National Pollutant Discharge Elimination System (NPDES) Permit Program

FACT SHEET

Regarding an NPDES Permit To Discharge to Waters of the State of Ohio
for **Cardinal Operating Company**

Public Notice No.: 212710
Public Notice Date: June 6, 2025
Comment Period Ends: July 5, 2025

Ohio EPA Permit No.: **0IB00009*BE**
Application No.: **OH0012581**

Name and Address of Applicant:
Cardinal Operating Company – Cardinal Plant
6677 Busch Blvd
Columbus, OH 43229

Name and Address of Facility Where Discharge Occurs:
Cardinal Operating Company
306 County Road 7E
Brilliant, OH 43913
Jefferson County

Receiving Water: **Ohio River, Blockhouse Hollow Run, Riddles Run**

Subsequent Stream Network: **Ohio River**

INTRODUCTION

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.

Antidegradation provisions in Ohio Administrative Code (OAC) Chapter 3745-1 describe the conditions under which water quality may be lowered in surface waters. No antidegradation review was 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

The effluent limits and/or monitoring requirements proposed for all parameters are the same as in the current permit, except those listed below.

<u>Outfall 001/091:</u>

- Monitoring is proposed to be removed for ammonia, barium, and copper. See discussion under the Reasonable Potential Section.
- Zinc monitoring is proposed to be a flow-weighted calculation similar to mercury.
- Fictitious Outfall 091 is proposed to be removed. The facility does not continuously chlorinate and plans to continue intermittent use of no more than 2 hours/day.
- Monitoring is proposed to be removed for total residual oxidant. The facility does not use bromine-based additives.

<u>Outfall 006:</u>

- New quarterly monitoring is proposed for ammonia.
- Limits and monitoring for copper are proposed to be removed.

<u>Outfall 008:</u>

- Monitoring is proposed to be removed for copper.

<u>Outfall 019:</u>

- The existing technology-based limits for combustion residual leachate for total suspended solids, oil and grease and pH are proposed to be relocated at internal station 602, where leachate has been redirected around the FAR II reservoir.
- Technology-based limits are proposed for arsenic and mercury (daily maximum only) by January 1, 2030. The technology-based limits for total suspended solids, oil and grease and pH are proposed to reapply by January 1, 2030, for the application of the unmanaged combustion residual leachate waste stream.
- Monthly monitoring is proposed for all limited parameters. This includes total suspended solids, oil and grease, and mercury. Weekly pH monitoring is proposed to continue.
- Monitoring is proposed to be reduced for arsenic (monthly) and total filterable residue (quarterly).

- New monitoring for hardness is proposed.
- Monitoring requirements are proposed to be removed for ammonia based on the Group 2 placement and temperature because sluice water transport has ceased.
- Monitoring of alkalinity, boron, chlorides, chromium (hexavalent), copper, nitrate plus nitrite, specific conductance, selenium, sulfates, total kjeldahl nitrogen and zinc are proposed to be removed.

Outfall 024:

- Replacing Outfall 023 due to bottom ash pond retrofit, wastestream and location changes.
- New daily maximum limit is proposed for copper based on the wasteload allocation. A compliance schedule is proposed for meeting the new final effluent limit.
- Daily maximum limit for total suspended solids is proposed to decrease slightly due to flow data.
- New monitoring for hardness is proposed.
- Monitoring is proposed to decrease to quarterly for ammonia and selenium.
- Monitoring is proposed to be removed for arsenic, boron, cadmium, chromium (dissolved hexavalent), fluoride and zinc.

Internal monitoring station 601 (existing FGD treatment system):

- Technology based effluent limits are proposed for oil and grease. Weekly monitoring is proposed.
- Monitoring is reduced to once per month for arsenic, mercury, nitrate plus nitrite, selenium and zinc.
- Monitoring of water temperature, specific conductance, alkalinity, total kjeldahl nitrogen, chloride, sulfate, fluoride, iron, boron, barium, nickel, cadmium, chromium, copper, lead, and total filterable residue, are proposed to be removed.

Internal monitoring station 602 (FAR I RSW landfill leachate):

- Technology based limits are proposed for combustion residual leachate for total suspended solids and oil and grease.
- New monitoring is proposed for ammonia, arsenic, total suspended solids, and oil and grease based on final effluent limits at outfall 019.
- Monitoring for fluoride is proposed to be removed.
- Monthly monitoring is proposed for all parameters, except flow monitoring which is proposed daily.

Internal Station 603

This station is used to make record of bottom ash transport waters discharge as required under the federal effluent limit guidelines. An interim outfall table is proposed to track the primary wetted volume until December 31, 2029. The final table includes a limit of "0" for number of days to discharge that correspond to the 2024 ELG date of "no discharge of pollutants" in bottom ash transport waters. On October 13, 2023, Cardinal Power Plant submitted certification of zero-discharge fly ash transport water pursuant to 40 CFR 423.13(h) and of the 2020 BAT bottom ash transport water (≤ 10% primary wetted volume) pursuant to 40 CFR 423.13(k)(2).

Internal monitoring station 604 (new FGD biological treatment):

The use of internal monitoring station 604 is proposed to change. Previously, this station was used to make record of days when fly ash transport water was discharged. The conversion to a dry fly ash system was completed with a last day of fly ash transport water discharge on 5/4/21. Station 604 is proposed for monitoring the FGD wastewater effluent from the new biological treatment system. Details of the monitoring and limit requirements at this station are proposed below:

- Technology based effluent limits are proposed for total suspended solids, oil and grease, pH, along with the following parameters which apply as soon as possible but not later than December 31, 2025: arsenic, nitrate/nitrite, mercury and selenium.
- Monitoring is proposed for zinc for Outfall 001 flow-weighted calculation.

- Monthly monitoring is proposed for all parameters, except flow rate is to be monitored daily, and pH weekly.
- An interim and final table are proposed that correspond to the 2024 ELG date of "no discharge of pollutants" in FGD wastewaters. The 2020 BAT limitations are proposed at the interim table until December 31, 2029. The 2024 BAT limitations are proposed at the final table to make record of days when FGD wastewaters are discharged and includes a limit of "0" for number of days to discharge.

Internal monitoring station 605 (FAR I RSW landfill stormwater)
A benchmark for total suspended solids is proposed with quarterly monitoring.

Stormwater outfalls 011, 012, 025, 026 and 027
Three new stormwater outfalls are being added to the permit, Outfalls 025-027. Monitoring is only proposed at outfalls 012, 025 and 027. New quarterly benchmark monitoring is proposed for pH and total suspended solids.

New Intake stations 800 and 802; and existing 801
New upstream station number 800 is proposed to report monitoring of mercury and zinc at the marina on the Ohio River. New intake station number 802 is proposed for Units 1 & 2 to monitor flow and temperature. Intake station 801 for Unit 3 is proposed to continue, except monitoring of cycles of concentration is proposed to be removed.

Compliance Schedules
Part I, C includes two schedules to meet the applicable final effluent limits mentioned in the above summary for Outfall 019 and Outfall 024. A third schedule is also proposed to comply with the 2020 BAT federal effluent guideline limitations in 40 CFR 423 for FGD wastewaters.

In Part II of the permit, special conditions are included that address the following: operator certification for the sanitary package plants, minimum staffing and operator of record; limits below quantification; downstream public water supply notification; Section 316(b); federal effluent limitation requirements; thermal load calculation; and outfall signage.

The chemical metal cleaning wastewater requirement is proposed to be removed since the permittee no longer intends to discharge from this operation.

Stormwater Requirements
Updates to Parts IV, V and VI to maintain consistency with the renewed Industrial Stormwater Multi-Sector General Permit are proposed. The main changes include the following: benchmark sampling to be taken within the first 8 quarters (2 years); quarterly sample collection during any month of the quarter; and submission of a corrective action report for benchmark exceedances.

Table of Contents

List of Figures

List of Tables

List of Attachments

List of Addendums

PROCEDURES FOR PARTICIPATION IN THE FORMULATION OF FINAL DETERMINATIONS

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 emailed to HClerk@epa.ohio.gov or mailed 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 by email to epa.dswcomments@epa.ohio.gov (preferred method) 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 Allison Cycyk 330-963-1132, allison.cycyk@epa.ohio.gov

INFORMATION REGARDING CERTAIN WATER QUALITY BASED EFFLUENT LIMITS

This draft permit may contain proposed water-quality-based effluent limits (WQBELs) for parameters that **are not** priority pollutants. (See the following link for a list of the priority pollutants: https://epa.ohio.gov/static/Portals/35/pretreatment/Pretreatment_Program_Priority_Pollutant_Detection_Limits.pdf . In accordance with ORC 6111.03(J)(3), the Director established these WQBELs 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 email to epa.dswcomments@epa.ohio.gov (preferred method) or 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, a written request 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 WQBELs 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 WQS used to develop the proposed effluent limitation in accordance with the terms and conditions set forth in OAC 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 3745-1-39. The permittee shall submit written notification regarding their intent to develop site specific WQS 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

Cardinal Operating Company (Cardinal Plant) discharges to the Ohio River at Mile Point 76.6 (Outfall 001), Mile Point 77.0 (Outfall 008), and Mile Point 78.4 (Outfall 023). Cardinal Plant also discharges to Blockhouse Hollow Run at River Mile (RM) 0.82 (Outfall 019), and Riddles Run at RM 0.01 (Outfall 006). Figure 1 shows the approximate location of the facility.

This segment of the Ohio River is described by Ohio EPA River Code: 25-001, County: Jefferson, Ecoregion: Western Allegheny Plateau. The Ohio River is designated for the following uses under Ohio's WQS (OAC 3745-1-32): Warmwater Habitat, Agricultural Water Supply, Industrial Water Supply, Bathing Waters, Public Water Supply.

The segments of the Riddles Run and Blockhouse Hollow Run are described by Ohio EPA River Code 06-087; Hydrologic Unit Code: 05030106-12-02. Blockhouse Hollow Run is designated for the following uses: Limited Resource Water (LRW), IWS, and Secondary Contact Recreation (SCR). Riddles Run has no designated uses. By default, the stream is categorized as general high quality waters and warmwater habitat Ohio River Basin criteria applies.

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 (Primary Contact Recreation) and wading only (Secondary Contact which are 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 water supply and industrial water supply.

FACILITY DESCRIPTION

The Cardinal Operating Company operates three coal-fired steam electric generating units and has the capacity to produce 1830 megawatts (MW). The units are equipped with electrostatic precipitators for removal of fly ash particulate matter, selective catalytic reductions for control of NOx emissions and flue gas desulfurization (FGD) scrubber systems for removal of SO2. Units 1 & 2 have a capacity of 600 MW each and are once-through cooling water systems. Unit 3 has a capacity of 630 MW and utilizes a cooling tower. Buckeye Power Generating, LLC owns the three units.

The FGD bleed stream is managed through the FGD Wastewater Treatment Plant. Units 1 & 2 are cooled with a once-through cooling water system. Unit 3 utilizes a cooling tower. The residual waste of burning coal produces fly ash and bottom ash. Fly ash is stored in dry fly ash silos, where it is loaded onto trucks for disposal at the on-site residual solid waste landfill (RSW), Fly Ash Reservoir I (FAR I). Fly Ash Reservoir II (FAR II) does not receive any active waste streams and closure activities are ongoing. Bottom Ash is sluiced to the Retrofitted Bottom Ash Pond, where it is excavated and decanted, prior to disposal in the FAR I RSW landfill. The bottom ash transport water is re-circulated back to the generating units in a closed loop system. Blowdown from the closed loop system is sent to and reused in the FGD system.

The facility receives coal and limestone from barges on the Ohio River. The byproduct of the FGD air emission control system produces synthetic gypsum. Most of the gypsum is loaded onto barges from conveyor belts for beneficial sales (*i.e.*: wallboard). Coal, gypsum, and limestone are loaded/unloaded to and from the facility by conveyor belt systems.

The process operations at the Cardinal Plant are classified in the Standard Industrial Classification (SIC) category 4911, Electric Services. The process wastewaters generated from these operations are regulated under federal effluent guidelines (ELG) in 40 CFR 423, "Steam Electric Power Generating" Industrial Category. Since the facility was originally commissioned, the federal regulations applicable to the appropriate facility discharges are 40 CFR 423.12, Best Practicable Control Technology Currently Available (BPT), and 40 CFR Part 423.13, Best Available Technology Economically Achievable (BAT). Pursuant to the 2015 ELG rule update, the Cardinal Plant has achieved a zero liquid discharge of fly ash transport water by converting the generating units to dry fly ash handling systems. This project was completed in 2021.

Additionally, the bottom ash pond closure and retrofit project was completed on October 7, 2024. The south pond is now a coal combustion residual bottom ash pond that operates in a closed loop system with blowdown to the FGD system. Notification of zero ash transport water discharge was submitted to Ohio EPA on April 6, 2023. The north pond operates as a low volume waste pond receiving non-coal combustion residual waste streams.

The Cardinal Plant is currently working towards installing new treatment technology for FGD wastewater as required by the October 13, 2020, ELG Reconsideration Rule. Cardinal Plant submitted a Notice of Planned Participation to Ohio EPA stating the intent to close Unit 3 by the end of 2028 and install a supplemental FGD biological wastewater treatment system for Units 1 & 2. The Cardinal Plant is currently working to install the treatment system as soon as possible, but no later than December 31, 2025, as required by the effective rule.

The Cardinal Plant obtains cooling water for all three systems from the Ohio River from three intake structures (one for each unit). The facility obtains well water for potable use.

DESCRIPTION OF EXISTING DISCHARGE

The Cardinal Plant has five (5) main process outfalls and six (6) stormwater outfalls. Table 1 highlights the primary outfalls, internal monitoring stations, wastewater sources, treatment processes, discharge/receiving streams and associated flows at the Cardinal Plant. Stormwater outfalls are presented on Table 2. Figure 3 provides the current flow schematic of the wastewater sources associated with the Cardinal Plant. Figure 4 provides the future flow schematic of the wastewater sources associated with the Cardinal Plant.

Outfall 001 is associated with Units 1 & 2 cooling water, the flue gas desulfurization (FGD) treatment plant and the intakes screen backwash, which all outlet to a "cooling water channel" prior to the Ohio River. The effluent from the FGD wastewater treatment system (internal station 601) is discharged via a diffuser into this channel. The diffuser and FGD treatment system were approved under PTI#557305 on February 20, 2007. The internal diffuser was designed to receive water pumped from the storage tank at a rate of 630 GPM (0.90 MGD) to ensure an even flow pattern and promote mixing within the cooling water channel prior to final outfall 001 discharge to Ohio River.

Outfalls 006 & 008 are the sanitary wastewater treatment plants.

Outfall 019 is the fly ash reservoir (FAR) II closure dewatering and FGD landfill leachate from FAR I RSW landfill (monitored at Internal Station 602).

Outfall 024 is the low volume waste pond. The previous Outfall 023 has been retrofitted to a closed loop system with zero ash transport water discharge as of April 6, 2023. The discharge location from the low volume waste pond has moved slightly and is proposed under this permit to be renumbered as Outfall 024.

Changes at the facility are addressed with new monitoring requirements:

- internal station 603 is used to make record of bottom ash transport waters ELG regulations.
- internal station 604 is proposed to monitor biologically treated FGD wastewater from Units #1 & #2 prior to discharge to the diffuser and cooling channel.
- internal station 605 is proposed to monitor FAR I RSW landfill contact stormwater from FAR I runoff pond, upstream of outfall 019.

During the previous permit cycle there were two effluent violations at outfall 019 for mercury, both a load and a concentration violation were reported in 2022. No other violations were reported.

Table 3 presents the flow rates for the permit cycle for each outfall.

Table 4 presents data compiled from the NPDES permit renewal application Form 2C.

Table 5 presents data compiled from the NPDES permit renewal application Form 2E.

Table 6 presents data compiled from the NPDES permit renewal application Form 2F.

Table 7 presents a summary of unaltered Discharge Monitoring Reports (DMRs). Data are presented for the period February 2019 through February 2024. Except for Outfalls 019 and 023, where the date range is June 2021 through February 2024 and March 2023 through February 2024, respectively. This is to reflect the time periods of the recent changes to FAR handling and low volume wastewater handling. Current permit limits are presented for comparison.

Table 8 summarizes the chemical specific data for outfalls 001, 006, 008, 019 and 024 by presenting the average and maximum PEQ values.

ASSESSMENT OF IMPACT ON RECEIVING WATERS

The Cardinal Plant discharges directly to the Ohio River in the Pike Island dam pool. Water quality monitoring on the Ohio River is performed by the Ohio River Valley Water Sanitation Commission (ORSANCO). This information can be found in the *2022 Biennial Assessment of Ohio River Water Quality Conditions (305b) Report* and/or biological survey results/pool reports.

The Biennial Report can be found at this website – https://www.orsanco.org/publications/biennial-assessment-305b-report/ .

The most recent pool report can be found here – https://www.orsanco.org/publications/pool-assessments/ .

ORSANCO evaluates the river for four uses: aquatic life, contact recreation impairment, public water supply, and fish consumption. The entire Ohio River is in partial support for fish consumption due to legacy polychlorinated biphenyl (PCBs) and dioxins contamination but meets the other use designations (i.e. aquatic life). The determination that the Ohio River is not supportive of fish consumption use means that either 1) fish caught in the Ohio River had tissue samples containing pollutants at levels which present a health risk if consumed in certain amounts or 2) chemistry results from the water exceeded the human health criteria for fish consumption. Cardinal Plant has no known discharges of PCBs or dioxins and therefore is not contributing to the conditions of the Ohio River. In the 2018 Pike Island dam pool survey, overall, the results show on average fish population in 'Fair' condition.

Within the discharge segment of the Cardinal Plant, ORSANCO data shows mile points 40.2 to 82.2 not supporting recreational use caused by *E. coli* or fecal coliform bacteria. The Cardinal Plant is not contributing to the recreational impairment because discharges potentially containing *E.coli* are treated by UV disinfection. *E. coli* and fecal coliform permit limits are proposed to continue for the sanitary waste treatment facilities.

The Salt-Run watershed assessment unit, which includes Blockhouse Hollow Run and Riddles Run in the vicinity of the Cardinal Plant, is listed as impaired for aquatic life (warmwater habitat) and recreation (primary contact) on Ohio's 303(d) list. The identified issues for aquatic life are sedimentation/siltation and total dissolved solids. The identified issues for recreation are *E. coli*.

The most recent data available for Salt Run-Ohio River watershed assessment unit is from 2010. Salt Run-Ohio River is impaired for total dissolved solids and siltation due to the following: surface mining. Salt Run-Ohio River is also impaired for *E. coli* due to the following: failing home sewage treatment system or poor agricultural activities. This indicates that the Cardinal Plant is not contributing to the impairments in Salt Run-Ohio River watershed. As mentioned above, the Cardinal Plant discharges associated with *E. coli* are in compliance with permit limits. No additional limits are recommended for Cardinal Plant.

The full Integrated Report is available through the Ohio EPA, Division of Surface Water website at:
https://epa.ohio.gov/static/Portals/35/tmdl/2022intreport/Full-2022-IR.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 Cardinal 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)	February 2019 through February 2024 except for the following outfalls:
– Outfall 019	June 2021 through February 2024 (Fly ash transport water ceased operations in May 2021)
– Outfall 023/024	March 2023 through February 2024 (Bottom ash transport water ceased discharge in February 2023)
NPDES application Form 2C data	May 2022 to April 2023

Statistical Outliers and Other Non-representative Data
The data were examined and the following values were removed from the evaluation to give a more reliable PEQ:

- Outfall 019 – Total Filterable Residue: 11,400 mg/L (5/2/22); seven times higher than the next highest value
- Outfall 024 – Selenium: 230 ug/L (3/15/23); ten times higher than the next highest value

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 (see Table 8).

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 Table 11)

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. By rule, mixing zones are not authorized for pollutants, such as mercury, which have been designated as bioaccumulative chemicals of concern (BCCs). For BCCs, the WLA is set equal to the respective WQS value.

The methodology employed generally depends on whether the facility is considered a direct discharger to a free-flowing receiving water/stream or non-flowing receiving water/Lake.

For free flowing streams, WLAs for both average and maximum criteria are performed 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.

WLAs for direct discharges to lakes are done using the following equation for average criteria: WLA = (11 x Water Quality Criteria) – (10 x Background Concentration). Allocations for maximum criteria are set equal to the Inside Mixing Zone Maximum (IMZM) values.

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

Aquatic life (Warmwater Habitat)		
Toxics (metals, organics, etc.)	Average	Annual 7Q10
	Maximum	Annual 1Q10
Ammonia	Average	Summer 30Q10
		Winter 30Q10
Wildlife		Annual 90Q10
Agricultural Water Supply		Harmonic mean flow

Human Health (nondrinking)	Harmonic mean flow

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

Aquatic life (Warmwater Habitat)		
Toxics (metals, organics, etc.)	Average	10% of annual 7Q10
	Maximum	1% of annual 7Q10
Agricultural Water Supply		10% of harmonic mean flow
Human Health (carcinogens)		10% of harmonic mean flow
Human Health (non-carcinogens)		100% of 7Q10

Allocations are developed using a percentage of stream design flow as specified in Table 10 and allocations cannot exceed the Inside Mixing Zone Maximum (IMZM) criteria.

Thermal Wasteload

The NPDES permit for Cardinal Plant contains alternate thermal effluent limits established in accordance with Section 316(a) of the CWA for Units 1 & 2. The alternate limits of a net daily maximum of 6340 million British Thermal Units (mBTU)/Hour were developed as a part of the 316(a) approval given in 1977 by the U.S. EPA. The alternate limits were continued in the permit renewals that occurred prior to this renewal with the last renewal occurring on January 1, 2018. Those renewals were based on the initial 316(a) study and the fact that no harm to aquatic life has been documented due to the thermal discharge from outfall 001 since the discharge began operations. In January 2017, AEP submitted a new 316(a) study which supports the fact that no harm to aquatic life will result from the thermal discharge from outfall 001. The 2017 demonstration is still applicable to the present day conditions and Cardinal requests the existing 316(a) variance be continued.

Per AEP's 2017 316(a) study, the thermal mixing zone encompasses no more than 40 percent of the Ohio River's 7Q10 flow. The thermal discharge has been evaluated year-round by calculating a wasteload allocation (WLA) for the thermal load using the Ohio River temperature criteria per OAC 3745-1-32, Table 32-3. The following equation was used to calculate the thermal load WLA at outfall 001:

MBTU/hr = $\underline{[Q_{up} \text{ x (WQS °F - background temperature °F) x conversion factor]}}$ / 24]

Where: Q_{up} = Ohio River 7Q10 flow at 40% per 316(a) study (cfs) - Q_d

Q_d = Unit 1 & 2 intake flow rate (cfs) (i.e., Outfall 001 flow – Internal Station 601)

WQS = Monthly Temperature Standard from OAC 3745-1-32

Background temperature = 75th percentile of daily temperature data represents the maximum. 75th percentile of the monthly average daily temperature data represents the average. Data collected at the ETEM Remediation One LLC, Sammis Plant intake, 0IB00010800 from July 2018- July 2023. (This facility is located approximately 23 miles upstream of the Cardinal Plant)

Conversion factor = 8.34 * (1/1.547)

Month	Upstream Temp. (°F)		WQS Temp. (°F)		Thermal Load WLA (MBTU/hr)	
	Max	*Ave*	*Max*	*Ave*	*Max*	*Ave*
January	40.0	38.8	47.0	47.0	1156.7	1361.2
February	40.0	39.7	46.2	43.9	1024.5	694.0
March	46.0	44.9	56.4	51.2	1718.5	1046.0
April	55.0	52.7	66.3	61.2	1867.2	1407.5
May	64.0	62.8	76.5	71.2	2065.5	1385.0
June*	77.0	74.7	87.0	87.0	1652.4	2035.4
July*	80.3	80.7	89.0	89.0	1445.8	1379.1
August	81.0	79.4	89.0	89.0	1321.9	1587.7
September*	76.0	74.7	87.0	87.0	1817.6	2040.7
October	69.0	66.4	78.3	74.1	1536.7	1267.6
November	53.0	51.8	69.0	65.0	2642.0	2181.4
December	42.0	42.1	60.0	55.8	2972.2	2262.2

* Most conservative value.

Cardinal Power Plant has reasonable potential to exceed temperature standards on the Ohio River, and an alternate under the Section 316(a) limit of 6340 MBTU/Hr is proposed to be continued. The permittee has demonstrated that the alternate thermal load limit will allow a balanced, indigenous community of aquatic life in the Ohio River.

Whole Effluent Toxicity Wasteload Allocation

Whole effluent toxicity (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. Numeric WQS for WET are listed in the Ohio WQS [OAC 3745-1-44]. This rule lists numeric values of 0.3 TUa and 1.0 TUc. WLAs are calculated using these criteria.

The WLA calculations for WET are similar to those for aquatic life criteria - using the chronic toxicity unit (TUc) and 7Q10 flow for the average and the acute toxicity unit (TUa) and 1Q10 flow for the maximum. WET WLAs are based on meeting the values of 0.3 TUa and 1.0 TUc downstream of the discharge and include any available dilution. These values are the levels of effluent toxicity that should not cause instream toxicity during critical low-flow conditions. WLAs for acute toxicity are capped at 1.0 TUa unless the discharger demonstrates that an Area-of-Initial-Mixing (AIM) exists under OAC 3745-1-06, or that one of the factors in OAC 3745-33-07(B)(5)-(9) allows a higher TUa limit to be granted. For the purposes of establishing WET limitations, the values of 1.0 TUa and 1.0 TUc are the most restrictive limitations that can be applied in NPDES permits [OAC 3745-33-07(B)(10)].

For the Cardinal Plant, the WLA values are:

Outfall	TUa	TUc
001	0.3	1.36
019	0.3	Not Applicable - Only acute criteria apply to Limited Resource Waters

The chronic toxicity unit (TUc) is defined as 100 divided by the estimate of the effluent concentration which causes a 25% reduction in growth or reproduction of test organisms (IC25):

$$TUc = 100/IC25$$

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):

TUc = 100/geometric mean of No Observed Effect Concentration and Lowest Observed Effect Concentration

The acute toxicity unit (TUa) is defined as 100 divided by the concentration in water having 50% chance of causing death to aquatic life (LC50) for the most sensitive test species:

$$TUa = 100/LC50$$

This equation applies outside the mixing zone for all designated waters. Based on the above, a value of 1.0 TUa is the lowest value that can be calculated using the equation. TUa values between 0.2 and 1.0 are based on an interpolation of toxic effects where an LC50 cannot be identified.

When the acute WLA is less than 1.0 TUa, it may be defined as a ratio of the stream dilution to the effluent flow:

Acute Dilution Ratio (downstream flow to discharger flow)	Allowable Effluent Toxicity (percent effects in 100% effluent)
up to 2 to 1	30
greater than 2 to 1 but less than 2.7 to 1	40
2.7 to 1 to 3.3 to 1	50

$$\text{Acute Dilution Ratio} = \frac{\text{7Q10 + [OUTFALL “00Y” flow rate]}}{\text{[OUTFALL “00Y” flow rate]}}$$

$$\text{Outfall 001} = \frac{58.8 \text{ cfs} + 1617 \text{ cfs}}{1617 \text{ cfs}} = 1.04$$

$$\text{Outfall 019} = \frac{0.0965 \text{ cfs} + 9.79 \text{ cfs}}{9.79 \text{ cfs}} = 1.1$$

The acute WLA for the Cardinal Plant at outfalls 001 and 019 can be expressed as 30% in 100% effluent based on 1 to 1 dilution ratio. If the acute dilution ratio is less than 3.3 to 1.0, and there is evidence that effluent values between 0.3 TUa and 1.0 TUa cause or contribute to violations of WQS, the permittee may be required to investigate and remediate toxicity in this range.

REASONABLE POTENTIAL/EFFLUENT LIMITS/MANAGEMENT DECISIONS

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 8, 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 Table 12.

The final effluent limits are determined by evaluating the groupings in conjunction with other applicable rules and regulations. Table 13 presents the final effluent limits and monitoring requirements proposed for the Cardinal Plant outfalls 001, 006, 008, 019 and 024 and internal monitoring stations 601, 602, 603, 604 and 605 and the basis for their recommendation. Unless otherwise indicated, the monitoring frequencies proposed in the permit are continued from the existing permit.

Outfall 001

Outfall 001 represents total flow and thermal loads of the non-contact cooling water (NCCW), treated FGD wastewater from the diffuser (internal stations 601 and 604) and screen backwash, that mix within the cooling channel prior to discharging to the Ohio River. Note the screen backwash water is drawn from the condenser NCCW.

pH

The pH data is representative of NCCW only. Limits proposed for pH are based on the WQS in OAC 3745-1-35.

Total Residual Chlorine, Total Residual Oxidants, and Chlorination/Bromination Duration

The total residual chlorine data is representative of NCCW only. Permit limits for total residual chlorine and the duration of chlorine discharges are being continued due to the use in the cooling water processes. The daily maximum chlorine limit is based on Best Technical Judgement (BTJ), which stems from an analysis of the inside-mixing-zone maximum (IMZM) WQS, when discharges of chlorine are limited to two hours per day. This information indicates that excursions of the IMZM criterion are not acutely toxic to aquatic life within the mixing zone when limited to two hours per day. The 120-minute limit on chlorine duration regulates the exposure time so that acutely toxic conditions are avoided. Details regarding quantification levels for these parameters are in Part II of the permit.

Total residual oxidant monitoring and limits are proposed to be removed as the facility does not use bromine-based additives. Past authorizations that authorized bromine-based additives were issued under Director Final Findings and Orders (DFFOs), journalized in 2002 and 2011, these chemicals are no longer used. If Cardinal Power Plant proposes to use bromine-based additives in the future, then a new approval must be obtained from the director of the Ohio EPA prior to the use of any treatment additives.

Zinc

The Ohio EPA risk assessment (Table 15) places zinc in group 5, which recommends limits to protect water quality. Using the discretion allowed the Director under OAC 3745-33-07(A)(5), monitoring rather than limits is proposed for this parameter. The PEQ values calculated for zinc (Table 8) are not representative of its actual levels in a discharge to the Ohio River. The cooling channel is expected to reasonably mix the NCCW with the diffused/treated FGD water prior to entering the Ohio River. Monitoring is proposed to represent all discharges within the cooling channel and be reported as a flow weighted calculation of internal stations 601 and 604 with the intake station. The purpose of the proposed monitoring is to collect additional data on the frequency of occurrence and variability of the pollutant in the discharge.

Copper

The Ohio EPA risk assessment (Table 15) places copper in group 4. This placement, as well as the data in Table 7 and Table 8, support that these parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. Using the discretion allowed the Director under OAC 3745-33-07(A)(6), monitoring is proposed to be removed since copper has not been detected since April 2020.

Ammonia (Summer and Winter), Barium, Boron, Fluoride, Iron, Magnesium, Manganese, Nitrate+Nitrite, and Sulfates
The data provided for these parameters is representative of NCCW only. A wasteload allocation using the data presented in Table 4, 7 and 8 would not reflect a direct discharge to the Ohio River. The cooling channel is expected to reasonably mix the NCCW with the diffused/treated FGD water prior to entering the Ohio River. The technology-based standards applied to the FGD discharge (stations 601 & 604) are protective of the water-quality standards for the Ohio River. These parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. Monitoring is proposed to be removed for ammonia and barium. No new monitoring is proposed for the other parameters.

Mercury
The mercury data is calculated based on intake samples and internal station 601. The Ohio EPA risk assessment (Table 12) places mercury in group 3. This placement, as well as the data in Tables 4, 7, and 8, 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 mercury is proposed to continue and reported as a flow weighted calculation of internal stations 601 and 604 with the intake station.

Flow and Temperature
Monitoring for flow is proposed as a calculation of the total flow of all outputs to the cooling channel that represent the final outfall. Monitoring of temperature is necessary to verify the thermal loads are protective at the final outfall. Temperature monitoring is proposed as a calculation of the average of each condenser leg maximum hourly output for each day.

Thermal discharge
Based on the updated 316(a) demonstration submitted with the renewal application, the current limit and monitoring requirements are proposed to continue. Ohio EPA believes that the alternate effluent limitations will ensure the protection and propagation of the balanced and indigenous biological community in and on the water body.

Outfall 006

This outfall represents the sanitary wastewater treatment plant discharge from service buildings (Unit #3) to Riddles Run.

Total suspended solids and 5-day biological oxygen demand
The limits proposed for total suspended solids and 5-day biological oxygen demand are all based on plant design criteria.

E. coli and Fecal Coliform
Limits proposed for *E. coli* are based on WQS (OAC 3745-1-32), and fecal coliform are based on ORSANCO criteria protective of public water supply use.

pH
Limits proposed for pH are based on provisions of OAC 3745-1-35.

Ammonia (summer) and (winter)
The Ohio EPA risk assessment (Table 12) places ammonia (summer) and (winter) in groups 3 and 4. This placement, as well as the data in Table 7 and Table 8, support that this parameter does not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. New quarterly monitoring is proposed.

Copper
The Ohio EPA risk assessment (Table 12) places copper in group 3. This placement, as well as the data in Tables 4, 5, 6, and 7, support that this parameter does not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. Limits and monitoring for copper are proposed to be removed.

Flow rate
Monitoring for this parameter is proposed to continue in order to evaluate the performance of the treatment plant.

Outfall 008

This outfall represents the sanitary wastewater treatment plant discharge from FGD and service buildings (Units #1 & 2) to the Ohio River.

Total suspended solids and 5-day biological oxygen demand
The limits proposed for total suspended solids and 5-day biological oxygen demand are all based on plant design criteria.

E. coli and Fecal Coliform
Limits proposed for *E. coli* and fecal coliform are based on WQS (OAC 3745-1-32).

pH
Limits proposed for pH are based on provisions of OAC 3745-1-35.

Ammonia and Copper
The Ohio EPA risk assessment (Table 12) places ammonia and copper in groups 2 and 3. This placement, as well as the data in Tables 4, 5, 6, and 7, support that these parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. No new monitoring is proposed.

Flow rate
Monitoring for this parameter is proposed to continue in order to evaluate the performance of the treatment plant.

Outfall 019

Fly Ash Reservoir II (FAR II) closure activity discharge (including unmanaged combustion residual leachate, seepage, and legacy wastewaters associated with FAR II), internal stations 602 (FAR I RSW landfill leachate) and 605 (FAR I RSW landfill contact stormwater).

Oil and Grease, pH and Total Suspended Solids
Federal effluent guideline limitations (ELGs) apply for these parameters are based on available treatment technology. Federal and State laws and regulations require that dischargers meet both the ELGs and any standards need to comply with state WQS. Permit limits are based on the more stringent of the two. All ELGs are listed in Attachment 1.

Best Practicable Control Technology Available (BPT) ELGs (40 CFR 423.12) apply to combustion residual leachate which has been redirected around FAR II to internal station 602. These limits are proposed to be assessed at internal station 602 rather than the final outfall. Federal rules at 40 CFR 125.3(f) prohibit attaining compliance with technology-based standards by dilution. For an interim period, monitoring is proposed for oil and grease, pH and total suspended solids based on BPJ. A total suspended solids benchmark of 100 mg/L is proposed based on BPJ.

When the new 2024 BAT ELGs are applicable on December 31, 2029, the unmanaged combustion residual leachate at outfall 019 will also need to meet technology-based limits. Therefore, on January 1, 2030, the BPT ELGs for total suspended solids, oil and grease and pH are proposed based on BPJ. Limits for pH are based on the more stringent WQS in OAC 3745-1-35.

Arsenic and Mercury

The 2024 Best Available Technology Economically Achievable (BAT) ELGs (40 CFR 423.13) for arsenic and mercury are proposed. The mercury (30-day average) limit is proposed to continue based on the more stringent WQBEL. BAT limits are concentration-based limits and are not required to be expressed with a corresponding mass loading limit per OAC 3745-33-05(C)(3), therefore loading limits are proposed to be removed. Additionally, the discharge fluctuates with discharge volume based on the size of precipitation event. Cardinal Power Plant shall ensure the dilution sources from the contact stormwater pond and capped impoundment area are not used to attain compliance with the technology standards for arsenic and mercury (daily maximum). A compliance schedule is proposed for final limits to be effective as soon as possible but no later than December 31, 2029.

Total Filterable Residue

The Ohio EPA risk assessment (Table 15) places this parameter in group 3. This placement, as well as the data in Table 7 and Table 8, 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 at a quarterly frequency is proposed to document that this parameter continues to remain at low levels.

Ammonia (summer and winter), Barium, Boron, Chlorides, Chromium (Total), Copper, Dissolved Hexavalent Chromium, Fluoride, Molybdenum, Selenium, Sulfates and Zinc

The Ohio EPA risk assessment (Table 15) places these parameters in groups 2 and 3. This placement, as well as the data in Table 7 and Table 8, 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 and limits are proposed to be removed for ammonia. Monitoring for boron, chlorides, chromium (hexavalent), selenium, sulfates and zinc are proposed to be removed. No new monitoring is proposed for the other parameters.

Alkalinity, Flow Rate, Hardness, Nitrate+Nitrite, Specific Conductance, Total Kjeldahl Nitrogen and Temperature

Monitoring for flow rate is proposed to continue in order to evaluate the performance of the treatment plant. Based on best technical judgment, monitoring is proposed for hardness in order to determine future IMZM criteria for metals. Monitoring is proposed to be removed for all other parameters.

Outfall 024 (formally Outfall 023)

This outfall consists of the discharge from the low volume wastewater pond that contains flow from coal pile runoff, cooling towers, water supply treatment wastewaters, boiler blowdown and stormwater. The renumbering to outfall 024 is because the discharge type has changed, and the discharge pipe has been relocated just further south along the pond. Bottom ash transport water ceased discharge in February 2023 and the south pond was converted to a closed loop system with restricted blowdown to the scrubber system. Metal cleaning wastes are no longer discharged.

pH
Limits are proposed to continue for pH based on provisions of OAC 3745-1-35.

Oil and Grease, Total Residual Chlorine and Total Suspended Solids
Permit limits for oil and grease, total residual chlorine and total suspended solids are recommended based on the federal effluent limitation guidelines (ELGs) found in 40 CFR Part 423.12 – Best Practicable Control Technology Currently Available (BPT) and 40 CFR Part 423.13 – Best Available Technology Economically Achievable (BAT). ELG limits are shown in Attachment 1. The chlorine limit is proposed to continue based on the more stringent WQS IMZM.

Maximum limits for TSS are based on a flow-weighted concentration that accounts for the coal pile runoff ELG listed in Attachment 1. The flow-weighted data and example calculation can be found in Attachment 3.

Copper
The Ohio EPA risk assessment (Table 12) places copper in group 5, which recommends limits to protect water quality. This placement, as well as the data in Table 7 and Table 8, indicates that the reasonable potential to exceed WQS exists and limits are necessary to protect water quality. For these parameters, the PEQ is greater than 100 percent of the WLA. Pollutants that meet this requirement must have permit limits under OAC 3745-33-07(A)(1). For copper, the proposed limitations are based on the WLA. Monitoring is proposed to continue at the same frequency. A 36-month compliance schedule is proposed for meeting the new final effluent limit.

Mercury
The Ohio EPA risk assessment (Table 12) places mercury in group 4. This placement, as well as the data in Table 7 and Table 8, 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). Monitoring is proposed to continue at the same frequency.

Ammonia and Selenium
The Ohio EPA risk assessment (Table 15) places these parameters in group 3. This placement, as well as the data in Table 7 and Table 8, 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 reduced frequency is proposed to document that these pollutants continue to remain at low levels.

Arsenic, Barium, Boron, Cadmium, Dissolved Hexavalent Chromium, Fluoride, Iron, Lead, Nitrate+Nitrite and Zinc
The Ohio EPA risk assessment (Table 15) places these parameters in groups 2 and 3. This placement, as well as the data in Table 7 and Table 8, 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 is proposed to be removed for arsenic. No new monitoring is proposed.

Flow Rate and Hardness
Monitoring for this parameter is proposed to continue in order to evaluate the performance of the treatment plant. Monitoring for hardness are proposed to evaluate the effluent quality.

Internal Station 601

This station consists of a discharge from the existing FGD non-biological treatment system. The flow volume to this station will be reduced once the new biological treatment system commences operation which is required as soon as possible, but no later than December 31, 2025. The new biological system discharge is to be monitored by internal station 604. Once the new biological treatment commences discharge, flows to station 601 will consist only of the portion of flow that exceeds the design maximum flow rate (0.63 MGD) of the biological system associated with two units in operation. The existing 601 discharge and the future 604 are combined and directed to an internal diffuser within the cooling channel to mix with NCCW prior to final discharge at Outfall 001. Once Unit 3 retires by December 31, 2028, all FGD wastewater flows shall be directed through biological treatment and monitored at 0IB00009604.

Consistent with 40 CFR 122.45(h), technology-based limits from the federal effluent limitation guidelines (ELGs) found in 40 CFR 423, are applied at internal stations 601. ELGs are applied at this station to ensure that these treatment standards are met prior to combining with other waste streams. Federal rules at 40 CFR 125.3(f) prohibit attaining compliance with technology standards by dilution. If monitoring was not done at these locations, it would not be possible to verify compliance with these standards due to dilution.

Oil and Grease and Total Suspended Solids and pH
The ELGs apply to FGD wastewaters (40 CFR 423.12) and are listed in Attachment 1. Limits for oil and grease, pH and total suspended solids are proposed based on the ELG.

Arsenic, Barium, Boron, Cadmium, Chloride, Chromium, Copper, Fluoride, Iron, Lead, Mercury, Nickel, Nitrate Plus Nitrite, Total Kjeldahl Nitrogen, Selenium, Sulfate, Total Filterable Residue and Zinc
Based on best technical judgement, monitoring is proposed to continue for arsenic, mercury, nitrate plus nitrite, selenium and zinc, but be reduced to once per month. The purpose of the monitoring is to ensure these metals remain at low levels and are well mixed within the cooling channel prior to discharging to the Ohio River. All other parameters are proposed to be removed.

Flow Rate and Temperature
Monitoring for flow rate is proposed to continue in order to evaluate the performance of the treatment plant. Temperature is proposed to be removed as the thermal load calculation does not use this value.

Internal Station 602

This station consists of a discharge from FAR I RSW landfill leachate. Final discharge is to Outfall 019.

Oil and Grease, Total Suspended Solids and pH
The 2020 BPT ELGs for combustion residual leachate that apply for these parameters are proposed.

Arsenic and Mercury
Monitoring is proposed based on best technical judgement. The new 2024 BAT ELGs for combustion residual leachate are proposed at final outfall 019, which contains all ELG sources, both managed and unmanaged combustion residual leachate. Cardinal Power Plant shall ensure the dilution sources from outfall 019 are not used to attain compliance with the technology standards for arsenic and mercury.

Ammonia, Boron, Selenium and Total Filterable Residue
Monitoring is proposed to continue based on best technical judgement. The purpose of the ammonia monitoring is to ensure it remains at low levels at the final outfall since ammonia indicated reasonable potential at outfall 019. The purpose of the proposed monitoring is to collect additional data on the frequency of occurrence and variability of these pollutants in the effluent.

Fluoride
Monitoring is proposed to be removed based on best technical judgement as this was not a parameter detected at final outfall 019.

Flow Rate
Monitoring for this parameter is proposed to continue to characterize the volume of wastewater attributable to this station.

Internal Station 603

This station is used to make record of bottom ash transport waters ELG regulations. The primary wetted volume shall be tracked in the interim table to December 31, 2029. If Cardinal Power Plant operates past December 31, 2034, then the "no discharge of pollutants" requirement applies as soon as possible, but no later than December 31, 2029, for bottom ash transport waters. A final table is intended for compliance with this 2024 ELG date [40 CFR 423.13(k)(4)(i)] and includes a limit of "0" for number of days to discharge, consistent with "no discharge of pollutants". A permit modification may be necessary, if certification pursuant to 40 CFR 423.19(h) for permanent cessation of coal is sought. Additional details on ELG date applicability are outlined below under the section Steam-Electric ELG Compliance.

Internal Station 604

This station will consist of the FGD wastewater from the new biological treatment system (design with a maximum flow rate of 0.63 MGD) for the portion of the scrubber blowdown associated with two units in operation. This station will also contain Unit 3 until it retires by December 31, 2028. The treated water will blend with internal station 601 and discharge to the diffuser which will blend with NCCW in the cooling water channel prior to final outfall 001.

Federal effluent guidelines apply to the discharge at internal station 604. Consistent with 40 CFR 122.45(h), technology-based limits from the federal effluent limitation guidelines (ELGs) found in 40 CFR 423, are applied at internal stations 604. ELGs are applied at this station to ensure that these treatment standards are met prior to combining with other waste streams. Federal rules at 40 CFR 125.3(f) prohibit attaining compliance with technology standards by dilution. If monitoring was not done at these locations, it would not be possible to verify compliance with these standards due to dilution.

<u>Interim</u>
This table is consistent with the BPT and 2020 BAT limitations for FGD wastewaters.

Oil and Grease and Total Suspended Solids and pH
The ELGs apply to FGD wastewater (40 CFR 423.12, BPT) and are listed in Attachment 1. Limits for the above parameters are proposed based on the ELGs.

Arsenic, Mercury, Nitrate/Nitrite, and Selenium
Federal and State laws and regulations require that dischargers meet both the technology based effluent limits (TBELs) and state WQS. Permit limits are based on the more stringent of the two. In order to ensure the TBELs are protective of the Ohio WQS, the WQBEL must also be evaluated. By back calculating the flows from outfall 001, both sets of limits were compared (See Attachment 2.) The TBELS are protective of the WQBELs. Limits for the above parameters are proposed based on the ELGs, which are to be effective as soon as possible but not later than December 31, 2025. The ELGs apply to FGD wastewater (40 CFR 423.13, 2020 BAT) are listed in Attachment 1.

Zinc
Based on best technical judgement, monitoring is proposed for zinc. The purpose of the monitoring is to ensure the metal remain at low levels and are well mixed within the cooling channel prior to discharging to the Ohio River.

Flow Rate
Monitoring for this parameter is proposed to continue in order to evaluate the performance of the treatment plant.

Final
This table is consistent with the 2024 BAT limitations for "no discharge of pollutants" in FGD wastewaters, as soon as possible, but not later than December 31, 2029. If Cardinal Power Plant operates past December 31, 2034, then the "no discharge of pollutants" requirement applies as soon as possible, but no later than December 31, 2029, for FGD wastewater. A final table is intended for compliance with this 2024 ELG date [40 CFR 423.13(g)(4)(i)] and includes a limit of "0" for number of days to discharge, consistent with "no discharge of pollutants". A permit modification may be necessary, if certification pursuant to 40 CFR 423.19(h) for permanent cessation of coal is sought. Additional details on ELG date applicability are outlined below under the section Steam-Electric ELG Compliance.

Internal Station 605

This station consists of a discharge from FAR I RSW landfill contact stormwater. Final discharge is to Outfall 019.

Total Suspended Solids
Monitoring with a benchmark is proposed at the internal station based on best technical judgement.

Flow Rate
Monitoring for this parameter is proposed to continue to characterize the volume of wastewater attributable to this station.

Whole Effluent Toxicity Reasonable Potential

There are no current toxicity tests that have been performed on Cardinal Power Plant discharges. Historical data from the previous permit cycle did not indicate the presence of toxicity associated with the discharge. The existing impairment identified in the Ohio River is due to dioxins, PCBs and *E. coli*. Presently, there is no information to suggest that Cardinal Power Plant is contributing to this impairment. Based on this assessment, Cardinal Power Plant is placed in Category 4 with respect to WET and toxicity monitoring is not necessary at this time. The chemical specific effluent limitations proposed in the permit should provide protection against any adverse effluent toxicity.

Additional Monitoring Requirements

Intake monitoring at station 801 is proposed to continue for flow rate. New upstream station 800 is proposed to report monitoring of mercury and zinc at the marina on the Ohio River. New intake station number 802 is proposed for Units 1 & 2 to monitor flow and temperature.

Monitoring of mercury at the scrubber purge stream WWTP (internal station 600) is proposed to be removed. Cardinal can continue to monitor internal sources for mercury for process control as necessary.

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.

Sludge

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

OTHER REQUIREMENTS

Compliance Schedule

> ***New Limit(s)*** – A schedule to meet final effluent limits at Outfall 019 is proposed as soon as possible but no later than December 31, 2029 (consistent with 40 CFR 423). A schedule to meet final effluent limits at Outfall 024 is proposed as soon as possible but no later than December 31, 2029. Details are in Part I, C of the permit.
>
> ***Flue Gas Desulfurization (FGD) wastewater treatment system construction*** – This is a construction schedule to achieve the final effluent limitations pursuant to 40 CFR 423.13(g)(1)(i) as soon as possible but not later than December 31, 2025.

Operator Certification and Operator of Record

Operator certification requirements have been included in Part II of the permit in accordance with rules adopted on August 15, 2018 (OAC 3745-7). These rules require the Cardinal Plant to have a Class A wastewater treatment plant operator in charge of the sewage treatment plant operations discharging through outfalls 006 and 008. These rules also require the permittee to designate one or more operator of record to oversee the technical operation of the treatment works.

Sufficiently Sensitive Method

Part II of the permit includes a condition requiring the Cardinal Plant to use laboratory analytical methods with a sufficiently sensitive MDL.

Method Detection Limit Reporting

When submitting monitoring results in eDMR, the permittee must report all detected concentration values above the method detection limit (MDL), even if that value is below the quantification level, as indicated in Permit Guidance 9: Limits below Quantification. A detection above the MDL indicates the presence of a pollutant with strong confidence, which must be considered in reasonable potential analyses. Per OAC 3745-33-07(C)(2)(c), for the purpose of assessing compliance, any value reported below the quantification level shall be considered in compliance with an effluent limit.

Cooling Water Intake Structure Compliance

Under Section 316(b) of the federal CWA, cooling water intake structures (CWISs) are required to use best technology available (BTA) to minimize adverse environmental impact resulting from the operation of the intake. New rules were promulgated on October 14, 2014, and facilities with permits that expire after July 18, 2018 must be in compliance with the new rules. The CWIS is considered an existing unit at an existing facility and therefore must comply with 40 CFR 125, Subpart J. Information supplied from the permittee regarding the CWIS and other pertinent data can be found in Attachment 5.

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

In order to ensure that the facility remains compliant with Section 316(b), special conditions are included in Part II of the permit.

Steam-Electric ELG Compliance

Revisions to the Effluent Limitations Guidelines and Standards (ELGs) for the Steam Electric Power Generating Point Source Category became effective on July 8, 2024, published in the Federal Register on May 9, 2024. The rule revision requires implementation of a “no discharge of pollutants” requirement, as soon as possible beginning July 8, 2024, but no later than December 31, 2029 for the following: FGD wastewater, bottom ash (BA) transport water, and combustion residual leachate (CRL). CRL includes new defined subcategories for unmanaged CRL and legacy wastewaters with established numeric discharge limitations.

U.S. EPA retained the 2020 FGD wastewater and BA transport water guidelines and affirms that the technologies on which they are based are available and achievable, as an interim step toward meeting the “no discharge of pollutants” requirement in this rule. The less stringent FGD wastewater and BA transport water guidelines are based on a certification that qualifies a subcategory based on permanent cessation of coal combustion. The 2020 reconsideration rule is to be implemented as soon as possible beginning October 13, 2021, but no later than December 31, 2025.

The 2020 BAT guidelines that apply to Cardinal Power Plant include:

- A "no discharge of pollutants" requirement for bottom ash transport water, except as provided for in 40 CFR 423.13(k)(2); and
- Arsenic, mercury, selenium, and nitrate/nitrite limits based on physical/chemical and biological treatment for FGD wastewater.

If Cardinal Power Plant operates past December 31, 2034, then the “no discharge of pollutants” requirement applies as soon as possible, but no later than December 31, 2029, for FGD wastewater, BA transport water, and CRL.

If Cardinal Power Plant seeks to qualify electrical generating units #1 & #2 that will achieve permanent cessation of coal combustion, then the rule includes a certification under 40 CFR 423.19(h), no later than December 31, 2028, or December 31, 2034. Under the 40 CFR 423.19(h) certification, the following 2024 BAT limitations apply to each waste stream and extended compliance dates:

- A "no discharge of pollutants" requirement for FGD wastewater and BA transport after April 30, 2035.
- Arsenic and mercury limitations based on chemical precipitation treatment for CRL as soon as possible beginning 120 days after permanently ceasing coal combustion, but no later than April 30, 2035.
- Arsenic and mercury limitations based on chemical precipitation treatment for unmanaged CRL, no later than December 31, 2029.
- BPJ limits apply for CRL and unmanaged CRL until permanent cessation of coal combustion.
- Legacy wastewater related to FAR II closure is subject to BPJ limitations.

These limitations would apply if cessation occurred by the date provided. If Cardinal Power Plant fails to cease combustion of coal by December 31, 2034, for any reason other than those specified in 40 CFR 423.18, then the "no discharge of pollutants" requirement would automatically apply.

On October 13, 2021, Cardinal Power Plant submitted a Notice of Planned Participation (NOPP) (revised October 4, 2022), indicating Unit #3 will retire by December 31, 2028.

On October 13, 2023, Cardinal Power Plant submitted certification of zero-discharge fly ash transport water pursuant to 40 CFR 423.13(h) and of the 2020 BAT bottom ash transport water (≤ 10% primary wetted volume) pursuant to 40 CFR 423.13(k)(2).

Part II of the permit renewal requires annual status reports related to the requirements under the 40 CFR 423 supplemental rule effective on July 8, 2024. This includes the regulation applicability deadlines for each waste stream type if the permittee decides to cease coal combustion prior to December 31, 2034 and submit the Notice of Planned Participation, or if the permittee decides to continue operating past December 31, 2034. ELG compliance dates extend beyond the expiration date of the permit. A permit modification may be necessary, if regulations are met sooner.

Outfall Signage

Part II of the permit includes requirements for the permittee to place and maintain a sign at each outfall to the Blockhouse Hollow Run, Riddles Run, and the Ohio River providing information about the discharge. Signage at outfalls is required pursuant to OAC 3745-33-08(A).

Public Water Supply Notification

An addition to OAC 3745-33-08 requires that permittees discharging wastewater within ten miles of a downstream public water supply intake located on the same waterway must develop and implement notification procedures in conjunction with the downstream public water supply operator in the event of a spill, separate sewer overflow, bypass or upset that reaches waters of the state. Since the Wheeling Water Treatment Plant operates a public water supply intake ten miles downstream from the Cardinal Plant, an item in Part II of the permit requires the development of notification procedures within six months after the effective date of the permit.

Part III

Part III of the permit details standard conditions that include monitoring, reporting requirements, compliance responsibilities, and general requirements.

Stormwater Compliance

Parts IV, V, and VI have been included with the draft permit to ensure that any stormwater flows from the facility site are properly regulated and managed. As an alternative to complying with Parts IV, V, and VI, the Cardinal Plant may seek permit coverage under the general permit for industrial stormwater (permit # OHR000007) or submit a “No Exposure Certification.” Parts IV, V, and VI will be removed from the final permit if: 1) the Cardinal Plant submits a Notice of Intent (NOI) for coverage under the general permit for industrial stormwater or submits a No Exposure Certification, 2) Ohio EPA determines that the facility is eligible for coverage under the general permit or meets the requirements for a No Exposure Certification, and 3) the determination by Ohio EPA can be made prior to the issuance of the final permit.

Stormwater monitoring is proposed at Outfalls 012, 025 and 027 based on best technical judgement of assessment of Form 2F data and WQS IMZMs. Benchmark values for pH and total suspended solids. There are no applicable benchmarks for Outfall 014 as the drainage areas consists of the sewage treatment plants.

See Part V for more details.

Figure 1. Location of Cardinal Operating Company

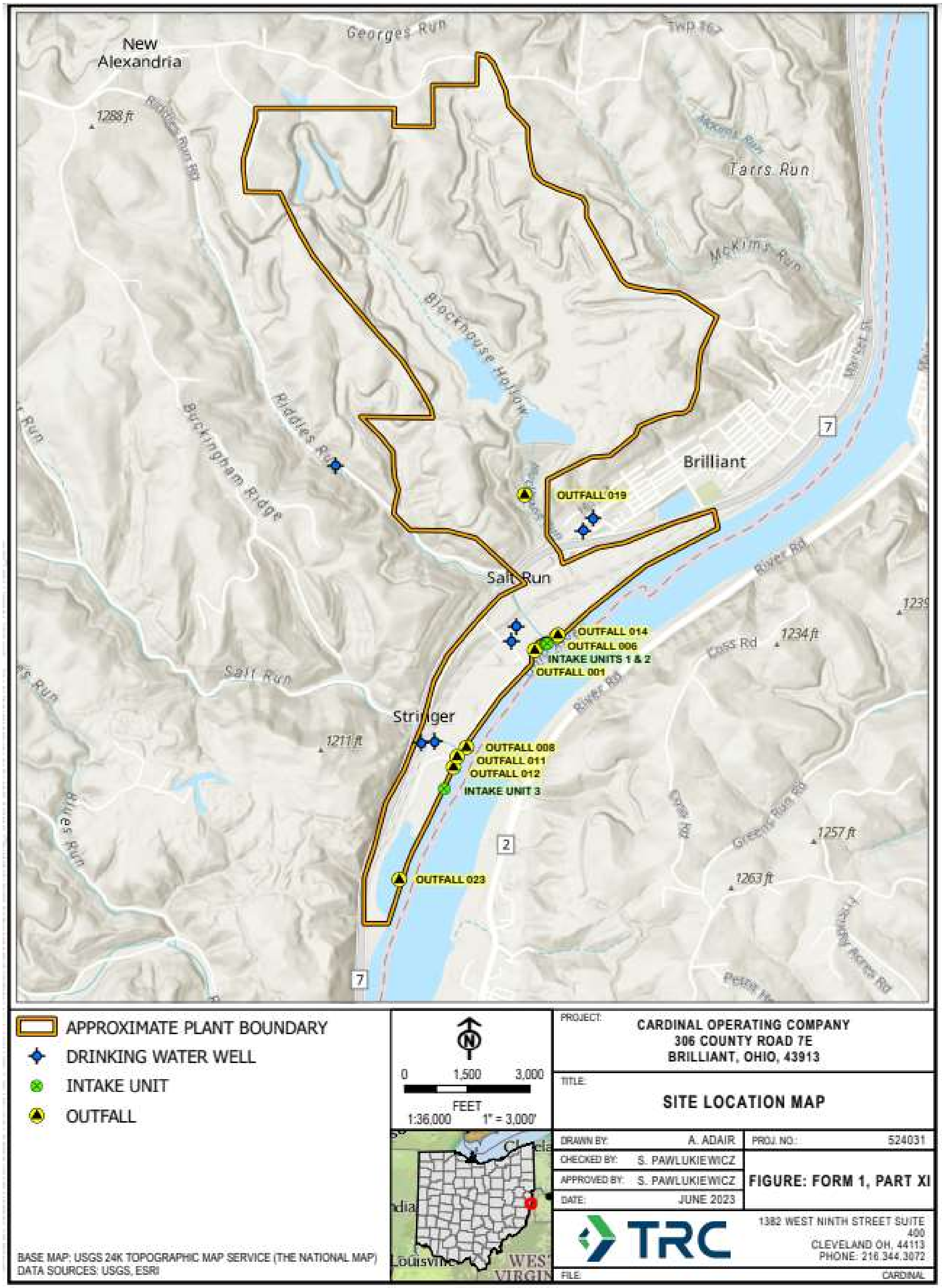


Figure 2. Site Drainage Map

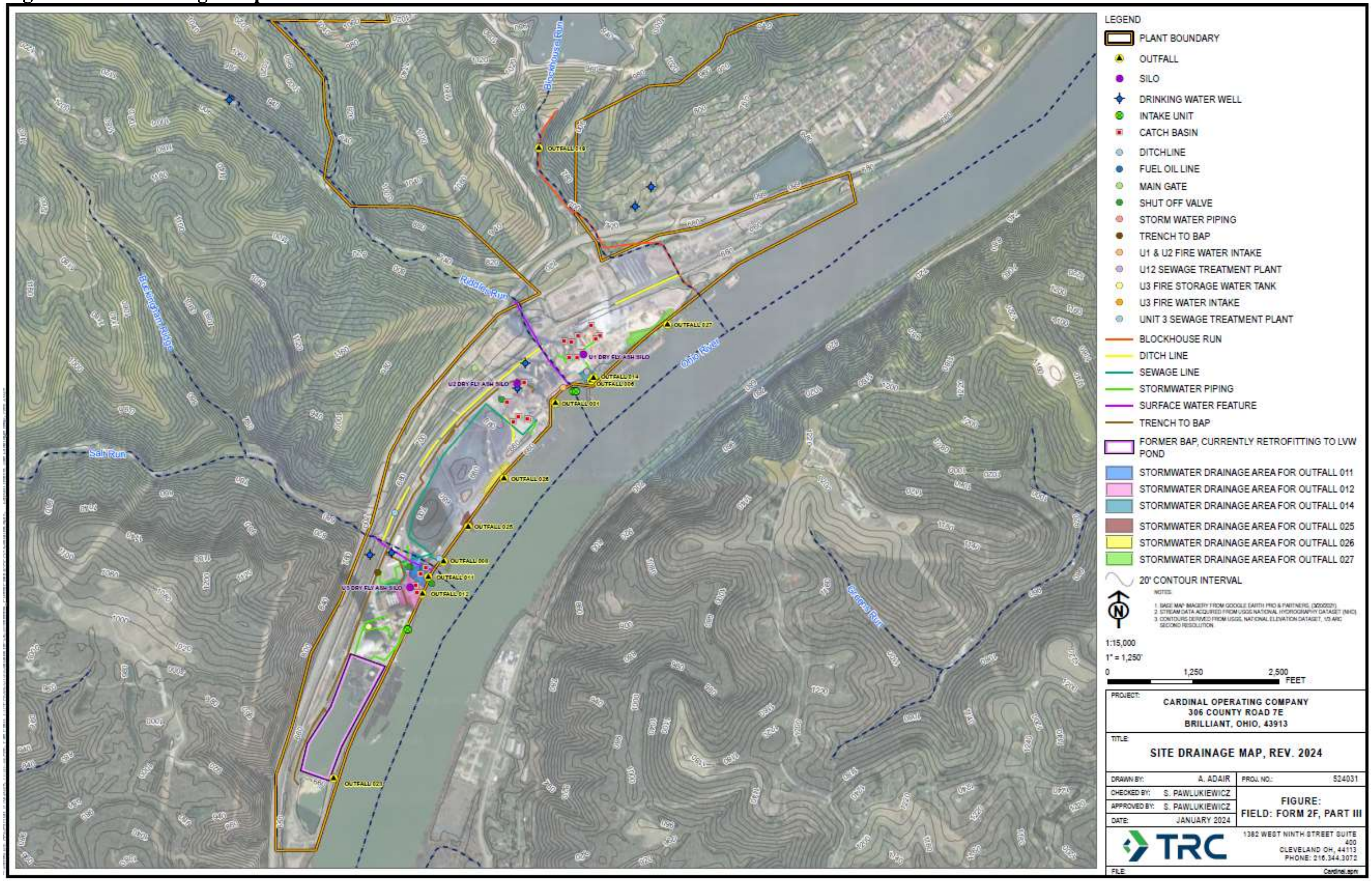


Figure 3. Current Flow Diagram

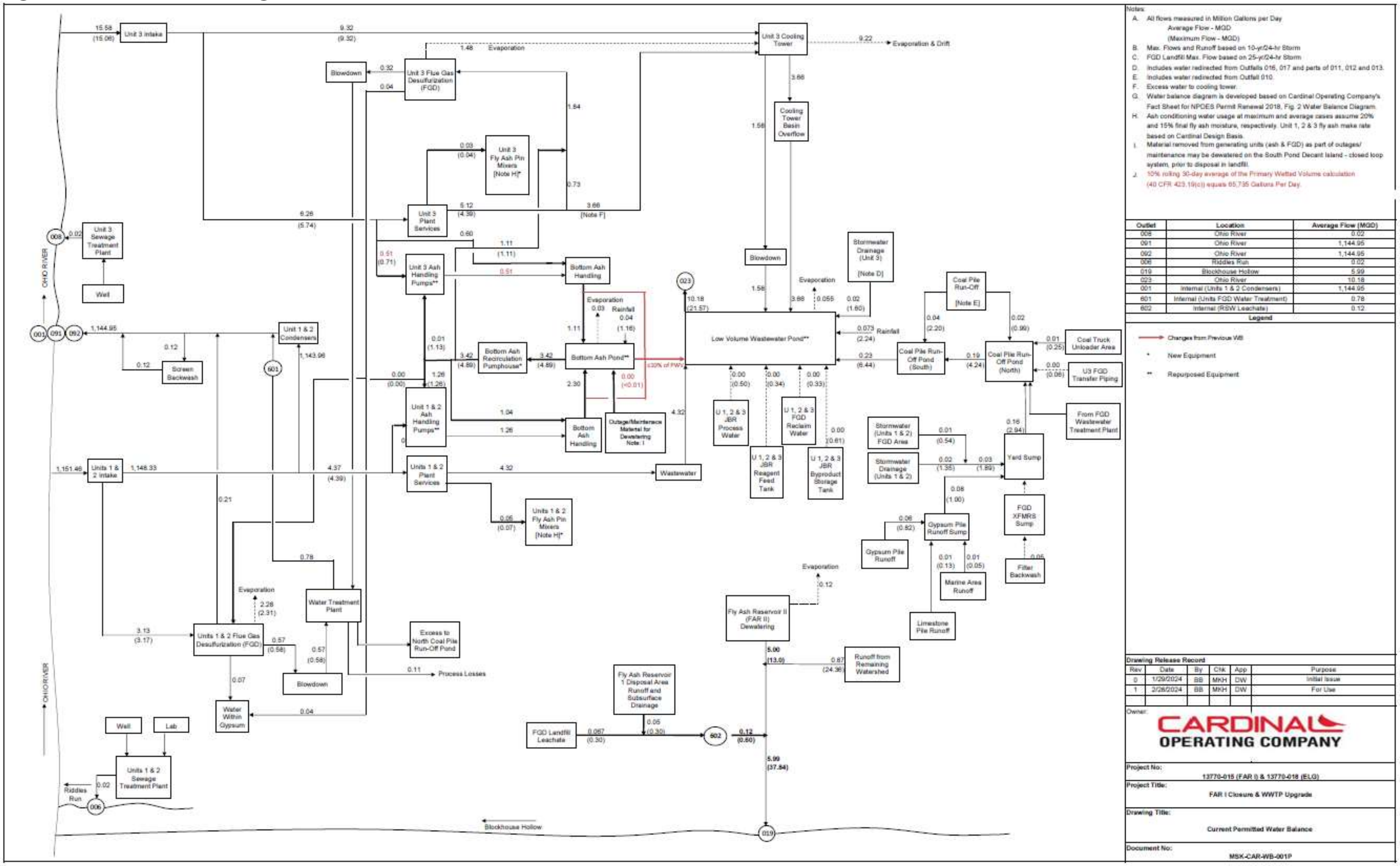


Figure 4. Future Flow Diagram

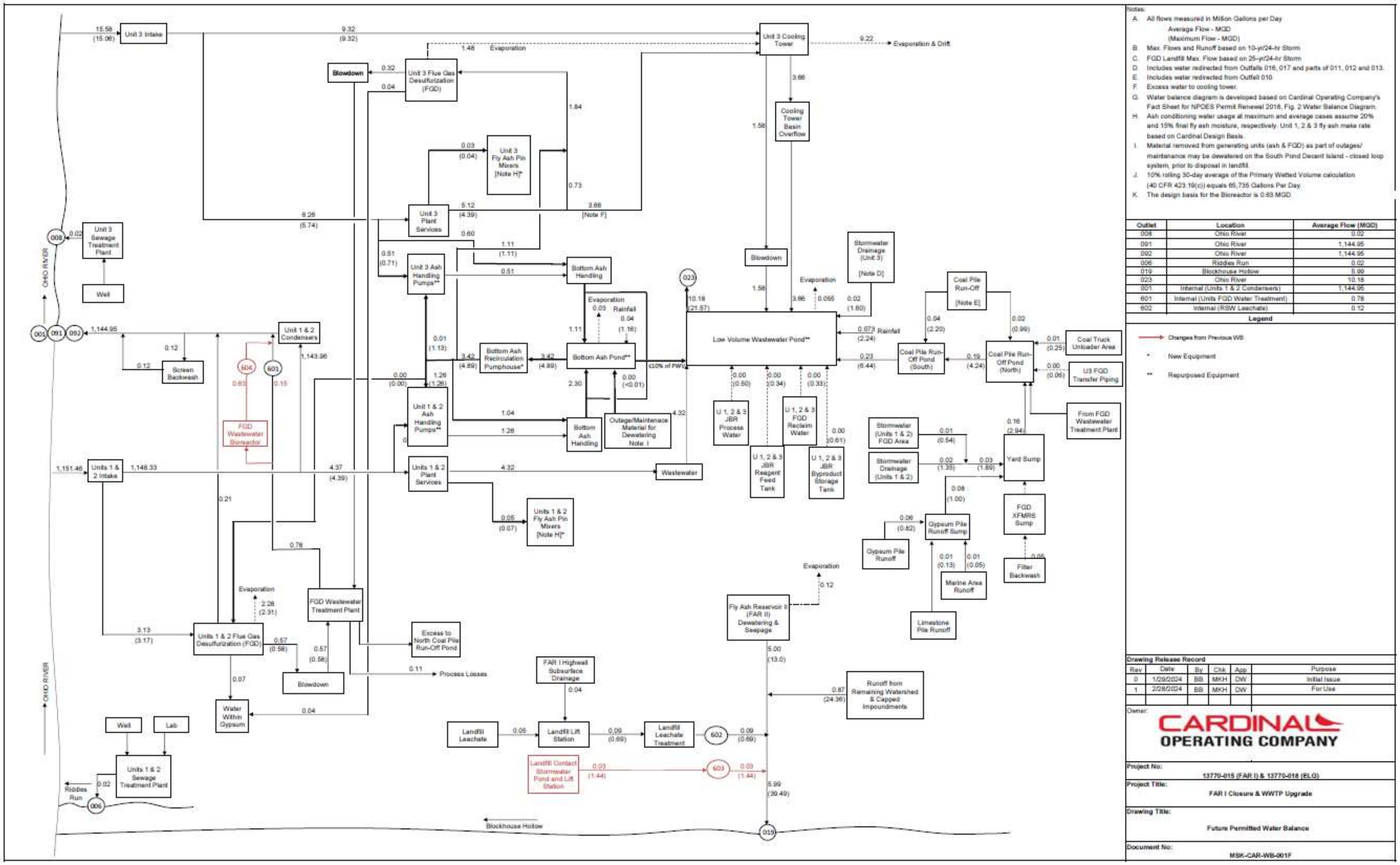


Table 1. Monitoring Stations, Wastewater Sources, Treatment Processes, Discharge Points, and Flow Rates

Station #	Wastewater Source	Treatment Utilized	Discharge/ Receiving Stream	Average Flow Rate (MGD)
001	Units 1 & 2 condensers, Intake 1 & 2 Screen backwash	Reuse/Recycle. Screening, Chlorination	Ohio River	1145
006	Sanitary Waste (Service buildings include Unit 3)	Activated sludge, Settling, Surface Sand Filters and Ultraviolet Disinfection	Riddles Run	0.01*
008	Sanitary Waste (Service buildings include Units 1, 2 and FGD)	Activated sludge, Settling, Surface Sand Filters and Ultraviolet Disinfection	Ohio River	0.015*
019	Station 602 & 605, Fly Ash Reservoir (FAR) II dewatering and seepage, stormwater runoff from capped impoundments	Settling and Neutralization	Blockhouse Hollow Run	5.99
024	Low volume wastewater pond (boiler blowdown, cooling tower blowdown, cooling tower basin overflow, stormwater, water supply treatment wastewaters and coal pile runoff)	Reuse/Recycle. Sedimentation, Chemical Oxidation, Chemical Precipitation, Neutralization	Ohio River	9.09**
601	Current: FGD non-biological wastewater treatment, includes blowdown from bottom ash recycle. *(Prior to Unit #3 closure)* Future: FGD non-biological wastewater treatment (portion of flow generated by Unit #3)	Equalization, Neutralization, Clarification (Primary and Secondary) and Diffuser	Cooling Channel to Outfall 001	Current: 0.78 Future: 0.15

Station #	Wastewater Source	Treatment Utilized	Discharge/ Receiving Stream	Average Flow Rate (MGD)
602	Current: Fly Ash Reservoir (FAR) I RSW landfill runoff, subsurface drainage and leachate Future: FAR I subsurface drainage and FAR I RSW landfill leachate	Current: None Future: Landfill leachate treatment system (TBD)	Outfall 019	0.1
603	Bottom Ash Transport Water		Directed to scrubber system where later purged to treatment associated with Outfall 601/604	≤ 10% primary wetted volume
604	Portion of FGD purge wastewaters associated with Units #1 & 2 *(PROPOSED)*	Biological treatment system and Diffuser	Cooling Channel to Outfall 001	0.63
605	FAR I RSW Landfill contact stormwater	Contact Stormwater Runoff Pond and Lift Station	Outfall 019	0.03
801	Intake associated with Unit 3 CWIS	Screening		
802	Intake associated with Units 1 and 2 CWIS	Screening		

* Plant Design
**95th percentile of the monthly averages from March 2023 through February 2024

Table 2. Stormwater Outfalls at Cardinal Operating Company

Outfall #	Represented by	Representative Sampling Basis	Receiving Stream
011	012	Northeast of Unit #3 plant building	Ohio River
012[a]		Northeast of Unit #3 plant building	Ohio River
014		Adjacent to Units #1 & 2 sewage treatment plant areas	Riddles Run
025[a]		Coal unloaders and conveyor belt from river barge	Ohio River
026	025	Coal unloaders and conveyor belt from river barge	Ohio River
027		Gypsum conveyor load out system and limestone unloader system	Ohio River

[a] = representative sampling outfall per Part V of the permit.

Table 3. Average Annual Flow Rates

Outfall	Flow Rate (Million Gallons per Day)					
	Year	# obs	Average	Median	95th Percentile	Maximum
001	2019	334	965.93	1045	1045	1045
001	2020	366	883.07	1045	1045	1045
001	2021	365	840.44	1045	1045	1045
001	2022	365	937.74	1045	1045	1045
001	2023	365	922.81	1045	1046	1046
001	2024	31	1045	1045	1045	1045
019	2019	334	9.50	9.55	12.98	17.57
019	2020	366	11.15	11.2	14.11	24.46
019	2021	365	7.34	8.04	15.34	27.31
019	2022	365	3.15	2.74	7.1	14.74
019	2023	357	2.09	1.7	4.84	9.11
019	2024	31	1.70	1.13	3.71	4.83
023	2020	1	0.16	0.158	0.158	0.158
023	2021	245	5.46	6.47	11.02	15.53
023	2022	365	8.50	8.32	15.20	20.90
023	2023	365	6.65	6.01	11.46	19.87

Time period of review is from February 2019 to February 2024.

Table 4. Effluent Characterization Based on Form 2C Data

Parameter	Units	Concentration	
Outfall 001 [a]		*Effluent*	*Intake*
Boron	µg/L	130	34
Fluoride	mg/L	0.199	0.105
Iron	µg/L	510	260
Magnesium	mg/L	9.78	8.37
Manganese [b]	µg/L	94	100
Nitrate + Nitrite	mg/L	0.76	0.56
Sulfates	mg/L	63	56
Outfall 019			
Barium	µg/L	25	
Chromium	µg/L	AA (20)	
Fluoride	mg/L	0.625	
Magnesium	mg/L	75.6	
Manganese	µg/L	110	
Molybdenum	µg/L	230	
Outfall 023			
Barium	µg/L	51	
Iron	µg/L	1900	
Lead	µg/L	4	
Magnesium	mg/L	12.8	
Manganese	µg/L	120	
Nitrate + Nitrite	mg/L	1.08	
Sulfate	mg/L	110	

[a] Outfall 001 data represents NCCW only.
[b] Result excluded due to presence of pollutant in the intake. Form 2C intake data exceeds or is within 10% of the effluent result.

One test result was provided for the above parameters.
AA = non-detection; analytical method detection limit in parentheses

Table 5. Effluent Characterization Based on Form 2E Data

Parameter	Units	Maximum Concentration	Number of Observations
Outfall 006			
Ammonia (summer)	mg/L	0.98	3
Ammonia (winter)	mg/L	1.6	1
Chemical Oxygen Demand	mg/L	27	1
Hardness	mg/L	730*	3
Total Organic Carbon (TOC)	mg/L	5.6	1
Outfall 008			
Ammonia	mg/L	0.1	1
Chemical Oxygen Demand	mg/L	17	1
Hardness	mg/L	657*	3
Total Organic Carbon (TOC)	mg/L	3.6	1

*Represents the average of the three observations.

- Additional data for ammonia (summer) and hardness were provided on 10/17/2023 to support the application. Sample dates include 9/20/23, 9/27/23, and 10/4/23.
- All other Form 2E data was sampled between May 2022 and April 2023.

Table 6. Effluent Characterization Based on Form 2F Data

Parameter	Units	Concentration
		Grab Sample
Outfall 011		
Ammonia	mg/L	1.44
Arsenic	µg/L	13
Barium	µg/L	69
Boron	µg/L	54
Cadmium	µg/L	AA (1.0)
Chloride, Total	mg/L	93
Chromium	µg/L	AA (20)
Cobalt	µg/L	AA (20)
Copper	µg/L	AA (20)
Iron	µg/L	8300
Lead	µg/L	20
Mercury	ng/L	137
Nickel	µg/L	AA (20)
Nitrogen, Total	mg/L	13.4
Nitrate Plus Nitrite	mg/L	1.23
Oil and Grease	mg/L	AA (5.2)
pH	S.U.	9.87
Total Filterable Residue	mg/L	240
Total Suspended Solids	mg/L	380
Selenium	µg/L	AA (10)
Sulfate	mg/L	76
Zinc	µg/L	200
Outfall 012		
Ammonia	mg/L	7.95
Arsenic	µg/L	29
Barium	µg/L	98
Boron	µg/L	270
Cadmium	µg/L	AA (1.0)
Chloride, Total	mg/L	41
Chromium	µg/L	AA (20)
Cobalt	µg/L	AA (20)
Copper	µg/L	20
Iron	µg/L	13000
Lead	µg/L	24

Parameter	Units	Concentration
		Grab Sample
Mercury	ng/L	47.9
Nickel	µg/L	AA (20)
Nitrogen, Total	mg/L	37.4
Nitrate Plus Nitrite	mg/L	1.09
Oil and Grease	mg/L	AA (5.1)
pH	S.U.	9.21
Total Filterable Residue	mg/L	228
Total Suspended Solids	mg/L	530
Selenium	µg/L	AA (10)
Sulfate	mg/L	62
Zinc	µg/L	320
Outfall 025		
Ammonia	mg/L	0.10
Arsenic	µg/L	7.8
Barium	µg/L	47
Boron	µg/L	59
Cadmium	µg/L	1.1
Chloride	mg/L	43
Chromium	µg/L	AA (20)
Cobalt	µg/L	AA (20)
Copper	µg/L	AA (20)
Iron	µg/L	6900
Lead	µg/L	16
Mercury	ng/L	52.5
Nickel	µg/L	AA (20)
Nitrate Plus Nitrite	mg/L	AA (0.50)
Nitrogen, Total	mg/L	6.44
Oil and Grease	mg/L	AA (5.0)
Total Filterable Residue	mg/L	408
Total Kjeldahl Nitrogen	mg/L	6.36
Total Suspended Solids	mg/L	590
Selenium	µg/L	AA (10)
Sulfate	mg/L	180
Zinc	µg/L	160

Parameter	Units	Concentration
		Grab Sample
Outfall 026		
Ammonia	mg/L	0.07
Arsenic	µg/L	AA (6.0)
Barium	µg/L	28
Boron	µg/L	32
Cadmium	µg/L	AA (1.0)
Chloride	mg/L	27
Chromium	µg/L	AA (20)
Cobalt	µg/L	AA (20)
Copper	µg/L	AA (20)
Iron	µg/L	2800
Lead	µg/L	8.0
Mercury	ng/L	44.8
Nickel	µg/L	AA (20)
Nitrate Plus Nitrite	mg/L	AA (0.50)
Nitrogen, Total	mg/L	7.45
Oil and Grease	mg/L	<5.0
Total Filterable Residue	mg/L	114
Total Kjeldahl Nitrogen	mg/L	7.24
Total Suspended Solids	mg/L	300
Selenium	µg/L	AA (10)
Sulfate	mg/L	33
Zinc	µg/L	100
Outfall 027		
Ammonia	mg/L	0.16
Arsenic	µg/L	6.8
Barium	µg/L	42
Boron	µg/L	67
Cadmium	µg/L	AA (1.0)
Chloride	mg/L	83
Chromium	µg/L	AA (20)
Cobalt	µg/L	AA (20)
Copper	µg/L	AA (20)
Fluoride	mg/L	0.409
Hardness	mg/L	890
Iron	µg/L	4500

Parameter	Units	Concentration
		Grab Sample
Lead	µg/L	10
Mercury	ng/L	256
Nickel	µg/L	AA (20)
Nitrate Plus Nitrite	mg/L	0.53
Nitrogen, Total	mg/L	1.38
Oil and Grease	mg/L	AA (5.6)
Total Filterable Residue	mg/L	1210
Total Kjeldahl Nitrogen	mg/L	0.85
Total Suspended Solids	mg/L	240
Selenium	µg/L	AA (10)
Sulfate	mg/L	680
Zinc	µg/L	140

AA = non-detection; analytical method detection limit in parentheses

Table 7. Effluent Characterization Using Self-Monitoring Data

Outfall	Parameter	Unit	Current Limits		# Obs	Percentiles		Data Range
			30 Day	Daily		50th	95th	
001	Water Temperature	°F	Monitoring Only		1826	71.9	101	41.3 - 105
	Thermal Discharge	Million BTU/Hr	6340	6340	1826	4820	5870	0 - 6310
	pH	S.U.	6.5 - 9.0		241	7.7	8.47	6.5 - 8.9
	Nitrogen, Ammonia	mg/L	Monitoring Only		20	.135	148	0 - 183
	Barium	µg/L	Monitoring Only		20	41.4	87.3	36 - 130
	Zinc	µg/L	Monitoring Only		20	18.5	193	0 - 254
	Copper	µg/L	Monitoring Only		61	< 10	7.42	0 - 17.1
	Flow Rate	MGD	Monitoring Only		1826	1050	1050	261 - 1050
	Chlorine, Total Residual	mg/L	--	0.20	1421	0	0	0 - .18
	Mercury, Total	ng/L	Monitoring Only		61	1.37	6.54	0 - 8.19
	Chlorination/Bromination Duration	Minutes	--	120	1739	120	120	0 - 120
006	Flow Rate	GPD	Monitoring Only		1826	4930	9650	0 - 17300
	pH	S.U.	6.5 - 9.0		60	7.67	8.2	6.8 - 8.35
	Total Suspended Solids	kg/day	0.48	0.73	60	< .00919	.0357	0 - .0527
	Total Suspended Solids	mg/L	12	18	60	< 4	1.61	0 - 2.4
	Copper	kg/day	--	0.0019	60	.00021	.000415	0 - .000849
	Copper	µg/L	--	47	60	12	20.1	0 - 28
	Fecal Coliform	#/100 mL	1000	2000	30	< 2	80.8	0 - 182
	E. coli	#/100 mL	126	240[w]	31	< 1	< 1	0 - 42
	CBOD 5 day	kg/day	0.40	0.60	61	< .0172	.0334	0 - .139
	CBOD 5 day	mg/L	10	15	61	< 2	1.53	0 - 2.3
008	Flow Rate	GPD	Monitoring Only		1826	3510	8190	24 - 26100
	pH	S.U.	6.5 - 9.0		61	7.51	8.1	6.86 - 8.33
	Total Suspended Solids	kg/day	0.72	1.08	61	< .00181	.0254	0 - .107
	Total Suspended Solids	mg/L	12	18	61	< 4	3	0 - 11
	Copper	µg/L	Monitoring Only		60	19.7	36.8	0 - 62
	Fecal Coliform	#/100 mL	1000	2000	30	--	--	< 1
	E. coli	#/100 mL	126	240[w]	30	--	--	< 1
	CBOD 5 day	kg/day	0.60	0.90	60	< .0312	.0228	0 - .0779
	CBOD 5 day	mg/L	10	15	60	< 2	1.48	0 - 2.9
019	Water Temperature	°F	Monitoring Only		264	57.2	75.2	33.8 - 81.5

Outfall	Parameter	Unit	Current Limits		# Obs	Percentiles		Data Range
			30 Day	Daily		50th	95th	
	Specific Conductance at 25 Degrees C	Umho/cm	Monitoring Only		33	1610	2100	973 - 2190
	pH	S.U.	6.5 - 9.0		135	8.10	8.40	7.20 - 8.90
	Alkalinity, Total (CaCO3)	mg/L	Monitoring Only		33	140	160	62.0 - 160
	Total Suspended Solids	kg/day	1490	4838	263	32.0	147	0 - 418
	Total Suspended Solids	mg/L	30	97.4	264	3.50	11.0	0 - 34.5
	Oil and Grease	kg/day	745	993	33	--	--	< 16.9
	Oil and Grease	mg/L	15	20	33	--	--	< 5.00
	Nitrogen, Ammonia - June - Oct.	kg/day	--	184	119	0.591	6.06	0 - 13.0
	Nitrogen, Ammonia - June - Oct.	mg/L	--	3.7	120	0.100	0.300	0 - 0.490
	Nitrogen, Ammonia - Nov - May	kg/day	--	179	72	0.867	2.90	0 - 4.86
	Nitrogen, Ammonia - Nov - May	mg/L	--	3.6	72	0.100	0.200	0 - 0.400
	Nitrogen Kjeldahl, Total	mg/L	Monitoring Only		6	< 0.500	5.99	0 - 7.72
	Nitrite Plus Nitrate, Total	mg/L	Monitoring Only		6	0.565	0.988	0 - 1.08
	Chloride, Total	mg/L	Monitoring Only		33	43.0	61.6	19.0 - 90.0
	Sulfate, (SO4)	mg/L	Monitoring Only		33	770	888	340 - 920
	Arsenic	µg/L	Monitoring Only		66	37.5	60.8	0 - 69.0
	Selenium	µg/L	Monitoring Only		66	11.0	23.5	0 - 35.0
	Boron	µg/L	Monitoring Only		66	3900	6750	880 - 11000
	Chromium, Hexavalent - 2021-2023	kg/day	--	0.79	51	< 0.0369	< 0.0369	0 - 0.0420
	Chromium, Hexavalent - 2023-2024	µg/L	--	16	51	< 4.00	< 4.00	0 - 4.70
	Chromium, Hexavalent	µg/L	Monitoring Only		16	--	--	< 4.00
	Zinc	µg/L	Monitoring Only		38	< 20.0	4.05	0 - 60.0
	Copper	µg/L	Monitoring Only		6	--	--	< 20.0
	Flow Rate	MGD	Monitoring Only		996	2.03	10.1	0.530 - 19.3
	Mercury, Total	kg/day	0.00060	0.084	11	0.0000131	0.000520	0.00000298 - 0.000920
	Mercury, Total	ng/L	12	1700	11	1.65	17.9	0.560 - 24.0
	Residue, Total Filterable	mg/L	Monitoring Only		33	1320	1590	568 - 11400

Outfall	Parameter	Unit	Current Limits		# Obs	Percentiles		Data Range
			30 Day	Daily		50th	95th	
023	pH	S.U.	6.5 - 9.0		12	7.65	8.25	6.70 - 8.30
	Total Suspended Solids	mg/L	30	98.9	12	6.50	18.7	1.50 - 19.0
	Oil and Grease	mg/L	15	20	12	--	--	< 5.00
	Nitrogen, Ammonia	mg/L	Monitoring Only		12	0.575	6.44	0.150 - 9.18
	Fluoride, Total (F)	mg/L	Monitoring Only		12	0.270	0.414	0.150 - 0.480
	Arsenic	µg/L	Monitoring Only		12	--	--	< 6.00
	Selenium	µg/L	Monitoring Only		12	< 10.0	112	0 - 230
	Boron	µg/L	Monitoring Only		12	170	506	78.0 - 550
	Chromium, Hexavalent	µg/L	Monitoring Only		12	--	--	< 4.00
	Zinc	µg/L	Monitoring Only		12	5.50	58.0	0 - 58.0
	Cadmium	µg/L	Monitoring Only		12	< 1.00	1.31	0 - 2.90
	Copper	µg/L	Monitoring Only		12	34.0	61.9	0 - 69.0
	Flow Rate	MGD	Monitoring Only		366	6.01	11.1	0 - 19.9
	Chlorine, Total Residual	mg/L	--	0.038	12	--	--	0 - 0
	Mercury, Total	ng/L	Monitoring Only		12	3.59	5.70	1.17 - 5.87
588	Sludge Volume, Gallons	Gals	Monitoring Only		5	30600	42300	20.4 - 43400
600	Mercury, Total	ng/L	Monitoring Only		60	185000	364000	1570 - 722000
601	Water Temperature	°F	Monitoring Only		240	78.7	95.8	15.7 - 100
	Specific Conductance at 25 Degrees C	Umho/cm	Monitoring Only		65	13900	19800	0 - 22200
	pH - 2020-2024	S.U.	6.0 - 9.0		160	8.1	8.57	7.4 - 8.7
	pH - 2019-2020	S.U.	6.5 - 9.0		80	8.58	8.85	7.71 - 8.97
	Alkalinity, Total (CaCO3)	mg/L	Monitoring Only		68	389	650	160 - 856
	Total Suspended Solids	kg/day	80	265	245	14.6	67.2	0 - 161
	Total Suspended Solids	mg/L	30	100	245	8	26.4	.05 - 51
	Nitrogen Kjeldahl, Total	mg/L	Monitoring Only		10	6.6	20.9	3.07 - 30.4
	Nitrite Plus Nitrate, Total	mg/L	Monitoring Only		11	5.13	14.6	1.11 - 18.5
	Chloride, Total	mg/L	Monitoring Only		120	3200	5300	110 - 5900
	Sulfate, (SO4)	mg/L	Monitoring Only		120	3700	6110	91 - 13500
	Fluoride, Total (F)	mg/L	Monitoring Only		121	37.3	61.5	3.2 - 98.2
	Arsenic- 2019-2020	µg/L	8	11	40	6.56	19.6	0 - 73
	Arsenic- 2020-2024	µg/L	Monitoring Only		80	< 6	22.5	0 - 54

Outfall	Parameter	Unit	Current Limits		# Obs	Percentiles		Data Range
			30 Day	Daily		50th	95th	
	Iron	µg/L	Monitoring Only		120	420	1810	0 - 14000
	Selenium	µg/L	Monitoring Only		121	210	510	0 - 644
	Boron	µg/L	Monitoring Only		121	180000	320000	0 - 650000
	Barium	µg/L	Monitoring Only		120	57.5	88.3	26 - 594
	Nickel	µg/L	Monitoring Only		120	24	222	0 - 390
	Zinc	µg/L	Monitoring Only		120	< 20	34	0 - 160
	Cadmium	µg/L	Monitoring Only		81	< 1	7	0 - 15
	Lead	µg/L	Monitoring Only		81	< 4	21	0 - 44
	Chromium	µg/L	Monitoring Only		120	< 20	14.1	0 - 26
	Copper	µg/L	Monitoring Only		87	< 20	11.5	0 - 24
	Flow Rate	MGD	Monitoring Only		1826	.608	.925	0 - 1.01
	Mercury, Total	ng/L	Monitoring Only		61	128	745	1.2 - 1110
	Residue, Total Filterable	mg/L	Monitoring Only		84	10900	16500	2580 - 19400
602	pH	S.U.	Monitoring Only		65	7.97	8.4	7.1 - 8.5
	Fluoride, Total (F)	mg/L	Monitoring Only		20	3.37	4.46	1.87 - 4.58
	Selenium	µg/L	Monitoring Only		20	74.6	121	0 - 130
	Boron	µg/L	Monitoring Only		20	10300	22100	110 - 23000
	Flow Rate	MGD	Monitoring Only		269	.094	.315	.005 - 60
	Mercury, Total	ng/L	Monitoring Only		20	3.9	151	0 - 468
	Residue, Total Filterable	mg/L	Monitoring Only		20	2910	3420	1170 - 3760
603	Number of Events	No./Month	Monitoring Only		1218	1	1	0 - 1
	Overflow Occurrence	No./Month	Monitoring Only		608	1	1	1 - 1
604	Number of Events	No./Month	Monitoring Only		1218	0	1	0 - 1
	Overflow Occurrence	No./Month	Monitoring Only		608	1	1	1 - 1
801	Flow Rate	MGD	Monitoring Only		1826	9	9	0 - 9
	Mercury, Total	ng/L	Monitoring Only		60	1.38	6.55	0 - 8.2
	Cycles of Concentration	Cycles	Monitoring Only		1624	1.69	2.15	0 - 3.15

Data Range from February 2019 through February 2024. Except for Outfalls 019 and 023, where the date range is June 2021 through February 2024 and March 2023 through February 2024, respectively.

^{w} = weekly average

Table 8. Projected Effluent Quality

Parameter	Units	Number of Samples	Number > MDL	PEQ Average	PEQ Maximum
Outfall 001*					
Ammonia (Summer)	mg/L	10	8	0.36	0.64
Ammonia (Winter)	mg/L	5	5	0.44	0.60
Barium	µg/L	20	20	69.68	94.62
Boron	µg/L	1	1	588.38	806
Chlorine, Total Residual	mg/L	1450	41	0.079	0.12
Copper	µg/L	62	9	7.15	10.318
Fluoride	mg/L	1	1	0.90	1.23
Iron	µg/L	1	1	2.31	3.16
Magnesium	mg/L	1	1	44.26	60.64
Mercury	ng/L	62	57	4.16	6.54
Nitrate-N + Nitrite-N	mg/L	1	1	3.44	4.71
Sulfates	mg/L	1	1	285.14	390.6
Zinc	µg/L	20	13	259.59	355.6
Outfall 006					
Ammonia (Summer)	mg/L	3	3	2.15	2.94
Ammonia (Winter)	mg/L	1	1	7.24	9.92
Copper	µg/L	61	46	17.89	24.59
Outfall 008					
Ammonia (Summer)	mg/L	1	1	0.4526	0.62
Ammonia (Winter)	mg/L	1	1	0.4526	0.62
Copper	µg/L	61	58	30.49	40.53
Outfall 019					
Ammonia (Summer)	mg/L	96	87	0.179	0.309
Ammonia (Winter)	mg/L	36	34	0.178	0.251
Arsenic	µg/L	66	64	56.02	75.98
Barium	µg/L	1	1	113.2	155
Boron	µg/L	66	66	6202	8801
Chlorides	mg/L	33	33	60.65	78.76
Chromium	µg/L	1	1	--	--
Hexavalent Chromium (Dissolved)	µg/L	66	2	3.43	4.7
Copper	µg/L	6	0	--	--
Dissolved Solids	mg/L	32	32	1612	2037
Fluoride	mg/L	1	1	2.83	3.88
Magnesium	mg/L	1	1	342.17	468.72
Manganese	µg/L	1	1	497.86	682
Mercury	ng/L	11	11	22.23	43.22
Molybdenum	µg/L	1	1	1041	1426
Nitrate-N + Nitrite-N	mg/L	6	4	1.66	2.27

Parameter	Units	Number of Samples	Number > MDL	PEQ Average	PEQ Maximum
Selenium	µg/L	66	40	18.56	26.79
Sulfates	mg/L	33	33	905	1115.6
Zinc	µg/L	38	2	4.70	6.44
Outfall 024					
Ammonia (Summer)	mg/L	4	4	3.00	4.12
Ammonia (Winter)	mg/L	3	3	9.20	12.6
Arsenic	µg/L	12	0	--	--
Barium	µg/L	1	1	230.83	316.2
Boron	µg/L	12	12	444	769
Cadmium	µg/L	12	1	3.39	4.64
Chlorine – Total Residual	mg/L	12	0	--	--
Hexavalent Chromium (Dissolved)	µg/L	12	0	--	--
Copper	µg/L	12	9	67.74	92.8
Fluoride	mg/L	12	12	0.49	0.59
Iron	µg/L	1	1	8599	11780
Lead	µg/L	1	1	18.10	24.8
Magnesium	mg/L	1	1	57.93	79.36
Manganese	µg/L	1	1	543.12	744
Mercury	ng/L	12	12	6.89	11.42
Nitrate-N + Nitrite-N	mg/L	1	1	4.89	6.70
Selenium	µg/L	11	1	19.86	27.2
Sulfates	mg/L	1	1	497.86	682
Zinc	µg/L	12	6	67.74	92.8

*Outfall 001 represents NCCW only, except for mercury which is a calculated value based on intake and internal station 601 samples.
MDL = analytical method detection limit
PEQ = projected effluent quality

Table 9. Water Quality Criteria in the Study Area

Parameter	Units	Outside Mixing Zone Criteria				Inside Mixing Zone Maximum
		Average			Maximum	
		Human Health	Agri-culture	Aquatic Life	Aquatic Life	
Outfall 001						
Ammonia (Summer)	mg/L	--	--	0.9	--	--
Ammonia (Winter)	mg/L	--	--	3.6	--	--
Arsenic [a]	µg/L	50	100	150	340	680
Barium	µg/L	1000	--	620	2700	5300
Boron	µg/L	--	--	3900	33000	65000
Chlorine, Total Residual	mg/L	--	--	0.011	0.019	0.038
Copper	µg/L	--	--	500	--	--
Fluoride	mg/L	--	1	2	--	--
Iron	µg/L	--	--	5000	--	--
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--
Mercury	ng/L	12	10000	910	1700	3400
Nitrate-N + Nitrite-N [a]	mg/L	10	100	--	--	--
Selenium [a]	µg/L	170	50	5	62	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	7400	25000	120	120	230
Outfall 006						
Ammonia (Summer)	mg/L	--	--	0.9	--	--
Ammonia (Winter)	mg/L	--	--	1.9	--	--
Copper	µg/L	--	500	15	24	100
Outfall 008						
Ammonia (Summer)	mg/L	--	--	0.9	--	--
Ammonia (Winter)	mg/L	--	--	3.6	--	--
Copper	µg/L	--	500	9.1	14	100
Outfall 019						
Ammonia (Summer)	mg/L	--	--	--	7.4	--
Ammonia (Winter)	mg/L	--	--	--	5.1	--
Arsenic	µg/L	--	--	--	340	680
Barium	µg/L	--	--	--	4500	8900
Boron	µg/L	--	--	--	33000	65000
Chlorides	mg/L	--	--	--	--	--
Chromium	µg/L	--	--	--	2900	5700
Hexavalent Chromium (Dissolved)	µg/L	--	--	--	16	31
Copper	µg/L	--	--	--	24	47
Dissolved Solids	mg/L	--	--	--	--	--
Fluoride	mg/L	--	--	--	--	--
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--

Parameter	Units	Outside Mixing Zone Criteria				Inside Mixing Zone Maximum
		Average			Maximum	
		Human Health	Agri-culture	Aquatic Life	Aquatic Life	
Mercury	ng/L	12	--	--	1700	3400
Molybdenum	µg/L	--	--	--	190000	370000
Nitrate-N + Nitrite-N	mg/L	--	--	--	--	--
Selenium	µg/L	4200	--	--	62	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	26000	--	--	190	380
Outfall 024						
Ammonia (Summer)	mg/L	--	--	0.9	--	--
Ammonia (Winter)	mg/L	--	--	3.6	--	--
Arsenic	µg/L	50	100	150	340	680
Barium	µg/L	1000	--	620	2700	11000
Boron	µg/L	--	--	3900	33000	65000
Cadmium	µg/L	--	50	2.4	4.4	23
Chlorine, Total Residual	mg/L	--	--	0.011	0.019	0.038
Hexavalent Chromium (Dissolved)	µg/L	--	--	11	16	31
Copper	µg/L	--	500	9.1	14	61
Fluoride	mg/L	1	2	--	--	--
Iron	µg/L	--	5000	--	--	--
Lead	µg/L	--	100	6.2	120	710
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--
Mercury	ng/L	12	10000	910	1700	3400
Nitrate-N + Nitrite-N	mg/L	10	100	--	--	--
Selenium	µg/L	170	50	5	62	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	7400	25000	120	120	490

a The criteria for these parameters is provided for the TBEL verse WQBEL comparison shown in Attachment 2.

Table 10. Instream Conditions and Discharger Flow

Parameter	Units	Season	Value	Basis
Riddles Run				
Stream Flows				
1Q10	cfs	annual	0.1	USGS StreamStats - 2.28 sq mi
7Q10	cfs	annual	0.12	USGS StreamStats - 2.28 sq mi
30Q10	cfs	summer	0.162	USGS StreamStats - 2.28 sq mi
		winter	0.162	USGS StreamStats - 2.28 sq mi
Harmonic Mean	cfs	annual	0.559	USGS StreamStats - 2.28 sq mi
Mixing Assumption	%	average	100	
		maximum	100	
Hardness, OMZ	mg/L	annual	175	BWR central Ohio River 2018, n=960
Hardness, IMZ	mg/L	annual	400	default. 006 9/1/23 (n=3) hardness = 730 mg/l
pH	S.U.	summer	8.09	BWR Central Ohio River 2018, n=631
		winter	8.29	BWR central Ohio River 2018, n=47
Temperature	ºC	summer	22.7	BWR central Ohio River 2018, n=634
		winter	6.06	BWR central Ohio River 2018, n=47
Cardinal Power flow, Outfall 006	cfs	annual	0.030945	Average Daily Design Flow – Outfall 006
Background Water Quality – Riddles Run, Outfall 006				
Ammonia (Summer)	mg/L		0.025	BWR; 2018; n=651; 401<MDL; Central Ohio River tributaries (median)
Ammonia (Winter)	mg/L		0.025	BWR; 2018; n=57; 48<MDL; Central Ohio River tributaries (median)
Copper	µg/L		1	BWR; 2018; n=960; 752<MDL; Central Ohio River tributaries (median)

BWR = Ohio EPA 2018 Background Water Quality Report
MDL = analytical method detection limit
n = number of samples
Ohio EPA = Ohio Environmental Protection Agency
USGS = United States Geological Survey

Parameter	Units	Season	Value	Basis
Ohio River				
Stream Flows				
1Q10	cfs	annual	5000	Direct Ohio River dischargers use 7Q10 instead of 1Q10; ORSANCO MP 31.7-161.7
7Q10	cfs	annual	5880	ORSANCO MP 31.7-161.7
Harmonic Mean	cfs	annual	20500	ORSANCO MP 31.7-161.7
Mixing Assumption	%	average	10	(***WLAs for non-carcinogens are developed using 100 percent of the 7Q10.)
		maximum	1	
Hardness, OMZ	mg/L	annual	97	ORSANCO, Pike Island, median, n=27
Hardness, IMZ (Outfalls 001 and 019)	mg/L	annual	97	ORSANCO, Pike Island, median, n=27
Hardness, IMZ (Outfall 008)	mg/L	annual	400	Outfall 008 from October 2023 (n=3) = 657 mg/L (average). Default maximum = 400 mg/l
Hardness, IMZ (Outfall 024)	mg/L	annual	230	Outfall 023 effluent data October 2023 (n=3)
pH	S.U.	summer	8	ORSANCO 75th% (Pike Island, 2019-2023, n=5)
		winter	7.8	ORSANCO 75th% (Pike Island, 2019-2023, n=5)
Temperature	ºC	summer	26.3	0IB00010800, 75th%, (7/2019-7/2023)
		winter	13.6	0IB00010800, 75th%, (7/2019-7/2023)
Cardinal Power flow, Outfall 001	cfs	annual	1616.9	95th percentile monthly avg (Feb19-Feb24)
Cardinal Power flow, Outfall 008	cfs	annual	0.030945	Average Daily Flow - Outfall 008
Cardinal Power flow, Outfall 019	cfs	annual	9.794	(June2021-Feb2024) 95th% of monthly average flows
Cardinal Power flow, Outfall 024	cfs	annual	14.064	95th% (March 2023-Feb2024)
Background Water Quality – Ohio River				
Ammonia (Summer)	mg/L		0.067	ORSANCO; 2019-2023; n=7; 0<MDL; bimonthly, New Cumberland, average
Ammonia (Winter)	mg/L		0.058	ORSANCO; 2019-2023; n=4; 1<MDL; bimonthly, New Cumberland, average
Arsenic	µg/L		0.5	ORSANCO; 2019-2023; n=27; 25<MDL; clean metals, New Cumberland, median
Barium	µg/L		36.8	ORSANCO; 2019-2023; n=27; 0<MDL; clean metals, New Cumberland, median
Boron	µg/L		0	No representative data available.
Cadmium	µg/L		0	ORSANCO; 2019-2023; n=27; 27<MDL; clean metals, New Cumberland, median

Parameter	Units	Season	Value	Basis
Chlorine–, Total Residual	mg/L		0	No representative data available.
Hexavalent Chromium (Dissolved)	µg/L		0	No representative data available.
Copper	µg/L		2.06	ORSANCO; 2019-2023; n=27; 1<MDL; clean metals, New Cumberland, median
Fluoride	mg/L		0	No representative data available.
Iron	µg/L		373	ORSANCO; 2019-2023; n=27; 0<MDL; clean metals, New Cumberland, median
Lead	µg/L		0.5	ORSANCO; 2019-2023; n=27; 23<MDL; clean metals, New Cumberland, median
Magnesium	mg/L		7.1	ORSANCO; 2019-2023; n=27; 0<MDL; clean metals, New Cumberland, median
Manganese	µg/L		70.3	ORSANCO; 2019-2023; n=27; 0<MDL; clean metals, New Cumberland, median
Mercury	ng/L		0.75	ORSANCO; 2019-2023; n=27; 16<MDL; clean metals, New Cumberland, median
Nitrate-N + Nitrite-N	mg/L		0.8	ORSANCO; 2019-2023; n=24; 0<MDL; bimonthly, New Cumberland, median
Selenium	µg/L		0	ORSANCO; 2019-2023; n=27; 27<MDL; clean metals, New Cumberland, median
Sulfates	mg/L		48.2	ORSANCO; 2019-2023; n=25; 0<MDL; bimonthly, New Cumberland, median
Zinc	µg/L		3.75	ORSANCO; 2019-2023; n=27; 0<MDL; clean metals, New Cumberland, median

MDL = analytical method detection limit
n = number of samples
ORSANCO = Ohio River Valley Water Sanitation Commission

Parameter	Units	Season	Value	Basis
Blockhouse Hollow Run				
Stream Flows				
1Q10	cfs	annual	0.0965	USGS Streamstats - 2.12 sq mi
7Q10	cfs	annual	0.112	USGS Streamstats - 2.12 sq mi
		summer	0.112	USGS Streamstats - 2.12 sq mi
		winter	0.112	USGS Streamstats - 2.12 sq mi
Harmonic Mean	cfs	annual	1.01	USGS Streamstats - 2.12 sq mi
Mixing Assumption	%	average	100	
		maximum	100	
Hardness, OMZ	mg/L	annual	175	BWR Central Ohio River 2018, n=960
Hardness, IMZ	mg/L	annual	175	BWR Central Ohio River 2018, n=960
pH	S.U.	summer	8.09	BWR Central Ohio River 2018, n=631
		winter	8.29	BWR Central Ohio River 2018, n=47
Temperature	ºC	summer	22.7	BWR Central Ohio River 2018, n=634
		winter	6.06	BWR Central Ohio River 2018, n=47
Cardinal Power flow - Outfall 019	cfs	annual	9.794	(June 2021-Feb 2024) 95th% of monthly average flows
Background Water Quality – Blockhouse Hollow Run				
Ammonia (Summer)	mg/L		0.025	BWR; 2018; n=651; 401<MDL; Central Ohio River tributaries (median)
Ammonia (Winter)	mg/L		0.025	BWR; 2018; n=57; 48<MDL; Central Ohio River tributaries (median)
Arsenic	µg/L		0	STORET C03S07; n=19; 19<MDL; Short Creek (Ohio River tributary); 2010-2011
Barium	µg/L		31	STORET C03S07; n=19; 0<MDL; median; Short Creek (Ohio River tributary); 2010-2011
Boron	µg/L			No representative data available.
Chlorides	mg/L		16.4	BWR; 2018; n=960; 81<MDL; Central Ohio River tributaries (median)
Chromium	µg/L		1	BWR; 2018; n=960; 875<MDL; Central Ohio River tributaries (median)
Hexavalent Chromium (Dissolved)	µg/L		5	BWR; 2018; n=18; 17<MDL; statewide (median)
Copper	µg/L		1	BWR; 2018; n=960; 752<MDL; central ohio river tributaries (median)
Dissolved Solids	mg/L		241	BWR; 2018; n=960; 0<MDL; central ohio river tributaries (median)
Fluoride	mg/L			No representative data available.
Magnesium	mg/L		11	BWR; 2018; n=960; 0<MDL; central ohio river tributaries (median)
Manganese	µg/L		29	STORET C03S07; n=19; 0<MDL; median; Short Creek (Ohio River tributary); 2010-2011

Mercury	ng/L			No representative data available.
Molybdenum	µg/L			No representative data available.
Nitrate-N + Nitrite-N	mg/L		0.11	BWR; 2018; n=946; 360<MDL; central ohio river tributaries (median)
Selenium	µg/L			No representative data available.
Sulfates	mg/L		1220	STORET C03S07; n=19; 0<MDL; median; Short Creek (Ohio River tributary); 2010-2011
Zinc	µg/L		5	BWR; 2018; n=960; 775<MDL; central ohio river tributaries (median)

BWR = Ohio EPA 2018 Background Water Quality Report
MDL = analytical method detection limit
n = number of samples
Ohio EPA = Ohio Environmental Protection Agency
STORET = STOrage and RETrieval
USGS = United States Geological Survey

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

Parameter	Units	Outside Mixing Zone Criteria				Inside Mixing Zone Maximum
		Average			Maximum	
		Human Health	Agri-culture	Aquatic Life	Aquatic Life	
Outfall 001						
Ammonia (Summer)	mg/L	--	--	1.2	--	--
Ammonia (Winter)	mg/L	--	--	4.89	--	--
Arsenic [a]	µg/L	232	227	205	352	680
Barium	µg/L	4503	--	832	2797	5300
Boron	µg/L	--	--	5318	34200	65000
Chlorine, Total Residual	mg/L	--	--	0.015	0.02	0.038
Copper	µg/L	--	1131	12	14	27
Fluoride	mg/L	4.6	4.5	--	--	--
Iron	µg/L	--	10866	--	--	--
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--
Mercury	ng/L	12	10000	910	1700	3400
Nitrate-N + Nitrite-N [a]	mg/L	43	226	--	--	--
Selenium [a]	µg/L	788	113	6.8	64	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	34297	56692	162	124	230
Outfall 006						
Ammonia (Summer)	mg/L	--	--	5.48	--	--
Ammonia (Winter)	mg/L	--	--	11.72	--	--
Copper	µg/L	--	9514	69	98	100
Outfall 008						
Ammonia (Summer)	mg/L	--	--	15829.11	--	--
Ammonia (Winter)	mg/L	--	--	67306.75	--	--
Copper	µg/L	--	32987315	133779	22702	100
Outfall 019 – Blockhouse Hollow						
Ammonia (Summer)	mg/L	--	--	--	7.48	--
Ammonia (Winter)	mg/L	--	--	--	5.16	--
Arsenic	µg/L	--	--	--	343	680
Barium	µg/L	--	--	--	4544	8900
Boron	µg/L	--	--	--	33325	65000
Chlorides	mg/L	--	--	--	--	--
Chromium	µg/L	--	--	--	2929	5700
Hexavalent Chromium (Dissolved)	µg/L	--	--	--	16	31
Copper	µg/L	--	--	--	24	47
Dissolved Solids	mg/L	--	--	--	--	--
Fluoride	mg/L	--	--	--	--	--
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--

Parameter	Units	Outside Mixing Zone Criteria				Inside Mixing Zone Maximum
		Average			Maximum	
		Human Health	Agri-culture	Aquatic Life	Aquatic Life	
Mercury	ng/L	12	--	--	1700	3400
Molybdenum	µg/L	--	--	--	191872	370000
Nitrate-N + Nitrite-N	mg/L	--	--	--	--	--
Selenium	µg/L	4633	--	--	63	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	28681	--	--	192	380
Outfall 019 – Ohio River						
Ammonia (Summer)	mg/L	--	--	53.43	--	--
Ammonia (Winter)	mg/L	--	--	218.23	--	--
Arsenic	µg/L	30068	21031	9156	2381	680
Barium	µg/L	582756	--	35982	18724	5300
Boron	µg/L	--	--	238043	231121	65000
Chlorides	mg/L	--	--	--	--	--
Chromium	µg/L	--	20822	5067	12601	3500
Hexavalent Chromium (Dissolved)	µg/L	--	--	371	82	31
Copper R	µg/L	--	104947	495	92	27
Dissolved solids (ave)	mg/L	--	--	77086	--	--
Fluoride	mg/L	601	421	--	--	--
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--
Mercury	ng/L	12	10000	910	1700	3400
Molybdenum	µg/L	--	--	1220735	1330698	370000
Nitrate-N + Nitrite-N	mg/L	5948	21008	--	--	--
Selenium	µg/L	102232	10516	305	434	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	4447118	5256749	7024	810	230
Outfall 024						
Ammonia (Summer)	mg/L	--	--	35.73	--	--
Ammonia (Winter)	mg/L	--	--	151.69	--	--
Arsenic	µg/L	20745	14603	6400	1759	680
Barium	µg/L	403703	--	25003	13835	11000
Boron	µg/L	--	--	166955	170969	65000
Cadmium	µg/L	--	7338	103	23	23
Chlorine, Total Residual	mg/L	--	--	0.47	0.098	0.038
Hexavalent Chromium (Dissolved)	µg/L	--	--	471	83	31
Copper	µg/L	--	73081	303	64	61
Fluoride	mg/L	419	294	--	--	--
Iron	µg/L	--	679442	--	--	--
Lead	µg/L	--	14603	245	620	710
Magnesium	mg/L	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--

Parameter	Units	Outside Mixing Zone Criteria				Inside Mixing Zone Maximum
		Average			Maximum	
		Human Health	Agri-culture	Aquatic Life	Aquatic Life	
Mercury	ng/L	12	10000	910	1700	3400
Nitrate-N + Nitrite-N	mg/L	3856	14560	--	--	--
Selenium	µg/L	71245	7338	214	321	120
Sulfates	mg/L	--	--	--	--	--
Zinc	µg/L	3099689	3668509	4980	606	490

a The criteria for these parameters is provided for the TBEL verse WQBEL comparison shown in Attachment 2.

Table 12. Parameter Assessment

Outfall 001

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

Magnesium	Manganese	Sulfates

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

Ammonia (Winter)	Barium	Boron
Iron		

Group 3: PEQmax < 50 percent of maximum PEL and PEQavg < 50 percent of average PEL.
No limit recommended; monitoring optional.

Ammonia (Summer)	Fluoride	Mercury
Nitrate-N + Nitrite-N		

Group 4: PEQmax >= 50 percent, but < 100 percent of the maximum PEL or
PEQavg >= 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

		Recommended Effluent Limits	
Parameter	*Units*	*Average*	*Maximum*
Chlorine – Total Residual	mg/L	0.015	0.02
Zinc	µg/L	--	124

PEL = preliminary effluent limit
PEQ = projected effluent quality
WLA = wasteload allocation
WQS = water quality standard

Outfall 006

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

No parameters

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

No parameters

Group 3: PEQmax < 50 percent of maximum PEL and PEQavg < 50 percent of average PEL.
No limit recommended; monitoring optional.

Ammonia (Summer) Copper

Group 4: PEQmax >= 50 percent, but < 100 percent of the maximum PEL or
PEQavg >= 50 percent, but < 100 percent of the average PEL. Monitoring is appropriate.

Ammonia (Winter)

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.

No parameters

PEL = preliminary effluent limit
PEQ = projected effluent quality
WLA = wasteload allocation
WQS = water quality standard

Outfall 008

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

No parameters

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

Ammonia (Winter)

Group 3: PEQmax < 50 percent of maximum PEL and PEQavg < 50 percent of average PEL.
No limit recommended; monitoring optional.

Ammonia (Summer) Copper

Group 4: PEQmax >= 50 percent, but < 100 percent of the maximum PEL or
PEQavg >= 50 percent, but < 100 percent of the average PEL. Monitoring is appropriate.

No parameters

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.

No parameters

PEL = preliminary effluent limit
PEQ = projected effluent quality
WLA = wasteload allocation
WQS = water quality standard

Outfall 019
(Most restrictive grouping is shown between the Blockhouse Hollow and Ohio River allocations)

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

Chlorides	Fluoride	Magnesium
Manganese	Nitrate-N + Nitrite-N	Sulfates

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

Ammonia-S	Ammonia-W	Barium
Chromium	Copper	Molybdenum

Group 3: PEQmax < 50 percent of maximum PEL and PEQavg < 50 percent of average PEL.
No limit recommended; monitoring optional.

Arsenic	Boron	Fluoride
Hexavalent Chromium (Dissolved)		Selenium
Total Filterable Residue	Zinc	

Group 4: PEQmax >= 50 percent, but < 100 percent of the maximum PEL or
PEQavg >= 50 percent, but < 100 percent of the average PEL. Monitoring is appropriate.

No parameters

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.

<u>Limits to Protect Numeric Water Quality Criteria</u>

		Recommended Effluent Limits	
Parameter	*Units*	*Average*	*Maximum*
Mercury	ng/L	12	1700

PEL = preliminary effluent limit
PEQ = projected effluent quality
WLA = wasteload allocation
WQS = water quality standard

Outfall 024

Group 1:	Due to a lack of criteria, the following parameters could not be evaluated at this time.		
	Magnesium	Manganese	Sulfates
Group 2:	PEQ < 25 percent of WQS or all data below minimum detection limit. WLA not required. No limit recommended; monitoring optional.		
	Arsenic	Boron	Chlorine, Total Residual
	Hexavalent Chromium (Dissolved)		
Group 3:	PEQmax < 50 percent of maximum PEL and PEQavg < 50 percent of average PEL. No limit recommended; monitoring optional.		
	Ammonia (Summer)	Ammonia (Winter)	Barium
	Cadmium	Fluoride	Iron
	Lead	Nitrate-N + Nitrite-N	Selenium
	Zinc		
Group 4:	PEQmax >= 50 percent, but < 100 percent of the maximum PEL or PEQavg >= 50 percent, but < 100 percent of the average PEL. Monitoring is appropriate.		
	Mercury		
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*
Copper	µg/L	--	61

PEL = preliminary effluent limit
PEQ = projected effluent quality
WLA = wasteload allocation
WQS = water quality standard

Table 13. Final Effluent Limits

Parameter	Units	Concentration		Loading (kg/day)[a]		Basis[b]
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Outfall 001						
Water Temperature	°F	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Thermal Discharge	MBTU/Hr	6340	6340	--	--	316(a)
pH	S.U.	6.5 - 9.0		--	--	WQS
Zinc	µg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Flow Rate	MGD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Chlorine, Total Residual	mg/L	--	0.20	--	--	BTJ/OMZM
Mercury	ng/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Chlorination Duration	Minutes	--	120	--	--	BTJ/OMZM
Outfall 006						
Flow Rate	GPD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
pH	S.U.	6.5 - 9.0		--	--	WQS
Total Suspended Solids	mg/L	12	18	0.45	0.73	PD
Ammonia	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Fecal Coliform (Winter)	#/100 mL	1000	2000	--	--	WQS/BTJ
E.coli (Summer)	#/100 mL	126	240[c]	--	--	WQS
CBOD	mg/L	10	15	0.40	0.60	PD
Outfall 008						
Flow Rate	GPD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
pH	S.U.	6.5 - 9.0		--	--	WQS
Total Suspended Solids	mg/L	12	18	0.72	1.08	PD
Fecal Coliform	#/100 mL	1000	2000	--	--	WQS/ORS
E.coli	#/100 mL	126	240[c]	--	--	WQS
CBOD	mg/L	10	15	0.60	0.90	PD

Parameter	Units	Concentration		Loading (kg/day)[a]		Basis[b]
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Outfall 012						
pH	S.U.	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				BTJ
Total Suspended Solids	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				BTJ
Outfall 019						
pH	S.U.	6.5 - 9.0		--	--	WQS
Total Suspended Solids	mg/L	30	100	--	--	BPJ/BPT
Oil and Grease	mg/L	15	20	--	--	BPJ/BPT
Hardness	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Arsenic	µg/L	8	11	--	--	BAT
Flow Rate	MGD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Mercury	ng/L	12	788	--	--	BAT/WLA
Total Filterable Residue	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Outfall 024						
pH	S.U.	6.5 - 9.0		--	--	WQS
Hardness	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Total Suspended Solids	mg/L	30	98.8	--	--	BPT
Oil and Grease	mg/L	15	20	--	--	BPT
Nitrogen, Ammonia	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Hardness	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Selenium	µg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Copper	µg/L	--	61	--	--	WLA
Flow	MGD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Chlorine, Total Residual	mg/L	--	0.038	--	--	WLA/IMZM
Mercury	ng/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				RP
Outfalls 025 and 027						
pH	S.U.	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Total Suspended Solids	mg/L	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M

Parameter	Units	Concentration 30 Day Average	Concentration Daily Maximum	Loading (kg/day)[a] 30 Day Average	Loading (kg/day)[a] Daily Maximum	Basis[b]
Internal Monitoring Station 601						
pH	S.U.	6.0 - 9.0		--	--	BPT
Total Suspended Solids	mg/L	30	100	--	--	BPT
Oil and Grease	mg/L	15	20	--	--	BPT
Nitrate Plus Nitrite	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Arsenic	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Selenium	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Zinc	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Flow Rate	MGD	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Mercury	ng/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Internal Monitoring Station 602						
pH	S.U.	6.0 - 9.0		--	--	M
Total Suspended Solids	mg/L	30	100	--	--	BPT
Oil and Grease	mg/L	15	20	--	--	BPT
Ammonia	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Arsenic	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Selenium	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Boron	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Flow Rate	MGD	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Mercury	ng/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Total Filterable Residue	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Internal Monitoring Station 603 (Interim)						
Flow Rate	MGD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Internal Monitoring Station 603 (Final)						
Number of Events	No./Month	--	0	--	--	BAT
Internal Monitoring Station 604 (Interim)						
pH	S.U.	6.0 - 9.0		--	--	BPT
Total Suspended Solids	mg/L	30	100	--	--	BPT
Oil and Grease	mg/L	15	20	--	--	BPT
Nitrate Plus Nitrite	mg/L	3	4	--	--	BAT

Parameter	Units	Concentration		Loading (kg/day)[a]		Basis[b]
		30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	
Arsenic	µg/L	8	18	--	--	BAT
Selenium	µg/L	29	70	--	--	BAT
Zinc	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Flow Rate	MGD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]
Mercury	ng/L	34	103	--	--	BAT
Internal Monitoring Station 604 (Final)						
Number of Events	No./Month	--	0	--	--	BAT
Internal Monitoring Station 605						
Total Suspended Solids	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Flow Rate	MGD	- - - - - - - - - - - - Monitor - - - - - - - - - - - -				M[c]

[a] Effluent loadings based on: Outfall 006 – 0.01 MGD, Outfall 008 – 0.015 MGD and Outfall 019 – 6.33 MGD.

[b] Definitions:

316(a) = CWA 316(a) thermal variance
ABS = Antibacksliding Rule (OAC 3745-33-05(F) and 40 CFR Part 122.44(l))
BAT = Best Available Technology Economically Achievable, 40 CFR Part 423.13
BPJ = Best Professional Judgment
BPT = Best Practicable Control Technology Currently Available, 40 CFR Part 423.12
BTJ = Best Technical Judgment
CFR = Code of Federal Regulations
M = Division of Surface Water NPDES Permit Guidance 2: Determination of Sampling Frequency Formula for Industrial Waste Discharges
NPDES = National Pollutant Discharge Elimination System
OAC = Ohio Administrative Code
ORS = ORSANCO WQS
PD = Plant Design (OAC 3745-33-05(E))
RP = Reasonable Potential for requiring water quality-based effluent limits and monitoring requirements in permits (OAC 3745-33-07(A))
WLA = Wasteload Allocation procedures (OAC 3745-2)
WLA/IMZM = Wasteload Allocation limited by Inside Mixing Zone Maximum
WQS = Ohio Water Quality Standards (OAC 3745-1)

[c] Monitoring of flow and other indicator parameters is specified to assist in the evaluation of effluent quality and treatment plant performance.

Attachment 1. Applicable Federal Effluent Limitation Guidelines

40 CFR 423.12 – Best Practicable Control Technology (BPT)

Parameter (mg/L)	Daily Maximum	30-Day Average
Low Volume Waste Sources		
Total Suspended Solids	100	30
Oil & Grease	20	15
Once Through Cooling Water		
Chlorine, Total Residual	0.5	0.2
Cooling Tower Blowdown		
Chlorine, Total Residual	0.5	0.2
Coal Pile Runoff		
Total Suspended Solids	50	--
FGD wastewater, Combustion Residual Leachate		
Total Suspended Solids	100	30
Oil & Grease	20	15

The pH for all sources, except once through cooling water shall be within the range of 6.0-9.0.
*BPT limits for Outfall 024 are subject to reductions due to dilution factors presented in the tables below.

40 CFR 423.13 – Best Available Technology Economically Achievable (BAT)

Parameter	Daily Maximum	30-Day Average
Once Through Cooling Water		
Chlorine, Total Residual (mg/L)	0.2	--
Cooling Tower Blowdown		
Free Available Chlorine (mg/L)	0.5	0.2
Chromium, Total (mg/L)	0.2	0.2
Zinc, Total (mg/L)	1.0	1.0
FGD Wastewater (2020 BAT)		
Arsenic, Total (ug/L)	18	8
Mercury, Total (ng/L)	103	34
Selenium, Total (ug/L)	70	29
Nitrate/Nitrite, as N(mg/)	4	3
FGD Wastewater (2024 BAT)		
No Discharge of Pollutants	--	--
Fly Ash Transport Water		
No Discharge of Pollutants	--	--

<u>Bottom Ash Transport Water (2020 BAT)</u>		
Exception to no discharge of pollutants (k)(2)(i)(B): In no event shall such discharge exceed a 30-day rolling average of ten percent of the primary active wetted bottom ash system volume. The volume of daily discharges used to calculate the 30-day rolling average shall be calculated using measurements from flow monitors.		
<u>Bottom Ash Transport Water (2024 BAT)</u>		
No Discharge of Pollutants	--	--
<u>Combustion Residual Leachate</u>		
Arsenic, Total (ug/L)	11	8
Mercury, Total (ng/L)	788	356
<u>Unmanaged Combustion Residual Leachate</u>		
Arsenic, Total (ug/L)	11	8
Mercury, Total (ng/L)	788	356

Attachment 2. Internal Station 604, TBEL verse WQBEL Comparison

Parameter	Units	WQBEL at Outfall 001		WQBEL conversion to Station 604 limits				TBEL			
				Concentration		Loading (kg/d)		Concentration		Loading (kg/d)	
		Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg
Arsenic - TR	µg/L	352	205	5838.73	3400.40	13.92	8.11	**18**	**8**	0.04	0.02
Mercury - TR	ng/L	1700	12	28198.41	199.05	67.24	0.47	**103**	**34**	0.25	0.08
Nitrate-N + Nitrite-N	mg/L	--	43	--	713.25	--	1.70	**4**	**3**	0.01	0.01
Selenium - TR	µg/L	64	6.8	1061.59	112.79	2.53	0.27	**70**	**29**	0.17	0.07

The most restrictive concentrations and loads are in **bold** and are limited at internal outfall 604.

Outfall 001 flows are based on 1045 MGD and Station 604 flows are based on 0.63 MGD.

Station 604 WQBEL Load Calculation:

$$Load\,\frac{kg}{day} = \frac{\left(\text{WQ Criteria}\,\frac{\text{ug}}{\text{Litre}}\right) * \left(3.785\,\frac{\text{Litres}}{\text{Gallon}}\right) * (10{,}450{,}000\,\frac{\text{Gallons}}{\text{Day}})}{1{,}000{,}000{,}000\,\frac{\text{ug}}{Killogram}}$$

Station 604 WQBEL Concentration Equation:

$$Concentration\,\frac{ug}{l} = \frac{\dfrac{Daily\ Max\ Load\,\frac{kg}{day}}{630{,}000\,\frac{Gallons}{day}} * 1{,}000{,}000{,}000\,\frac{ug}{kg}}{3.785\,\frac{\text{Litres}}{\text{Gallon}}}$$

Example Daily Max Concentration Calculation for Arsenic:

$$3{,}400\,\frac{ug}{L} = \frac{\dfrac{8.11\,\frac{kg}{day}}{630{,}000\,\frac{gallons}{day}} * 1{,}000{,}000{,}000\,\frac{ug}{kg}}{3.785\,\frac{\text{Litres}}{\text{Gallon}}}$$

Attachment 3. Dilution Factors for Flow-Weighted Calculation

Outfall 024 – Total Suspended Solids (TSS) Calculation

Source of Flow	MGD	% of Total
Unit 3 Cooling Tower	5.24	53.32%
net rain minus evaporation	0.038	0.39%
Coal Pile Runoff	0.23	2.34%
Units 1 & 2 wastewater	4.32	43.96%
Total	9.828	100%

Outfall 024 TSS calculation:

C_{wgt} = [100 mg/L* (100% -% of Q_c) + (50 mg/L * % of Q_c)]
C_{wgt} = [100 mg/L* (100% -2.34%) + (50 mg/L * 2.34%)] = 98.8 mg/L

Where:
C_{wgt} = the flow-weighted concentration for TSS
% of Q_c = percent of flow without the coal pile runoff ($Q_{total} – Q_c$)
Q_{total} = total flow to Outfall 024 = 9.83 MGD
Q_c = flow rate of coal pile runoff = 0.23 MGD

Attachment 4. List of Approved Boiler/Cooling Water System Additives

Form 2C, Part II - Approved Additives			
Chemical Additive Name	**Purpose**	**System**	**Date**
3D TRASAR 3DT121	Cooling Water Treatment	Recirculating Cooling Water	9/8/2009
NALCO 1315	Detoxification agent	Zebra Mussel Control	10/8/2009
NALCO 7468	Defoamer	Recirculating Cooling Water	10/8/2009
NALCO H-130M	Biocide	Zebra Mussel Control	10/8/2009
NALCO 73297	Corrosion inhibitor	Wet Flue Gas Desulfurization System	1/22/2010
ChemTreat RL9007	Reverse osmosis cleaner	Reverse Osmosis Boiler WTS	3/18/2011
ControlBrom CB70	Biocide	Recirculating Cooling Water	11/28/2011
NALCO 7468	Defoamer	Zebra Mussel Control	11/28/2011
NALSPERSE 73550	Dispersant and detergent	Recirculating Cooling Water	11/28/2011
NALCO 5200M	Scale inhibitor	Wet Flue Gas Desulfurization System / JBR	10/2/2014
3DT138	Dispersant	Wastewater Treatment Systems	2/5/2019
ChemTreat CL1365	Scale inhibitor	Fly Ash Disposal System	2/5/2019
ChemTreat FGD1300	Scale inhibitor	Fly Ash Disposal System	2/5/2019
NALCO 3DT120	Dispersant	Wastewater Treatment Systems	2/5/2019
pHREEdom 5200M	Scale inhibitor	Wastewater Treatment Systems	2/5/2019
ChemTreatCL4075	Scale inhibitor	Cooling Tower Basin	3/30/2022
ChemTreatCL4428	Dispersant	Cooling Tower Basin	3/30/2022
ChemTreatP8007L	Metal Precipitant	Outlet of primary clarifier	3/30/2022
ChemTreatP817E	Flocculant	Inlet to primary and secondary clarifiers	3/30/2022
ChemtreatP8281L	Coagulant	Inlet to coagulant mix tank	3/30/2022
Nalco MerControl 8034 Plus	Mercury re-emission prevention	U1, U2 or U3 JBR	3/30/2022
PC191T	Scale inhibitor		9/8/2010
Ferric chloride	Coagulant	Wastewater Treatment Systems	8/29/2011
CAT-FLOC 71264	Coagulant aid	Wastewater Treatment Systems	pre-2018
NALCLEAR 7768	Flocculant	Wastewater Treatment Systems	pre-2018
NALCO 1393	Scale inhibitor	Recirculating Cooling Water	pre-2018
NALMET 1689	Water clarification aid	Wastewater Treatment Systems	pre-2018
PermaClean PC-11	Biocide	Reverse Osmosis Boiler WTS	pre-2018
PermaClean PC-33	Reverse osmosis cleaner	Reverse Osmosis Boiler WTS	pre-2018
PermaClean PC-67	Reverse osmosis cleaner	Reverse Osmosis Boiler WTS	pre-2018
PermaClean PC-77	Reverse osmosis cleaner	Reverse Osmosis Boiler WTS	pre-2018
Redox-HgRPC	Mercury re-emission prevention	Wet Flue Gas Desulfurization System	pre-2018
Sodium formate 40%	Cleaning material/ detergent	Wet Flue Gas Desulfurization System	pre-2018
Sodium hypochlorite	Biocide	Recirculating Cooling Water	pre-2018

Attachment 5. Cooling Water Intake Structure

Cooling Water Intake Structure Compliance – Units 1 & 2

Cooling water intake structure information

The CWIS is considered an existing unit at an existing facility and therefore must comply with 40 CFR 125, Subpart J. Information supplied from the permittee regarding the CWIS and other pertinent data include the following:

- Design intake flow (DIF) – 1,152 MGD
- Ninety nine percent of the intake water flow is used for non-contact cooling. The remaining water is used for plant service water, bottom ash disposal, fly ash handling water, and water for the Unit 1 and Unit 2 flue-gas desulfurization (FGD) system.
- Biological data for impingement and entrainment evaluation were compiled from the Ohio River Ecological Research Program (ORERP), ORSANCO, and Cardinal Plant reports.
- Through-screen design intake velocity – 1.5 feet per second (fps).
- The Cardinal Plant uses traveling water screens with no fish returns.

Description of intake structure

The facility withdrawals once-through cooling water for Units 1 and 2 into the screen house through a 405' x 200' forebay. A floating debris boom and parked coal barges prevent floating debris from entering the forebay. Each unit has a screen house that is divided into six intake bays (three bays per pump). Water is fed to one of twelve bays and passes through trash racks with 2" openings. Downstream of the trash racks are 8' wide traveling water screens equipped with 14-gauge stainless steel wire screen cloth with 0.375-inch square openings. These screens do not include any fish-friendly features.

Operation and Intake Flows

Four circulating water pumps supply the Cardinal Plant's two generating units with a DIF of 800,000 gpm (1,782.4 cfs, 1,152 MGD). Normally, both circulating water pumps per unit are operated when a unit is operating, however both units can operate with only one pump per unit, which typically occurs during the winter. The four intake pumps operate 24 hours per day, 365 days per year to maintain adequate cooling water to the generating units. The Unit 1 circulating water pumps withdrew an average of 75%, and Unit 2 withdrew an average of 74% of their respective DIF from 2013-2017. Combined, Unit 1 and Unit 2 withdrew an average of 74% of their total DIF during the same period. The table below presents historical DIF and AIF data compared to average Ohio River flows.

Average Monthly Ohio River Flow and Percent of Ohio River Flow Withdrawn by the Cardinal Plant

Month	Ohio River Flow (cfs)	Design Intake Flow (cfs)	Percent of River Withdrawn	Actual Intake Flow (cfs)	Percent of River Withdrawn
January	57,693	1,782	3.1	1,377	2.4
February	55,308	1,782	3.2	1,516	2.7

Month	Ohio River Flow (cfs)	Design Intake Flow (cfs)	Percent of River Withdrawn	Actual Intake Flow (cfs)	Percent of River Withdrawn
March	68,954	1,782	2.6	1,364	2.0
April	60,772	1,782	2.9	1,072	1.8
May	47,100	1,782	3.8	1,150	2.4
June	28,482	1,782	6.3	1,520	5.3
July	20,967	1,782	8.5	1,379	6.6
August	17,590	1,782	10.1	1,413	8.0
September	19,675	1,782	9.1	1,460	7.4
October	20,710	1,849	8.6	962	4.6
November	33,814	1,849	5.3	1,301	3.7
December	53,069	1,849	3.4	1,439	2.7

*Actual intake flow based on average monthly intake.

Fish and wildlife in the vicinity of the intake structure

The Cardinal Plant submitted biological characterization data based on an electrofishing survey conducted by ORSANCO in 2012, their recent entrainment study (2015-2016), and 2012-2016 fish survey results provided from EPRI's Ohio River Ecological Research Program (ORERP). Data for mussels were also provided from an EPRI study (2012), which contains data collected from four surveys conducted between 1990 and 2008.

Mussels

A total of eight different mussel species were collected within five miles of the Cardinal Plant during surveys in 1990, 1993, 2005, and 2008. The table below summarizes the mussel species observed.

		1990		1993		2005		2008		Surveys Combined	
Scientific Name	**Common Name**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Amblema plicata	Threeridge	--	--	--	--	--	--	3	4.8	3	3
Lasmigona complanata	White Heelsplitter	--	--	--	--	3	9.1	8	12.9	11	10.9
Lasmigona costata	Flutedshell	--	--	--	--	--	--	1	1.6	1	1
Obliquaria reflexa	Threehorn Wartyback	--	--	1	50	3	9.1	8	12.9	12	11.9
Potamilus alatus	Pink Heelsplitter	--	--	--	--	5	15.2	28	45.2	33	32.7
Quadrula quadrula	Mapleleaf	--	--	1	50	22	66.7	14	22.6	37	36.6
Uniomerus tetralasmus	Pondhorn	3	75	--	--	--	--	--	--	3	3
Utterbackia imbecillis	Paper Pondshell	1	25	--	--	--	--	--	--	1	1
Total Individuals		**4**		**2**		**33**		**62**		**101**	
Total Species		**2**		**2**		**4**		**6**		**8**	

Fish
A list of fish species in the vicinity of the Cardinal Plant was compiled from ORERP surveys conducted from 2012-2016 and an ORSANCO electrofishing survey of the Pike Island Pool from 2012. In total, 63 species and two hybrids were observed (123,878 total specimens), representing 14 families. Nine taxa accounted for 89.3% of the five-year total: Emerald Shiner (55.3%), Channel Shiner (13.5%), Gizzard Shad (5.3%), Bluegill (4.6%), young-of-the-year (YOY) Ictiobinae sp. (2.7%), Spotfin Shiner (2.1%), Freshwater Drum (2.1%), Bluntnose Minnow (2.0%), and Smallmouth Bass (1.7%).

A two-year entrainment study was conducted at the Cardinal Plant in 2015 and 2016. In 2015, 1,840 specimens were collected, representing 18 distinct identifications. The most abundant taxa collected in 2015 were, in decreasing order of abundance, *Ictiobinae sp.* (carpsucker/buffalo species), Freshwater Drum, Emerald Shiner (+type), *Pimephales sp.* (+type), *Cyprinidae sp.* (+type), and Gizzard Shad (+Clupeidae). These taxa composed 86% of the specimens collected. The following year's collections yielded 3,269 specimens, embodying 15 distinct identifications. Dominant taxa inlcuded Logperch type, Gizzard Shad (+Clupeidae), *Ictiobinae sp.*, Freshwater Drum, *Pimephales sp.* (+type), and *Morone sp.* (+not Striped Bass). The table below summarizes the observations of the entrainment study.

Family	Taxa	2015		2016		Years Combined	
		#	%	#	%	#	%
Clupeidae	GIZZARD SHAD (+Clupeidae)	128	7.0%	913	27.9%	1,041	20.4%
	SKIPJACK HERRING	1	0.1%	1	<0.05%	2	<0.05%
Hiodontidae	MOONEYE	1	0.1%	--	--	1	<0.05%
Cyprinidae	COMMON CARP	70	3.8%	89	2.7%	159	3.1%
	STRIPED SHINER type	1	0.1%	--	--	1	<0.05%
	SHINER type	2	0.1%	51	1.6%	53	1.0%
	EMERALD SHINER (+type)	233	12.7%	99	3.0%	332	6.5%

Family	Taxa	2015		2016		Years Combined	
		#	%	#	%	#	%
	CHANNEL SHINER	3	0.2%	--	--	3	0.1%
	Pimephales sp. (+type)	183	9.9%	211	6.5%	394	7.7%
	CYPRINIDAE sp. (+type)	135	7.3%	103	3.2%	238	4.7%
Catostomidae	*Moxostoma* sp.	--	--	4	0.1%	4	0.1%
	CATOSTOMINAE sp.	--	--	1	<0.05%	1	<0.05%
	ICTIOBINAE sp.	537	29.2%	332	10.2%	869	17.0%
	CATOSTOMIDAE sp.	--	--	1	<0.05%	1	<0.05%
Ictaluridae	CHANNEL CATFISH	2	0.1%	2	0.1%	4	0.1%
Moronidae	*Morone* sp. (+not STRIPED BASS)	20	1.1%	112	3.4%	132	2.6%
Centrarchidae	*Lepomis* sp.	30	1.6%	4	0.1%	34	0.7%
	Lepomis/*Pomoxis* sp.	--	--	2	0.1%	2	<0.05%
	SMALLMOUTH BASS	1	0.1%	--	--	1	<0.05%
	Micropterus sp.	1	0.1%	--	--	1	<0.05%

Family	Taxa	2015		2016		Years Combined	
		#	%	#	%	#	%
	Pomoxis sp.	--	--	1	<0.05%	1	<0.05%
Percidae	GREENSIDE DARTER type	--	--	1	<0.05%	1	<0.05%
	TIPPECANOE DARTER	1	0.1%	--	--	1	<0.05%
	YELLOW PERCH	1	0.1%	--	--	1	<0.05%
	SAUGER	1	0.1%	2	0.1%	3	0.1%
	LOGPERCH type	41	2.2%	960	29.4%	1,001	19.6%
	DARTER sp.	--	--	82	2.5%	82	1.6%
	DARTER (not LOGPERCH) sp.	1	0.1%	--	--	1	<0.05%
	PERCIDAE (not *Sander*) sp.	10	0.5%	4	0.1%	14	0.3%
	PERCIDAE sp.	2	0.1%	7	0.2%	9	0.2%
Sciaenidae	FRESHWATER DRUM	374	20.3%	265	8.1%	639	12.5%
	CYPRINIDAE/ CATOSTOMIDAE	8	0.4%	--	--	8	0.2%

Family	Taxa	2015		2016		Years Combined	
		#	%	#	%	#	%
	CYPRINIDAE/ CATOSTOMIDAE type	--	--	5	0.2%	5	0.1%
	Morone/FRESHWATER DRUM	--	--	1	<0.05%	1	<0.05%
	UNIDENTIFIED	53	2.9%	16	0.5%	69	1.4%
	Grand Total	1,840	100.0%	3,269	100.0%	5,109	100.0%

Federal and State-Listed Species

The U.S. Fish and Wildlife Services (USFWS) and Ohio Department of Natural Resources (ODNR) lists the species in the table below as endangered or threatened in the State of Ohio and nationally. There are no federally-listed species known to occur in the action area according to USFWS.

Five state-threatened fish species were noted as present in Jefferson County: American Eel, Goldeye, Ohio Lamprey, Channel Darter, and River Darter. Only one specimen of Channel Darter (*Percina copelandi*) was collected during the 2012-2016 in-river surveys and none were impinged during the recent two-year study. No River Darters (*Percina shumardi*) were collected during the recent in-river surveys nor during the impingement study. No other state-listed fish species were identified in entrainment samples collected at the Cardinal Plant. However, Channel Darter specimens may have been represented among the following percid taxa groups in 2015 and/or 2016: Logperch type, Darter sp., Darter (not Logperch) sp., Percidae (not Sander) sp., and Percidae sp. Therefore, entrainment of Channel Darter specimens cannot be completely ruled out.

The Pondhorn is the only state-listed mussel species identified by ODNR as present in Jefferson County. At least one specimen was observed during the 1990 mussel survey near the Cardinal Plant. The Pondhorn typically inhabits the quiet or slow-moving, shallow waters of sloughs, borrow pits, ponds, ditches, and streams. It is tolerant of poor water conditions and can be found well-buried in a substrate of fine silt and/or mud.

The habitat of the state-endangered Eastern Hellbender consists of large slab rocks in clear and well aerated streams and rivers, habitat that is lacking in the impounded Ohio River near the facility.

Group	Common Name	Scientific Name	Listing Status	
			Federal	State
Amphibian	Eastern Hellbender	*Cryptobranchus alleganiensis alleganiensis*	--	Endangered
Fish	American Eel	*Anguilla rostrata*	--	Threatened
	Goldeye	*Hiodon alosoides*	--	Endangered
	Ohio Lamprey	*Ichthyomyzon bdellium*	--	Endangered
	Channel Darter	*Percina copelandi*	--	Threatened
	River Darter	*Percina shumardi*	--	Threatened
Mussels	Pondhorn	*Uniomerus tetralasmus*	--	Threatened

Mussels are not among the organisms most susceptible to impingement and entrainment. However, impingement of glochidia host fish may present a risk for impact. Most common host species for listed mussels are bottom-dwelling fish, as they provide the greatest opportunity for interaction with mussels and provide the greatest success rates for glochidia attachment.

Federal Critical Habitat
None were identified.

Fragile Species
Fragile species are defined in 40 CFR 125.92 (m) as *"... a species of fish or shellfish that has an impingement survival rate of less than 30 percent even when the BTA technology of modified travelling screens are in operation.*" The only fragile species susceptible to impacts from the Cardinal Plant's intake is gizzard shad.

Impingement and Entrainment

Impingement
A two-year impingement study conducted from June 2005 through June 2007 provided recent data that addressed the species and life stages susceptible to impingement at the Cardinal Plant. That study consisted of thirty-seven, 24-hour sampling events during which 29 fish species were impinged. Impingement collections were dominated by Gizzard Shad, and Freshwater Drum was the second most abundant species. Collectively, they accounted for over 99% of the fish impinged during the two-year study. Compared to the in-stream sampling, Freshwater Drum had approximately the same abundance, and Gizzard Shad were proportionally much more abundant. This indicates that Gizzard Shad are considerably more susceptible to impingement due to their abundance, pelagic schooling behavior of young-of-year, and vulnerability to winter die-offs. Emerald Shiner ranked first in the in-river catch but ranked tenth in the impingement collections as only 13 specimens were collected during the two-year study. The in-river collections showed that cyprinids were much more abundant than indicated by the impingement collections, suggesting that they are not susceptible to impingement. Similarly, Bluegill and Ictiobinae (carpsucker/buffalo) species also had higher relative abundances in the in-river surveys compared to the impingement collections. Recreational fish taxa contributed less than 1% to the impingement catch, suggesting low susceptibility to impingement at the Cardinal Plant. Species identified during the impingement studies conducted in 2005-2007 are presented in the table below.

Species	June 2005 – June 2006		June 2006 – June 2007		Years Combined	
	Number	%	Number	%	Number	%
Crayfish	8	0.01	12	0.81	20	0.02
Skipjack Herring	4	0.01	23	1.57	28	0.03
Gizzard Shad	76,105	96.09	1,165	78.19	77,270	95.76
Mooneye	25	0.03	2	0.14	27	0.03
Common Carp	3	0.00	1	0.07	4	0.01
Silver Chub	6	0.01	5	0.30	11	0.01
Golden Shiner	--	--	1	0.09	1	0.00
Emerald Shiner	13	0.02	--	--	13	0.02
Bluntnose Minnow	--	--	1	0.07	1	0.00
River Carpsucker	2	0.00	1	0.	3	0.00
Quillback	7	0.01	6	0.40	13	0.02
Carpiodes sp.	1	0.00	--	--	1	0.00
Northern Hog Sucker	2	0.00	1	0.07	3	0.00
Smallmouth Redhorse	3	0.00	--	--	3	0.00
Silver Redhorse	--	--	1	0.07	1	0.00
Yellow Bullhead	1	0.00	--	--	1	0.00
Channel Catfish	133	0.17	18	1.20	150	0.19
Flathead Catfish	7	0.01	3	0.22	10	0.01
White Perch	7	0.01	--	--	7	0.01
White Bass	144	0.18	37	2.48	181	0.22
Hybrid striper	--	--	1	0.07	1	0.00
Morone sp.	225	0.28	1	0.07	226	0.28
Rock Bass	1	0.00	--	--	1	0.00
Warmouth	1	0.00	--	--	1	0.00
Bluegill	7	0.01	28	1.91	36	0.04
Spotted Bass	1	0.00	1	0.07	2	0.00
White Crappie	9	0.01	2	0.13	11	0.01
Black Crappie	1	0.00	1	0.07	2	0.00
Yellow Perch	--	--	2	0.13	2	0.00
Logperch	--	--	1	0.07	1	0.00
Sauger	14	0.02	23	1.51	36	0.05
Walleye	2	0.00	5	0.33	7	0.01
Saugeye	1	0.00	2	0.14	3	0.00
Freshwater Drum	2,471	3.12	145	9.75	2,616	3.24
Totals	**79,205**	**100**	**1,490**	**100.00**	**80,696**	**100**
Number of Fish Species	**24**		**23**		**29**	
24-hr sampling events	**17**		**20**		**37**	

*0.00 denotes values less than 0.005; % = relative abundance; "--" indicates none collected.

Entrainment
The two-year study conducted in 2015 and 2016 provided recent data that addressed the taxa and life stages susceptible to entrainment at the Cardinal Plant. Twenty-one unique taxa were collected during the study with *Ictiobinae* sp. and Freshwater Drum accounting for 50% of the catch in 2015 and Logperch type, Gizzard Shad

(+Clupeidae), *Ictiobinae* sp. and Freshwater Drum composing 48% of the catch in 2016. Collectively, these four taxa composed 48% to 59% of the catch each year. These taxa are considered baitfish and/or commercial and rough or forage by the Ohio Administrative Code. Morone sp. (+not Striped Bass) was the most commonly entrained recreational fish taxon and is most likely represented by White Bass, a recreational "protected" species. Morone sp. (+not Striped Bass) composed only 1.1% to 3.4% of the catch each year. The table below summarizes data collected during the entrainment study.

Year	**2015**			**2016**		
Volume Sampled (m3)	**9,442.60**			**10,414.50**		
Taxa	**#**	**%**	**Density**	**#**	**%**	**Density**
Gizzard Shad (+Clupeidae)	128	7	0.14	913	27.9	0.88
Emerald Shiner (+type)	233	12.7	0.25	99	3	0.1
Pimephales sp. (+type)	183	9.9	0.19	211	6.5	0.2
Cyprinidae sp. (+type)	135	7.3	0.14	103	3.2	0.1
Ictiobinae sp.	537	29.2	0.57	332	10.2	0.32
Morone sp. (+not Striped Bass)	20	1.1	0.02	112	3.4	0.11
Logperch type	41	2.2	0.04	960	29.4	0.92
Freshwater Drum	374	20.3	0.4	265	8.1	0.25
Other Identified Taxa	136	7.4	0.14	258	7.9	0.25
Unidentified	53	2.9	0.06	16	0.5	0.02
Total	1,840	100	1.95	3,269	100	3.14

*# = number collected; % = relative abundance; and Density = #/10m³

Compliance with 40 CFR 125.94(c) and (d)

This facility utilizes the following to minimize adverse environmental impacts:

1. **Impingement**

    a. ***Impingement Mortality BTA - 40 CFR 125.94(b):*** The permittee proposes to defer selection until after the entrainment BTA determination has been made.

2. **Entrainment**

    a. ***Site-Specific Entrainment Standards – 40 CFR 125.94(d):*** The permittee proposes that no additional technologies are necessary to minimize entrainment.

Director Requirements

The Director is required to include monitoring requirements, record keeping requirements, and reporting requirements within the permit. Additionally, the Director is required to make site-specific entrainment requirements weighing various factors.

Monitoring

40 CFR 125.96(a) – Monitoring requirements for impingement mortality for existing facilities:

The Director may establish monitoring requirements such as intake velocity, biological monitoring, and flow measurements. No additional monitoring is proposed at this time. New requirements may be established once an impingement mortality compliance option has been selected.

40 CFR 125.96(b) – Monitoring requirements for entrainment for existing facilities:

The Director may establish monitoring requirements for entrainment. A new intake flow monitoring requirement is proposed for Units 1 and 2 to characterize intake volumes and temperature.

40 CFR 125.96(e) – Visual or remote inspections:

To comply with the regulation, the permit proposes weekly visual or remote monitoring devices to ensure that all technologies installed are maintained and operated as designed.

Reporting and Recordkeeping Requirements

40 CFR 125.97(a) – Monitoring Reports

The permittee is required to submit eDMRs which will characterize intake flows.

40 CFR 125.97(c) – Annual certification

The permittee is required to submit an annual certification indicating any substantial changes at any unit which may impact cooling water intake. This is consistent with the rule.

40 CFR 125.97(d) – Permit reporting records retention

The permittee shall retain all records of all submissions related to 316(b) until the subsequent permit is issued.

Site Specific Entrainment BTA Determination

The permittee has provided information on multiple new technologies to minimize entrainment at the Cardinal Plant. For *existing units*, the Director must weigh factors to determine whether these entrainment control technologies perform better than the current technologies. The proposed entrainment reduction options are evaluated below.

Must Consider Factors

The following correlate to subparagraphs of 40 CFR 125.98(f)(2) and are factors the Director must consider in BTA determination.

Numbers and types of organisms entrained, including, specifically, the numbers and species (or lowest taxonomic classification possible) of Federally-listed, threatened and endangered species, and designated critical habitat (e.g., prey base).

A two-year entrainment characterization study was conducted at the Cardinal Plant in 2015 and 2016 and the results were summarized earlier in this attachment. Total entrainment of all species was estimated to be 128 million fish in 2015 and 176 million in 2016. In 2015, collections were dominated by Ictiobinae sp. (25.06%), Freshwater Drum (21.78%), Emerald Shiner type (14.22%), Pimephales sp. type (12.16%), Cyprinidae sp. Type (8.2%) that together made up over 81% of the entrainment. The 2016 entrainment was dominated by Logperch type (38.10%), Gizzard Shad (Clupeidae) (24.17%), Pimephales sp. Type (7.56%), Ictiobinae sp. 7.49%) and Freshwater Drum (7.13%) that together made up just under 85% of the entrainment. Entrainment at Cardinal was consistent with historical and expected temporal spawning patterns in the Ohio River. For example, the vast majority of entrainment in 2015 occurred from May through August with comparatively few ichthyoplankton or adults estimated to have been entrained outside of these times. Similarly, the majority of entrainment in 2016 occurred from May through early August. An evaluation of river drift was conducted using entrainment data and the Ohio River flow. River drift of ichthyoplankton was approximately 3.0 billion in 2015 and 3.1 billion in 2016, with estimated entrainment representing 4.2% and 5.7% of the river drift, respectively. Based on in-river abundance and the highly fecund reproductive strategy for most of the common taxa entrained, it is unlikely that losses due to entrainment would have population level impacts.

Importantly, there was no entrainment of state or federally protected fish species at the Cardinal Plant, with the exception of a single Tippecanoe Darter collected in 2015. Further, there is no designated critical habitat at risk due to entrainment. However, fish utilized as host species for glochidia of listed mussel species may have been entrained during the study.

Impact of changes in particulate emissions or other pollutants associated with entrainment technologies.

There are two sources of additional air emissions related to operation of a closed-cycle recirculation system (CCRS). One is the emissions of the cooling towers themselves in the form of 'drift' particulate matter (PM) which results from the aerosol droplets of cooling water that are released from the towers. The second source of emissions is related to additional generation that would be required from the regional power grid to replace the reduction in net power output of 2.0% from the Cardinal Plant due to the efficiency loss from a CCRS retrofit.

The calculated total PM drift estimate for the Cardinal Plant is 9.2 tons per year, based on the use of a mechanical draft cooling tower equipped with state-of-the-art drift eliminators. The annual loss of plant power generation when the hypothetical CCRS would become operational is estimated to be 53.4 MWe. At current operating capacity, a retrofit to a CCRS would entail an estimated average increase in heat input of 3,068,663 MMBTU per year. This increase in operation would result in the following emissions increases:

- 130 tons per year nitrogen oxides (NOX)
- 383 tons per year sulfur dioxide (SO2)
- 3.7 tons per year volatile organic compounds (VOCs)
- 317,392 tons per year carbon dioxide equivalents
- 3.7 tons per year PM1024
- 0.94 pounds per year mercury

Noise modeling suggests that there would not be noise impacts requiring mitigation as there was no violation of any noise ordinance. However, noise level could increase offsite that could be considered an impact.

There are no particulate emissions or other pollutants associated with narrow-slot cylindrical wedgewire screens or fine-mesh travelling screens.

Land availability inasmuch as it relates to the feasibility of entrainment technology.

Cardinal does have adequate space to accommodate installation of cooling towers and a CCRS, modified travelling screens, or cylindrical wedgewire screens (except 0.5 mm).

The installation of cooling towers would be considered difficult, as it requires substantial piping across a major roadway and around the existing infrastructure, in addition to construction of several large structures within the limited available space.

For cylindrical wedgewire screens, it was determined that installation of 0.5mm sized screens is not feasible due to the number of screen units needed to maintain the through-screen velocity and the confines of the coal barge lane. Additionally, there is significant concern regarding the conditions in the intake channel and the operational costs associated with installing wedgewire screens. One major issue with this option is the lack of flow in the intake channel. To maximize effectiveness, a current is needed to carry debris and organisms with limited motility past the screens. Other concerns stemming from the conditions in the intake channel include sedimentation and biofouling of the screens. Also, according to Cardinal's application materials, there are no known examples of facilities using wedgewire screens of this size for once-through cooling applications.

Remaining useful plant life.

Units 1 and 2 have significant remaining life, and Cardinal plans to operate well into the future.

Quantified and qualitative social benefits and costs of available entrainment technologies when such information on both benefits and costs is of sufficient rigor to make a decision.

A rigorous analysis of retrofitting the Cardinal Plant with a CCRS or fine-mesh screens (both wedgewire and modified traveling screens) was conducted and provided in the CWIS reports. The social cost of a CCRS retrofit would be primarily characterized by increased electricity costs for consumers and decreased shareholder dividends to offset exorbitant costs associated with construction and operation. Other less significant costs include reduced property values in the vicinity of the facility and the regulatory burden of project. Similar social costs apply to the installation of fine-mesh screens but on a lesser scale. The table below outlines estimated social costs of feasible entrainment technologies at the Cardinal Plant.

Discount Rate	Compliance Costs[a]				Social Costs[b]					
	Technology Type	Total Design, Construction, & Installation Costs	Annual O&M Costs	Shareholder Dividend Decreases	Electricity Price Increases	Power System Costs	Externality Costs	Permitting Costs	Total Present Value of Social Costs	Annual Social Costs
3%	Closed-cycle cooling	$400.2M	$7.1M	$172.7M	$172.7M	$118.6M	$4.0M	$69.0k	$468.0M	$15.6M
	Fine mesh traveling screens	$17.5M	$0.8M	$12.6M	$12.6M	$1.2M	$0	$2.0k	$26.4M	$0.9M
	Wedge wire screens 1mm	$30.7M	$0.6M	$14.8M	$13.7M	$0.2M	$0	$2.9k	$29.9M	$1.0M
	Wedge wire screens 2mm	$24.6M	$0.5M	$11.6M	$10.6M	$0.2M	$0	$2.3k	$23.4M	$0.8M
7%	Closed-cycle cooling	$400.2M	$7.1M	$90.4M	$90.4M	$61.2M	$3.1M	$57.1k	$245.1M	$8.2M
	Fine mesh traveling screens	$17.5M	$0.8M	$7.4M	$7.4M	$0.7M	$0	$1.8k	$15.5M	$0.5M
	Wedge wire screens 1mm	$30.7M	$0.6M	$8.4M	$7.8M	$0.1M	$0	$2.6k	$16.9M	$0.6M
	Wedge wire screens 2mm	$24.6M	$0.5M	$6.6M	$6.0M	$0.1M	$0	$2.0k	$13.2M	$0.4M

[a] Compliance costs are undiscounted and in 2018 dollars. These costs were developed as part of the engineering studies for Cardinal.
[b] Social costs associated with each technology are discounted at 3 and 7 percent.

The cost of a CCRS retrofit exceeds the annualized benefit by a ratio of 2,517 to 1 and 2,407 to 1 at discount rates of 7% and 3%, respectively. The entrainment technology with the lowest cost to benefit ratio is 1.0 mm narrow-slot wedgewire screens, however, this technology has an annualized cost benefit ratio of 195 to 1 and 190 to 1 at discount rates of 7% and 3%, respectively. There is legislative and judicial history to aid in deciding whether these cost-benefit ratios are appropriate for mandating application of an alternative technology at the Cardinal Plant. The term "wholly disproportionate" has been used as a descriptor in judicial decisions for when the additional degree of effluent reduction is wholly out of proportion to the costs of achieving a marginal level of reduction. In an analysis of the Phase III 316(b) rule, EPA found a ratio of costs to benefits that ranged from

17-to-1 to 22-to-1 and found this to be "wholly disproportionate." In other cases, lower ratios have been found to be "wholly disproportionate." Comparison of these precedents with the cost benefit ratios for the Cardinal Plant suggests that the costs of any of the alternative technologies would be disproportionate to benefits.

May consider factors

The following correlate to subparagraphs of 40 CFR 125.98(f)(3) and are factors the Director may consider when determining BTA.

Entrainment impacts on the waterbody.

Surveys of the fish assemblage near the Cardinal Plant have been conducted by the Ohio River Ecological Research Program (ORERP) since 1978, except in 2002, using a variety of collection methods. Since 1991, seasonal surveys (typically June, August, and October) have been conducted by daytime seining and nighttime electrofishing at six locations, three upstream of the facility's discharge and three downstream of it. The CWIS report summarizes the number and relative abundance of fish collected by these two sampling gears from 2012 through 2016. In recent years, nine electrofishing community measures have been calculated and analyzed to detect temporal and spatial differences at the facility. One of these measures, the modified Ohio River Fish Index (mORFIn), is an Index of Biotic Integrity that was developed by the Ohio River Valley Water Sanitation Commission (ORSANCO) specifically for the Ohio River. ORSANCO uses average mORFIn scores to assist with determining the overall biological condition of Ohio River pools, and mORFIn scores greater than or equal to 20.0 are considered to be in attainment of the aquatic life-use designation. The ORERP has used the mORFIn since 2011 and mean August/October scores for the Cardinal Plant study area from 2011 through 2016 were consistently greater than 22.0 and in attainment of the aquatic life-use designation. However, the study area was in non-attainment in 2013, which was attributed to low catch rates caused by dense beds of Hydrilla that reduced electrofishing effectiveness and the well above normal flow regime in July that likely reduced recruitment of the 2013 year class for some species. Therefore, the non-attainment in 2013 was not related to operation of the Cardinal Plant.

River drift of ichthyoplankton was approximately 3.0 billion in 2015 and 3.1 billion in 2016. Therefore, the estimated entrainment of 128 million in 2015 represented approximately 4.2% of the river drift, and the estimated entrainment of 176 million in 2016 represented approximately 5.7% of the river drift. Based on in-river abundance and the highly fecund reproductive strategy for most of the common taxa entrained, it is unlikely that losses due to entrainment would have population level impacts.

ORSANCO assessed the fish community in Pike Island Pool during 2012 (http://www.orsanco.org/programs/biological-programs/pool-results/). ORSANCO used a random, probability-based survey design to select 15 electrofishing locations throughout the Pool. The average Pool mORFIn score for 2012 was 31.6 and in attainment of the aquatic life-use designation.

Thermal discharge impacts.

In terms of thermal impacts, the Cardinal Plant has been granted alternate thermal effluent limitations. The facility's 316(a) demonstration showed that the thermal discharges would ensure a balanced indigenous population of shellfish, fish, and wildlife as a result of the thermal mixing zone that was granted. It is therefore reasonable to assume that the only technology that would further reduce thermal discharge temperatures (i.e., a CCRS) would not provide a significant biological benefit. The addition of narrow-slot cylindrical wedgewire or fine-mesh screens would not further reduce thermal discharge temperatures, and therefore, would not provide a biological benefit in this sense.

Credit for reductions in flow associated with the retirement of units occurring within the ten years preceding October 14, 2014.

No units were retired at the Cardinal Plant in the ten years preceding October 14, 2014.

Impacts on the reliability of energy delivery within the immediate area.

The evaluation determined that if required to install an entrainment reduction technology it would do so rather than retire Cardinal's once-through cooled units. A retrofitted CCRS at the Cardinal Plant would result in higher power requirements for additional pumping, cooling tower fan operation, and a reduced electrical energy output due to lowered turbine efficiency from increased cooling water temperatures (heat rate penalty). The additional required pumping power to the Cardinal units in the retrofitted system is estimated to be 20.7 megawatts-electric (MWe). The cooling tower fan power is estimated to require an additional 7.9 MWe. Therefore, the combined power loss while operating at full-load is approximately 28.6 MWe; which is approximately 2.3% of the plant's gross power rating of 1,240 MWe.

Retrofitting the Cardinal Plant with an all-wet CCRS would likely cause short-term decreases in the facility's electrical output during tie-in of the cooling tower during the construction phase. During operations, it does not appear that there are any times at which the turbine backpressure would approach a backpressure limit, so no capacity limit is to be expected. The increased turbine exhaust pressure, due to an expected increase in the intake cooling water temperatures used in the condenser, could result in an output restriction on the hottest days. However, based on available facility operating information, a retrofit would appear to have a minor effect on output.

Impacts on water consumption.

The Cardinal Plant uses the Pike Island Pool of the Ohio River as a source waterbody. Given that water levels in the Pike Island Pool are regulated by the United States Army Corps of Engineers to maintain a minimum pool elevation for navigational purposes and the amount of water the facility would be withdrawing is approximately 0.07% of the total river flow, minimal water consumption impacts are expected. Water consumption would be similar to the current system with the installation of fine-mesh screens. If utilizing a wet mechanical draft cooling tower, withdrawals from the river would be drastically reduced but evaporative loss would increase (approximately 50%). The estimated evaporative loss would be 11,434 gpm, an increase of approximately 5,717 gpm from open cycle flow.

The utilization of narrow-slot cylindrical wedgewire or fine-mesh travelling screens would not significantly impact the volume of water withdrawn from the Ohio River. Cardinal would not expect impacts from water consumption to change from the current condition with the use of these technologies.

Availability of process water, gray water, wastewater, reclaimed water, or other waters of appropriate quantity and quality for reuse as cooling water.

The Cardinal Plant has no available alternative source capable of supplying the volume of cooling water necessary to operate the facility using this alternative. Water reuse through use of a CCRS is discussed in the CWIS report.

BTA Evaluation – Closed-Cycle Recirculating System (CCRS)

The installation of a CCRS at the Cardinal Plant undoubtedly would result in a significant reduction in entrainment, as the intake flow would decrease by an estimated 90.3-percent. However, Ohio EPA must give significant weight to the social costs of this technology. At a 7-percent discount rate, installation of a CCRS has a cost:benefit ratio which exceeds that of any other technology by over thirteen times (2,407:1 compared to

847:1 for fine-mesh modified screens). In addition, the cost is approximately thirteen times that of 1.0mm cylindrical wedgewire screens, which can potentially outperform the CCRS biologically.

In addition to the cost concerns associated with a CCRS retrofit, the fish entrained at the Cardinal Plant are primarily forage and bait species, which do not have significant recreational value. According to surveys performed by ORSANCO, the Ohio River in the vicinity of the Cardinal Plant is meeting the aquatic life use designation, meaning an adequate forage base is available to maintain the fish community. Additionally, entrainment of federally or state-listed species has been limited to a single specimen and river surveys do not indicate notable populations of listed species near the facility.

Based on the information available, Ohio EPA has considered the factors established in 40 CFR 125.98(f)(2-3) and determined that the installation of a CCRS is not an appropriate entrainment control technology. This conclusion was reached primarily due to the unproportionate social cost:benefit ratio, discussed above.

BTA Evaluation – Narrow-Slot Cylindrical Wedgewire Screens

With respect to social costs and entrainment reduction, the installation of 1.0mm cylindrical wedgewire screens is the best option at the Cardinal Plant. The installation of this technology has a social cost:benefit ratio of approximately 190:1 (at 3% discount rate) and is estimated to have a biological effectiveness near to or better than a CCRS. However, the Cardinal Plant still finds the benefits of this compliance option to be wholly disproportionate to the costs.

Studies at the Cardinal Plant have shown impingement and entrainment numbers dominated by forage and bait fish (gizzard shad, freshwater drum, etc.). The use of cylindrical wedgewire screens would result in significant reductions in entrainment from exclusion, and impingement due to the screen surface and through-screen velocity. However, the impact to federally and state-listed species, as well as recreational species would be minimal, as they are not commonly impinged/entrained at the Cardinal Plant. As previously stated, one single federally or state-listed species specimen was collected during the 2015-2016 entrainment study. While not ideal, Ohio EPA does not believe that the loss of forage base associated with operation of the Cardinal Plant’s CWIS causes any significant adverse impact to the biological community.

Ohio EPA’s final determination on narrow-slot cylindrical wedgewire screens was also influenced by conditions in the space that is available for the installation of this technology. The Cardinal Plant is limited to the space within their forebay to construct the new screens. Screens cannot be installed outside the forebay, as they would block the coal barges. The facility would need to install up to 64 5.5-foot diameter screens, which will leave no open space in the forebay. While the technology is feasible, there are significant uncertainties regarding the conditions in the forebay, as it relates to the operation and maintenance of the screens. The screens are designed to function in a current so that debris and organisms can statically drift by the intake. Wedgewire screens do not include an automated means to collect and remove the debris, relying on natural sweeping currents to move debris past the screens. Over time, this would lead to an accumulation of debris around the screens that would need to be manually removed. It is likely that the plant will experience debris and sediment trapped in the forebay, inhibiting the function of the screens and causing additional maintenance (cleaning, dredging, screen replacement, etc.). As there are no known comparable examples of this technology under these conditions, Ohio EPA is not recommending that the Cardinal Plant take on the financial burden of installing narrow-slot cylindrical wedgewire screens to address entrainment.

BTA Evaluation – Fine Mesh Travelling Screens

While fine-mesh traveling screens tend to be the lowest cost entrainment reduction technology, biological performance (i.e., entrainment survival) for early life stages (e.g., larvae <12 mm) is generally poor (<0 to 15%) as the larvae have not yet developed scales and musculature needed to survive the collection and handling process associated with this technology. After development of scales and musculature, biological performance improves (depending on species and life stage). Impingeable sized gizzard shad are defined in the rule as a fragile species and it is the most dominant species entrained at Cardinal. Survival is expected to be particularly poor. Additionally, modifying the existing traveling screens with fine-mesh would result in increased through-screen velocity and, therefore, increased impingement. In order to equip the facility with fine-mesh traveling screens and maintain the through-screen intake velocity, the Cardinal Plant would need to construct a new screen house, creating significant additional financial responsibility. The small screen openings would also make the screens susceptible to clogging/fouling, increasing operation and maintenance costs.

Summary

Based on an evaluation of the application materials provided by the Cardinal Plant and the factors established in 40 CFR 125.98(f), the Director has determined that the existing CWIS represents BTA for entrainment. A compliance schedule is included in Part I, C of the permit for the Cardinal Plant to declare their intended method of compliance with the impingement mortality standard.

Cooling Water Intake Structure Compliance – Unit 3

Cooling water intake information

The CWIS for Unit 3 is considered an existing unit at an existing facility and therefore must comply with 40 CFR 125, Subpart J. Information supplied from the permittee regarding the CWIS and other pertinent data include the following:

- Design intake flow rate – 12,900 gallons per minute (gpm), or 18.6 MGD.
- Maximum design intake flow rate of pumps – 17,200 gpm or 24.8 MGD. Normal water needs can be met with three pumps while the fourth pump is held in standby and reserve mode.
- Cardinal Plant Unit 3 uses a closed-cycle cooling system. The cooling tower is presently operating at two-to-five cycles of concentration and provides a flow reduction of at least 96.5% compared to a once-through system.
- Impingement/entrainment data
    - Impingement sampling was done at Units 1 & 2 from June 2005 to June 2007
    - Custom-built mesh baskets were used to conduct 37, 24-hour sampling events
    - The collected species were dominated by gizzard shad, freshwater drum, and *Morone* species
- Operation of the cooling water system – The CWIS is operated 24 hours per day, 365 days per year. It is only shut down during unit outages.

Description of intake structure

The Unit 3 intake structure is comprised of a 96-foot long, 36-inch diameter perforated intake screen, with the perforated section spanning 59 feet. This structure is located 105 feet from the onshore caisson and 66 inches above the river bottom. Two 36-inch intake pipes deliver water from the screen to the caisson, which lies beneath the pump house. Air lines at each perforated intake header function to clean the screens using air bursts to clear trash and debris. AEP calculates the area of influence (intake velocity > 0.5 fps) to be a radius of one foot surrounding the intake screen.

Intake flow

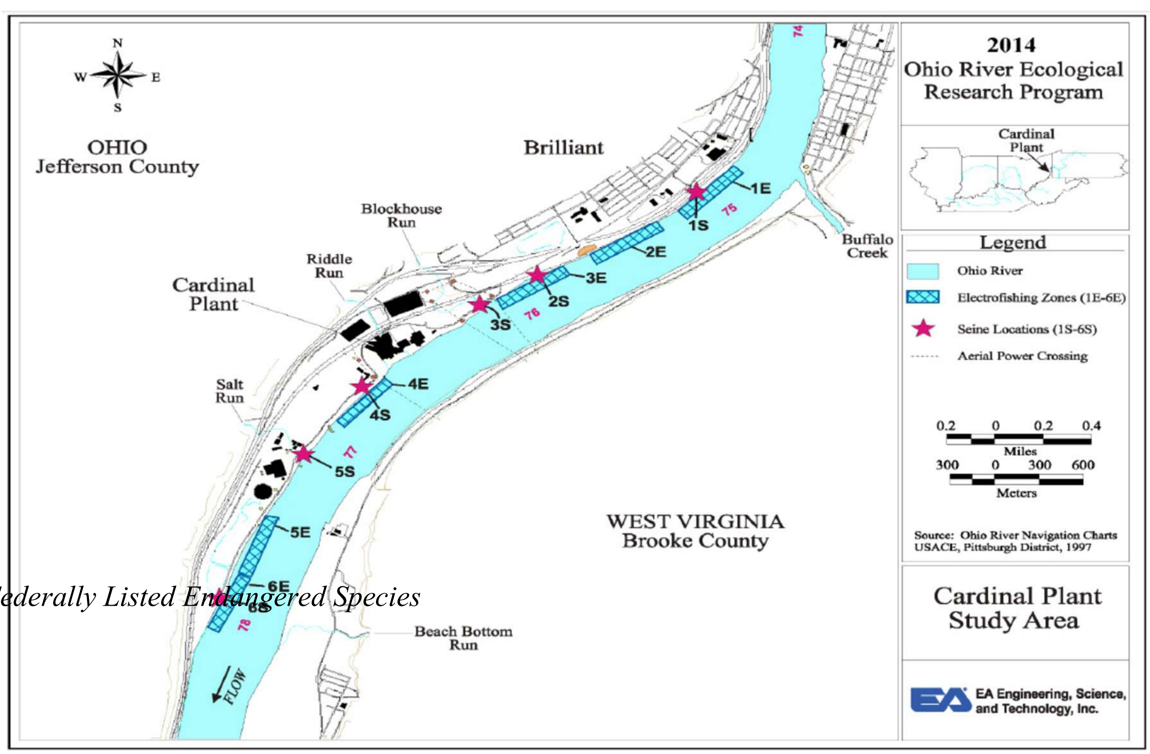
The design intake flow of the intake structure (18.6 MGD) represents only 0.09% of the mean annual Ohio River flow. The table below shows monthly withdrawal percentages for the design flow and actual flow of the intake.

Month	Ohio River Flow (MGD)	Design Flow (%)	Actual Flow (%)
January	37,000	0.05	0.02
February	35,200	0.05	0.02
March	45,300	0.04	0.01
April	39,500	0.05	0.01
May	29,600	0.06	0.02
June	18,900	0.10	0.03
July	14,200	0.13	0.03
August	11,100	0.17	0.05
September	12,500	0.15	0.03
October	13,500	0.14	0.04
November	22,000	0.08	0.03
December	33,900	0.05	0.02
*Averages calculated based on data from 2012-2015 (National Weather Service)			

Fish and wildlife in the vicinity of the intake structure

AEP submitted biological characterization data from the Ohio River Ecological Research Program (ORERP) surveys of power plants on the Ohio River. The Cardinal Plant has participated in this study since 1978.

Electrofishing and seining were performed in the study area between river miles 74.8 and 78.1. The Unit 3 intake structure is located between sampling stations 5S and 5E. A total of 407,236 fish were collected, representing 78 different species. Gizzard shad (58.59%) and emerald shiners (26.13%) made up a majority of the species collected. Significant quantities of freshwater drum (1.44%), carpsucker (1.35%), smallmouth bass (1.28%), and bluegill (1.17%) were also collected near the intake. Sampling performed at the Unit 1 & 2 intake indicated that gizzard shad, freshwater drum, emerald shiner, and temperate bass species are most likely to be affected by impingement and/or entrainment at the facility.



Federally Listed Endangered Species

The U.S. Fish and Wildlife Services (USFWS)- Information, Planning, and Conservation System (IPaC) lists no endangered or threatened species possibly present near the intake.

Federal Critical Habitat
None were identified.

State-Listed Endangered or Threatened Species
The ODNR lists the black sandshell and threehorn wartyback as state-threatened mussels that may potentially occur in this part of the Ohio River. Also included on this list as threatened species are the channel darter, river darter, and Tippecanoe darter. Due to the intake system design and life history characteristics, it is unlikely that any of these species would become impinged or entrained.

Fragile Species
Fragile species are defined in 40 CFR 125.92 (m) as *"… a species of fish or shellfish that has an impingement survival rate of less than 30 percent even when the BTA technology of modified travelling screens are in operation.*" The only fragile species found in the vicinity of the Cardinal Plant is gizzard shad.

U.S. Fish and Wildlife Services
The USFWS, Ohio Ecological Services office was provided the Cardinal Plant's Unit 3 316(b) information submittal for a 60-day review period. No comments or objections regarding the facility's biological data were received by Ohio EPA.

Impingement and Entrainment BTA Determination
The facility proposes the following to minimize adverse environmental impacts:

Impingement option - 40 CFR 125.94(c)(1)
The facility utilizes a recirculating cooling system with one cooling tower. This system is maintained at two-to-five cycles of concentration and reduces actual intake flow (AIF) by 96.5%.

Entrainment – 40 CFR 125.94(d)
The permittee proposes closed-cycle recirculation to minimize entrainment. Assuming that the reduction in entrainment is commensurate with reduction in flow, the Cardinal Plant's CWIS reduces entrainment by approximately 96.5 percent. By rule, closed-cycle recirculating systems are considered BTA for both new units at existing facilities and new facilities.

Director Requirements

The Director is required to include monitoring requirements, record keeping requirements, and reporting requirements within the permit. Additionally, the Director is required to make site-specific entrainment requirements weighing various factors.

Monitoring

40 CFR 125.96(a) – Monitoring requirements for impingement mortality for existing facilities:

The Director may establish monitoring requirements such as intake velocity, biological monitoring, and flow measurements. No additional monitoring is proposed due to the withdrawal reduction from the closed-cycle recirculating system and low intake rates relative to the water body.

40 CFR 125.96(b) – Monitoring requirements for entrainment for existing facilities:

The Director may establish monitoring requirements for entrainment. No additional monitoring is proposed due to the reduction of water withdrawn due to the closed-cycle recirculating system.

40 CFR 125.96(e) – Visual or remote inspections:

To comply with the regulation, the permit proposes weekly visual or remote monitoring devices to ensure that all technologies installed are maintained and operated as designed.

Reporting and Recordkeeping Requirements

40 CFR 125.97(a) – Monitoring Reports

The permittee is required to submit eDMRs which will characterize blowdown rates.

40 CFR 125.97(c) – Annual certification

The permittee is required to submit an annual certification indicating any substantial changes at any unit which may impact cooling water intake. This is consistent with the rule.

40 CFR 125.97(d) – Permit reporting records retention

The permittee shall retain all records of all submissions related to 316(b) until the subsequent permit is issued.

Site Specific Entrainment BTA Determination

The permittee proposes closed-cycle recirculating system to minimize entrainment. For both *new units at existing facilities* and *new facilities*, closed-cycle recirculating systems are indicated as the best technology available according to the 40 CFR 125.94(e) and 40 CFR 125.85, respectively, although additional measures may be required depending on site conditions and *new facilities* also require additional flow requirements based on water source body. For *existing units*, the Director must weigh factors to determine whether there are entrainment control technologies that perform better than the selected technologies. However, since this facility employs closed cycle cooling and minimizes the amount of makeup water withdrawn, it was the only technology evaluated.

Must Consider Factors

The following correlate to subparagraphs of 40 CFR 125.98(f)(2) and are factors the Director must consider in BTA determination.

Numbers and types of organism entrained, including, specifically, the numbers and species (or lowest taxonomic classification possible) of Federally-listed, threatened and endangered species, and designated critical habitat (e.g., prey base).

There are no known Federally-listed, threatened and endangered species, or designated critical habitats. Gizzard shad made up nearly 60 percent of the local population and were the predominate species which would be prone to entrainment. This species utilizes broadcast spawning, making their early life stages vulnerable to entrainment. In addition, adults and juveniles are attracted to current and tend to congregate at the nearby outfall. Freshwater drum were also observed and may be susceptible to entrainment for similar reasons.

Impact of changes in particulate emissions or other pollutants associated with entrainment technologies.

It is believed that this project will not increase particulate emissions. The cooling towers are already present.

Land availability inasmuch as it relates to the feasibility of entrainment technology.

This is not applicable as cooling towers are already on-site and allow for a closed-loop recirculating system.

Remaining useful plant life.

There is no proposed production end date for this facility.

Quantified and qualitative social benefits and costs of available entrainment technologies when such information on both benefits and costs is of sufficient rigor to make a decision.

There is no data on the social benefits and costs of available entrainment technology of sufficient rigor to weigh this factor.

May consider factors

The following correlate to subparagraphs of 40 CFR 125.98(f)(3) and are factors the Director may consider when determining BTA.

Entrainment impacts on the waterbody.

The entrainment impacts are thought to be negligible based on the operation of a closed-cycle recirculating system and small size of the intake versus the size of the water body. Section 5.1.7 of the 316(b) application submittal indicate that the Unit 3 CWIS withdrew between 0.01 and 0.05% of the monthly average of the Ohio River flows from 2012 – 2015. In addition, Section 6.1 of the submittal provides calculations indicating a flow reduction of 96.5%. Assuming that intake flow reduction is proportional to reduction in entrainment, the facility demonstrates significant entrainment reduction.

Thermal discharge impacts.

The thermal discharge impacts of Unit 3 are thought to be negligible as the facility utilizes cooling towers.

Credit for reductions in flow associated with the retirement of units occurring within the ten years preceding October 14, 2014.

This is not applicable

Impacts on the reliability of energy delivery within the immediate area.

This is not applicable

Impacts on water consumption.

The impact on water consumption is thought to be negligible as the facility uses cooling towers and withdrawals a minimal amount versus the size of the water body. While operating at 2 cycles of concentration, loss from evaporation, drift, and blowdown require the facility to uptake approximately 10,106 gpm (14.6 MGD) in makeup water. As a result, the percent flow reduction compared to a once-through cooling flow of 288,400 gpm (415.3 MGD) is approximately 96.5%.

Availability of process water, gray water, waste water, reclaimed water, or other waters of appropriate quantity and quality for reuse as cooling water.

This is not applicable

Summary

The Director considers the Cardinal Plant's cooling water intake structure to be BTA to minimize adverse environmental impacts based on the use of a recirculating cooling system. In addition, the facility withdrawals between 0.01 and 0.05% of the monthly average of source water flows, which can be considered minimal.

Addendum 1. Acronyms

ABS	Anti-backsliding
BAT	Best Available Technology Economically Achievable
BCT	Best Conventional Pollutant Control Technology
BPJ	Best professional judgment
BPT	Best Practicable Control Technology Currently Available
BTJ	Best technical judgment
CFR	Code of Federal Regulations
CONSWLA	Conservative substance wasteload allocation
CWA	Clean Water Act
CWIS	Cooling water intake structure
DMR	Discharge Monitoring Report
DMT	Dissolved metal translator
ELG	Federal effluent limitation guideline
gpm	Gallons per minute
IMZM	Inside mixing zone maximum
MDL	Analytical method detection limit
MGD	Million gallons per day
NPDES	National Pollutant Discharge Elimination System
NSPS	New source performance standards
OAC	Ohio Administrative Code
Ohio EPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
ORSANCO	Ohio River Valley Water Sanitation Commission
PEL	Preliminary effluent limit
PEQ	Projected effluent quality
PMP	Pollution Minimization Program
PPE	Plant performance evaluation
SIC	Standard Industrial Classification
TBEL	Technology-based effluent limit
TMDL	Total Daily Maximum Load
TRE	Toxicity reduction evaluation
TU	Toxicity unit
U.S. EPA	United States Environmental Protection Agency
WET	Whole effluent toxicity
WLA	Wasteload allocation
WQBEL	Water-quality-based effluent limit
WQS	Water Quality Standards