirements for Outfall 0IB00003602.

Parameter	Units	Effluent Limits				Basis
		Concentration		Loading (kg/day)		
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Flow	MGD	Monitor		--	--	M
Total Suspended Solids	mg/L	30	45[a]	--	--	EP/FEG
Fecal Coliform	#/100 mL	1000	2000	--	--	WQS
pH	S.U.	6.0 min	9.0 max			FEG
CBOD5	mg/L	25	40[a]	--	--	EP/FEG

[a]: Weekly average limits.

<u>Definitions:</u>

316(a) Demo. = Alternate thermal limitation developed under Section 316(a) of the Clean Water Act;
$CBOD_5$ = 5 day carbonaceous biochemical oxygen demand;
BAT = Best Available Technology;
BEJ = Best Engineering Judgment;
EP = Existing Permit;
FEG = Federal Effluent Guidelines, 40 CFR Parts 133 and 423;
M = BEJ of Permit Guidance 2: Determination of Sampling Frequency Formula for Industrial Waste Discharges;
RP = Reasonable potential;
WQS = Ohio Water Quality Standards (OAC 3745-1).

Attachment I

AEP Muskingum Thermal Wasteload Allocation

Background flows: Average = summer 30Q10 = 726.8 cfs

Maximum = summer 1Q10 = 537 cfs
Annual 7Q10 = 642.5 cfs

Intake flow: 584.7 MGD = 904.53 cfs (95^{th} percentile of monthly averages for past two years.)
Percent of stream flow: 904.53/642.5= 1.4%

Summer temperatures (F)

	Maximum	**Average**
Upstream	81.98	81.64
WQS	89	85

Upstream from AEP 801. Ave = 75^{th} percentile of monthly averages for June through Sept.
Max = 75^{th} percentile of data from June through Sept.
WQS from OAC 3745-1-07 (E).

Summer maximum = (537 cfs)(0.646 MGD/cfs)(8.34 lb/gal)(89-81.98) = 20,310 Million BTU/day = 846.25 Million BTU/hr

Summer Average = (726.8 cfs)(0.646 MGD/cfs)(8.34 lb/gal)(85-81.64) = 13,156.9 MBTU/day =548.2 BMTU/hr

	Summer (MBTU/day)	**Summer (MBTU/hr)**	**Summer PEQ (MBTU/hr)**
Maximum	20310.0	846.3	9364
Average	13156.9	548.2	6836

Attachment II

3. RESULTS

3.1 IMPINGEMENT

3.1.1 Species Composition and Relative Abundance

A total of 41 fish species, plus 3 hybrids and 8 taxa that could not be identified to species, were collected from the cooling water intake screens at MR between June 2005 and January 2007 (Table 1). A total of 155,604 fish and invertebrates were collected during this 20-month sampling program. Gizzard shad was the most common species accounting for 93.7 percent of the total impingement collection by number and 83.8 percent of the biomass impinged. The 5 most abundant taxa (gizzard shad, freshwater drum, channel catfish, and unidentified carpsucker/buffalofish) accounted for over 99 percent of the total catch (Table 2); these same species composed over 97 percent of the collected biomass. The unidentified amphipod was collected only during February 2006. The remaining taxa were represented by 10 or fewer individuals; 10 species were represented by only 1 specimen. The total weight of fish collected was 853 kg (1,881 pound [lb]).

One mountain madtom, a state listed endangered species, was collected during this sampling program.

The majority of impingement (73 percent) occurred between December 2005 and March 2006 associated with peak impingement of gizzard shad (Table 3, Figure 9). Relatively few gizzard shad were collected after May 2006 with the exception of a peak in September 2006. A total of 29 taxa were collected in July 2005, 21 in August 2005, and 27 in September 2005. Typically, 13 or fewer taxa were collected each month during the rest of the sampling program (Table 3).

Impingement sampling was previously conducted at MR from 1 December 1976 through 31 December 1977. One sample was collected in December 1976, 2 samples per month were collected in January-March and November 1977, 3 samples were collected in December 1977, and 4 samples per month were collected April through October 1977. Each sample was one 28-hour period broken into seven consecutive 4-hour sampling periods. An estimated total of 1,733,544 fish were impinged during the historical study; of that total, 99.2 percent were gizzard shad, primarily YOY collected in the summer, autumn, and early winter of the 1-year period from December 1976 through November 1977. The remaining fish included channel catfish (3,153), freshwater drum (2,645), emerald shiner (2,009), and bluegill sunfish (1,859); each of these species was among the 7 most common fish taxa impinged during the 2005-2007 sampling program.

Species composition of impinged fish during the 2005-2006 sampling program was similar to that observed in 1977-1978. Gizzard shad was the most abundant species during both programs and the majority of those were YOY. Freshwater drum and channel catfish were the second and third most common fish taxa in both studies. Bluegill was the fifth most abundant fish taxa in both studies. Emerald shiner was the fourth most common species impinged in 1977-1978 and ranked seventh in the 2005-2006 impingement collection.

3.1.2 Size Distribution

Length measurements were taken for approximately 3 percent of the gizzard shad collected and approximately 35 percent of the specimens of the other species collected. Impinged fish ranged in size from 27 mm (gizzard shad) to 685 mm (longnose gar). Gizzard shad, the most abundant impinged species, ranged from 27 to 376 mm with a mean length of 99 mm for 4,594 measured fish (Table 4). Most of the impinged fish measured were less than 200 mm (96 percent); approximately 60 percent were less than 100 mm (Table 5).

The majority of impinged fish were YOY (Tables 6 through 11). YOY gizzard shad first became abundant in impingement collections in July 2005 and 2006; most were 40-80 mm but ranged from 30 to 120 mm (Table 6). By March 2006, the 2005 year-class ranged from approximately 60 to 190 mm; however, YOY gizzard shad from 70 to 110 mm were most abundant. Fewer YOY gizzard shad were impinged in 2006 than in 2005. Comparison of the length distribution of the 2005 and 2006 year-classes on a month-to-month basis indicates that impinged gizzard shad from 2006 year-class were smaller than the 2005 year-class at the same time of the year (Table 6).

YOY freshwater drum were first abundant in July 2005, primarily between 40 and 90 mm (Table 7). The length distribution increased rapidly through October when abundance in impingement of freshwater drum declined sharply. The 2005 year-class was common in the March 2006 impingement samples as yearlings and were primarily between 90 and 140 mm (Table 7). Few freshwater drum and no YOY from the 2006 year-class were collected in impingement samples after July 2006 (Table 7).

Similarly, for channel catfish (Table 8), the 2005 year-class occurred from July (most 50-80 mm) through October 2005 (most 60-120 mm). Yearlings from the 2005 year-class occurred again beginning in late Winter 2006. Few YOY channel catfish from the 2006 year-class were impinged in the summer and fall (Table 8).

Bluegill (Table 9) and orangespotted sunfish (Table 10) exhibited a relatively strong 2005 year-class based on the length frequency data, however, the 2006 year-class of both species was much less distinct. YOY bluegill were mostly 40-90 mm in length from August to November 2005, whereas orangespotted sunfish were primarily 30-80 mm.

YOY emerald shiner were primarily 30-60 mm from July through October 2005 (Table 11). The 2006 year-class was common in April and May 2006 in a similar size range. Few were collected from June through September 2006.

Daily average flows (ft^3/second) in the Muskingum River during late spring and summer were typical of the long-term median daily average flows; whereas in 2006, storm events resulted in higher than normal flows throughout much of May-July (Figure 4). These abnormally high river flows in 2006 coincided with the typical period of peak YOY abundance for many of the most common species impinged at MR, which were represented in the 2006 impingement collections by relatively small 2006 year-classes.

3.1.3 Water Quality Data

Water temperature, DO, and specific conductance were measured in front of the cooling water intake at the beginning and end of each sampling event (Table 12). Water temperature varied seasonally from a low of 1.1°C in December 2005 to a high of 28.6°C in July 2005 (Figure 10). DO also varied seasonally ranging from 5.5 mg/L in August 2006 to 14.6 mg/L in February 2006, with a mean of 9.6 mg/L (Figure 10). Specific conductance exhibited a range of 378-771 µS/cm; the mean was 577 µS/cm.

3.1.4 Estimated Total Impingement

3.1.4.1 Circulating Cooling Water Flow

The circulating cooling water flow for the sampling dates varied from 177.6 to 864.01 million gal/day (Table 13, Figure 11); flow during the first sampling date in June 2005 was 966.01 during the 28.6-hour sample. Extrapolated volumes for the 7-day sampling intervals associated with these sampling events ranged from 1,794.3 to 6,048.1 million gallons (Table 13). The design intake flow scenario that assumes Units 1-4 circulating water pumps operated at full capacity and Unit 5 operated in the closed cycle mode yielded a cooling water flow volume of 6,048.7 million gallons for each 7-day sampling interval (Table 13). The second design intake flow scenario, which assumes that in addition to Units 1-4 pumps operating at full capacity, Unit 5 operated in the once-through cooling mode yielded a design cooling water intake flow rate of 9,460.8 million gallons for each 7-day sampling interval (Table 13).

3.1.4.2 Observed Operating Conditions

Under the operating conditions and circulating water flows observed during these studies in 2005-2006, approximately 707,387 (±22,637) fish were impinged during the 6-month 2005 study period and 522,156 (±5,995) fish were impinged during the 2006 12-month study (Table 14). Of the total estimated 1.3 million fish impinged under observed conditions during the 18-month study, approximately 94 percent were gizzard shad and 5 percent were freshwater drum, mostly YOY. The estimated total mass of impinged fish was 23,821 kg (52,516 lb), approximately 94 percent of which was comprised of gizzard shad and 5 percent was freshwater drum (Table 14).

3.1.4.3 Design Intake Flow Conditions

Scenario 1

Scenario 1 assumes that Units 1-4 each operated at design circulating cooling water flow and Unit 5 operated on closed cycle cooling drawing makeup water from the Unit 4 cooling system at the condenser pit. Under this scenario, 1.1 million (±41,757) fish with a weight of 25,584 kg (56,403 lb) would have been impinged during the 2005 study period and 653,677 (±7,279) fish weighing 9,964 kg (21,967 lb) would have been impinged during 2006 (Table 14).

Impingement under Scenario 1 would have been approximately 61 percent higher than observed or actual intake flow during the second half of 2005 and approximately 25 percent higher during 2006.

Scenario 2

Scenario 2 assumes that Units 1-4 each operate at design circulating cooling water flow and that Unit 5 was also designed, constructed, and operated with a once-through cooling water system. Under this scenario, 1.8 million (±66,042) fish with a weight of 40,021 kg (88,231 lb) would have been impinged during the second half of 2005 and 1.0 million (±11,659) fish weighing 15,587 kg (34,363 lb) would have been impinged during 2006 (Table 14). Impingement under Scenario 2 would have been approximately 151 percent higher than observed during the second half of 2005 and approximately 96 percent higher during 2006.

3.2 JUVENILE AND ADULT FISH SAMPLING

3.2.1 Description of Study Area

The sampling area near MR extended from RM 101.0 to RM 103.5 (Figure 6). No major dischargers or water intakes occur in the sampling area other than those at MR. Tributaries in the area include Robinson Run upstream of MR and Wills Creek downstream of MR.

Adult and juvenile fish were collected by electrofishing and seining at three locations upstream and three locations downstream of MR (Figure 6). Sampling locations were the same as those used during previous surveys in the vicinity of MR (EA 1982). General habitat characteristics, as well as the QHEI score for each electrofishing and seine location, are presented in Table 15.

3.2.2 Physiochemical Data

3.2.2.1 Water Quality Data

Water temperature, DO, specific conductance, and water clarity (i.e., Secchi disk depth) were measured during each sampling effort. Measurements for electrofishing were made at night, whereas measurements for seining were made during the day.

Water temperatures during the study ranged from 15.8 to 34.5°C (Figure 12 and Appendix E). Temporal differences in water temperature conformed to expected patterns; coolest in October (range of means = 16.5-21.1°C), warmest in August (26.9-32.4°C), and intermediate in June (25.8-27.0°C) (Figure 12 and Table 16). Spatial differences in temperatures were slight to moderate throughout the study. During each survey, mean downstream temperatures were from 0.5 to 4.0 C° higher than mean upstream temperatures. Among individual sampling locations, temperatures were consistently highest at the discharge during each survey (Figure 12), with temperatures at the discharge being 2-7 C° warmer than at Location 3. In June, temperatures returned to near-ambient levels downstream, typically by Location 5. However, in August and during October electrofishing, temperatures remained 2-2.5 C° above ambient throughout the downstream portion by the study area (Figure 12).

DO was not limiting during the study, as mean values were consistently ≥5.9 parts per million (ppm) (Table 16). Temporally, mean DO values were comparable in June (range of means = 6.3-7.1 ppm) and August (5.9-8.6 ppm), but higher in October (9.2-10.4 ppm). Spatially, mean DO values were similar (within 0.5 ppm) upstream and downstream of MR during each month, except during seining in June and August. During June seining, the downstream mean was 0.8 ppm lower than the upstream mean; whereas during August seining, the opposite pattern was observed with the downstream mean 0.8 ppm higher than the upstream mean (Table 16). Diel differences were apparent as the mean daytime (i.e., seining) DO was from 0.1 to 2.7 ppm higher than mean nighttime (i.e., electrofishing) DO during all sampling events except downstream in June when the mean nighttime DO was 0.2 ppm higher than the corresponding daytime DO (Table 16).

Mean specific conductance values ranged from 654 to 773 µS/cm and were comparable spatially and temporally (Table 16).

Mean water clarity (i.e., Secchi disk depths) ranged from 570 to 919 mm (Table 16). Mean depths were lower in June than in August or October. During electrofishing, mean Secchi readings were marginally higher downstream compared to upstream in June, slightly higher upstream in August, and comparable in October (Table 16). Water clarity values during seining were comparable upstream and downstream of MR in June, higher upstream in August, and higher downstream in October. Mean water clarity values were generally higher during electrofishing than during seining (Table 16).

3.2.2.2 Habitat Quality

Habitat quality at electrofishing locations near MR was from fair to good based on QHEI scores that ranged from 44.5 (Location 4) to 62.5 (Location 5) at the six electrofishing locations near MR (Table 15). QHEI scores were lowest at Locations 1, 3, and 4 (range 44.5-49), intermediate at Locations 2 and 6 (55-58), and highest at Location 6 (62.5). QHEI scores exhibited less variability upstream of MR (range of scores 47-58) than downstream of MR (44.5-62.5).

Even so, the mean QHEI score upstream of MR (51.3) was comparable to the downstream mean (54). The variability among QHEI scores within the study area was due, in large part, to differences in substrate quality (Table 15).

QHEI scores were very similar among seine Locations 1, 2, 5, and 6 (range 55-57) and lower, but similar, at Locations 3 and 4 (43.5 and 46.5, respectively). Thus, spatially, the seine QHEI scores were nearly identical upstream (mean = 51.8) and downstream (52.3) of MR (Table 15). The lower QHEI scores observed at Locations 3 and 4 were due to a combination of poor substrate quality, lack of a variety of instream cover types, and slower current velocity.

3.2.2.3 Hydrological Data

River flow data were obtained from the USGS gauging station at McConnelsville, Ohio (03150000). Data were obtained and analyzed for the period May-October 2005 (Figure 13). For this period, flows ranged widely from 12,300 ft^3/second on 26 August to 198,000 ft^3/second on 1 May (Figure 13). In contrast, daily mean flows during the three surveys were low and relatively stable: 16-17 June (31,700-31,800 ft^3/second); 16-17 August (20,000-22,200 ft^3/second); and 18-19 October (19,100-20,100 ft^3/second).

Monthly mean flows in 2005 approximated normal flows in May; were below normal in June, July, and August; and were above normal in September and October:

Monthly Mean Flows (× 1,000 ft^3/second)						
	May	June	July	August	September	October
2005	98.5	33.9	29.0	20.6	37.8	38.0
Historical	94.3	68.5	45.4	35.0	29.4	25.1
NOTE: Historical means are from 1921 to 2004.						

3.2.3 Taxonomic Composition and Abundance

A total of 27,157 fish representing 49 species and three hybrids was collected by electrofishing and seining in the vicinity of MR (Tables 17 and 18). Numerically, Ictiobinae (28.0 percent), emerald shiner (20.4 percent), spotfin shiner (17.6 percent), orangespotted sunfish (8.0 percent), and gizzard shad (6.2 percent) dominated the combined catch (Table 18). Other moderately common (>1 percent of the catch) taxa were Catostominae (3.6 percent), central stoneroller (2.4 percent), bullhead minnow (1.8 percent), bluntnose minnow (1.6 percent), creek chub (1.6 percent), and bluegill (1.2 percent). In contrast, 8 species were represented by only one or two individuals: ghost shiner, spottail shiner, black redhorse, blackstripe topminnow, rock bass, warmouth, white crappie, and fantail darter (Table 18). No Ohio threatened or endangered species were collected during this survey (Ohio Department of Natural Resources 2003).

Differences in community composition were apparent between electrofishing and seining catches. Electrofishing and seining yielded nearly identical numbers of individuals, 13,911 and 13,246, respectively; however, electrofishing produced more species (46 species) and appreciably more biomass (464 kg) than seining (30 species; 4 kg). Twenty-one species (primarily catostomids and centrarchids) were collected exclusively by electrofishing; 4 species (suckermouth minnow, creek chub, blackstripe topminnow, and rainbow darter) were collected by seining only, and 23 species were shared by both gear types (Table 18). The dominant taxa differed between gear types as they shared only 2 (emerald shiner and spotfin shiner) of the top 5 most abundant taxa collected and compositional differences among gears were dramatic for some dominant species. The 5 most abundant taxa collected by gear are presented below:

Species	Electrofishing (% Abundance)	Seining (% Abundance)
Emerald shiner	34.4	5.7
Spotfin shiner	18.6	16.6
Orangespotted sunfish	15.5	0.1
Gizzard shad	12.0	<0.1
Bullhead minnow	3.5	<0.1
Ictiobinae	0.3	57.2
Catostominae	0.0	7.4
Central stoneroller	0.1	4.8

As expected, biomass differed substantially between gears. The electrofishing biomass was dominated by smallmouth buffalo (31.8 percent), common carp (16.6 percent), flathead catfish (9.3 percent), and gizzard shad (9.0 percent); whereas Ictiobinae (33.9 percent), spotfin shiner (26.7 percent), emerald shiner (8.7 percent), central stoneroller (5.2 percent), Catostominae (5.2 percent), and bluntnose minnow (4.8 percent) dominated the seining biomass (Table 18).

3.2.3.1 Incidence of Parasites, Diseases, and Abnormalities

Eighty-five fish, representing 0.3 percent of the total catch, exhibited some type of external anomaly (Table 19 and Appendix A). Excluding Ictiobinae, emerald shiner, and spotfin shiner, 0.9 percent of the total catch exhibited anomalies. DELT anomalies (primarily erosion) were present in 0.3 percent of the annual catch (without the aforementioned 3 taxa) and were most frequently observed on common carp, smallmouth buffalo, gizzard shad, silver redhorse, channel catfish, bluegill, and spotted bass. The DELT anomaly percentage is considerably lower than the median value (1.1 percent) observed at Ohio EPA's boat electrofishing reference sites (Ohio EPA 1987). The percentage of fish with DELT anomalies is one of Ohio EPA's IBI metrics. Except at Locations 2, 3, and 4 in June, this metric would have consistently scored a 5 at 6 at electrofishing locations sampled in June, August, and October 2005 (Appendix A).

DELT anomalies are the group of anomalies most relevant for this study because relationships have been established between their incidence rates and water quality (Ohio EPA 1989, 1996; Emery et al. 2003). The percentages of DELT anomalies, parasitic infestations (i.e., blackspot, leeches, and anchor worm), and other anomalies (primarily swirled scales) were similar in June, August, and October (Table 19).

3.2.3.2 Length Frequency Distributions

Length frequency distributions were compiled for the six most abundant non-cyprinid species collected near MR in 2005: gizzard shad, orangespotted sunfish, bluegill, smallmouth buffalo, spotted bass, and freshwater drum.

Gizzard shad ranged in size from 40 to 359 mm (Table 20). The vast majority (97 percent) of the catch consisted of fish between 40 and 199 mm in length, primarily YOY and Age I fish (EA 2003). The remaining fish were sporadically distributed from 230 to 359 mm, likely representing Ages II through V fish (EA 2003).

All orangespotted sunfish measured were between 20 and 109 mm (Table 20), and likely comprised of YOY through Age IV fish (Carlander 1977). However, most were $\leq$ Age II (20-9 m).

Bluegill were fairly evenly distributed in size from 20 to 199 mm (Table 20), likely representing YOY through Age VII fish (EA 2003; Carlander 1977).

Smallmouth buffalo were sporadically distributed between 70 and 600+ mm (Table 20). The catch was dominated (96 percent) by fish 70-169 mm (YOY, Age I, and possibly Age II fish) and fish that were 410-600 mm+ (likely Age III through Age VII fish) (Carlander 1969).

Spotted bass ranged in size from 60 to 319 mm (Table 20). YOY through Age III fish (60-209 mm) dominated (89 percent) the catch. The remainder of the spotted bass catch likely consisted of Age IV through Age VII fish (Carlander 1977).

Freshwater drum were collected between 80 and 489 mm, however, most (94 percent) were smaller fish ranging in size from 80 to 159 mm (Table 20). These smaller fish represented YOY and Age I fish (EA 2003).

3.2.4 Temporal Variation

3.2.4.1 Electrofishing

Community-level parameters differed significantly ($P<0.05$) among the three seasonal surveys (Tables 21 and 22). Except for mean diversity, all community-level parameters (mean CPUE by number and weight, species richness, IBI, and IWBmod) were significantly lower in June than in August and October. In all cases, August values were intermediate to those observed in June and October (Table 22). Conversely, diversity was significantly higher in June than in October. Mean diversity was lower in August than in June, however, the difference was not statistically significant.

Electrofishing CPUE (by number) for nearly all of common to abundant species or taxa collected in 2005 was higher in August and October than in June (Table 21). However, significantly higher total catch rates in the summer and fall were primarily attributable to 5 species: gizzard shad, emerald shiner, spotfin shiner, orangespotted sunfish, and freshwater drum. CPUE for these species were generally an order of magnitude higher in August and October than in June (Table 21).

Temporal characterization of the fish community also included an analysis of the omnivore, insectivore, and top carnivore trophic guilds by weight and number. CPUE by number were consistently lowest in June and much higher in August and higher yet in October for all three trophic guilds (Figure 14). Similarly, omnivore, insectivore, and top carnivore biomass was lower in June and slightly to moderately higher in August and October.

3.2.4.2 Seining

Unlike electrofishing catches, seine catches declined substantially from June through October. The variability in catch rates was due to the abundance of Ictiobinae, spotfin shiner, and, to a lesser extent, Catostominae, central stoneroller, and creek chub (Table 23). For example, Ictiobinae (all YOY) accounted for 72 percent of the 10,574 fish caught in June, however, only a single Ictiobinae was collected in August and October combined. Similarly, 70 percent of the August catch was comprised of spotfin shiner compared to 6 percent in June and 28 percent in October. Many species such as longnose gar, common carp, channel shiner, white sucker, blackstripe topminnow, brook silverside, green sunfish, largemouth bass and greenside darter were collected in a single season (Table 23). The temporal differences in the capture of the dominant taxa largely reflected the variability in abundance and susceptibility of YOY to seining.

Species richness in June and August was roughly twice as high as in October (Table 23).

3.2.5 Spatial Variation

3.2.5.1 Electrofishing

For trips combined, none of the six community-level parameters evaluated showed significant ($P<0.05$) upstream versus downstream differences (Table 24). Most of the community-level parameters (mean CPUE by weight, species richness, diversity, and IWBmod) were comparable to or marginally higher downstream compared to upstream of MR. However, the mean CPUE by number was marginally higher upstream of the plant than downstream (Table 24); however, this difference was not statistically significant.

Although mean total CPUE was comparable upstream and downstream of MR, there were noticeable differences of some common species. For example, golden redhorse CPUE and, to a lesser extent, silver redhorse and slenderhead darter CPUE, were higher upstream than downstream (Table 25). In contrast, CPUE for channel catfish, flathead catfish, brook silverside, green sunfish, and bluegill were from 2 (flathead catfish) to 36 (bluegill) times higher downstream of MR compared to upstream of MR.

Mean species richness (No./location) was nearly identical upstream and downstream of MR; however, spatial differences were apparent in composition (Table 25). For example, ghost shiner, white sucker, northern hog sucker, and rock bass were collected exclusively upstream of MR whereas many species such as silverjaw minnow, spottail shiner, channel shiner, black redhorse, warmouth, longear sunfish, largemouth bass, white crappie, greenside darter, and fantail darter were only collected downstream of MR (Table 25). Mean IBI values were identical upstream (38.2) and downstream (38.0) of MR. Mean IWBmod values were marginally higher downstream of the plant (9.1) compared to upstream of the plant (8.7). These patterns suggest that thermal avoidance did not occur during the seasonal surveys in the vicinity of MR.

All community-level parameters were comparable upstream and downstream of MR throughout the study, further indicating a lack of thermal avoidance (Table 26).

Spatially, CPUE by number and weight was comparable for omnivores and insectivores whereas top carnivore CPUE by number and weight was marginally higher downstream of MR (Figure 14).

3.2.5.2 Seining

For trips combined, seining catches (total numbers and CPUE) were over twice as high downstream of MR (8,958 fish and 186.6 fish/haul) compared to upstream of MR (4,288 fish and 89.3 fish/haul) (Table 27). Spatial differences were largely due to the variable abundance of spotfin shiner and Ictiobinae:

	Upstream	Downstream
All fish	4,288	8,958
Spotfin shiner	1,597	601
Ictiobinae	871	6,704
All fish less these two species	1,820	1,653

Other species that exhibited upstream versus downstream differences were emerald shiner and bluntnose minnow, which were more abundant upstream of MR and creek chub, central stoneroller, and rainbow darter, which were more abundant downstream of MR (Table 27). Although abundance differed between the upstream and downstream areas, total richness and mean richness were similar between the two areas.

For individual surveys, CPUE (No./haul) was higher downstream of MR in June but higher upstream of the plant in August and October (Table 26). The higher catch rate observed downstream in June was due almost exclusively to YOY Ictiobinae. The higher catch rates observed upstream in August and October were due to higher upstream catch rates of emerald shiner, spotfin shiner, bluntnose minnow, and sand shiner (August only).

3.2.6 Summary of the 2005 Fisheries Data

A total of 27,157 fish, representing 49 species and 3 hybrids was collected by electrofishing and seining in the vicinity of MR during the 2005 study. Numerically, the combined catch was dominated by YOY Ictiobinae (28.0 percent), emerald shiner (20.4 percent), spotfin shiner (17.6 percent), orangespotted sunfish (8.0 percent), gizzard shad (6.2 percent), Catostominae (3.6 percent), central stoneroller (2.4 percent), bullhead minnow (1.8 percent), bluntnose minnow (1.6 percent), creek chub (1.6 percent) and bluegill (1.2 percent). No Ohio threatened or endangered species were collected during this survey. Electrofishing and seining catch totals were similar, 13,911 and 13,246 fish, respectively. However, electrofishing produced more species (46 species) and appreciably more biomass (464 kg) than seining (30 species; 4 kg). Twenty-one species (primarily catostomids and centrarchids) were collected exclusively by electrofishing; four species (suckermouth minnow, creek chub, blackstripe topminnow, and rainbow darter) were collected by seining only; and 23 species were shared by both gear types. Emerald shiner, spotfin shiner, orangespotted sunfish, gizzard shad, and bullhead minnow dominated the electrofishing catch whereas the seine catch was strongly dominated by YOY Ictiobinae (57 percent), spotfin shiner, Catostominae, emerald shiner, and central stoneroller.

Electrofishing biomass was dominated by smallmouth buffalo (31.8 percent), common carp (16.6 percent), flathead catfish (9.3 percent), and gizzard shad (9.0 percent); whereas Ictiobinae (33.9 percent), spotfin shiner (26.7 percent), emerald shiner (8.7 percent), central stoneroller (5.2 percent), Catostominae (5.2 percent), and bluntnose minnow (4.8 percent) dominated the biomass collected seining.

All community-level electrofishing measures differed significantly ($P<0.05$) among seasons. Except for mean diversity, all community-level parameters were significantly lower in June than in August and October. In all cases, August values were intermediate to those observed in June and October. Conversely, diversity was significantly higher in June than in October. Unlike temporal comparisons in which all community measures were significantly different, none of the six community-level parameters evaluated showed significant ($P<0.05$) upstream versus downstream differences.

3.2.7 Comparison of 2005 Surveys to Historical Fish Surveys

Adult and juvenile fish were sampled by EA in the vicinity of MR in 1976-1977 as part of a Section 316(a) monitoring program (EA 1978). Considerably more effort was expended during these earlier studies in terms of types of sampling gear, frequency of sampling, and seasonal coverage. Fish populations in the Muskingum River were sampled from stations in the lock and dam pool upstream of the plant (control pool), in the pool on which the plant is located (discharge pool), and the next pool downstream from the plant (discharge effects pool or P1) from December 1976 through November 1977. All sampling stations for the 2005 program were within the 1976-1977 discharge pool. Four sampling gears, electroshocker boat, fyke nets, seines, and hoop nets were used in the control pool, discharge pool, and P1 during the historical study.

Electrofishing at each station was conducted for 15 minutes and over a measured distance along the shoreline to minimize the effect of flow rates on sampling. Fyke nets were set overnight; the cod end of the fyke net was made of 3/8-in. bar mesh netting and the leads and wings were of 0.5-in bar mesh net material. Gill nets were set parallel to shore and fished overnight at the same stations as the fyke nets. Each gill net was 225-ft long and had nine panels with 0.5-4.5 in. bar mesh net material. Beach seine samples were collected with a 100 × 8 ft bag seine in December and January, after which a 50 × 6 ft bag seine was used. Both seines had 3/8-in. bar mesh wings and 0.25-in. bar mesh bag.

Sampling was conducted twice per month in November, December, January, February, and March and weekly April through October for all methods except gill netting and fyke netting, which were reduced to semi-monthly (June-October) at the request of the Ohio Department of Natural Resources.

A total of 71 species were collected from all locations and all gears during the historical study. A total of 66 species were collected from the Muskingum River control pool, discharge pool, and P1 stations. A total of 57 species were collected from the discharge pool, 52 species were collected by electrofishing, and 51 species by seining. This species diversity is similar to the results from the three 2005 surveys conducted in the same general area of the discharge pool; 49 species, 3 hybrids, and 10 family or subfamily categories.

The most abundant taxa in the 1976-1977 survey were gizzard shad, emerald shiner, spotfin shiner, spotted bass, bluntnose minnow, smallmouth buffalo, redhorse (silver, golden, and shorthead), bluegill, mimic shiner, channel catfish, and orangespotted sunfish. Considering the differences in gear types and seasonal effort between the two studies, the community composition of the most abundant taxa collected almost three decades later in 2005 is remarkably similar: carpsucker and buffalofish subfamily, emerald shiner, spotfin shiner, orangespotted sunfish, gizzard shad, sucker subfamily, central stoneroller, bullhead minnow, creek chub, bluntnose minnow, bluegill, and redhorse (golden, silver, and smallmouth).

3.3 COMPARISON OF IMPINGEMENT AND ADULT FISH RESULTS

Sixty-two fish taxa (49 species, 3 hybrids, and 10 taxa identified to the family or subfamily level) were collected during the three sampling efforts that comprised the 2005 river survey of juvenile and adult fish compared to 52 taxa (41 species, 3 hybrids, and 8 taxa identified to the family or subfamily level) collected during the 18-month 2005-2006 impingement study. A total of 11 impinged species were not collected during the river survey and 20 species collected in the river were not in the impingement samples.

The relative abundance of the 10 most abundant species in impingement collections during 2005 is compared below to the abundance of those same species collected in 2005 during the juvenile and adult surveys in the Muskingum River in the vicinity of MR:

Taxon	Impingement		River	
	Number	Percent	Number	Percent
Gizzard shad	72,449	90.6	1,673	6.2
Freshwater drum	5,444	6.8	241	0.9
Channel catfish	1,061	1.3	117	0.4
Carpsucker/buffalofish	266	0.3	7,616	28
Bluegill	199	0.2	335	1.2
Orangespotted sunfish	120	0.1	2,170	8
Quillback	106	0.1	40	0.1
Emerald shiner	63	<0.1	5,546	20.4
Spotfin shiner	23	<0.1	4,787	17.6
Longnose gar	23	<0.1	33	0.1
Total	79,754	99	22,558	82.9

It is clear from these results that the two sampling efforts reflect different components of the fish community. The 10 most abundant species accounted for more than 99 percent of fish collected from the cooling water intake screens; however, those same 10 species represented only 82.9 percent of the fish collected in the river. Gizzard shad dominated (90.6 percent) the impingement samples but accounted for only 6.2 percent of the river catch. The adult fish collections were dominated by the carpsucker and buffalofish subfamily, emerald shiner, and spotfin shiner which collectively accounted for 17,949 individuals representing 66 percent of the catch. In contrast, these 3 taxa were represented by only 352 individuals (0.4 percent) in the impingement catch. Four of the 10 most abundant taxa collected during the juvenile and adult survey in the river were not among the 10 most abundant taxa impinged: central stoneroller, bluntnose minnow, bullhead minnow, and creek chub. Freshwater drum, channel catfish, bluegill, quillback, and longnose gar were among the 10 most common impinged species, but were not among the most common fish collected in the river.

EA concludes that the species composition and abundance of fish in the vicinity of the intake structure represented by electrofishing and seining is **not** an accurate prediction of its likelihood of being impinged.

3.4 ICHTHYOPLANKTON ENTRAINMENT

3.4.1 Species Composition

Entrainment of ichthyoplankton was monitored during the expected period of peak ichthyoplankton abundance, beginning in July through September 2005 and from April through September 2006. During the 2006 sampling program, which encompassed the entire entrainment season, no entrained organisms were collected before the last week of April or after mid-September during 2005 or 2006. Ichthyoplankton were most abundant in entrainment samples collected between early June and early August (Figure 15).

Twenty-three taxa were identified in entrainment samples collected during 2005-2006 at MR (Table 28). The most abundant taxa collected were the herring family including gizzard shad, sucker family, and freshwater drum (Table 29) which accounted for approximately 55 percent of ichthyoplankton collected during entrainment sampling. Freshwater drum eggs were collected from late May through mid-June; other eggs collected could not be identified to any taxon. Gizzard shad and other clupeid specimens occurred over the longest portion of the entrainment season compared to other taxa collected from late May into early September. Twelve taxa occurred during only one sampling event in 2005 or 2006. Specimens that could not be identified to any taxonomic level or life stage due to damage or lack of distinguishing morphometric characteristics occurred throughout the entrainment study and accounted for approximately 40 percent of the specimens collected.

3.4.2 Size Distribution

Fish eggs collected during entrainment sampling were generally 1.7 mm diameter or smaller (Table 30). With the exception of one 122-mm channel catfish, an 81-mm emerald shiner, and several spottail shiners, all larval and juvenile specimens collected were <80-mm total length. The mean lengths for most taxa and life stages were typically less than 20 mm (Table 30). The majority (95 percent) of organisms collected during this study were <40 mm (Table 31). Early life stages of gizzard shad, one of the most abundant taxa, were between 10 and 69 mm. Members of the sucker family (redhorse, carpsucker, sucker, and quillback) were between 5 and 20 mm; unidentified specimens were all less than 8 mm (Table 31).

3.4.3 Physicochemical Parameters

Intake and discharge water temperature, DO, and specific conductance were recorded at the beginning and end of each diel sampling period on each sampling date. The average daily temperature in the intake ranged from 12.9°C in April to 28.8°C in early August (Table 32) and cooled back to 19.1°C in late September. Discharge water temperatures during the same period ranged from 16.2°C in May to 34.2°C in early August. DO ranged from 10.8 mg/L in June to 5.2 mg/L in September. Specific conductance varied between 400 and 781 µS/cm during the study.

3.4.4 Estimates of Total Entrainment

3.4.4.1 Circulating Cooling Water Usage

Circulating cooling water daily volume varied during entrainment sampling from 403.2 to 1,728 million gal (Table 33). The observed total circulating water volume for each 1- to 3-week entrainment estimating period represented by each entrainment sampling event ranged from 1,955.6 to 17,599.9 million gal (Table 33).

MR Unit 5 was designed to operate using a cooling tower for heat rejection with makeup water drawn from the Unit 4 condenser pit. In order to estimate the potential effect of closed cycle cooling at Unit 5 on overall entrainment, two additional cooling water intake flow scenarios were evaluated:

- ***Scenario 1***—Units 1-4 operate at design cooling water intake flow rate for the entire year. Unit 5 operates, as designed, with a closed cycle cooling system.

- ***Scenario 2***—Units 1-4 operate at design cooling water intake flow rate for the entire year. Unit 5 has a once-through circulating water cooling system with a design cooling water intake flow rate of 338,571 gal/minute and a design temperature rise across the condenser of 14 °F.

Under Scenario 1, the total cooling water volume for each entrainment estimating period ranged from 6,048.1 to 18,144.2 million gal (Table 33). For Scenario 2, the total cooling water volume for each entrainment estimating period ranged from 9,460.9 to 28,382.6 million gal (Table 33).

3.4.4.2 Estimated Total Entrainment for Observed Cooling Water Volumes

The 2005 entrainment sampling was initiated in July, approximately halfway through the expected entrainment season, and the 2006 sampling program appears to have captured the full seasonal duration of ichthyoplankton entrainment at MR. Consequently, the data collected during the 2006 sampling program are representative of potential annual ichthyoplankton entrainment at MR. It is estimated that the total number of fish of all life stages entrained at MR during 2005 and 2006 at the observed cooling water flows was 8.4 million (±32.8 million) and 28.3 million (±91.8 million) organisms, respectively (Table 34). The 2005-2006 total of 37.7 million ichthyoplankton included 20.9 million eggs, 3.2 million yolk-sac larvae, 736,234 post yolk-sac larvae, 6.9 million early juveniles, and 4.9 million organisms not identified to a specific life stage. Gizzard shad and other early clupeid life stages accounted for 25 percent of the estimated number of ichthyoplankton entrained during 2006; members of the sucker family accounted for 11 percent. Approximately 13,386,643 entrained ichthyoplankters (47.3 percent) could not be identified to a specific taxonomic group. Ten other taxa accounted for the remaining 17 percent of the estimated number of organisms entrained in 2006.

3.4.4.3 Estimated Total Entrainment for the Design Cooling Water Intake Flow Scenarios

Scenario 1

Based on the 2006 entrainment data, if Units 1-4 had operated at design circulating cooling water flow throughout the 2006 entrainment season (April-September), an estimated 38.9 million (±126.1 million) early life stages of fish would have been entrained at MR (Table 34), representing a 37 percent increase over the 2006 actual cooling water flow conditions (Section 3.4.4.2). Clupeid (herring family) early life stages comprised 26 percent and catostomid (sucker family) comprised 14 percent of the Scenario 1 for entrained ichthyoplankton at MR. Approximately 43 percent of the entrained organisms could not be identified to a specific taxonomic group.

Scenario 2

Scenario 2 assumes Units 1-5 operated as once-through cooling water systems at the design intake flow rates for the entire entrainment season (April-September). Based on that assumption, it is estimated that 60.8 million (±197.4 million) early life stages of fish would have been entrained at MR based on the 2006 entrainment sampling program (Table 34). This represents a 115 percent increase in the number of entrained ichthyoplankton compared to the 2006 actual intake condition (Section 3.4.4.2) and a 56 percent increase compared to Scenario 1 that represents the existing engineering design of MR. Clupeid (herring family) early life stages comprised 26 percent and catostomid (sucker family) comprised 14 percent of the estimated number of entrained ichthyoplankton at MR. Approximately 43 percent of the entrained organisms could not be identified to a specific taxonomic group.

3.4.4.4 Comparison to Historical Data

Entrainment samples were collected at MR from December 1976 through November 1977. Monthly samples were collected in December 1976; January, February, and November 1977; and twice per month in March, September, and October 1977. Weekly sampling was conducted from April through August 1977. Water was pumped from the discharge canal at MR at 4-hour intervals for a total of 7 samples during each 28-hour sampling event. Approximately 100 m^3 was pumped through a 505-μm mesh plankton net that was suspended in a barrel of water. A flowmeter on the overflow was used to measure the volume of water filtered. One-third of the total volume filtered for each sample was pumped from three depths in the discharge: surface, mid-depth, and bottom. The pooled sample across the three depths was analyzed as one sample.

The predominant taxa and seasonal distribution of entrained ichthyoplankton during the 1976-1977 study were similar to the findings of the 2005-2006 study. An annual estimated 8.0 million eggs were entrained including 4.2 million carp eggs and 2.4 million freshwater drum eggs. The annual estimate of larvae entrained was 65.7 million, of which 28.8 million (44 percent) were in the suckers family, 13.6 million (21 percent) were minnows, 11.8 million (18 percent) were gizzard shad, 6.6 million (10 percent) were unidentified, and 2.6 million (4 percent) were freshwater drum. Eggs were first collected in mid-March and last collected in mid-July 1977. Larvae were collected from late April through early September with the bulk of the larvae collected by mid-July.

Overall, the 1976-1977 estimate of 73.7 million ichthyoplankton (8.0 million eggs and 65.7 million larvae) was 2.6 times higher than the 2006 observed entrainment estimate.

3.5 RIVER ICHTHYOPLANKTON SAMPLING

Ichthyoplankton were collected in the Muskingum River in the vicinity of the MR cooling water intake from early July through September 2005 and April through June during 2006 coincident with the entrainment study. Physicochemical parameters were similar to those measured during entrainment sampling at MR (Table 35). River temperature during this sampling program ranged from 12.5°C on 10 April 2006 to 29.1°C on 5 August 2005 (Table 35). DO was 7 mg/L or higher except on 25 July 2005 when DO was 61 mg/L. The maximum DO was 11.2 mg/L recorded in June 2006. Specific conductance ranged from 412 to 796 µS/cm, and water clarity indicated by Secchi depth ranged from 0.2 to 1.2 m.

A total of 26 ichthyoplankton taxa were collected in the Muskingum River during the 2005-2006 sampling program; 13 of these taxa were identified to species (Table 36). The river samples were collected at mid-depth during the first 3 weeks of July 2005; after that period, a location was identified with sufficient depth to allow sampling at near bottom and near surface depths (Table 37). Ichthyoplankton occurred in all samples collected from early April to late September.

River ichthyoplankton collections were dominated in numbers and period of occurrence by various minnow taxa (cyprinid family) and sucker taxa (catostomid family). The density of most taxa and life stages was typically less than 20/1,000 m^3 on most sampling dates (Table 37). The peak density was 162.4 and 89.6 unidentified eggs per 1,000 m^3 in the 19 June 2006 bottom and surface samples, respectively. The highest density for an identified taxon was 88 yolk-sac carpsucker per 1,000 m^3 on 30 May 2006. No consistent differences were observed between densities of ichthyoplankton collected near the bottom and surface of the river (Table 37, Figure 16). The majority of organisms collected in the river were larvae less than 20 mm total length (Tables 38 and 39); those larger than 20 mm were typically early juveniles.

Historic ichthyoplankton sampling was conducted at MR from December 1976 through November 1977. Day and nighttime samples were collected at various locations upstream of MR, at the MR discharge, and downstream of MR. Approximately 1,460 ichthyoplankton samples (860-daytime and 600-nighttime) were collected. Sampling methods were similar to the 2005-2006 study using 0.5-m, 505-µm 5:1 conical plankton nets towed near surface and near bottom. Sample volumes in the 1976-1977 study ranged from 1,500 to 2,000 ft^3 of filtered water (42.5-56.6 m^3) compared to a target of 60 m^3 for the current study.

The seasonal distribution of ichthyoplankton in the Muskingum River was similar between the two studies. Samples containing ichthyoplankton were collected from 14 March through 30 August during the 1976-1977 study. Eggs were collected from March through 19 July with peak densities during the last half of May and the last week of June. Larvae were collected from 26 April through 30 August and the peak abundance in the samples was during the last week of April, May, and the first week of June. Species composition and most common species were also similar between the two studies. Freshwater drum and common carp accounted for 90 percent of the identified eggs and 7 taxa and other life stages comprised 89 percent of the total collections. In descending order, these taxa and life stages were catostomid larvae (25.1 percent), gizzard shad larvae (20.9 percent), cyprinid larvae (14.4 percent), emerald shiner (10.2 percent), freshwater drum larvae (7.4 percent), and common carp eggs (6.0 percent) and larvae (54 percent). Other taxa collected during the 1976-1977 study included channel and flathead catfish, and centrarchids.

3.6 COMPARISON OF ENTRAINED ICHTHYOPLANKTON AND RIVER ICHTHYOPLANKTON RESULTS

A similar mix of taxa was collected during entrainment sampling at MR and the Muskingum River ichthyoplankton surveys near the cooling water intake (Tables 28 and 36). The most common taxa seasonally in both surveys were cyprinids (minnows) and catostomids (suckers) (Tables 29 and 37). Densities and seasonal patterns for catostomids were generally similar between the river entrainment samples (Figure 17). Densities of cyprinids were relatively low at both locations, but typically higher in the entrainment samples (Figure 17).